The Nutrient Rich Foods Index NRF9.3:
The science behind nutrient density scores

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What is nutrient profiling?

Nutrient profiling is the *science* of ranking or classifying foods based on their nutrient composition*

Each food is assigned a unitary score that best reflects its nutrient *quality*

***Defined by the UK Food Standards Agency, FSA**

Applications of nutrient profiling

- **Protect public health**

Help consumers get more nutrients from the calories they consume and so promote healthier diets

- **Promote regulation**

Provide a uniform benchmark for mandated or self-regulation by industry

Develop front of pack labels
Develop shelf labels
Harmonize health and nutrition claims

- **Promote innovation**

Encourage the production and selling of more nutrient-rich foods

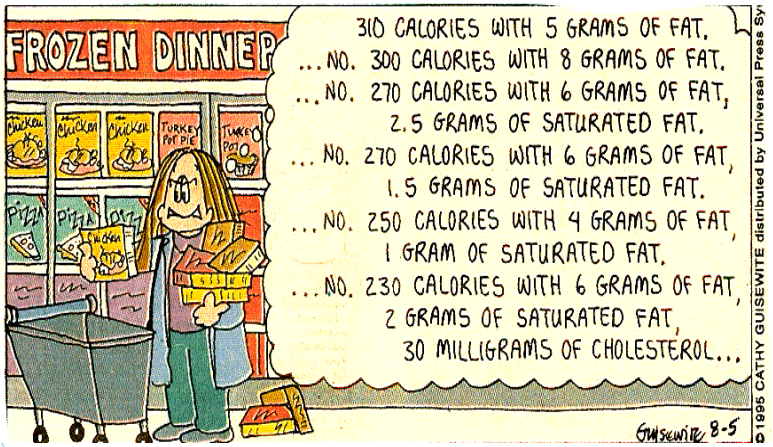
Drewnowski Nutrition Today, Sep/Oct 2007

Food labeling or food *guidance*?

Nutrient Rich Foods Index is a science-based, consumer-driven, guidance system

Drewnowski Nutrition Today, Sep/Oct 2007

Provide “nutrition at a glance”

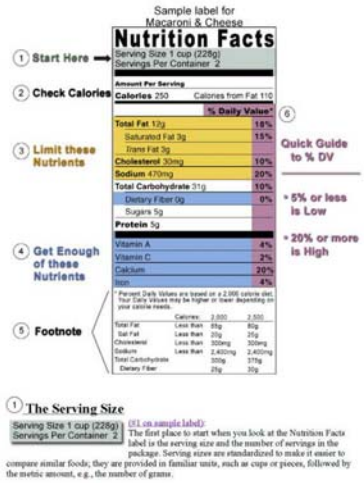


Is this “nutrition at a glance”?

The Nutrition Facts Panel stresses nutrients to avoid…

…rather than the total nutrient package

It may be too complex anyway.

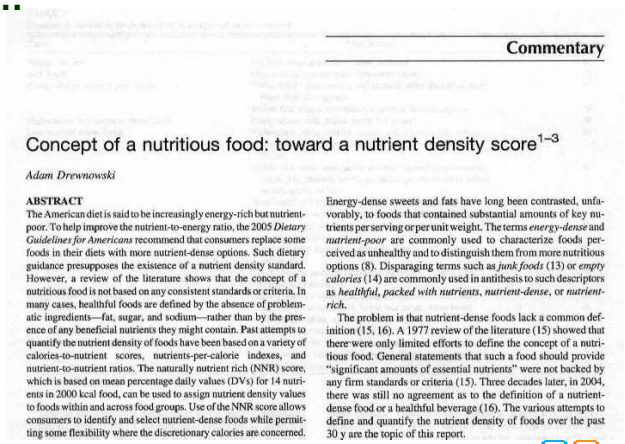


For effective nutrition labeling follow these steps

The Nutrient Rich Foods Index

The beginning….

