RESEARCH ARTICLE

Development of Food Group Composites and Nutrient Profiles for the MyPyramid Food Guidance System

Kristin Marcoe, MBA, RD[1]; WenYen Juan, PhD[1]; Sedigheh Yamini, PhD, RD[2]; Andrea Carlson, PhD[1]; Patricia Britten, PhD[1]

ABSTRACT

Objective: To identify food selections in each MyPyramid food group or subgroup reflective of typical consumption patterns by Americans, and the nutrient intake that can be expected from consuming a specified amount of these foods from each group, in a low-fat and no-added-sugars form.

Design: An analytical process to identify food consumption choices within each food group and subgroup using national food consumption surveys, and to identify the expected nutrient content of each group using food composition databases.

Variables Measured: Relative consumption of foods within each food group; nutrient content for each food group and subgroup (energy plus 27 nutrients).

Analysis: Disaggregated foods from consumption surveys into component ingredients. Combined similar ingredients into "item clusters" and determined relative consumption of each. Calculated a consumption-weighted nutrient profile for each food group.

Results: Consumption-weighted food intake selections and nutrient profiles were developed for all MyPyramid food groups and subgroups.

Conclusions and Implications: This analytical process derived food group and subgroup composites which estimate typical food choices within each MyPyramid food group. These were used to assess the adequacy of the MyPyramid food intake patterns as they were being iteratively developed.

Key Words: MyPyramid, food guides, dietary guidance, food intake patterns

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INTRODUCTION

The MyPyramid Food Guidance System is a nutrition education tool to help implement the Dietary Guidelines for Americans, based on food intake patterns that meet current nutritional standards for adequacy and moderation. MyPyramid is the result of a revision of the Food Guide Pyramid that was undertaken to meet new nutrition standards, account for changes in food consumption patterns, and improve consumer understanding of nutrition guidance messages.[1] The technical research conducted in developing the food intake patterns that underlie MyPyramid followed procedures similar to those described in the development of the food patterns for the original Food Guide Pyramid.[2,3] The overall development of the food intake patterns is described in an accompanying article.[4]

Food guides commonly use some food grouping system in making recommendations about what and how much to eat.[3] To determine if a food guide meets its nutritional goals, the nutrient content of the food groups that compose it must be determined. The dietary pattern for Dietary Approaches to Stop Hypertension (DASH),[5] for example, uses the average nutrient content from a 7-day sample menu of foods that fit its food group recommendations for comparison to nutrient standards.

The original Food Guide Pyramid used another approach—a "composite" system—to determine the expected nutrient content of each food group. A food group composite is a representation of the foods contained in the group, in amounts that correspond to their relative consumption. Composites are based on actual food choices and reflect the proportional use of individual foods within the group. For example, if cooked broccoli accounts for 36% of all dark-green vegetables consumed, cooked broccoli would compose 36% of the dark-green vegetable composite. Composites were developed for each food group or subgroup.

[1]USDA Center for Nutrition Policy and Promotion, Alexandria, VA
[2]FDA Center for Food Safety and Applied Nutrition, formerly with USDA Center for Nutrition Policy and Promotion, Alexandria, VA

Address for correspondence: Kristin Marcoe, MBA, RD, USDA Center for Nutrition Policy and Promotion, 3101 Park Center Drive, Room 1034, Alexandria, VA 22302; Phone: (703) 305-7600; Fax: (703) 305-3300; E-mail: Kristin.Marcoe@cnpp.usda.gov
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The term food group composite is used to represent the composites for both entire food groups (eg, fruit) and food subgroups (eg, dark-green vegetables, dry beans and peas, whole grains).

Nutrient profiles are developed for each composite. These profiles are the population-weighted average nutrient content for each food group or subgroup used in developing the MyPyramid food intake patterns. They reflect the nutrients contained in "typical choices" within each group or subgroup, as represented by foods in nutrient-dense forms. For instance, lean cuts of meats, fat-free milk, and vegetables and fruits without added fat or sweeteners are used as representative foods in developing the nutrient profiles. In this way, the profiles illustrate the nutrient content of each food group when the most nutrient-dense forms of food are selected.

The primary objective of this article is to identify nutrient intake that can be expected from consuming a specified amount of each MyPyramid food group or subgroup, reflecting typical American food selections, but in their most nutrient-dense forms. To achieve this end, the article describes the development of food group composites and nutrient profiles for the MyPyramid Food Guidance System. These composites and nutrient profiles are key elements in the process the U.S. Department of Agriculture (USDA) uses to develop intake patterns that meet specified nutrient standards as part of its food guidance for consumers.

METHODS

The USDA Center for Nutrition Policy and Promotion developed the final food group composites and nutrient profiles for MyPyramid using one-day food consumption data, collected via 24-hour recall, from the National Health and Nutrition Examination Survey 1999-2000 (NHANES) for 8,070 individuals over the age of 2 years for whom dietary intake data were reliable.[6] This data set was used because it was the most current national dietary data available at the time of the analysis. We applied sample weights to provide food consumption estimates that were representative of the population. The nutrient data used to calculate nutrient profiles of each composite came from the USDA National Nutrient Database for Standard Reference, Release 17 (2004) (SR17).[7]

Step 1. Identification of Food Group(s) Assignments for All Food Items Consumed

We used the USDA Agricultural Research Service's (ARS) Pyramid Servings Database (PSD), version 1.0[8] to identify the Pyramid food groups and subgroups contained in each food reported in NHANES and the amount in servings of each group in the food. The PSD consists of NHANES survey food codes, their descriptions, and numbers of food group servings per 100 grams of food. For example, the PSD identifies that each 100 grams of cooked carrots contains 1.37 servings of orange vegetables, and that each 100 grams of beef stew contains 0.13 servings of orange vegetables. In the same way, the PSD identifies the number of servings of whole and refined grains in 100 grams of a mixed-grain bread product such as oatmeal bread or part-whole wheat bread.

This breakdown allows the calculation of an amount consumed from each food group for a specified intake (in grams) of different food items. The PSD categories include not only the major Pyramid food groups (grains, vegetables, fruits, milk, and meat and beans) and subgroups, but also additional subcategories and components such as "discretionary" fat, added sugars, and alcohol. PSD data for the grains, vegetables, fruits, and milk food groups are reported in servings. Since MyPyramid no longer uses the nomenclature of "servings," data for food groups from the PSD were translated into cup or ounce equivalents. One serving of fruit or vegetable is equal to one-half cup equivalent; one serving of milk is one cup equivalent; and one serving of grains is one ounce equivalent. For fruit juices, vegetable juices, and nuts and seeds, we updated the equivalencies

