Nutrient density: principles and evaluation tools[1–3]

Adam Drewnowski and Victor L Fulgoni III

ABSTRACT

Nutrient profiling is the technique of rating or classifying foods on the basis of their nutritional value. Foods that supply relatively more nutrients than calories are defined as nutrient dense. Nutrient profile models calculate the content of key nutrients per 100 g, 100 kcal, or per serving size of food. For maximum effectiveness, nutrient profile models need to be transparent, based on publicly accessible nutrient composition data, and validated against independent measures of a healthy diet. These rigorous scientific standards were applied to the development of the Nutrient-Rich Foods (NRF) family of nutrient profile models. First, the NRF models included nutrients to encourage as well as nutrients to limit. Second, NRF model performance was repeatedly tested against the Healthy Eating Index (HEI), an independent measure of a healthy diet. HEI values were calculated for participants in the 1999–2002 NHANES. Models based on 100 kcal and serving sizes performed better than those based on 100 g. Formulas based on sums and means performed better than those based on ratios. The final NRF9.3 index was based on 9 beneficial nutrients (protein; fiber; vitamins A, C, and E; calcium; iron; potassium; and magnesium) and on 3 nutrients to limit (saturated fat, added sugar, and sodium). Higher NRF9.3 scores were associated with lower energy density and more nutrient-rich diets. The nutrient density of foods, paired with a comprehensive program of consumer education, can become the foundation of dietary recommendations and guidelines. *Am J Clin Nutr* 2014;99(suppl):1223S–8S.

INTRODUCTION

Nutrient profiling is the technique used to rate, rank, or classify foods on the basis of their nutritional value (1). Nutrient profile models provide ratings of overall nutrient density, as determined by a balance between beneficial nutrients and nutrients to limit (2–4). Among the beneficial nutrients to encourage are protein, dietary fiber, and a variety of vitamins and minerals, whereas nutrients to limit include free or added sugars, saturated fat, and sodium (2–4). Given that most foods provide multiple nutrients, developing a formal quantitative system to rate the overall nutritional value of individual foods poses both a scientific and a communications challenge.

The proposed front-of-pack labeling systems, as reviewed by the Institute of Medicine, are intended to help shoppers identify healthier food options readily and at a glance (5). Helping consumers identify and select nutrient-dense foods is expected to lead to higher-quality diets and better health (5–7). Studies based on analyses of NHANES data have pointed to an association between the consumption of nutrient-dense foods, lower energy intakes, higher diet quality overall, and improved health outcomes (3).

Nutrient profiling can also help identify foods that are nutrient rich, affordable, and sustainable. The inclusion of food prices in nutrient density calculations has allowed researchers to create new metrics of affordability and to identify those foods that provide the most nutrients per penny (8, 9). This econometric approach to nutrient profiling (10, 11) was among the first to explore the interrelations between nutrient density, energy density, and energy cost. More recent studies have taken nutrient profiling in a different direction, exploring the relation between the nutrient density of foods and their carbon footprint, as determined by greenhouse gas emissions from life-cycle analysis (12).

Nutrient profiling techniques developed for individual foods can also be applied to meals, menus, and total diets. By showing how the nutrient density concept applies to total diet quality and the economics of food choice behavior, nutrient profiling provides a ready way to put the *Dietary Guidelines for Americans* and MyPlate into practice (6, 7).

PRINCIPLES OF NUTRIENT PROFILING

The intent of composite nutrient density scores is to capture the multiple nutritional attributes of a given food (2, 3, 8). Wholesome, nutrient-rich foods receive high scores, whereas foods that provide calories but few nutrients score lower (2). By including multiple beneficial nutrients to encourage, balanced nutrient profile models shift the emphasis from "bad" nutrients to "good" and "better" foods. Nutrient profiling exemplifies a positive way to convey vital information about nutritional attributes of foods and beverages to the consumer (2, 3, 6, 7).

For nutrient profiling to remain a science, it needs to follow scientific rules (13). Thus far, the procedures for developing, testing, and validating nutrient profile models have not been standardized (14, 15). 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 (14, 15). Nutrient profile models also need to be tested against other food attributes (14) and need to be validated with respect to independent measures of a healthy diet (3, 16).

