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Nutrient density of dairy products:

Helping build healthier diets worldwide

Adam Drewnowski[1,2]

[1] Center for Public Health Nutrition and the UW Center for Obesity Research, School of Public Health, University of Washington, Seattle, USA.

[2] Research supported by the Nutrient Rich Foods Coalition.

Correspondence:
Adam Drewnowski
305 Raitt Hall # 353410
University of Washington, Seattle, WA 98195-3410
E-mail: adamdrew@u.washington.edu
Tel: +1 206 543 8016; Fax: +1 206 685 1696

Short title: The nutrient rich foods index NRF9.3

Abstract

The Nutrient Rich Foods (NRF) index is a formal scoring system that ranks or classifies individual foods based on their nutrient composition. The NRF index balances nine nutrients to encourage (protein, fiber, vitamins A, C, and E, calcium, iron, potassium and magnesium) against three nutrients to limit (saturated fat, added sugar and sodium). Nutrient content is calculated as percent daily value (%DV) per 100 kcal or per serving, each capped at 100%. Applications of the NRF index to different foods and food groups showed that nutrient rich choices were to be found within every food group. Rather than classify foods as "good" or "bad", the NRF index ranked foods and food groups along a continuum. Comparing NRF scores with food costs per 1,000 kcal helped to identify foods that were both affordable and nutrient rich. Based on NHANES data, diets containing higher-scoring NRF foods contained more nutrients and food groups to encourage, were lower in energy, and were linked to better health outcomes. Nutrient density of foods, when coupled with consumer education, can become the foundation of dietary guidelines worldwide.

Keywords: Food analysis, nutrition value, nutrition requirements, energy intake, food supply, food legislation, nutrient quality

Introduction

Nutrient density of foods and beverages, conveyed to the consumer simply and at a glance, can become the foundation of food-based dietary guidelines worldwide. The Nutrient Rich Foods (NRF) index can help consumers make smart, nutrient dense choices from every food group. More than a front-of-pack logo, the NRF index is a part of a food navigation system [2, 3].

The NRF index can be readily applied to individual foods, meals, or menus – or to the total diet [4, 5]. Analyses of data from the 2001 US National Health and Nutrition Examination Survey (NHANES) showed that diets composed of high scoring NRF foods were also higher in food groups and nutrients to encourage and with lower in energy [5]. The link between food ratings, diet quality, and health is what distinguishes the NRF index from other nutrient profiles and food labeling tools.

The NRF emphasis is on the many beneficial nutrients naturally contained in beverages and foods. Whereas some food rating systems warn consumers away from foods containing saturated fats, added sugars, and sodium, the NRF approach creates a more positive message. In the NRF index, nine nutrients to encourage, protein, fiber, vitamins and minerals, are balanced against three nutrients to limit. Wholesome nutrient rich foods receive high NRF scores, whereas foods that provide calories but few nutrients score low [4, 5].

The NRF index allows the calculation of nutrients per calorie as well as nutrients per dollar [8, 9]. Some consumers make food purchases based on nutrient density but others are more concerned with food price [7, 8]. By identifying foods and food groups that provide optimal nutrition at lowest cost, the NRF index can help consumers create diets that are both affordable and nutrient dense. Estimating nutrient density and affordability of milk and milk products, as compared to other food groups, is the purpose of this report.

The need to re-shape dietary advice worldwide

Diets of many societies are becoming energy dense but nutrient poor [1]. It is therefore possible to remain undernourished in essential nutrients yet calorically overfed. In the United States, the recommended dietary values for potassium, fiber, calcium, magnesium, or vitamin E are not being met. Dietary guideline committees and other expert panels have stressed that consumers need to consume more nutrient dense foods from every food group [10]. That is the best way to meet nutrient requirements without exceeding daily energy needs.

Paradoxically, much of dietary advice emphasizes what nutrients to avoid. The notion of what constitutes a healthful food is increasingly based on the *absence* of fats, sugars, and sodium and not on the *presence* of beneficial nutrients in beverages and foods [1]. As witnessed by lower diet quality and dramatic increases in obesity rates, the negative dietary advice has not been effective. It may be time to develop food based dietary guidelines that take the total nutrient package – as well as food costs – into account [3].

Food scores based on the NRF index scores shift the emphasis from “bad” nutrients to good and better foods. What counts is not a single nutrient but the total nutritive value of the food. By showing how more nutrient rich choices translate into better diets, the NRF index provides a positive way to put dietary guidelines into practice [3].