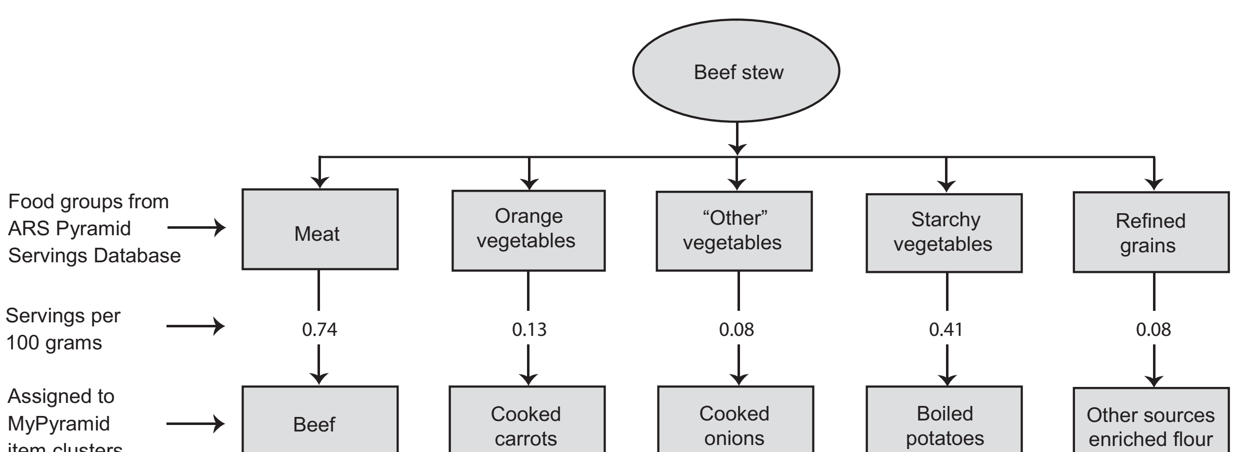

Figure 1. Example of Disaggregation of a Food (NHANES Food Code 27311410) into Item Clusters

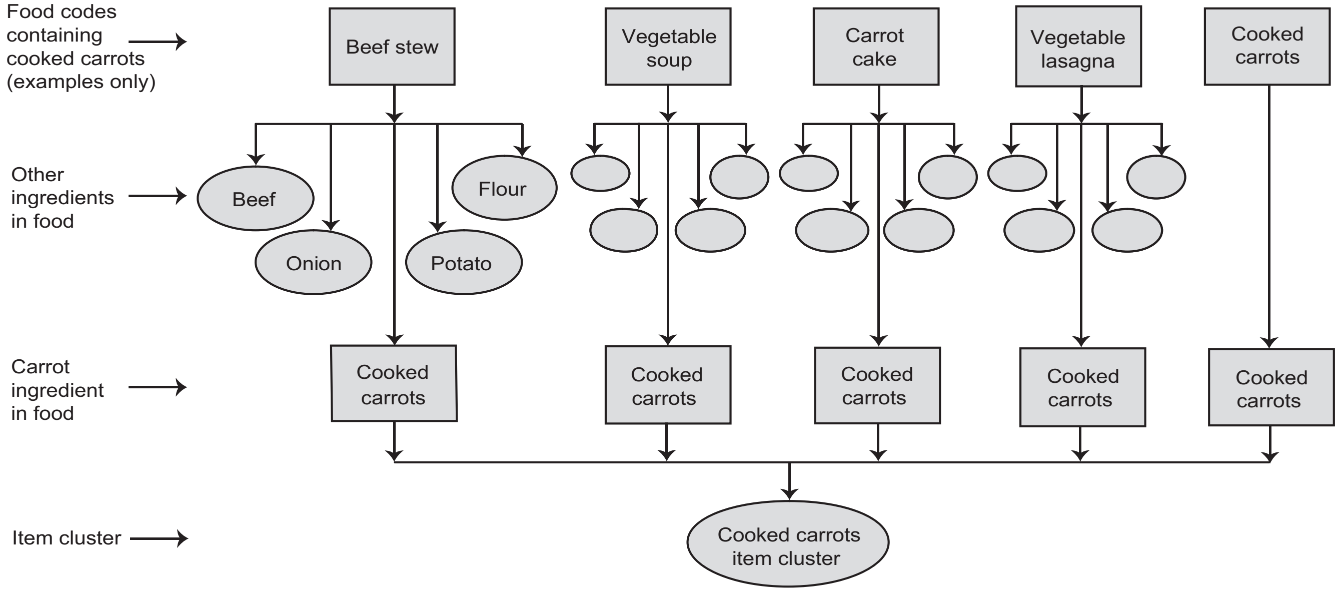

Figure 2. Example of Aggregation of Food Ingredients into Item Clusters

from PSD version 1.0. PSD data for the meat and beans food group are reported in ounces of cooked lean meat equivalents. Discretionary fat is reported in grams, added sugars in teaspoons, and alcohol in number of drinks.

Step 2. Identification of Specific Foods Within Each Group, Including Disaggregation of Mixed Foods into Component Ingredients (Figure 1)

The PSD can be used to identify total food group and subgroup consumption for each food reported in NHANES, but it does not indicate which specific item within the group the survey food contains. For example, the PSD shows that vegetable lasagna contains a certain amount of dark-green vegetables, but it is unknown what specific ingredient—such as spinach or broccoli—is responsible for this amount of dark-green vegetables. To determine the consumption-weighted intakes of foods in each food group and subgroup, more specificity is needed.

Therefore, in the development of the food patterns for the original Pyramid, food "item clusters" were created that identified specific foods within each Pyramid group.[2] An item cluster was originally created for all foods whose consumption was more than 1% of the total number of servings consumed from each group or subgroup. Examples of item clusters are cooked broccoli, apples, and white rice.

For the current research project, we reviewed each food reported in NHANES within a particular food group or subgroup and assigned each food to an item cluster within that food group, based on the ingredients it contained. For example, we reviewed all survey foods containing dark-green vegetables, identified the vegetable they contained, such as cooked spinach or cooked broccoli, and assigned the food to the appropriate item cluster (cooked spinach or cooked broccoli). Each food item reported in NHANES may be a single ingredient food, such as an apple, or may contain multiple ingredients, such as a beef stew. One food as eaten may contribute to multiple food groups, subgroups, or item clusters. For example, a stew can be disaggregated into multiple food item clusters, as shown in Figure 1. We used an ARS food survey recipe file (Continuing Survey of Food Intakes by Individuals [CSFII] 1994-96, 1998)[9] when necessary to identify specific ingredients in a mixed food. If the food were a new food in NHANES, we identified the ingredients from the food description or a market check.

Step 3. Aggregation of Foods and Ingredients in Each Item Cluster (Figure 2)

After disaggregating mixed foods into their component ingredients, these component ingredients were then aggregated into food item clusters with the same ingredient from other foods, to identify total consumption. For example, amounts of tomatoes eaten as part of pizza, chili, spaghetti, and many other foods were identified and grouped together to determine total cooked tomato consumption.

To determine total consumption of specific foods, we summed the amounts, in cup or ounce equivalents, of each survey food that had been assigned to the item cluster. These amounts represented only the fraction of the food that the PSD identified as being in that item cluster. The amounts of other ingredients in a mixed food were counted in other item clusters. For instance, we summed the total amount of cooked carrots from all survey foods containing orange vegetables that we had identified as cooked carrots, to determine the total amount consumed from the cooked carrots item cluster (see Figure 2).