The basic principles of nutrient profiling have been laid out before (1–3), stressing the need for objectivity, transparency, simplicity, and validation. Briefly, nutrient profile models had to be based on objective nutrition science; they had to be totally transparent and based on open-source data and published algorithms. Nutrient composition databases had to be of high quality and available from public sources. Simple algorithms were preferable to more complex ones, and alternative models were to be tested against other food attributes, notably energy density and energy cost (14, 15). Most important, alternative models were to be validated against independent measures of a healthy diet and, wherever possible, compared with selected health outcomes (16). Here, nutrient composition data for individual foods and beverages had to be supplemented with population-based data on diets and health.

NUTRIENT-RICH FOODS INDEX

The development of the Nutrient-Rich Foods (NRF)[4] Index closely followed the regulatory guidelines in the United States, as formulated by the US Food and Drug Administration (FDA) (1, 2). In particular, the selection of beneficial nutrients followed federal policies and standards (1, 2). Foods are defined as "healthy" by the FDA on the basis of their content of protein, fiber, vitamins A and C, calcium, and iron. Foods are disqualified by the FDA from carrying nutrition and health claims if they contain more than specified amounts of fat, saturated fat, *trans* fat, cholesterol, or sodium. Additional NRF nutrients were suggested by the 2005 *Dietary Guidelines* (17), which identified potassium, magnesium, and vitamin E as shortfall nutrients in the US diet. The goal was to produce a nutrient density score that would be consistent with the Nutrition Facts panel and could be used for front-of-pack labeling.

One way to visualize the nutrient density of foods is to determine the percentage daily value (%DV) of different nutrients per serving, always in relation to calories. Thus, a 6-ounce serving of plain skimmed-milk yogurt supplied <5% DV of daily calories but >30% DV of calcium, >25% DV of phosphorus, >10% DV of potassium and zinc, and >5% DV of magnesium. Similarly, a fruit-flavored low-fat yogurt provided <10% of dietary energy but >25% DV of calcium, >20% DV of phosphorous, close to 15% DV of protein, and >10% DV of potassium. Given the favorable nutrients-to-calories ratio, a yogurt can be defined as a nutrient-rich food.

Nutrient profiling aims to provide an overall nutrient density score on the basis of several nutrients. Reference DVs, based on a 2000-kcal diet, were obtained for protein (50 g); fiber (25 g); vitamins A (5000 IU), C (60 mg), and E (30 IU); calcium (1000 mg); iron (18 mg); potassium (3500 mg); and magnesium (400 mg). Nutrient contents of foods were converted to %DVs per reference amount and

then capped at 100% DV so that foods containing very large amounts of a single nutrient would not obtain a disproportionately high index score (1). For nutrients to limit, maximum recommended values were 20 g for saturated fat, 125 g for total sugar, 50 g for added sugar, and 2400 mg for sodium. All scores were initially calculated per 100 kcal, per 100 g, or per serving size of food (14, 15).

The FDA-mandated serving sizes are otherwise known as reference amounts customarily consumed (RACCs). The FDA uses 139 different RACC values that are set lower for energy-dense sugar (4 g), fats and oils (15 g), and cheeses (30 g) than for meats (85 g), vegetables and fruit (120 g), yogurts (220 g), or milk, juices, and other beverages (240 g).

The family of NRF models was developed and tested by using the open-access USDA Food and Nutrient Database for Dietary Studies (FNDDS), which is used to code, process, and analyze the What We Eat in America dietary intake data (18). The FNDDS files include detailed food descriptions, food portions and weights, nutrient descriptions, and links to the USDA Standard Release nutrient composition databases (19). The FNDDS data now include vitamin D but need to be supplemented with the added sugar content of foods. RACC values were developed for 5096 foods in the FNDDS database.

In developing the family of NRF indexes, we first created nutrient-rich subscores based on a variable number n of beneficial nutrients (NRn). The NRn components were expressed as unweighted sums of %DVs (SUM) or as means of %DVs (MEAN) per reference amount. The negative limited nutrient score (LIM) component was based on 3 nutrients only (saturated fat, added sugar, and sodium), which were also expressed as %DVs per reference amount.

NRF indexes were calculated as the arithmetic differences between the positive (NRn) and the negative (LIM) components. A ratio-based algorithm was also tested. Food scores obtained by using alternative NRn, LIM, and NRF indexes were then compared with the energy density (kcal/100 g), energy cost ($/100 kcal), and nutrient content of the food. Different algorithms and calculation methods developed in past research (14, 15) are shown in **Table 1**.

