Development and Testing of a Modified Food Guide Diagram

Physicians Committee for Responsible Medicine

ABSTRACT

Objective: To develop and test a diagram that accurately and clearly conveys fundamental principles of healthful nutrition.

Design: A series of nutrition diagrams was developed based on human nutritional requirements and tested using online surveys. Children and adults were asked to look at one of four diagrams, recall and explain its content, and provide comments on the diagram's design.

Setting: Electronic survey completed online.

Participants: Males and females ages 8 to 84 years (n=228) from the Washington, D.C., metropolitan area.

Main Outcome Measures: (1) Ability to recall the number and names of food groups in each diagram and (2) aesthetic preferences.

Analysis: Answers to both quantitative and qualitative features were counted and categorized. Chi-square tests were used to determine statistical significance of quantitative answers.

Results: There were no significant differences between the four diagrams in the accuracy of recall of the number of food groups or food group names. A plate-shaped diagram had a higher aesthetic rating, compared with square and triangular diagrams.

Conclusions and Implications: A simple diagram, based on a plate design, has a high rate of recall and appeal, and may be a useful nutritional teaching tool.

INTRODUCTION

Food guide diagrams have long been used to present key principles of nutritional guidance in simplified form and have evolved to accommodate changing nutritional knowledge. In 1916, the U.S. Department of Agriculture (USDA) released a wheel-shaped diagram, including seven food groups. Over the ensuing decades, an evolving understanding of nutritional science and changing nutritional patterns in the American population have led to major changes in nutrition guidance and graphics. The “Basic Four” guide established in the 1950s promoted eating habits to prevent nutrient deficiencies. Later, nutritional concerns shifted toward prevention of chronic disease (1).

The pyramid-shaped diagram debuted in 1991 as the Eating Right Pyramid, followed by the Food Guide Pyramid in 1992. Its shape suggested that certain foods (grains, vegetables, and fruits) should be emphasized in the diet, while other foods (meats, dairy products, sweets, and oils) should be included in more moderate quantities. The most recent iteration, MyPyramid, was introduced in 2005 as a computerized program. Its colored, unlabeled segments represent grains, vegetables, fruits, milk, meat and beans, and oils. It also presents a human figure climbing stairs, indicating the value of physical activity.

MyPyramid has been controversial since its introduction (2, 3). The MyPyramid program presents the advantage of allowing portion sizes to be based on personal tastes or needs. It retains its predecessors’ emphasis on whole grains, vegetables, and fruits as dietary staples. However, using MyPyramid to select individualized portion sizes requires users to go beyond the unlabeled main graphic and enter personal information into a computerized program, a process that may be difficult for some users,

particularly those without Internet access or basic computer skills. Also, it retains food groupings and proportions that have been challenged. Researchers at the Harvard School of Public Health noted MyPyramid is “impossible to interpret” with advice that is “highly unrealistic” (3).

Toward a Simplified Graphic Representation

Historically, food diagrams have used geometric shapes that have no counterpart in food preparation. A pyramid, for example, conveys an abstract message that must be translated into concrete food choices. Several authorities have sought to simplify nutritional planning by using diagrams representing plates. A 2008 study used a plate diagram as a tool for weight loss-diets (4). This plate was designed to limit certain food groupings such as protein, dairy, and fat. Once these portions were measured, the remainder of the plate could be filled with salad and vegetables.

The American Institute for Cancer Research (AICR) uses the “New American Plate” to communicate information about healthful nutrition. The plate suggests that one-third or less of a meal should come from animal-derived products, with at least two-thirds from vegetables, fruits, whole grains, and beans. While this plate is intended to control portion sizes, it also emphasizes the AICR’s expert report findings, “Eat mostly plant-based foods, which are low in energy density” (5). Similarly, the American Diabetes Association uses the “Plate Method” for weight loss and diabetes management. The plate is divided into three sections: half of the plate is for “non-starchy vegetables” and the other half is divided equally between “meat or meat substitutes” and “starchy foods” (6).