Step 4. Calculation of Consumption from Each Food Group or Subgroup

We then summed the total group intake from all item clusters within each group and calculated the percentage of total consumption contributed by each item cluster. For instance, we calculated the total amount of orange vegetables consumed (in cup equivalents) and divided the amount of cooked carrots consumed (in cup equivalents) by this total. The resulting percentages are the composite for the group and represent the probability of a food being eaten in comparison to other foods in the group. Note that this probability represents the proportion of all orange vegetables that are cooked carrots consumed by the population, not the frequency with which a person might select cooked carrots in comparison to their selection of other orange vegetables.

As these calculations proceeded, item clusters were reassessed and updated as needed to reflect current food consumption of Americans. Food item clusters were retained for all foods whose intake represented more than 1% of the total intake of the food group or subgroup. Most foods accounting for less than 1% of intake were grouped together or with an existing item cluster. Similarity in nutrient composition and use in meals were used as guides for how foods should be combined. For example, since strawberries are the most widely consumed berry, other berries were grouped with strawberries in a single item cluster. Some exceptions were made to the 1% rule, such as liver, which was less than 1% of meat group consumption but was left as an item cluster, because it differs substantially in nutrient content from other meats. New item clusters were created for several reasons. In some cases, consumption of a food item had been relatively low when the original item clusters were established in the 1980s but had increased to more than 1% of consumption within the food group. One example is popcorn in the whole grains group. Another reason for creating new item clusters was that for some items, such as fish and nuts, a more detailed representation of their consumption was desired for related research.[10]

Step 5. Selection of Representative Food for Each Item Cluster

Once item clusters were established, we selected a food from SR17 to serve as the representative food for the cluster. The selected food was in a nutrient-dense form, that is, in a low-fat and no added sugar form. For all food groups, the standard is to select a food to represent each cluster that is in its leanest or lowest fat form and that is prepared without the addition of fat, oil, or sugar. For some groups, the selection of a nutrient-dense form mainly considers preparation, such as "cooked broccoli without fat" representing the cooked broccoli item cluster, and "raw strawberries" representing all berries in that item cluster. For other groups, the selection considers the item with the lowest fat content of all items in the cluster, such as using 95% lean/5% fat ground beef to represent all ground beef.

In some cases, the representative food was not the most highly consumed food within the cluster. For example, boiled potatoes were used as the food to represent all boiled and fried potatoes. French fries and potato chips are highly consumed but contain added fat or oil and therefore are not in the most nutrient-dense form. The fat or oil within foods such as French fries or in higher fat meats was represented within the discretionary fat composite described in step 7. The nutrient values of the food items selected to represent the item clusters were used to calculate the food group or subgroup nutrient profiles (step 6).

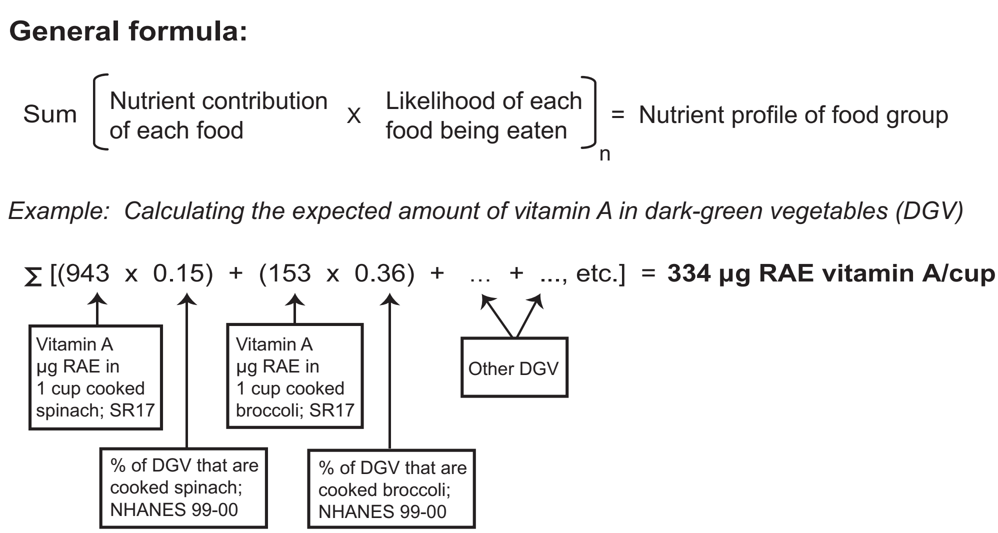

Figure 3. Calculation of Nutrient Profiles

Nutrient-dense forms of the food were selected to represent each item cluster, in keeping with one of the guiding principles for the original Pyramid and this revision, which is flexibility. This principle states that "the food guide should allow maximum flexibility for consumers to eat in a way that suits their taste and lifestyle while meeting nutritional criteria."[3] Using these nutrient profiles, food patterns can meet all nutrient needs at relatively low calorie levels. Once these needs are met, the balance of calories to meet energy needs can be selected by consumers from foods they prefer, as long as other nutritional criteria are met.

Step 6. Calculation of Nutrient Profile for Each Food Group and Subgroup (Figure 3)

We established nutrient profiles for each food group and subgroup for energy plus 27 nutrients. In calculating these nutrient profiles, we assigned a weight to the nutrients from each representative food that corresponded to the percent consumption of its item cluster. We then summed the nutrient values for all item clusters to calculate the total nutrient profile of each food group composite (see Figure 3). Nutrient profiles are based on the nutrient content of a half-cup equivalent for the fruits and vegetables groups, of a 1-ounce equivalent for the grains and meat and beans groups, of 1 cup of milk, of 1 teaspoon of added sugars, and of 10 grams of solid fats and oils.

There were two exceptions to the use of item clusters and composites for the calculation of nutrient profiles. We did not use the item cluster approach to calculate a nutrient profile for added sugars or the milk group. For all added sugars, the nutrients in granulated white sugar were used for the nutrient profile. The nutrient profile for the milk group was represented by the nutrients in 1 cup of fat-free fluid milk, with an exception made for vitamin A. For vitamin A, we used the amount found in whole milk (68.6 μg RAE per cup), instead of the amount found in fortified fat-free milk (149 μg RAE per cup). This exception was made to avoid overestimation of vitamin A for those who consume nonfortified milk products.

Table 1. Fruit Group Item Clusters and Percentage of Each in the Fruit Composite

Item Clusters (sample foods also grouped with this cluster)	Percent of Composite (% of total cup equivalents consumed)	
Orange juice (lemon juice, lime juice)[a,b]	30.4	
Apple juice[a,b]	10.2	
Grape juice[a,b]	4.3	
Grapefruit juice[a,b]	2.1	
Total Fruit Juice		47.0
Bananas (plantain)	10.3	
Apples	6.1	
Watermelon	5.6	
Strawberries (kiwifruit; blue-, cran-, rasp-, and blackberries)	5.3	
Grapes (cherries, rhubarb)	4.5	
Cantaloupe (honeydew, casaba)	4.2	
Oranges (tangerines)	2.9	
Peaches (mango, papaya, apricot, guava, avocado)	2.6	
Raisins (dates, figs)[c]	2.1	
Pears	1.4	
Plums (prunes)[c]	0.7	
Grapefruit	0.6	
Total Raw/Dried Fruit		46.3
Peaches, cooked or canned (mango, papaya, apricot, guava)	2.7	
Pineapple, cooked or canned	1.8	
Applesauce	1.4	
Apples, cooked or canned	0.9	
Total Cooked/Canned Fruit		6.8
Grand Total—All Fruits	100.0	

Source: Based on food consumption data from NHANES 99-00.
[a]All juices in composite are 100% fruit juice. For juices less than 100%, only the amount of 100% juice is included.
[b]For all fruit juices, the equivalent amount is 1 cup 100% juice equals 1 cup fruit.
[c]For all dried fruits, the equivalent amount is 1/2 cup dried fruit equals 1 cup fruit.