Index calculations based on 100 kcal and 100 g or serving size gave rise to very different results. Foods that benefited the most from the 100-kcal calculation were low-energy-dense vegetables and salad greens, such as spinach, lettuce, endive, watercress, and cabbage. Foods that benefited more from the 100-g calculation were energy-dense foods, notably nuts and seeds, protein powder, and fortified cereals. RACC-based calculations benefited foods that were consumed in amounts >100 g, including fruit and fruit juices, cooked vegetables and juices, milk and yogurts, and other beverages and mixed foods. By contrast, foods that were consumed in amounts <100 g, such as nuts and seeds, and fortified cereals received lower scores under a RACC-based system.

The LIM subscore performed differently when calculated per 100 g or per RACC. The most pronounced differences were obtained for fats, mixed foods, and beverages. Calculations based on 100 g strongly penalized foods that contained saturated fat and sodium but that were regularly consumed in serving sizes well below 100 g. RACC-based LIM scores penalized beverages that contained added sugar and were consumed in 240-g portion sizes, as opposed to 100 g. A system based on 100 g was more lenient toward sugar-sweetened beverages than a system based on serving size (240 g in the United States).

---

[4] Abbreviations used: DV, daily value; FDA, US Food and Drug Administration; FNDDS, Food and Nutrient Database for Dietary Studies; HEI, Healthy Eating Index; LIM, limited nutrient score; NRF, Nutrient-Rich Foods (index); NRn, subscore based on a variable number n of beneficial nutrients; RACC, reference amount customarily consumed.

TABLE 1
Algorithms for NR*n* and LIM subscores and for the composite NRF nutrient profile models[1]

Model	Algorithm	Reference amount	Comment
Subscores NR*n*			
NR*n*_100 g	$\sum_{1-n}$ (Nutrient$_i$/DV$_i$) $\times$ 100	100 g	Nutrient$_i$ = content of nutrient i in 100 g
			DV = daily value
NR*n*_100 kcal	(NR*n*_100 g/ED) $\times$ 100	100 kcal	ED = energy density (kcal/100 g)
NR*n*_RACC	(NR*n*_100 g/100) $\times$ RACC	Serving	RACC = FDA serving size
Subscores LIM			
LIM_100 g	$\sum_{1-3}$ (L$_i$/MRV$_i$) $\times$ 100	100 g	L$_i$ = content of limiting nutrient i in 100g
			MRV = maximum recommended value
LIM_100 kcal	(LIM_100 g/ED) $\times$ 100	100 kcal	ED = energy density (kcal/100 g)
LIM_RACC	(LIM_100 g/100) $\times$ RACC	Serving	RACC = FDA serving size
Composite NRF*n*0.3			
NRF*n*.3_sum	NR*n*_100 kcal – LIM_100 kcal	100 kcal	Difference between sums
NRF*n*.3_mean	NR*n*/*n* – LIM/3	100 kcal	Difference between means
NRF*n*.3_ratio	NR*n*/LIM[2]	None	Ratio

[1] FDA, US Food and Drug Administration; LIM, limited nutrient score; NRF, Nutrient-Rich Foods; NR*n*, subscore based on a variable number *n* of beneficial nutrients; RACC, reference amount customarily consumed.
[2] NR*n*_100 g/LIM_100 g was equivalent to NR*n*_100 kcal/LIM_100 kcal and to NR*n*_RACC/LIM_RACC.

VALIDATION OF NUTRIENT PROFILE MODELS

Choosing the best nutrient profile model from among multiple alternatives is another scientific challenge (2, 19). In some validation studies, food rankings generated by different models were compared with mean ratings for the same foods generated by health professionals or by expert panels (20). Only 3 published, fully transparent models have been validated with respect to objective diet quality measures: the French SAIN/LIM (16), the British FSA-Ofcom model (19), and the NRF9.3 index (3).

In the NRF9.3 validation study (3), each food reported by subjects in the NHANES 1999–2002 was scored by using NR*n*, LIM, and NRF*n*.3 algorithms. The NR*n* and NRF*n*.3 indexes were based on a variable number *n* of beneficial nutrients (where *n* = 6–15). An average nutrient density score for each person was calculated on the basis of either 100 kcal or RACC, and Healthy

Eating Index (HEI) 2005 values were independently calculated. Food-based scores per person were then regressed against HEI, with adjustment for sex, age, and ethnicity. The measure of index performance was the percentage of variation in HEI (R^2) explained by each model (3).