NATURALLY NUTRIENT RICH
a scientific symposium
...Putting More Power on Americans' Plates



Commentary

Concept of a nutritious food: toward a nutrient density score[1–3]

Adam Drewnowski

ABSTRACT

The American diet is said to be increasingly energy-rich but nutrient-poor. To help improve the nutrient-to-energy ratio, the 2005 *Dietary Guidelines for Americans* recommend that consumers replace some foods in their diets with more nutrient-dense options. Such dietary guidance presupposes the existence of a nutrient density standard. However, a review of the literature shows that the concept of a nutritious food is not based on any consistent standards or criteria. In many cases, healthful foods are defined by the absence of problematic ingredients—fat, sugar, and sodium—rather than by the presence of any beneficial nutrients they might contain. Past attempts to quantify the nutrient density of foods have been based on a variety of calories-to-nutrient scores, nutrients-per-calorie indexes, and nutrient-to-nutrient ratios. The naturally nutrient rich (NNR) score, which is based on mean percentage daily values (DVs) for 14 nutrients in 2000 kcal food, can be used to assign nutrient density values to foods within and across food groups. Use of the NNR score allows consumers to identify and select nutrient-dense foods while permitting some flexibility where the discretionary calories are concerned.

Energy-dense sweets and fats have long been contrasted, unfavorably, to foods that contained substantial amounts of key nutrients per serving or per unit weight. The terms *energy-dense* and *nutrient-poor* are commonly used to characterize foods perceived as unhealthy and to distinguish them from more nutritious options (8). Disparaging terms such as *junk foods* (13) or *empty calories* (14) are commonly used in antithesis to such descriptors as *healthful, packed with nutrients, nutrient-dense*, or *nutrient-rich*.

The problem is that nutrient-dense foods lack a common definition (15, 16). A 1977 review of the literature (15) showed that there were only limited efforts to define the concept of a nutritious food. General statements that such a food should provide "significant amounts of essential nutrients" were not backed by any firm standards or criteria (15). Three decades later, in 2004, there was still no agreement as to the definition of a nutrient-dense food or a healthful beverage (16). The various attempts to define and quantify the nutrient density of foods over the past 30 y are the topic of this report.

Drewnowski: American J Clinical Nutrition 2005;82:721-32

Nutrient Rich Foods Coalition

The Beef Checkoff through the National Cattlemen's Beef Association

The vision:

The Nutrient Rich Foods approach makes it easy for people to build and enjoy healthier diets by getting the most nutrition from their calories.

Coalition Advisory Committees

Adam Drewnowski, PhD, University of Washington
Victor Fulgoni III, PhD, Nutrition Impact
Dan Kraemer, IA Collaborative

Scientific Advisory Committee

- Robert Heaney, MD, FACP, FAIN, Creighton University
- Eileen Kennedy, PhD, Tufts University
- Janet King, PhD, University of California, Berkeley & Davis
- Nancy Krebs, MD, University of Colorado
- Paul LaChance, PhD, Rutgers University
- Esther Myers, PhD, RD, American Dietetic Association

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- Robert McKinnon, YellowBrick Road
- Amy Mobley, PhD, RD, Purdue University
- Laura Peracchio, PhD, University of Milwaukee
- Connie Diekman, MEd, RD, LD, FADA, Washington Univ St. Louis
- Kathleen Zelman, MPH, RD, nutrition consultant

Nutrient profiling criteria must be:

Objective
- ***B*ased on accepted nutrition science and labeling practices**

Simple
- **Based on published daily values and meaningful amounts of food**

Balanced
- ***B*ased on nutrients to encourage and on nutrients to limit**

Validated
- **Against measures of a healthful diet**

Transparent
- ***B*ased on published algorithms and open-source data**

Consumer-driven
- **Likely to guide better food choices and more healthful diets**