Table 2. Vegetable Subgroup Item Clusters and Percentage of Each in the Subgroup Composites

Item Clusters (sample foods also grouped with this cluster)	Percentage of Composite (% of total cup equivalents consumed)	
Dark-Green Vegetables		
Broccoli, cooked	35.8	
Broccoli, raw	8.2	
Total Broccoli		44.0
Romaine (endive, chicory, escarole, parsley)[a]	27.1	
Spinach, raw[a]	6.2	
Total Raw Leafy, Dark-Green Vegetables		33.3
Spinach, cooked	14.9	
Collard greens, cooked	4.2	
Mustard greens, cooked	1.4	
Kale, cooked (chard, parsley, dandelion)	1.2	
Turnip greens, cooked	1.1	
Total Cooked Leafy, Dark-Green Vegetables		22.8
Grand Total—All Dark-Green Vegetables	100.0	
Orange Vegetables		
Carrots, cooked	49.0	
Carrots, raw	39.9	
Total Carrots		88.9
Sweet potatoes, cooked	10.1	
Winter squash, cooked	0.5	
Pumpkin, cooked	0.5	
Total Other Orange Vegetables		11.1
Grand Total—All Orange Vegetables	100.0	
Dry Beans and Peas		
Pinto beans	33.0	
White beans	25.1	
Soy beans (tofu, soy-based meal replacement, soy beverages)	12.4	
Kidney beans	10.7	
Black beans	9.6	
Lentils	3.6	
Chickpeas	2.4	
Lima beans	1.5	
Cowpeas	1.0	
Split peas	0.8	
Grand Total—All Dry Beans and Peas	100.0	
Starchy Vegetables		
Potatoes, boiled (fried potatoes, chips)	79.3	
Potatoes, baked	9.1	
Corn	7.9	
Green peas	3.7	
Grand Total—All Starchy Vegetables	100.0	
Other Vegetables		
Tomatoes, cooked (tomato sauce)	29.7	
Tomatoes, raw	12.4	
Tomato juice[b]	1.5	
Total Tomatoes		43.6

(continued)

Table 2. Continued

Item Clusters (sample foods also grouped with this cluster)	Percentage of Composite (% of total cup equivalents consumed)	
Lettuce (iceberg, butterhead)[a]	20.1	
Cucumbers, raw	5.1	
Peppers, raw (green, red, chili, olives)	3.2	
Onions, raw (mature, green onions, leeks, chives, garlic)	2.7	
Celery, raw	2.0	
Cabbage, raw (red, green)	1.8	
Total Raw Other Vegetables, excluding tomatoes		34.9
Green beans, cooked (snow peas, asparagus, okra, artichokes)	7.2	
Onions, cooked (mature, green onions, leeks, chives, garlic)	4.3	
Cabbage, cooked (green, red, radish, beets, Brussels sprouts, turnips)	2.4	
Mushrooms, cooked	2.3	
Bean sprouts, cooked	2.0	
Summer squash, cooked (zucchini)	1.4	
Celery, cooked	1.1	
Cauliflower, cooked	0.9	
Total Cooked Other Vegetables, excluding tomatoes		21.6
Grand Total—All Other Vegetables	100.0	

Source: Based on food consumption data from NHANES 99-00.
[a]For raw leafy greens, the equivalent amount is 2 cups of raw leafy greens equals 1 cup of vegetable.
[b]For tomato and vegetable juices, the equivalent amount is 1 cup juice equals 1 cup vegetable.

Step 7. Calculation of Nutrient Profile for Discretionary Fats

In addition to the food group composites and nutrient profiles, we developed composites and nutrient profiles for "discretionary fats." Discretionary fats are fats in the diet above what would be found in lean meats and other low-fat foods used to represent item clusters. These fats may be contained within higher-fat forms of foods, or added in processing, cooking, or at the table. Because solid fats and oils have differing fatty acid profiles and effects on health, we separated solid fats from oils and constructed separate composites and nutrient profiles for each.

To summarize the method for deriving the solid fats and oils composites, we first calculated the amount of fat that was intrinsic in each of the food groups and subgroups. We needed to use the food supply to determine the different fats and oils, because the survey does not distinguish what the specific fats and oils are in many of the food items. We used percentages of different animal and vegetable fats in the food supply for 1996[11] and an in-house food supply database[12] to calculate the total amount of fat in a sample food intake pattern. (The 1996 food supply was used in order to match the CSFII 1994-96 food consumption data that were used for preliminary work on the food composites.) By subtracting the intrinsic fat from the total fat, we calculated the amount of extrinsic fat, or discretionary fat. Then, fat amounts in the food supply were used to estimate discretionary fat sources. These fat amounts reflect fat contributed from major food groups beyond the amounts that are intrinsic in lean choices within each food group composite, fat used in food processing or food preparation, and fat consumed by itself or with other foods. The types of hard and soft margarine chosen for the solid fats and oils composites, respectively, were obtained from data in USDA's CSFII 1994-96.[13]

Food group composites and their nutrient profiles were used to calculate nutrient levels in the MyPyramid food intake patterns as they were being iteratively developed. These nutrient levels in the patterns were then compared to nutritional standards to determine whether nutrient recommendations had been met by the food intake patterns. This process is described in detail in an accompanying article.[4]

SAS statistical software, version 9.1, was used to analyze weighted estimates for the representative population and to develop composites and nutrient profiles.

RESULTS

One hundred forty-four item clusters were developed to represent the 4,108 individual food items reported in NHANES. These item clusters were used to create the various food group and subgroup composites. Tables 1 through 4 identify the percentage of total consumption represented by each item cluster in each composite. (For some of the less-consumed fish, item clusters were grouped into "other fish" categories.) Nutrient profiles for each food group and subgroup, based on these composites, are presented in Table 5.