As shown in **Figure 1**, the NRF9.3 nutrient profile model based on 100 kcal and on RACC explained the most variation in HEI (44.5% of the variance). The NRF9.3 model was based on protein; fiber; vitamins A, C and E; calcium; iron; potassium; and magnesium. These are the nutrients of concern as identified by US government agencies and expert panels. The 3 nutrients to limit were saturated fat, added sugars, and sodium.

NRF indexes that included beneficial nutrients as well as nutrients to limit performed better than did indexes that were based on nutrients to limit only. The LIM score predicted ~32%
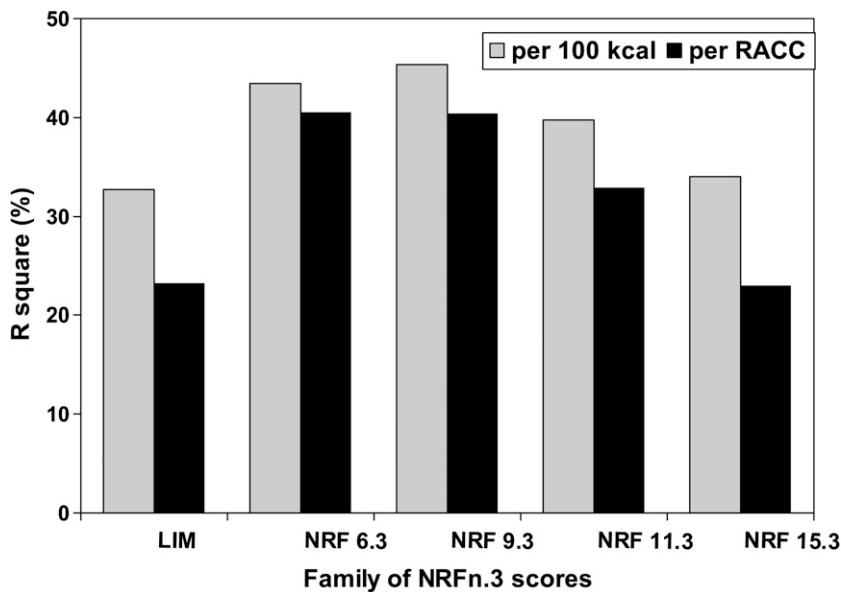

FIGURE 1. Linear regressions of LIM and NRF*n*.3 models on the Healthy Eating Index 2005 calculated for participants aged >4 y in the NHANES 1999–2002 database. Data are from reference 3 (Table 2, page 1551). LIM, limited nutrient score; NRF, Nutrient-Rich Foods; RACC, reference amount customarily consumed.

of the variance in HEI. Maximum variance in HEI was explained with the use of 6 or 9 beneficial nutrients; index performance actually declined with the inclusion of additional vitamins and minerals. The data confirmed previous studies (14, 15) showing that increasing the number of nutrients above 10 in a nutrient profile model provided little or no additional benefit in predicting overall diet quality.

In other analyses, NRF indexes based on 100 kcal (418 kJ) performed similarly to indexes based on RACC. Algorithms based on sums or means of nutrient-based subscores performed better than did algorithms based on dividing one subscore by another (eg, reference 21). Ratio-based scores are inherently problematic and may need to be radically transformed before they will be useful to consumers.

The NRF9.3 index was an unweighted score. Instances of weighted nutrient density scores do exist, and weights have been justified in a variety of ways: biological quality of nutrients, their bioavailability, their ubiquity in the food supply, and relative influence to health. In past studies, weighting has been based on expert opinion. However, new analyses point to novel approaches to weighting nutrients for inclusion in nutrient profiling schemes based on their estimated importance in the population diet (22).

IDENTIFYING NUTRIENT-DENSE FOODS

As shown in **Figure 2**, the median nutrient density of foods, as rated by the NRF system, differed across the major USDA food groups (2, 3). The highest scores were obtained by low-energy-dense vegetables and fruit, followed by legumes and eggs. Fats and oils, grains, and sweets had higher energy density and lower per-calorie nutrient content. Within food groups, whole grains scored higher than refined grains and 100% fruit juices scored higher than soft drinks. Lower-fat dairy products, including fluid milk and yogurts, had higher scores than did products containing more saturated fat.

