Nutrient Density – addressing the challenge of obesity

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Achieving a balanced and nutrient-rich diet is becoming progressively more difficult within the constraints of the global food supply. The observed disparities in health between the global rich and the global poor can be explained, in part, by unequal food prices and by the rising cost of eating healthy. In general, added sugars and fats cost less than do many of the recommended healthier options that provide better nutrition and better nutrient balance. But need healthier diets cost more? New metrics of nutrient density can help consumers identify foods that are nutrient-rich, affordable, and appealing. Metrics of nutrient balance can help identify those combinations of foods that provide optimal nutritional value. Merging dietary intakes data with local or national food prices permits the estimation of diet costs at the individual level, opening the door to novel studies in nutrition economics.

Is it possible to eat better for less? In the US, higher Healthy Eating Index (HEI-2010) scores were linked to higher energy-adjusted diet costs. Conversely, cheap empty calories from solid fats and added sugars were linked to lower diet costs. In general, lower cost diets were consumed by lower income groups. However, some population subgroups, including Mexican Americans and other Hispanics, managed to achieve diets consistent with DASH and other dietary guidelines at a lower-than-expected cost. Being able to achieve complete and balanced diets on limited budgets is one example of nutrition “resilience”.

Energy and nutrient density of foods

Energy density of foods is measured in terms of calories per gram (kcal/g). The extremes are represented by plain water (0 kcal/g) and oil (9 kcal/g). Carbohydrates, including sugar, and protein provide about 4 kcal/g. The main determinant of foods’ energy density is water, which provides bulk and volume but no calories and no nutrients. As a result, the most energy-dense foods are those that are dry. Refined grains, cereals, and fats, oils and sweets are more energy dense that are water-containing beverages (0.4 kcal/g) or fresh produce (<1 kcal/g).

Nutrient density of foods is measured as nutrients per calorie, serving, or per unit weight (100g). Nutrient profiling models rank foods by their nutritional value, separating foods that contain empty calories from those that are nutrient-rich. For example, the 2015 US Dietary Guidelines classified solid fats and added sugars as empty calories, while stressing the need to consume more dietary fiber, potassium, calcium and vitamin D. Since most foods provide multiple nutrients, profiling models have tried to take the overall nutritional value of foods into account. In compensatory models, beneficial nutrients (vitamins and minerals) were able to compensate for the presence of nutrients to limit (sugar, sodium and fat). In non-compensatory models, foods were disqualified because of excessive amounts of nutrients to limit. The communications goal was to convey the nutritional value of the food to the consumer easily and at a glance.

The Nutrient Rich Foods (NRF) family of scores was based on a variable number of nutrients to encourage and on three fixed nutrients to limit: saturated fat, added sugar and sodium. The NRF9.3 variant of the score was based on protein, fiber, calcium, iron, potassium, and magnesium, vitamin A, vitamin C and vitamin E. The final NRF9.3 algorithm was based on the sum of percent daily values (%DV$s) for 9 nutrients to encourage minus the sum of %DVs for the 3 nutrients to limit. Higher NRF scores were associated with food patterns of lower energy density and higher nutrient content.
New affordability metrics

The affordability of foods has been expressed in terms of calories or nutrients per penny or per dollar. Calcium value metrics developed for a wide range of milks and dairy products in France, showed that fluid milks, hard cheeses, and low fat yogurts delivered calcium at relatively low monetary cost and without excessive amounts of calories, sodium or fat. Based on USDA national prices for 98 vegetables, potatoes and beans were the lowest cost sources of potassium and fiber. Also providing high nutrient value per penny were carrots, sweet potatoes, red and green peppers, spinach and broccoli. Nutrient density was based on a custom-created nutrient profiling model that included fiber, vitamins A, C, and K, potassium and magnesium. Nutrient affordability was the cost associated with the provision of 10% daily value of each nutrient per cup equivalent.

Estimating individual-level diet costs

Estimating diet costs by attaching retail prices to dietary intakes data opens the door to novel studies on the relation between diet quality and diet cost. Merging dietary intake data from the National Health and Nutrition Examination Survey (NHANES) with the USDA national food prices allowed us to examine the monetary cost of different quality diets. In general, better diets were also more expensive, on a per calorie basis. The association was stronger among women (p-interaction=0.003). As expected, the higher cost diets higher in vegetables, fruits, whole grains, and seafood and were lower in refined grains and solid fats, added sugars, and alcohol. As diet cost increased, the proportion of empty calories in the diet dropped.

Calculating the relative costs of eating healthy has now entered the mainstream of nutrition economics. Helping consumers identify foods that are nutrient-rich, affordable, and culturally acceptable would go a long way to making sure that the DGAs can reach all socioeconomic strata of the US public. Mathematical modeling techniques, such as linear programming, have extended nutrient profiling of foods to create nutritionally acceptable food patterns, subject to a variety of constraints. Here, the goal is to create food patterns that are simultaneously nutrient-rich, affordable, acceptable and appealing. Following the principles of one health, linear programming techniques have been applied to developing optimal diets for both animals and humans.