Given the advantage of the plate diagram, we sought to adapt the food groups depicted in MyPyramid to fit current nutritional knowledge and to develop a diagram that is easy to understand and use.

METHODS

Food Group Selection

Substantial scientific evidence supports the inclusion of vegetable, fruit, and grain groups in any food diagram. Populations using these foods as dietary staples enjoy considerable nutritional advantages, including a lower body weight, lower risk of cardiovascular disease, type 2 diabetes, and certain types of cancers, and a greater life expectancy (7, 8). However, the remaining groups in MyPyramid raise nutritional issues.

The meat, poultry, fish, dry beans, eggs, and nuts group merits modification. While these foods provide protein, iron, and other nutrients, meats and eggs contribute significant amounts of saturated fat (ranging from 15 to 50 percent of energy) and cholesterol.

Like all animal products, meat contains no fiber or complex carbohydrate. The heme iron in meat is somewhat more bioavailable, compared with the non-heme iron in plants. While higher iron bioavailability may present a theoretical advantage in cases of iron deficiency, for other individuals heme iron may contribute to excessive iron accumulation, which may increase risk of cardiovascular disease and type 2 diabetes (9, 10).

Red meats are strongly linked to colon cancer risk (11) and are not nutritional essentials. Observational studies show that people who include meats in their diets

typically are at higher disease risk, compared with those who avoid them (12-18). Clinical trials confirm that individuals who remove meats from their diets, along with other lifestyle changes, improve body weight (19-25), glycemic control (19, 22), and plasma lipid concentrations (23, 26-28), reverse coronary atherosclerosis (23, 29), and greatly reduce the risk of cardiovascular events (20, 23).

These findings suggest that the meat, poultry, fish, dry beans, eggs, and nuts food group should be modified to recognize that meats are not dietary essentials and may present health risks. Beans present considerable nutrient advantages, and nuts, although high in fat, do have some nutritional advantages, such as the presence of fiber and antioxidants.

The milk, yogurt, and cheese group provides calcium. However, it is not unique in this regard. Calcium is readily available in green leafy vegetables, legumes, and fortified products. While calcium is essential for bone health, studies show that increasing consumption beyond approximately 600 mg per day—amounts that are easily achieved without dairy products or calcium supplements—does not improve bone integrity (30).

Nondairy calcium sources offer potential benefits. Except for nonfat versions, dairy products are a major source of saturated fat. They also contribute cholesterol and a form of sugar (lactose) that is indigestible to many people. Approximately 70 percent of African-Americans, 90 percent of Asian-Americans, 53 percent of Mexican-Americans, and 74 percent of Native Americans have lactose intolerance (i.e., lactase nonpersistence).

A 2005 review showed that milk consumption does not improve bone integrity in children (31). Similarly, the Harvard Nurses' Health Study, which followed more than

72,000 women for 18 years, showed no protective effect of increased milk consumption on fracture risk.

Dairy intake has also been associated with prostate cancer risk in several studies (32, 33), although this association remains controversial (34). While dairy products provide nutrients, they also present disadvantages and cannot be held to be dietary essentials.

The oil group represented at the top of the pyramid is the only group that represents a derivative product. Oils are derivatives of other foods, such as olives, corn, or peanuts, which are represented in other food groups.

Abundant evidence shows that diets based on the remaining food groups—grains, vegetables, and fruits, along with beans, which had been grouped with meats—are healthful and associated with nutritional benefits including reduced risks of heart disease, type 2 diabetes, and cancer.

We therefore sought to develop a food guidance diagram that was both simple to use and consonant with nutritional science, removing meats, eggs, and dairy products. It was not the aim of this effort to use a simple diagram to replace nutritional teaching. The use of any diet requires planning for nutrient adequacy.