Individual NRF9.3 scores showed more variance than did median scores for a given food category or food group. Thus, skimmed milk scored 123 on the NRF9.3 score, chocolate skimmed milk scored 56, milk with 2% fat (semiskimmed) scored 43, and whole milk scored 38. Plain nonfat yogurt scored 94, whereas vanilla-flavored nonfat yogurt scored 38. Lower NRF scores were obtained for ice cream and for some dairy desserts.

BUILDING HEALTHIER DIETS

Studies have shown that nutrient density is an accurate marker of healthy diets, distinguishing between diets that are energy dense and those that are nutrient rich (11). Participants in the 1999–2002 NHANES were then assigned to quintiles on the basis of their dietary NRF9.3 scores. Persons in the top quintile of NRF9.3 scores consumed more beneficial nutrients, including some that were not part of the model (vitamin B-12 and zinc). Their diets were also characterized by more whole grains, low-fat dairy, vegetables, and fruit. However, the more-nutrient-dense diets tended to be more expensive. As shown in **Figure 3**, the top NRF9.3 quintile was associated with significantly higher per-calorie diet costs compared with the lowest NRF9.3 quintile (4).

These findings, associating different nutrient density scores with diet quality measures, have implications for dietary guidance. Quintiles of NRF9.3 scores translated easily into a consumer-friendly 5-point scale (24). Preliminary data suggest that each point on a 5-point scale was approximately equivalent to 10% DV, a criterion favored by the FDA in regulating nutrition and health claims.

Focusing only on nutrients to limit may not necessarily guide consumers toward healthier options, especially if those options are associated with lower enjoyment and higher cost. However, a focus on nutrient density may influence healthier choices, as shown in a pilot intervention trial (25). However, more studies are
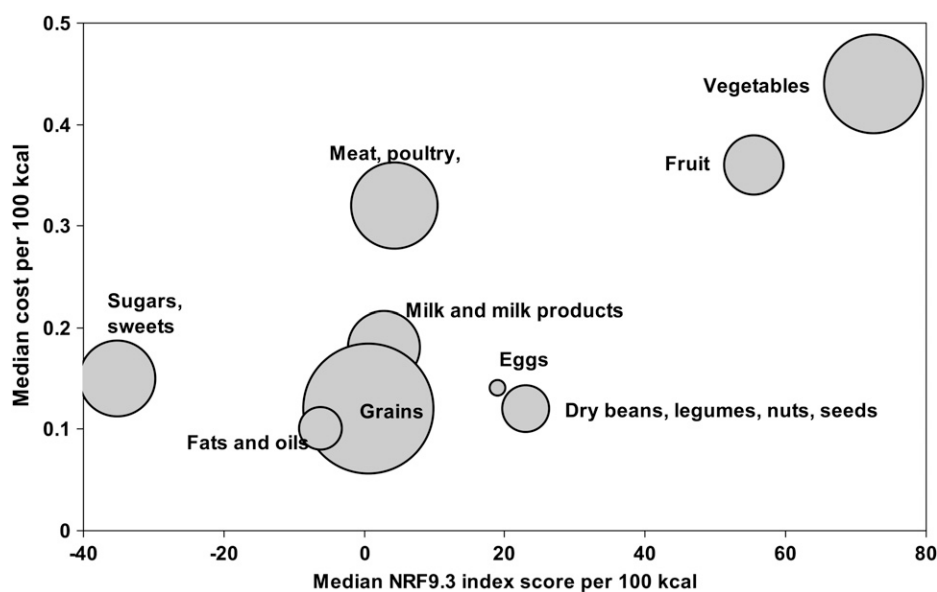