Table 3. Meat[a], Poultry[a], Fish[a], Dry Beans[b], Eggs, and Nuts Group Item Clusters and Percentage of Each in the Group Composite

Item Clusters (sample foods also grouped with this cluster)	Percentage of Composite (% of total ounce equivalents consumed)	
Beef (veal)	14.8	
Ground beef	12.0	
Luncheon meats, beef (hot dogs)	8.8	
Luncheon meats, pork	7.9	
Pork, fresh	5.9	
Pork, cured (ham, Canadian bacon)	2.8	
Liver	0.4	
Lamb (venison, goat, caribou, rabbit)	0.4	
Total Meat		53.0
Chicken	21.6	
Turkey (pheasant, duck)	1.7	
Total Poultry		23.3
Salmon	0.7	
Tuna (white/albacore—high in omega-3 fatty acids)[c]	0.4	
Trout	0.1	
Swordfish	0.1	
Sea bass	0.1	
Sardines	0.1	
Other fish high in omega-3 fatty acids (pompano, mackerel, anchovy)[d]	0.1	
Total Fish High in Omega-3 Fatty Acids		1.6
Tuna (light—low in omega-3 fatty acids)[c]	1.3	
Shrimp	1.3	
Crab	0.6	
Flounder	0.4	
Cod	0.4	
Catfish	0.3	
Porgy	0.2	
Clams	0.2	
Whiting	0.1	
Scallops	0.1	
Pollock	0.1	
Oysters	0.1	
Haddock	0.1	
Other fish low in omega-3 fatty acids (Unknown type, mixed fish, snapper, octopus/squid, pike, perch, lobster, mullet, halibut, frog, croaker, conch, carp)[d]	1.2	
Total Fish Low in Omega-3 Fatty Acids		6.4
Total Fish		8.0
Eggs[e]	7.4	
Peanuts[f]	3.8	
Peanut butter[g]	1.7	
Mixed nuts with peanuts[f]	0.9	
Seeds (sunflower, pumpkin)[f]	0.4	
Mixed nuts without peanuts[f]	0.4	
Coconut meat, fresh[f]	0.3	
Pistachios[f]	0.2	
Pecans[f]	0.2	
Cashews[f]	0.2	

(continued)

Table 3. Continued

Item Clusters (sample foods also grouped with this cluster)	Percentage of Composite (% of total ounce equivalents consumed)	
Walnuts[f]	0.1	
Almonds[f]	0.1	
Total Nuts		8.3
Grand Total—All Meat, Poultry, Fish, Eggs, and Nuts	100.0	

Source: Based on food consumption data from NHANES 99-00.

[a]One ounce of cooked lean meat, poultry, or fish equals 1 ounce equivalent of meat, poultry, fish, dry beans, eggs, and nuts.

[b]Item clusters for dry beans and peas are listed with the dry beans and peas subgroup in the vegetable group. See Table 2 One ounce equivalent for dry beans and peas in the meat, poultry, fish, dry beans, eggs, and nuts group is 1/4 cup cooked.

[c]Tuna was separated into two item clusters: 25% high in EPA/DHA and 75% low in EPA/DHA, based on market share.

[d]Item clusters were combined for this table because of the small contribution of each.

[e]For eggs, the equivalent amount is 1 egg equals 1 ounce equivalent of meat, poultry, fish, dry beans, nuts, and seeds.

[f]For nuts and seeds, the equivalent amount is 1/2 ounce of nuts or seeds equals 1 ounce equivalent of meat, poultry, fish, dry beans, and eggs.

[g]For peanut butter, the equivalent amount is 1 tablespoon peanut butter equals 1 ounce equivalent of meat, poultry, fish, dry beans, and eggs.

Composites

Table 1 shows the consumption of each of the 20 item clusters in the fruit group as a percentage of total cup equivalents. Forty-seven percent of fruits were consumed as juice, while raw and cooked fruit represented about 46% and 7% of total fruit consumption, respectively. In terms of total cup equivalents, orange juice was the most consumed item in the fruit group, and bananas were the next most commonly consumed.

For development of the new food group composites, nutrient profiles, and food intake patterns, the amount of fruit juice considered to be equivalent to 1/2 cup of fruit was changed from 3/4 cup to 1/2 cup. This change was based on differences in the nutrient content of fruits and juices that were largely due to the larger portion size for juices, and a desire to make the cup equivalencies easier for consumers to understand. This change resulted in a more accurate representation of the proportion of overall fruit intake that comes from fruit juice. The reason for this change is further described in an accompanying article.[10]

Table 2 presents the consumption of item clusters within each vegetable subgroup as a percentage of total cup equivalents. The composites do not directly identify the proportion of total vegetable intake from each subgroup, but these proportions were also calculated. Of all vegetables consumed, 6% were dark-green vegetables, 4% were orange vegetables, 7% were dry beans and peas, 37% were starchy vegetables, and 46% were other vegetables. Broccoli, raw and cooked, was the most commonly consumed dark-green vegetable; carrots were the most commonly consumed orange vegetable; pinto beans the most consumed dry bean; white potatoes (in any form) the most-consumed starchy vegetable; and tomatoes the most-consumed other vegetable. As with fruit juices, the amounts of vegetable juices considered equivalent to 1/2 cup of vegetables were changed from 3/4 cup to 1/2 cup.

The consumption for the numerous item clusters in the meat, poultry, fish, dry beans, eggs, and nuts group is reported in Table 3 as a percentage of total ounce equivalents. Meats (beef, pork, lamb, and organ meats) made up 53% of overall consumption in this group; poultry (chicken and turkey) accounted for about 23% of the group consumption; all fish and shellfish (high and low in eicosapentaenoic acid [EPA] and docosahexaenoic acid [DHA]) were 8% of the food group consumption; eggs were about 7% of overall consumption for the group; and nuts and seeds accounted for about 8% of total consumption.

Table 4 shows the percentage of consumption of the 12 item clusters in the refined grains and 11 item clusters in the whole grains subgroups. These results include the disaggregation of products that are a mix of whole and refined grains into appropriate item clusters in the two grain subgroups. Although not represented in the subgroup analysis, the proportion of all grains consumed that was whole or refined was also calculated. Whole grains made up 13% of all grain consumption, and refined grains made up the other 87%. Whole-grain snack products (corn chips, popcorn, and crackers) (38%) and cereals (36%) made up the majority of the consumption of whole grains, whereas whole-grain breads accounted for about 24% of all whole grains consumed. In contrast, refined breads and crackers (46%) and desserts and other baked products (25%) made up the majority of refined-grain consumption, whereas pasta and rice accounted for 18%, and cereals for only 4% of all refined-grain consumption.