Diagram Development

A team of registered dietitians, physicians, marketing experts, and graphic designers developed candidate designs of nutritional diagrams depicting four food groups: vegetables, fruits, whole grains, and legumes, without specifying relative portion sizes for the groups. Four diagrams were initially created. Three were circular, similar to plates, and one was in the shape of a tree. Ultimately, it was determined that simple

circular diagrams were the most clear and appealing, and the remaining diagrams were discarded.

Complexity. In order to determine the degree of complexity that was most informative and clear to users, especially children, two circular diagrams were created (Figure 1). One included graphics of several food items within each food group; the other included a single food representing each group. The diagrams were evaluated in focus groups at elementary, middle, and high schools, college settings, and after-school programs. Participants were selected based on instructors' willingness to allow focus groups in their classrooms. Some focus groups were conducted by the students' usual instructor, but most were done by a staff dietitian. In this casual setting, half the students received the diagram with multiple food items per group and the other half the single food representation. They were then presented with quantitative questions, "How many food groups are in the diagram?" and "What are the food groups according to the diagram you just saw?"

Diagram Shape. In order to identify the strengths and weaknesses of various shapes, four diagrams were developed and tested: a triangular shape similar to MyPyramid, a square, a stylized plate, and a simple plate. These were evaluated using an anonymous questionnaire to be administered online. Participants in this phase of testing were recruited by asking teachers and after school program directors to encourage students to go to a specified Web site, and by asking interested adults to visit the same Web site. The questionnaire was introduced on a Web page that was unadorned, requesting demographic information (age, gender, education, race, and ethnicity). Participants were asked to identify their race and ethnicity according to research guidelines provided

by the National Institutes of Health. No names or other identifying information were sought or received.

The next screen presented one randomly selected diagram (Figure 2). Participants were not able to view any diagram other than the one presented. After 15 seconds, the diagram disappeared and was irretrievable. The next screen appeared automatically and asked the following questions:

1. How many food groups were in the diagram?
2. What were the food groups in the diagram?

The correct answers were “four,” and “fruits, vegetables, beans/legumes, and grains,” respectively. In order for answers to the latter question to be considered correct, all four group names were required. All answers were entered by a single coder into a spreadsheet which was then checked for accuracy by a separate research staff member.

At the end of the survey, subjective information about the diagram was solicited from participants using the following open-ended questions:

1. What was the overall message of the diagram?
2. What type of diet does the diagram recommend?
3. What did you like best about the image?
4. What did you like least about the image?

Qualitative categories varied per diagram. Similar responses to questions were defined and grouped, and frequencies were calculated. The tabulations were reviewed and confirmed by two researchers.

The study protocol was submitted to Independent Review Consulting Inc., a private Institutional Review Board, which determined that no review was required because the protocol did not meet the definition of a study involving human subjects.

Analysis

Chi-square tests were used to determine statistical significance of quantitative answers. Qualitative answers were recorded, categorized, and then counted.

RESULTS

Focus Groups

Of the 129 participants in the initial focus groups, virtually all were able to recall the number and names of food groups recommended with the single iconic representation (100 percent and 99 percent, respectively). With the more complex diagram, these figures were 99 percent and 90 percent, respectively.

Online Surveys

Of the 228 individuals participating in the online survey, the majority were female. Approximately half were children (aged 8 to 18), and half were adults (aged 19 and older) (Table 1). Most participants were white or black, with fewer participants from other races. The majority were not Hispanic.

Quantitative Information

Answers to the two quantitative questions were totaled for each diagram and broken down demographically for age, gender, and race (Table 2). Because of the small number of individuals aged 51 and older, data for adults were reported in a single group, aged 19 and older. Recall for the number of food groups was greater than 95

percent for all diagrams. The correct naming of all four food groups for each plate design was as follows: 71 percent correct for the Simple Plate, 77 percent correct for the Stylized Plate, 60 percent correct for the Square, and 77 percent correct for the Triangle. There were no statistical differences among diagram groups.