FIGURE 2. Median NRF9.3 index scores for each major USDA food group plotted against median cost per 100 kcal. Higher NRF index scores denote higher nutrient density per 100 kcal (from reference 4, Figure 2). The size of the bubble denotes the number of foods per food group (from reference 4, Table 2). NRF, Nutrient-Rich Foods.
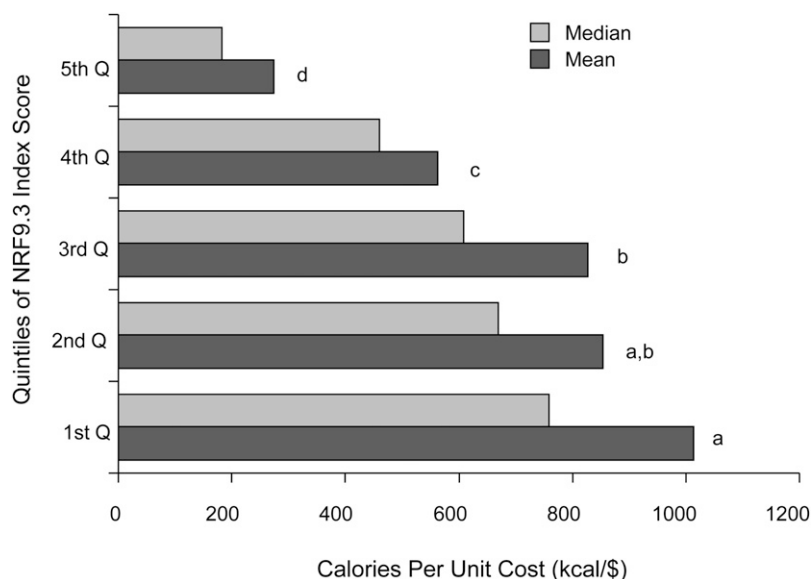
FIGURE 3. Quintiles of NRF9.3 index scores plotted against mean and median calories per unit cost. Higher NRF index score quintiles denote higher nutrient density per 100 kcal. Values with the same lowercase letters are not significantly different (from reference 4). NRF, Nutrient-Rich Foods; Q, quintile.

needed to confirm that nutrient density signposting can lead to positive changes in consumer food purchase behavior (26).

Nutrition experts agree that the US diet tends to be energy dense but nutrient poor (1). Increasing the consumption of lower-energy but nutrient-rich foods would achieve the twin objectives of reducing daily calories and increasing the overall nutrient density of the diet. Identifying foods that are affordable, sustainable, and nutrient rich is the goal of nutrient profiling (2–4). The NRF and other nutrient profiling models were intended to promote the consumption of fewer calories and more beneficial nutrients (2–4).

Paradoxically, much dietary advice emphasizes what nutrients to avoid. The notion of what constitutes a "healthful" food seems to be based on the absence of saturated fat, added sugars, and sodium rather than on the presence of beneficial nutrients that the food contains (1). As witnessed by dramatic increases in the rates of obesity and diabetes over the past 20 y, such negative dietary advice has not been effective. A more positive approach to dietary guidelines may prove to be more successful in the long term (6, 7).

Translating the concept of nutrient density into healthier everyday diets requires the combination of nutrient profiling methods with other strategies for improving food habits and health. Studies need to address food patterns and overall diet quality, especially in relation to sustainability and to monetary cost (23, 24) and greenhouse gas emissions (12). The NRF9.3 is the only index that has been linked to US food prices in an effort to identify affordable nutrient-rich foods that are part of the mainstream US diet.