As noted in the methods section, the "discretionary" fat composite from the original Pyramid was divided into separate composites for solid fats and oils/soft margarines. The solid fats composite is made up of butterfat (44%), shortening (21%), hard margarines (16%), lard (11%), beef fat (4%), chicken fat (2%), and pork fat (2%). Solid fats represent fats that may be consumed as part of higher-fat

Table 4. Grain Subgroup Item Clusters and Percentage of Each in the Subgroup Composites

Item Clusters (sample foods also grouped with this cluster)	Percentage of Composite (% of total ounce equivalents consumed)	
Refined Grains		
White bread (white rolls, hamburger and hot dog buns)[a]	28.2	
Enriched wheat flour crackers (pretzels)[a]	6.5	
Wheat flour tortilla[a]	4.3	
French bread (sub rolls; Italian, sourdough, and garlic bread)[a]	4.2	
Bagels (English muffins, pita)[a]	3.1	
Total Refined Bread and Crackers		46.3
Desserts & other sources of enriched flour (pizza and pie crusts, cakes, cookies, doughnuts, pastries, croissants)[a]	24.7	
Enriched pasta & noodles[b]	10.4	
White rice[b]	7.5	
Total Refined Pasta, Rice		17.9
Cornbread (cornmeal-based snacks)[a]	3.0	
Enriched flour quick breads (pancakes, waffles, muffins)[a]	2.7	
Biscuits (dumplings)[a]	1.9	
Total Refined Quick Breads		7.6
Refined Grain Cereals (ready-to-eat cereals, grits, cream of wheat)[b,c]	3.7	
Grand Total—All Refined Grains	100.0	
Whole Grains		
Whole-wheat bread (multigrain and cracked wheat bread; whole-wheat tortillas, pita, bagels, rolls, English muffins)[a]	17.4	
Oatmeal bread (granola bars, oatmeal cookies, oatmeal muffins)[a]	3.0	
Whole-wheat quick breads[a]	1.7	
Rye bread (pumpernickel)[a]	1.5	
Total Whole-Grain Breads		23.6
Whole-wheat ready-to-eat cereals[c]	15.5	
Whole oat ready-to-eat cereals[c]	10.3	
Oatmeal, cooked[b]	10.1	
Total Whole-Grain Cereals		35.9
Corn tortillas (corn chips)[c]	22.9	
Popcorn[d]	13.2	
Whole wheat crackers[a]	1.5	
Total Whole-Grain Snack Products		37.6
Brown rice (barley, wild rice)[b]	2.9	
Grand Total—All Whole Grains	100.0	

Source: Based on food consumption data from NHANES 99-00.
[a]For baked products, the amount that contains approximately 16 g flour equals 1 ounce equivalent of grains.
[b]For pasta, noodles, rice, and cooked cereal, 1/2 cup cooked equals 1 ounce equivalent of grains.
[c]For ready-to-eat cereal and chips, 1 ounce of grain ingredient equals 1 ounce equivalent of grains.
[d]For popcorn, 3 cups of popped corn equals 1 ounce equivalent of grains.

food selections within a food group, as well as those that might be added in food processing, cooking, or at the table. For example, the butterfat in whole milk and cheese is considered part of the solid-fat composite, as is the beef, pork, and chicken fat contained in higher-fat cuts of these foods. Solid fats used in the production of foods are also considered, such as shortening in a cracker or doughnut, and butter in a cake or cookie. The oils and soft margarines composite reflects those used in processing, in cooking, and at the table. It is composed of soybean oil (77%), soft margarines (13%), corn oil (6%), and cottonseed oil (4%). An allowance for oils was included in the final food intake

Table 5. Nutrient Profiles for Food Group and Subgroup Composites.

		Vegetable Subgroups					Grain Subgroups						
Nutrients, Unit Amount[a]	**Fruits 1/2 cup**	**Dark-green 1/2 cup**	**Orange 1/2 cup**	**Dry Beans 1/2 cup**	**Starchy 1/2 cup**	**Other 1/2 cup**	**Whole 1 oz**	**Refined 1 oz**	**Meat & Beans 1 oz**	**Milk 1 cup**	**Added Sugars 1 tsp**	**Oils 10 g**	**Solid Fats 10 g**
Calories, kcal	59	20	32	114	73	18	77	83	54	83	16	84	76
Protein, g	0.7	1.6	0.7	8.0	1.7	0.9	2.4	2.2	6.9	8.3	0	0.0	0.0
CHO, g	14.7	3.9	7.4	19.2	16.8	3.9	15.6	15.8	0.4	12.2	4.2	0.0	0.0
Total fat, g	0.2	0.2	0.1	1.0	0.2	0.2	1.1	1.1	2.6	0.2	0	9.5	8.5
Sat. fat, g	0.03	0.04	0.03	0.16	0.03	0.03	0.20	0.23	0.80	0.29	0	1.43	3.60
Mono. fat, g	0.02	0.02	0.01	0.19	0.03	0.02	0.33	0.39	1.09	0.12	0	3.27	3.27
Poly. fat, g	0.05	0.10	0.08	0.49	0.08	0.08	0.38	0.35	0.44	0.02	0	4.34	1.25
Linoleic acid, g	0.03	0.03	0.07	0.38	0.07	0.06	0.40	0.32	0.37	0.01	0	3.99	1.10
α-Linolenic, g	0.01	0.07	0.00	0.12	0.01	0.02	0.02	0.03	0.02	0.00	0	0.35	0.14
Cholesterol, mg	0	0	0	0	0	0	0.3	0.9	34.8	5.0	0	0	11.5
Dietary fiber, g	1.1	2.1	2.1	6.0	1.7	1.1	2.4	0.7	0.1	0.0	0	0.0	0.0
Vit. A, μg RAE	16	167	554	0	2	13	26	5	17	69	0	11	45
Vit. E, mg AT	0.2	1.0	0.6	0.6	0.0	0.4	0.1	0.1	0.2	0.0	0	1.4	0.4
Vit. C, mg	25	30	5	0	6	9	1	0	0	0	0	0	0
Thiamin, mg	0.06	0.05	0.05	0.14	0.09	0.04	0.13	0.14	0.06	0.11	0	0.00	0.00
Riboflavin, mg	0.03	0.10	0.04	0.05	0.03	0.04	0.11	0.10	0.07	0.45	0	0.00	0.00
Niacin, mg	0.3	0.4	0.6	0.4	1.1	0.5	1.4	1.4	1.6	0.2	0	0.0	0.0
Vit. B_6, mg	0.09	0.13	0.12	0.12	0.21	0.08	0.14	0.06	0.09	0.00	0	0.00	0.00
Folate, μg DFE	24	81	10	111	14	14	50	59	5	12	0	0	0
Vit. B_{12}, μg	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.6	1.3	0	0.0	0.0
Calcium, mg	11	50	23	57	8	21	26	30	6	306	0	0	1
Phosphorus, mg	17	39	25	119	43	21	85	33	63	247	0	0	1
Magnesium, mg	12	25	9	46	19	10	27	7	8	27	0	0	0
Iron, mg	0.2	1.0	0.3	2.3	0.4	0.6	1.8	1.2	0.5	0.1	0	0.0	0.0
Zinc, mg	0.1	0.3	0.2	1.0	0.3	0.2	0.9	0.2	1.0	1.0	0	0.0	0.0
Copper, mg	0.06	0.07	0.03	0.21	0.13	0.06	0.08	0.06	0.05	0.03	0	0.00	0.00
Sodium, mg	3	30	41	3	5	57	87	153	93	103	0	13	16
Potassium, mg	213	229	214	363	286	162	91	29	91	382	0	0	2

Source: Nutrient values of the item clusters in the food groups and subgroups are from SR17.

[a]Nutrient content is listed as the amount in each 1/2 cup equivalent or ounce equivalent. See http://www.mypyramid.gov/pyramid/index.html for a listing of the amounts of foods considered to be a cup or ounce equivalent in each food group.

patterns. The solid-fat composite was used in calculations to develop the discretionary calorie allowance for the food intake patterns and to determine the amounts of fatty acids in the resulting patterns.