What is nutrient profiling?

The science of ranking or categorizing foods, based on their nutrient composition, has become known as nutrient profiling [11]. Nutrient profile models attempt to capture the multiple nutritional attributes of a given food [4, 5, 11].

However, the procedures for developing, testing, and validating nutrient profile models have not been standardized. These include, but are not limited to, the selection of relevant nutrients; the choice of reference daily values, and the basis of calculation: 100 kcal, 100 g, or serving size [4, 11]. Nutrient profile models also need to be tested against other food attributes [12] and validated with respect to independent measures of a healthy diet [5].

A recent article [4] laid out the basic principles of nutrient profiling, stressing the need for objectivity, transparency, simplicity, and validation. Briefly, nutrient profile models need to be based on sound nutrition science, open-source data, and published algorithms. The models need to be simple, transparent, and available for scrutiny and comment. Alternative models need to be tested against other food attributes, notably energy density and energy cost [12, 13]. Most important, nutrient profiles need to be validated against independent measures of a healthy diet and, wherever possible, compared to health outcomes.

Comparing food rankings generated by different models to professional or consumer opinion is not validation [14]. Only three published models have been validated with respect to diet quality measures: the French SAIN/LIM [15], the British FSA-Ofcom model [16] and the present NRF index [5]. The SAIN/LIM [15] and FSA Ofcom scores [16] were developed for the French and UK food standards regulatory agencies, respectively.

The Nutrient Rich Food Index (NRF)

Details of the development of the Nutrient Rich Foods index has been published in professional journals [4, 5]. The choice of nutrients to encourage was based on US standards. The US Food and Drug Administration's definition of "healthy" foods is based on their content of protein, fiber, vitamins A and C, calcium, and iron. Foods are disqualified from nutrition and health claims if they contain above-specified amounts of fat, saturated fat, trans fat, cholesterol and sodium. The 2005 Dietary Guidelines for Americans [10] listed fiber, vitamins A, C, and E, calcium, potassium, and magnesium as shortfall nutrients in the US diet.

The NRF models were developed using the open-access USDA Food and Nutrient Database for Dietary Studies (FNDDS), which is also used to code, process and analyze the What We Eat in America food intake data [17]. It includes 8-digit codes for 6,940 foods from all food groups, including many mixtures, ethnic foods, and brand name items, and nutrient values for energy and 60 nutrients. The FNDDS files include detailed food descriptions, food portions and weights, nutrient descriptions and links to the USDA Standard Release (SR) nutrient composition databases [18]. Added were data on the added sugar content of foods and on FDA-mandated serving sizes, i.e. Reference Amounts Customarily Consumed or RACC.

Reference daily values, based on 2000 kcal diet, were obtained for protein (50g); fiber (25g), vitamin A (5000 IU), vitamin C (60 mg), vitamin E (30 IU), calcium (1000 mg), iron (18mg), potassium (3,500 mg) and magnesium (400 mg). All amounts were converted to percentage daily values (%DV) per reference amount and then capped at 100% DV(1). For nutrients to limit, maximum recommended values (MRVs) were 20g for saturated fat, 125g for total sugar, 50 g for added sugar and 2,400 mg for sodium. All NRF scores were initially calculated per 100 kcal, 100 g or per serving size of food [12, 13]

Foods that benefited the most from the 100 kcal calculation were low-energy-density vegetables and salad greens, such as spinach, lettuce, endive, water cress and cabbage. More energy dense foods, such as nuts and seeds or fortified cereals were treated more favorably by the 100g calculation base. A system based on 100 g was also more lenient toward sugar-sweetened beverages. Calculations based on serving sizes were most favorable for fruit and juices, vegetables and juices, milk and yogurts, and other beverages and mixed foods. Based on validation and other procedures, NRF values were calculated based on 100 kcal and serving size.

The NRF algorithm was the arithmetic difference between the unweighted sum of percent daily values (%DV) for the nine nutrients to encourage minus the sum of %DV for the three nutrients to limit. The NRF algorithms can be applied to any nutrient composition database that contain the index nutrients. The missing nutrients can be imputed from the USDA standards reference, as is common industry practice. The NRF algorithm can assign scores to soft drinks and fortified beverages. Diet soft drinks and foods and beverages with energy density below 10 kcal/100 g do not get a calorie based score.