REFERENCES

1. Drewnowski A. Concept of a nutritious food: toward a nutrient density score. Am J Clin Nutr 2005;82:721–32.
2. Drewnowski A, Fulgoni VL 3rd. Nutrient profiling of foods: creating a nutrient-rich food index. Nutr Rev 2008;66:23–39.
3. Fulgoni VL III, Keast DR, Drewnowski A. Development and validation of the Nutrient-Rich Foods Index: a tool to measure nutritional quality of foods. J Nutr 2009;139:1549–54.
4. Drewnowski A. The Nutrient Rich Foods Index helps to identify healthy, affordable foods. Am J Clin Nutr 2010;91(suppl):1095S–101S.
5. Wartella EA, Lichtenstein AH, Yaktine A, Nathan R, eds. Front-of-package nutrition rating systems and symbols: promoting healthier choices. Institute of Medicine, The National Academies Press. Available from: http://www.nap.edu/openbook.php?record_id=13221 (cited 30 July 2013).
6. Drewnowski A, Fulgoni VL 3rd, Young MK, Pitman S. Nutrient-rich foods: applying nutrient navigation systems to improve public health. J Food Sci 2008;73:H222–8.
7. Miller GD, Drewnowski A, Fulgoni V, Heaney RP, King J, Kennedy E. It is time for a positive approach to dietary guidance using nutrient density as a basic principle. J Nutr 2009;139:1198–202.
8. Darmon N, Darmon M, Maillot M, Drewnowski A. A nutrient density standard for vegetables and fruits: nutrients per calorie and nutrients per unit cost. J Am Diet Assoc 2005;105:1881–7.
9. Maillot M, Ferguson EL, Drewnowski A, Darmon N. Nutrient profiling can help identify foods of good nutritional quality for their price: a validation study with linear programming. J Nutr 2008;138:1107–13.
10. Maillot M, Darmon N, Darmon M, Lafay L, Drewnowski A. Nutrient-dense food groups have high energy costs: an econometric approach to nutrient profiling. J Nutr 2007;137:1815–20.
11. Drewnowski A. Defining nutrient density: development and validation of the Nutrient Rich Foods Index. J Am Coll Nutr 2009;28:421S–6S.
12. Vieux F, Soler LG, Touazi D, Darmon N. High nutritional quality is not associated with low greenhouse gas emissions in self-selected diets of French adults. Am J Clin Nutr 2013;97:569–83.
13. Tetens I, Oberdorfer R, Madsen C, de Vries J. Nutritional characterization of foods: Science based approach to nutrient profiling. Eur J Nutr 2007:46(suppl 2):4–14.
14. Drewnowski A, Maillot M, Darmon N. Testing nutrient profile models in relation to energy density and energy cost. Eur J Clin Nutr 2009;63:674–83.
15. Drewnowski A, Maillot M, Darmon N. Should nutrient profiles be based on 100 g, 100 kcal or serving size? Eur J Clin Nutr 2009;63:898–904.
16. Darmon N, Vieux F, Maillot M, Volatier J-L, Martin A. Nutrient profiles discriminate between foods according to their contribution to nutritionally adequate diets: a validation study using linear programming and the SAIN,LIM system. Am J Clin Nutr 2009;89:1227–36.

17. US Department of Health and Human Services; USDA. Dietary guidelines for Americans. Available from: http://www.health.gov/dietaryguidelines/dga2005/document/ (cited 14 March 2014).

18. USDA Food and Nutrient Database for Dietary Studies, 2.0. 2006 [monograph on the Internet]. Beltsville, MD: Agricultural Research Service, Food Surveys Research Group. Available from: http://www.ars.usda.gov/Services/docs.htm?docid=12083 (cited 14 March 2014).

19. Arambepola C, Scarborough P, Rayner M. Validating a nutrient profile model. Public Health Nutr 2008;11:371–8.

20. Scarborough P, Boxer A, Rayner M, Stockley L. Testing nutrient profile models using data from a survey of nutrition professionals. Public Health Nutr 2007;10:337–45.

21. Scheidt DM, Daniel E. Composite index for aggregating nutrient density using food labels: ratio of recommended to restricted food components. J Nutr Educ Behav 2004;36:35–9.

22. Arsenault JE, Fulgoni VL III, Hersey JC, Muth MK. A novel approach to selecting and weighting nutrients for nutrient profiling fo foods and diets. J Acad Nutr Diet 2012;112:1968–75.

23. Drewnowski A, Rehm CD. Vegetable cost metrics show that potatoes and beans provide most nutrients per penny. PLoS ONE 2013:8(5): e63277.

24. Drewnowski A. New metrics of affordable nutrition: which vegetables provide most nutrients for least cost. J Acad Nutr Diet 2013; 113:1182–7.

25. Mobley AR, Kraemer D, Nicholls J. Putting the nutrient –rich food index into practice. J Am Coll Nutr 2009;28:427S–35S.

26. Glanz K, Hersey J, Cates S, Muth M, Creel D, Nicholls J, Fulgoni V 3rd, Zaripheh S. Effect of a Nutrient Rich Foods consumer education program: results from the nutrition advice study. J Acad Nutr Diet 2012;112:56–63.

Consumer Education Project of Milk SA - CPD activity for Dietitians

You can obtain 1 CEU point for reading the review article **"Nutrient density: principles and evaluation tools"** and answering the accompanying questions.
The article has been accredited for 1 **CEU** for dietitians. Ref number: DT/A01/2017/00103
HOW TO EARN YOUR CEUs
1. Complete your personal details below.
2. Read the article titled **"Nutrient density: priciples and evaluation tools"** Drewnowski A & Fulgoni VL. 2014. American Journal of Clinical Nutrition. 99 (suppl): 1223S-8S and answer the questions.
3. Indicate your answers to the questions by making an "X" in the appropriate block at the end.
4. You will earn 1 CEU point if you answer 70% or more of the questions correctly. A score of less than 70% will unfortunately not earn you any CEU's.
5. Make a photocopy for your own records in case your answers do not reach us.
6. Cut and paste the area indicated below into an e-mail message and e-mail it to maretha@dairycep.co.za or post to P.O. Box 36332 Menlo Park 0102
7. The closing date for this activity is 30 December 2017. Answer sheets received after this date will not be processed. Certificates will be sent within two months from receipt of the answer sheet.