Drewnowski, Fulgoni. Nutr Rev 2008

Select nutrients to encourage

Use simple and objective criteria

- **The 2005 Dietary Guidelines *seven***
  - **Fiber, vitamins A, C, E, Ca, K, Mg**
- **The Food and Drug Administration *six***
  - **FDA defines "healthy" foods as those that contain ≥10% DV of protein, fiber, vitamins A, C, Ca, or Fe**
- **Additional nutrients for special population needs**
  - **Zn, Fe, folate, vitamins D, B_{12}**

Select nutrients to encourage

Nutrient profile model	Macronutrients	Vitamins	Minerals	Reference
NR5	Protein, fiber	Vit C	Ca, Fe	AFSSA 2008
NR6	Protein, fiber	Vit A, C	Ca, Fe	Drewnowski et al 2008
NR9	Protein, fiber	Vit A, C, E	Ca, Fe, Mg, K	Drewnowski et al 2008
NR9z	Protein, fiber	Vit A, C, E	Ca, Fe, Zn, K	Drewnowski et al 2008
NR11	Protein, fiber	Vit A, C, E, B_{12}	Ca, Fe, Zn, Mg,K	Drewnowski et al 2008
NR12	Protein, fiber	Vit A, C, E, thiamin, riboflavin, B_{12}	Ca, Fe, Zn, K	Drewnowski et al 2008
NR14	Protein, fiber	Vit C, D, E, thiamin, riboflavin, B_{12}, folate	Ca, Fe, Zn, K	Drewnowski et al 2008
NNR15	Protein, fiber, MUFA	Vit C, D, E, thiamin, riboflavin, B_{12}, folate	Ca, Fe, Zn, K	Drewnowski 2005
NDS16 afssa	Protein, fiber, linolenic, DHA	Vit C, D, E, thiamin, riboflavin, B_6, folate	Ca, Fe, Zn, Mg, K	Darmon et al 2006
NDS23	Protein, fiber, linoleic, linolenic, DHA	Vit A, C, D, E, thiamin, riboflavin, B_6, B_{12}, niacin, folate	Ca, Fe, Zn, Mg, Cu, Se, K, I, (*Ph*)	Maillot et al 2007

Select nutrients to limit

Use simple and objective criteria

- **The 2005 Dietary Guidelines *six***
  - **Total fat, saturated fat, trans-fat, cholesterol, added sugar, sodium**
- **The Food and Drug Administration *four***
  - **Foods are disqualified from health claims if they contain too much fat, saturated fat, cholesterol, or sodium**
- **The European Union *four***
  - **EC lists total fat, saturated fat, trans fat, sugar and sodium**
- **The AFSSA *three***
  - **Saturated fat, added sugar, sodium**

Select reference daily values

Use published reference amounts

Nutrient	Reference DV		Nutrient	Maximum RV
Protein	50 g		Total fat	65 g
Fiber	25 g		Saturated fat	20 g
Vit A	5000 IU		Total sugars	125 g
Vit C	60 mg		Added sugars	50 g
Vit E	30 IU		Sodium	2,400
Calcium	1,000 mg			
Iron	18 mg			
Potassium	3,500 mg			
Magnesium	400 mg			