Qualitative Information

Simple Plate. Of the 58 participants who were presented with the Simple Plate and asked what they liked best about the graphic, 47 percent stated they liked its aesthetics, specifically naming the colors and shape, while less than 20 percent disapproved of the aesthetics. Another 16 percent liked the simplicity of the diagram the most. Fifty-nine percent of the participants felt the overall message conveyed by the diagram was to eat a healthful diet. Some were confused by the text at the center of the plate, “All Four, Any Portion,” saying it was hard to read or hard to understand.

Stylized Plate. Sixteen out of 65 participants, or 25 percent of those who looked at the Stylized Plate, stated they liked the simplicity of the diagram as its best feature. Twenty-one of the viewers, or 32 percent, referenced an aesthetic aspect of the diagram as what they liked best about the diagram, while 22 percent referenced an aesthetic aspect as what they liked the least. For this diagram, 45 percent felt the overall message was about health with 63 percent reporting that having a balanced and varied diet from the four food groups was the key message.

Square. Of 48 participants, 12 (27 percent) reported the diagram’s simplicity as its best attribute. Seventeen of the viewers favored the overall appearance. However, 31 percent of participants cited the aesthetics as the least appealing quality. Descriptions

included “dull” and “bland.” A clear majority, 56 percent, felt the primary message was one of healthful eating.

Triangle. This was the least popular diagram for visual appeal with 33 percent reporting the aesthetics as the least appealing quality of the diagram, stating it was “boring” or “empty.” The diagram’s simplicity was favored by 21 percent of the 57 viewers. The Triangle also conveyed eating a healthful diet as the primary message according to 56 percent of the viewers. Thirty-seven percent cited eating a balanced varied diet as the chief message conveyed. Unlike the other three diagrams, the Triangle’s primary message, according to 8 percent of the viewers, related to the USDA’s food guide pyramid.

General Comments. Fourteen participants asked why groups that have appeared in the USDA pyramids were not in the diagrams tested in this survey (i.e., meat, dairy, sweets, and fats). Comments included, “There is no meat or dairy,” and “Not clear how other foods would fit in.” Eighteen participants asked about serving size recommendations, including what “All Four, Any Portion” meant, what were the specific serving sizes of each group, or whether it was nutritionally sound to recommend any portion of these four groups.

DISCUSSION

Dietary diagrams have long served as nutrition teaching tools that have evolved along with changes in nutritional and health sciences. We have developed and tested simple diagrams presenting whole grains, vegetables, fruits, and legumes as dietary staples.

The Simple Plate diagram was easy to understand and appealing to viewers, leading to a high rate of recall.

The omission of meat and dairy groups from the diagrams raised questions with some participants. However, there is no scientific basis for including a meat or dairy group, given that people who avoid these foods have no health disadvantages, and, in fact, have certain health advantages. Compared with meat-eaters, vegetarians have lower rates of diabetes (13, 14), cancer (15, 35), and risk factors for cardiovascular disease (12, 16). Dairy products are not essential for bone integrity in either childhood (31) or later life (30).

The plate-shaped food diagram does not provide serving size recommendations, nor does it present the food group hierarchy that was present in the 1991 and 1992 USDA pyramid diagrams. This is because of the lack of any scientific basis for emphasizing one or more groups (consuming fewer legumes than fruit, for example.) Healthful meal plans can be based on beans, grains, fruits, or vegetables and provide all the necessary nutrients. Since healthy plant-based diets come in variety of forms, from grain-based macrobiotic diets (36) to legume-based therapeutic diets (37), there appears to be little reason to limit the flexibility of the diagrams in this respect. The emerging message is to consume a variety of plant foods, rather than prioritizing specific food groups. The appeal of this diagram is its simple representation of a healthful diet.

The slogan “All Four, Any Portion” created some confusion among several participants and was modified to “All Four Every Day.” Of the four diagrams, the Simple

Plate had the advantage of a high aesthetic rating while effectively conveying nutrition information (Figure 3).