PLEASE ANSWER ALL THE QUESTIONS
(There is only one correct answer per question.)

1. Nutrient density of foods are defined as foods that supply relatively more nutrients than calories. Nutrient profile models calculate the content of key nutrients _____ of food.
[a] per 100g
[b] per 100kcal
[c] per serving size
[d] all of the above

2. Studies based on analyses of NHANES data have pointed to an association between the consumption of nutrient-dense foods, lower energy intakes, higher diet quality overall and _____.
[a] increased mortality rate
[b] improved health outcomes
[c] decreased risk of disease

3. Nutrient profiling models provide ratings of overall nutrient density, as determined by a balance between beneficial nutrients (protein, dietary fibre, cholesterol and a variety of vitamins and minerals) and nutrients to limit (free or added sugars, total fats and sodium)
[a] true
[b] false

4. Nutrient profiling extended its function to explore the inter relationship between nutrient density, energy density and (a) _____. More recently studies investigated the relationship between nutrient density of foods and its, (b) _____ as determined by greenhouse gas emissions from life-cycle analysis.
[a] (a) food cost (b) food waste
[b] (a) energy cost (b) carbon foot print
[c] (a) nutrient cost (b) sustainability

5. One way to visualize the nutrient density of foods is to determine the percentage daily value of different nutrient per serving, always in relationship to calories. Using this method yoghurt has a _____ nutrient-to-calories ratio and can be defined as a _____ food
[a] unfavourable/unhealthy
[b] neutral/ healthy
[c] favourable/nutrient rich

6. Foods are defined as "healthy" by the FDA on the basis of their content of protein, fibre, vitamins A and C, calcium and iron. Foods are disqualified by the FDA from carrying nutrition and health claims if they contain more than specified amounts of fat, saturated fat or sodium
[a] true
[b] false

7. Index calculations based on 100 kcal and 100g or serving size gave rise to different results. According to the reference amounts customarily consumed in amounts of > 100g included
[a] low-energy-dense vegetables and salad greens
[b nuts, seeds, protein powder and fortified cereals
[c] fruit, fruit juices, cooked vegetables and juices, milk and yoghurt and other beverages and mixed foods
[d] all the above

8. Focusing only on _____ may not necessarily guide consumers towards healthier options, especially if those options are associated with lower enjoyment and higher cost.
[a] nutrient-dense foods
[b] beneficial nutrients
[c] nutrients to limit

9. Increasing the consumption of _____but nutrient rich foods would achieve the twin objectives of reducing daily calories and increasing the overall nutrient density of the diet.
[a] lower-energy
[b] econometric-dense
[c] sustainable

10. To improve food habits and health, studies need to address food patterns and_____ especially in relation to sustainability and to monetary cost and greenhouse gas emissions.
[a] nutrient density
[b] overall diet quality
[c] profiling systems

Consumer Education Project of Milk SA - CPD activity for Dietitians
"Nutrient density: principles and evaluation tools" Ref number: DT/A01/2017/00103

Cut and paste the section below into an e-mail message

PLEASE WRITE <u>CLEARLY</u>
HPCSA number: DT_____
Surname as registered with HPCSA: _____Initials:_____
Cell phone number:_____ Fax No: _____
Email address*:_____
(*NB: Supply email address for certificate delivery – please write in clear BLOCK LETTERS)
Postal address: _____
Signature: _____
I hereby declare that this is my own unassisted work.

Please make an "X" in the appropriate block for each question:
1. a [ ] b [ ] c [ ] d [ ]
2. a [ ] b [ ] c [ ]
3. a [ ] b [ ]
4. a [ ] b [ ] c [ ]
5. a [ ] b [ ] c [ ]
6. a [ ] b [ ]
7. a [ ] b [ ] c [ ] d [ ]
8. a [ ] b [ ] c [ ]
9. a [ ] b [ ] c [ ]
10. a [ ] b [ ] c [ ]