Nutrient Profiles

Table 5 lists the amounts of energy and 27 nutrients per reference amount of each food group and subgroup. Reference amounts are 1/2 cup for the fruit and vegetable groups, 1 ounce equivalent for the grains and meat and beans groups, 1 cup for the milk group, 1 teaspoon for sugar, and 10 grams for solid fats and oils. The nutrients shown in Table 5 were those used in determining the nutrient adequacy and moderation of the food intake patterns. (See the accompanying article on the food intake patterns for additional details.)[4]

Each food group provides a wide array of nutrients for the food patterns in varying amounts. The major sources of several nutrients of concern will be summarized here. These nutrients are those that the Dietary Guidelines identified as "nutrients of concern" for Americans.[14]

- The highest amount of calcium per reference amount is found in the milk group, as would be expected, but dry beans and peas and dark-green vegetables also contribute substantial amounts of calcium, whereas grains, other vegetables, orange vegetables, and even fruit and meat and beans contribute smaller amounts.
- Milk and dry beans and peas also provide the most potassium in a reference amount. Starchy vegetables, dark-green and orange vegetables, and fruit also provide more than 200 mg of potassium in a half-cup portion.
- Dry beans and peas provide the highest amount of fiber, with whole grains, dark-green vegetables, and orange vegetables also providing more than 2 grams of fiber in the reference quantity.
- The nutrient profile for dry beans and peas shows they are also the richest sources of magnesium. Milk, whole grains, and dark-green vegetables also provide substantial amounts of magnesium.
- As would be expected, orange vegetables contained the most vitamin A per half cup, with dark-green vegetables the other major source.
- Fruits and dark-green vegetables contained the most vitamin C.
- The 10-gram reference amount of oils provided more vitamin E than any of the food groups. Dark-green and orange vegetables and dry beans contained the next highest amounts of vitamin E in a half-cup portion.

DISCUSSION

The item clusters and composites provide a useful tool for examining typical food choices within a food group or subgroup by the U.S. population. In the fruit group, for example, orange juice, bananas, and apple juice make up about 50% of all fruit consumption, whereas intake of all other raw fruit is about 1/3 of total fruit consumption.

The composites also allow for identification of changes in intake patterns over time. For example, one notable change from the composites developed for the original Food Guide Pyramid to the current composites is the relative increase in consumption of raw dark-green, leafy vegetables in comparison to cooked greens. Only a very small part of the dark-green vegetable composite (4%) was romaine, endive, escarole, and the like, when the initial work was done. Over a quarter of the current composite is raw leafy greens other than spinach. Other food items whose relative consumption has increased enough to now warrant having their own item clusters include popcorn, wheat flour tortillas, and tofu.

The nutrient profiles demonstrate the wide range of nutrients provided by each food group, in varied amounts. Certain food groups have typically been linked to one key nutrient, such as calcium to the milk group. The nutrient profiles show that although the milk group contains the most calcium, other food groups can also contribute substantially to overall calcium intake. In addition, the profiles show that the milk group, for example, contributes a wide range of nutrients, not just calcium. Substantial amounts of potassium, which was recognized as a nutrient of concern for adults and children by the 2005 Dietary Guidelines, are provided by the milk group, the fruit group, and every vegetable subgroup. It would be difficult for most Americans to meet potassium intake recommendations without obtaining some potassium from each of these groups.

The composites provide a more detailed picture of the relative consumption of types of fish and nuts in comparison to other major components of the meat and beans group. We calculated these detailed item clusters to provide a better assessment of fish and nut consumption for the Dietary Guidelines Advisory Committee (DGAC),[15] which was interested in investigating the impact on nutrient adequacy of potential advice to consume more nuts and more fish, especially those high in omega-3 fatty acids. Therefore, we separated survey foods containing fish into those containing fish high in the omega-3 polyunsaturated fatty acids EPA and DHA, and those with lower amounts of EPA and DHA, based on a data table provided by USDA's Nutrient Data Laboratory. The cutoff was 500 mg of EPA plus DHA per 3 ounces, the amount requested by the DGAC for their analyses. All tuna was initially assigned to one item cluster because survey food codes do not distinguish the type of tuna consumed, even though some tuna species are high in omega-3 fatty acids and others are not. We manually separated the tuna item cluster into high omega-3 (albacore) and low omega-3 tuna (all other tuna) based on market share. (According to the Nutrient Data Laboratory and the U.S. Tuna Foundation, 25% of canned tuna is albacore [Exler J, personal communication, April 2004]. Albacore was classified as high omega-3, based on the nutrient data table from the Nutrient Data Laboratory.)

Table 6. Nutrient Profiles for Major Components of the Meat, Poultry, Fish, Dry Beans, Eggs, and Nuts Group

Nutrient (unit)	Meat[a]	Poultry[a]	Fish[a]	Dry Beans and Peas[a] 1 ounce equivalent	Eggs	Nuts/Seeds[a] 1 ounce equivalent
Amount	1 ounce	1 ounce	1 ounce	(1/4 cup cooked)	1 large egg	(1/2 ounce)
Energy and macronutrients						
Calories (kcals)	49	53	35	57	78	85
Protein (g)	7.0	8.2	6.5	4.0	6.3	3.3
Carbohydrate (g)	0.2	0.0	0.1	9.6	0.6	2.9
Dietary fiber (g)	0.0	0.0	0.0	3.0	0.0	1.1
Linoleic acid (g)	0.09	0.38	0.04	0.19	0.59	2.25
α-Linolenic acid (g)	0.03	0.02	0.01	0.06	0.02	0.03
Cholesterol (mg)	22	25	22	0	212	0
Total fat (g)	2.0	2.1	0.8	0.5	5.3	7.4
Saturated fat (g)	0.8	0.6	0.2	0.1	1.6	1.2
Monounsaturated fat (g)	0.9	0.7	0.3	0.1	2.0	3.5
Polyunsaturated fat (g)	0.1	0.5	0.3	0.2	0.7	2.3
Vitamins						
Vitamin A (μg RAE)	17	4	8	0	84	0
Vitamin E (mg AT)	0.1	0.1	0.1	0.3	0.5	1.2
Vitamin C (mg)	0.0	0.0	0.6	0.0	0.0	0.0
Thiamin (mg)	0.09	0.02	0.03	0.07	0.03	0.04
Riboflavin (mg)	0.07	0.05	0.03	0.02	0.26	0.02
Niacin (mg)	1.4	2.5	1.5	0.2	0.0	1.5
Vitamin B_6 (mg)	0.11	0.13	0.08	0.06	0.06	0.05
Folate (μg DFE)	2	2	4	56	22	15
Vitamin B_{12} (μg)	0.8	0.1	1.6	0.0	0.6	0.0
Minerals						
Calcium (mg)	3	4	9	28	25	12
Phosphorus (mg)	62	56	59	60	86	70
Magnesium (mg)	6	7	11	23	5	26
Iron (mg)	0.6	0.4	0.6	1.2	0.6	0.4
Zinc (mg)	1.4	0.6	0.5	0.5	0.5	0.7
Copper (mg)	0.05	0.02	0.06	0.10	0.01	0.17
Sodium (mg)	145	24	51	2	62	16
Potassium (mg)	105	70	82	182	63	93

[a]Nutrient values shown are the weighted average nutrient values based on amounts of each item cluster in the food group composite (Table 3). Nutrient values are from SR17.