As noted above, a simple dietary graphic does not replace nutritional teaching, particularly with regard to nutrient adequacy, supplementation, and dietary changes for specific stages of life. It is important to note that vitamin B12 supplementation is essential for individuals following vegan diets. Because of absorption issues, the Dietary Guidelines for Americans and the IOM also recommend vitamin B12 supplementation for individuals older than 50 years (38).

Iron intake of vegans and vegetarians is typically higher than for nonvegetarians (7, 39), although plants provide iron in the non-heme form, raising the possibility of effects on iron status. However, the incidence of iron deficiency anemia is as similar among vegetarians and non-vegetarians (7). Zinc intake may be somewhat lower in individuals following vegetarian and vegan diets, but overt deficiencies are not seen in Western vegetarians (7).

While the diagram summarizes key nutritional points, no diagram can convey the full range of nutrition knowledge that consumers need.

In summary, a simple plate diagram effectively conveys fundamental principles of healthful nutrition.

IMPLICATIONS FOR RESEARCH AND PRACTICE

As an illustration of the fundamentals of a healthful diet, this simple plate diagram is a tool that can be used by teachers, nutrition professionals, industry, and others to provide new information to children and to reinforce healthy dietary habits for adults.

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Figure 1. Original diagrams used in focus groups to compare comprehension between icons and pictures

Icons:

Carrot = vegetable group

Pea pod = legume group

Wheat = grain group

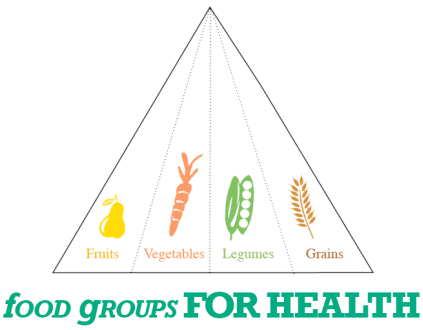
Pear = fruit group

Multiple graphics

Figure 2. Four diagrams randomly assigned in online survey to determine how shape influences comprehension and preference

Stylized Plate

Simple Plate



Triangle

Square

Figure 3. Final food diagram as determined by online survey

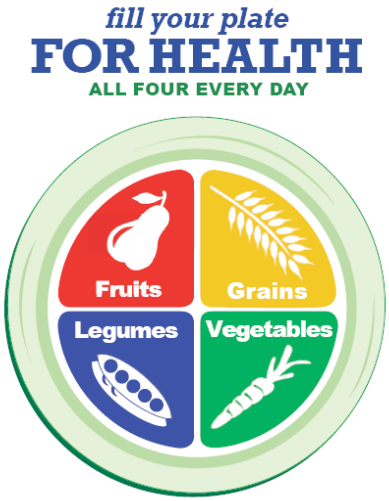


Table 1. Demographic information of participants (n = 228)

Category	Value
Age (years)	
8-18	115 (50)
19-84	113 (50)
Sex	
Male	94 (41)
Female	134 (59)
Race	
American Indian or Alaska Native	2 (1)
Native Hawaiian or Pacific Islander	3 (1)
Asian	9 (4)
Mixed race	11 (5)
African American or Black	72 (32)
White	131 (58)
Ethnicity	
Hispanic or Latino	17 (8)
Not Hispanic or Latino	210 (92)
Undeclared	1 (0)
Education	
Elementary, partial or graduate	63 (28)
Middle school, partial or graduate	42 (18)
High school, partial or graduate	27 (12)
College, partial or graduate	62 (27)
Graduate degree	34 (15)

Data are n (%).

Table 2. Quantitative responses by age, gender, and race.