Nutrient rich foods and energy density

As shown in **Figure 1**, median NRF scores per 100 kcal differed across food groups. Whereas fats and sweets got the lowest scores, the most nutrient dense foods were vegetables and fruit, narrowly followed by milk and yogurt [4, 5]. Within food groups, whole grain products scored higher than refined grain products, fresh and frozen fruits scored higher than canned fruit in syrup, and 100% citrus juices scored higher than many other fruit. Within the milk and milk products group, non-fat and low fat milk and yogurt scored higher than 2% fat or whole milk and yogurt. Within the cheese group, low fat cheeses had higher NRF scores than full fat cheeses.

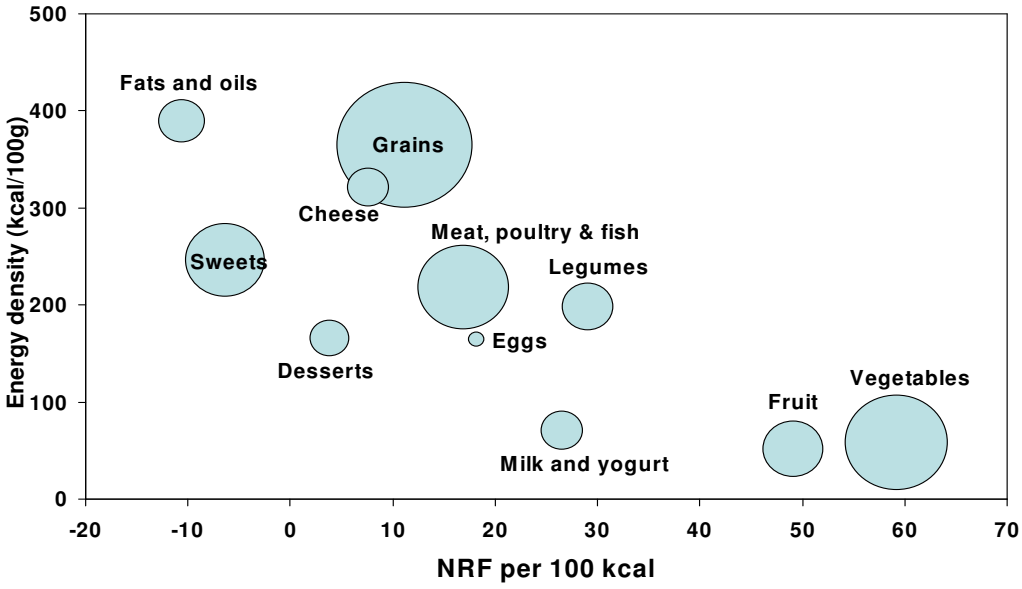

Figure 1. Median NRF index scores plotted against energy density (kcal/100g) of foods, for 9 major food groups. Size of the bubble denotes the number of foods in each group. Analyses were based on 1387 foods in the US Department of Agriculture Food and Nutrient Database for Dietary Studies (FNDDS 1.0).

Figure 1 shows raw NRF scores that span a range from -20 to +70. Further research is needed to determine what type of a scoring system would be best accepted by the consumer. Consumer studies have successfully converted NRF scores into a 5-point scale, based on quintile split of NRF index values. Preliminary data suggest that each point on a 5-point scale was roughly equivalent to 10% DV, a criterion the FDA uses in regulating nutrition claims.

Nutrient rich foods and energy cost

Figure 2 shows that the relation between median NRF scores per 100 kcal and energy costs also differed across food groups. The most nutrient dense vegetables and fruit were also the most expensive on a per calorie basis. By contrast milk and yogurt [4, 5], eggs and legumes were affordable and were more energy dense than grains. Although fats and sweets were cheap, they provided little nutritional value and their NRF scores were relatively low. Within food groups, fluid milk provided excellent nutrition value in relation to cost, followed by yogurt. Within the vegetable category, salad greens had very high NRF scores; however, carrots, broccoli, potatoes and sweet potatoes were both nutrient rich and affordable. Within the fruit category, fresh berries were most nutrient rich; however, citrus and citrus juices, oranges and bananas were nutrient rich and affordable. Beef and chicken were nutrient rich and more affordable than fish or shellfish.

Calculations based on NRF index values and food price can help consumers create healthier diet using foods that are both affordable and nutrient dense.