In addition, we also developed a more detailed nut and seed composite and nutrient profile because of the DGAC's interest in nut consumption. We included item clusters for nuts and seeds with less than 1% of total consumption in the meat, poultry, fish, egg, and nut group. In the original Food Guide Pyramid, the nutrients in peanut butter had been used to represent all nuts and seeds.

We also changed the amounts of nuts, seeds, and dry beans and peas used as an equivalent amount for an ounce of meat. In the original Pyramid, 1/3 cup nuts, 1/4 cup seeds, and 1/2 cup cooked dry beans and peas were considered equivalent to one ounce of meat, poultry, or fish, as those were the amounts that were approximately equivalent in protein to lean meat, poultry, or fish. Concern with caloric intake is much higher now than when these amounts were established. Nuts, seeds, and dry beans and peas provide substantially higher levels of calories than do lean meats, poultry, and fish based on the original equivalents. One ounce equivalent of lean meat or poultry contains, on average, about 50 to 55 calories; one ounce equivalent of eggs contains about 80 calories; and one ounce equivalent of fish about 40 calories. In contrast, the original equivalent amount of nuts contained over 200 calories, and the original equivalent amount of dry beans and peas over 100 calories.

The effect of lowering the overall amount of nuts, seeds, and dry beans and peas used in place of meat, poultry, or fish was examined during the investigation of vegetarian intake patterns for the DGAC, as is described in an accompanying article.[10] Lower amounts of nuts, seeds, and dry beans were found to still provide adequate protein and other nutrients in the overall patterns. As a result, we adjusted the equivalencies for these foods to better represent how they could be used as choices within the meat and beans food group, while maintaining caloric balance and nutrient adequacy.

The new amounts considered equivalent to 1 ounce of meat, poultry, or fish are 1/2 ounce of nuts and seeds, 1 tablespoon of peanut butter, and 1/4 cup of cooked dry beans and peas. As shown in Table 6, the caloric value of this new equivalent amount of nuts and seeds is 85, still higher than the calories in 1 ounce of meat, poultry, fish, or eggs, but it is roughly within their range. One-quarter cup of cooked dry beans and peas contains 57 calories, which is similar to that of meat, poultry, fish, and eggs. These equivalencies were used in calculating the new meat, poultry, fish, egg, and nut composite and nutrient profile. The adjustment for dry beans and peas affects only their use as part of the meat and beans group. For the dry beans and peas vegetable subgroup, the amount recommended is listed as a total number of cups, so no equivalent is needed or used.

Note that although dry beans and peas are considered part of the meat, poultry, fish, egg, and nut group, we did not include them in the nutrient profile calculations for the group. Because they also form the dry beans and peas subgroup in the vegetable group, including them in the meat, poultry, fish, egg, and nut group calculations would result in double-counting their nutrients.

There are some limitations to the current assignment of survey food codes to item clusters when the survey food contains more than one ingredient that could be classified in the same food group or subgroup. With the current system, a survey food can be assigned to only one item cluster within a food group or subgroup. In such cases, the intakes for the multiple ingredients are assigned to the item cluster having the largest quantity. For example, a spaghetti sauce containing tomato sauce, onions, and celery, all of which are classified as other vegetables, could be assigned to only one item cluster in the other vegetable subgroup. The sum total of amounts consumed for all these other vegetables are assigned to one item cluster, tomatoes, because that is the ingredient in largest amount. Many of the foods in the other vegetable subgroup are used in small amounts, mainly as flavorings, in mixtures.

Another limitation of the current system is that the nutrient profiles may provide relatively low levels of some nutrients if the richer sources are less commonly eaten foods, because the nutrient profiles reflect relative consumption. As a result, it can be challenging to meet recommendations for some nutrients. One example is vitamin E; the nutrient profiles are relatively low in vitamin E because richer sources are less common choices within the group. For example, oils rich in vitamin E, such as sunflower and safflower oils, are less consumed in comparison to soybean and canola oils. Also, nuts and seeds rich in vitamin E, such as almonds and sunflower seeds, are less consumed in comparison to peanuts and peanut butter.

An additional limitation is that the increasing complexity of nutritional recommendations necessitates the use of additional food subgroups, thus increasing the complexity of food guide recommendations. In addition to the grain and vegetable subgroups, discretionary fats have also been split into solid fats and oils. By incorporating these subgroups, however, it is more feasible to meet or come close to meeting the Dietary Reference Intakes for all nutrients evaluated. Future additions of even more dietary standards may necessitate creation of further subgroups, or perhaps realignment of existing food groups.

Finally, it is imperative for nutrition educators to remember that the foods selected to represent each item cluster were in nutrient-dense forms. The use of nutrient-dense forms of foods in calculating nutrient profiles also needs to be emphasized in nutrition education efforts based on MyPyramid. Consumers should be made aware that there is a trade-off if higher fat or sugar foods are chosen from a food group or subgroup. The advantage of using the nutrient-dense forms is that by keeping the intrinsic fat and added sugars content of each nutrient profile as low as possible, consumers are permitted flexibility in the foods they choose. For example, whereas one consumer may select fat-free milk but add sugar to cereal, another might prefer to have cereal with no sugar but topped with 2% milk.

We anticipate for our future work in updating the food guide composites that more item clusters will be included in the composites and that a survey food code with multiple ingredients could be assigned to more than one item cluster within a food group or subgroup. We are also planning to develop a milk composite, reflecting consumption of fluid milk and milk products, cheese, and yogurt. If possible, we would like to create a solid fats composite and an oils composite reflecting consumption, as opposed to food supply data. With the continual release of periodic nationwide food consumption data, we may be able to develop composites for different age, gender, and ethnic groups. These enhancements will allow for greater detail and will better reflect typical food choices within each food group by Americans, the goal of USDA's composite approach to food guide development.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Other scientists may also be able to apply the composite approach to research on consumers' food group and subgroup choices. Food choices affect nutrient intakes. Block determined the foods and food groups that contribute the most to energy intake by coding foods consumed into food items and food groups.[16] Item clusters created for MyPyramid composites may be useful in determining nutrient intakes and also in constructing food frequency questionnaires, to better capture different types of foods consumed. One novel method for creating such a questionnaire used weighed inventory supplied by a sample population.[17] Researchers, as well as nutritionists and educators, can use food guide composite information to examine food and nutrient intake and to tailor messages to consumers.

Information on typical food choices can also be useful to practitioners. The composites can be used to identify commonly eaten foods for use in educational programs as examples. In addition, foods that are not as commonly eaten but that are nutrient rich can be targeted to encourage increased consumption. The nutrient profiles are also useful to help practitioners identify the range of nutrients that may be expected from consumption of each food group.

All of the figures in this article have also been compiled into an online slideshow. See www.JNEB.org, under supplementary material for this article.

SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jneb.2006.05.014.

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