Answered Correctly: How many food groups are there?					
Age Group		**Simple Plate, n=58**	**Stylized Plate, n=65**	**Triangle, n=57**	**Square, n=48**
8-12 yo	male	12 (92%, n=13)	13 (100%, n=13)	7 (100%, n=7)	10 (100%, n=10)
	female	7 (100%, n=7)	13 (100%, n=13)	7 (88%, n=8)	3 (100%, n=3)
	African American or Black	15 (100%, n=15)	16 (100%, n=16)	9 (100%, n=9)	6 (100%, n=6)
	White	3 (100%, n=3)	4 (100%, n=4)	3 (75%, n=4)	5 (100%, n=5)
	Other*	1 (50%, n=2)	6 (100%, n=6)	2 (100%, n=2)	2 (100%, n=2)
13-18 yo	male	4 (100%, n=4)	7 (100%, n=7)	5 (83%, n=6)	6 (100%, n=6)
	female	6 (100%, n=6)	n/a	7 (100%, n=7)	4 (80%, n=5)
	African American or Black	5 (100%, n=5)	3 (100%, n=3)	7 (88%, n=8)	6 (100%, n=6)
	White	5 (100%, n=5)	3 (100%, n=3)	4 (100%, n=4)	2 (67%, n=3)
	Other*	n/a	1 (100%, n=1)	1 (100%, n=1)	2 (100%, n=2)
19+ yo	male	5 (100%, n=5)	10 (100%, n=10)	8 (100%, n=8)	5 (100%, n=5)
	female	23 (100%, n=23)	19 (86%, n=22)	21 (100%, n=2)	18 (95%, n=19)
	African American or Black	2 (100%, n=2)	n/a	1 (100%, n=1)	1 (100%, n=1)
	White	20 (95%, n=21)	29 (97%, n=30)	27 (100%, n=27)	21 (95%, n=22)
	Other*	5 (100%, n=5)	1 (50%, n=2)	1 (100%, n=1)	1 (100%, n=1)
Average		55 (95%, n=58)	62 (95%, n=65)	55 (96%, n=57)	46 (96%, n=48)
Answered Correctly: What are the food groups?					
Age Group		**Simple Plate, n=58**	**Stylized Plate, n=65**	**Triangle, n=57**	**Square, n=48**
8-12 yo	male	5 (38%, n=13)	7 (54%, n=13)	3 (43%, n=7)	6 (60%, n=10)
	female	4 (57%, n=7)	9 (69%, n=13)	7 (88%, n=8)	0 (0%, n=3)
	African American or Black	7 (47%, n=15)	10 (63%, n=16)	7 (78%, n=9)	3 (50%, n=6)
	White	1 (33%, n=3)	3 (75%, n=4)	3 (75%, n=4)	3 (60%, n=5)
	Other*	1 (50%, n=2)	3 (50%, n=6)	0 (0%, n=2)	0 (0%, n=2)
13-18 yo	male	1 (25%, n=4)	5 (71%, n=7)	4 (67%, n=6)	4 (67%, n=6)
	female	6 (100%, n=6)	n/a	2 (29%, n=7)	3 (60%, n=5)
	African American or Black	4 (80%, n=5)	3 (100%, n=3)	4 (50%, n=8)	4 (67%, n=6)
	White	3 (60%, n=5)	2 (67%, n=3)	2 (50%, n=4)	2 (67%, n=3)
	Other*	n/a	0 (0%, n=1)	0 (0%, n=1)	1 (50%, n=2)
19+ yo	male	4 (80%, n=5)	8 (80%, n=10)	8 (100%, n=8)	4 (80%, n=5)
	female	21 (91%, n=23)	21 (95%, n=22)	20 (95%, n=21)	12 (63%, n=19)
	African American or Black	2 (100%, n=2)	n/a	1 (100%, n=1)	1 (100%, n=1)
	White	18 (86%, n=21)	28 (93%, n=30)	26 (96%, n=27)	17 (77%, n=22)
	Other*	5 (100%, n=5)	1 (50%, n=2)	1 (100%, n=1)	0 (0%, n=1)
Average		41 (71%, n= 58)	50 (77%, n=65)	44 (77%, n=57)	29 (60%, n=48)

*Includes American Indian or Alaska Native, Native Hawaiian or Pacific Islander, Asian, and Mixed Race.