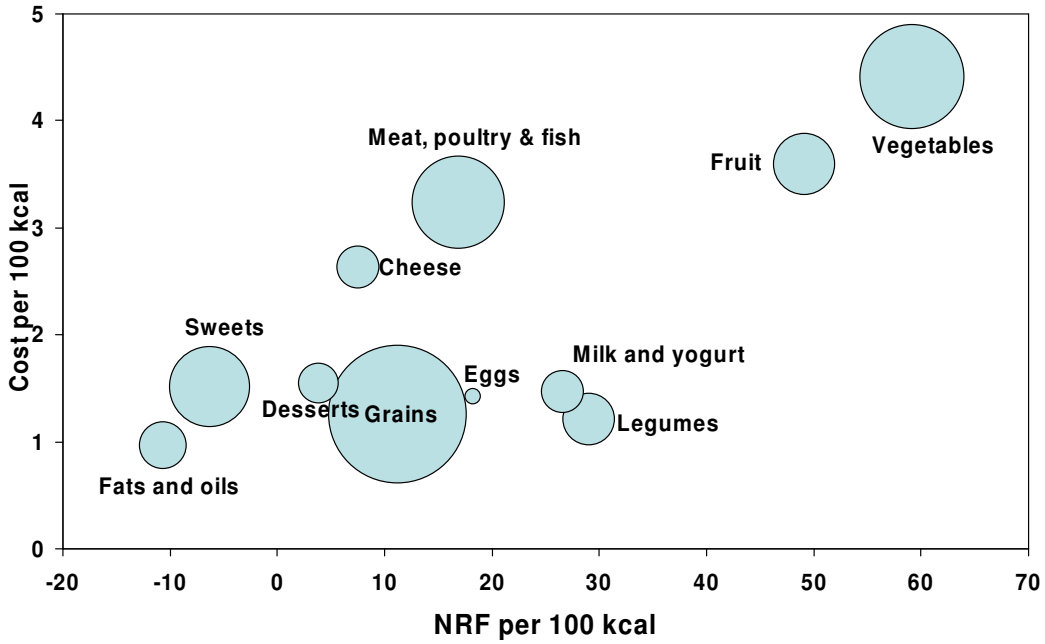

Figure 2. Median NRF index scores plotted against energy cost (kcal/1000kcal) of foods, for 9 major food groups. Size of the bubble denotes the number of foods in each group. Analyses were based on 1387 foods in the US Department of Agriculture Food and Nutrient Database for Dietary Studies (FNDDS 1.0).

From healthful foods to healthier diets

Analyses of diets of NHANES participants showed that diets ranked in the top quintile of NRF scores were higher in many nutrients to encourage, including some that were not part of the model (vitamin B12 and zinc). The top scoring diets were also higher in food groups to encourage, notably whole grains, low fat dairy, vegetables and fruit. In other words, the NRF scoring system accurately predicted diet quality in the NHANES data.

By contrast, diets lower in saturated fat, added sugar, sodium were not automatically higher in vitamins and minerals, whole grains, vegetables or low fat dairy. In other words, a scoring system based on nutrient avoidance was not associated – by default – with higher quality diets. These findings have implications for dietary guidance. Restricting problematic nutrients may not automatically guide consumers towards healthier options, especially if those options are associated with lower enjoyment and higher cost. Much research is still needed to determine how nutrient profiling can be translated into positive messages to help consumers select nutrient rich foods and so improve diet quality.

Are consumer needs being met?

One use of nutrient profiles lies in creating shelf labels, logos and symbols to track the nutritional value of foods at the point of purchase. Whether the introduction of such labels will lead to healthier diets is not yet clear. It would be important to show, for a given scoring system, how the higher ranked foods can fit into healthier meals and higher quality diets.

The NRF approach provides consumers with an easy way to make healthier food choices. Preliminary data show that the consumer is indeed looking for simple at-a-glance index of the nutrient quality of foods. The NRF index can be a valuable tool when integrated within a more comprehensive approach to nutrition education and guidance [1-3]. However, nutrient profiling methods need to be joined with other measures of diet quality, enjoyment, and cost (20]. The NRF is the only index that has been linked food prices and to global indices of sustainability such as the carbon cost [21]. As shown above, the NRF index can help consumers identify and select affordable, appealing, nutrient rich foods within each group.

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