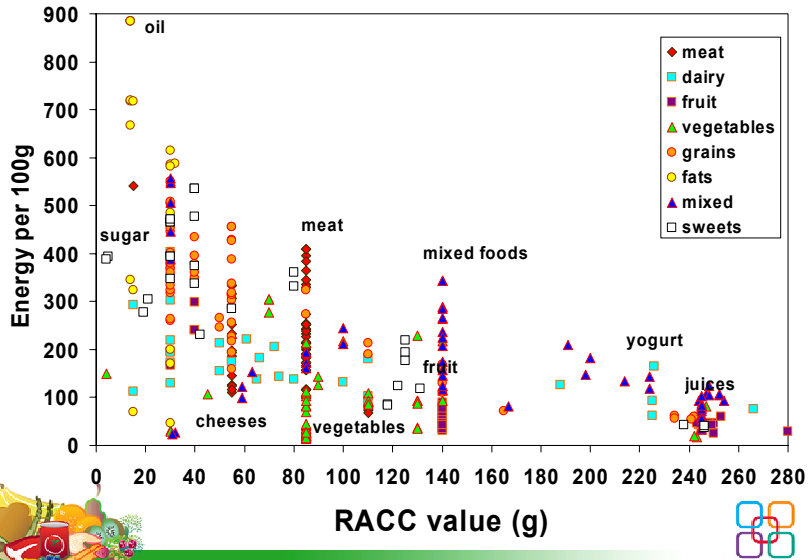
Drewnowski, Fulgoni. Nutr Rev 2008

Select the basis for calculation

Use science to decide among alternative options

- **100 grams**
  - **Food labels in the EU are based on 100g amounts – so are some EU-based nutrient profiles (e.g. UK FSA)**
- **100 kcal**
  - **Better reflects the nutrient-to-calorie ratio – but will consumers relate?**
- **Government-mandated serving size**
  - **Food labels in the US are based on Reference Amounts Customarily Consumed (RACC)**

RACC values and energy density are *inversely* linked



Maillot, Darmon, Drewnowski, EJCN in press

Best basis for NRF = 100 kcal

- Aligns closely with current Dietary Guidelines recommendations
- Correlates better with the Healthy Eating Index
- Is an accepted unit/base for defining nutrient density
- Is a standard measure for comparison for all foods
- Applies to the food packaging/labeling system both nationally and internationally

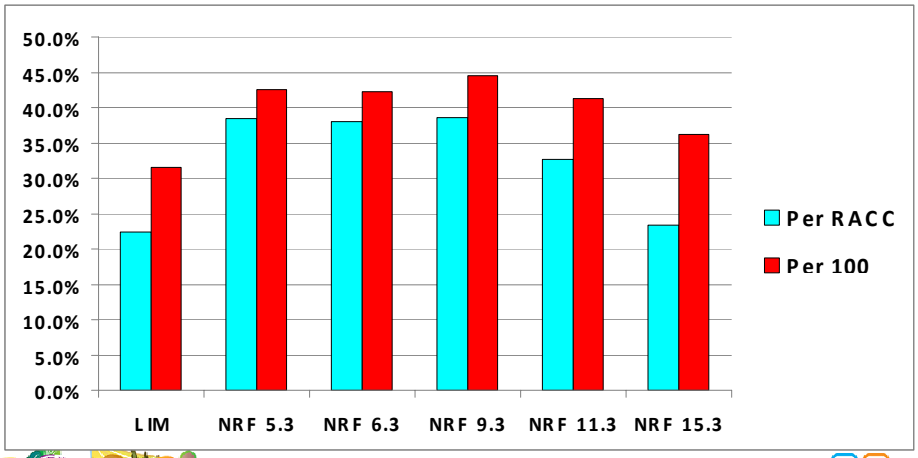
The validation process

- A formal process was used to decide among alternative algorithms
- Tested a family of NRF Indices
  - Range of positive nutrients (5-15)
  - With and without nutrients to limit (3-4)
  - Calculated per 100 kcal and per RACC
- Used diet quality measures (e.g., Healthy Eating Index- HEI-2005) and health-related variables
- Used regression analyses with dependent variables:
  - Measure of diet quality (HEI-2005)
  - Selected health outcomes (BMI, blood pressure, lipids)

Healthy Eating Index - 2005

Component	Points	Std. for max. score	Std. for min. score
Total Fruit (includes 100% juice)	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruit (not juice)	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No vegetables
Dark Green and Orange Vegetables and Legumes	5	≥0.4 cup equiv. per 1,000 kcal	No Dark Green or Orange Vegetables and Legumes
Total Grains	5	≥3.0 oz equiv. per 1,000 kcal	No Grains
Whole Grains	5	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Milk	10	≥1.3 cup equiv. per 1,000 kcal	No Milk
Meat and Beans	10	≥2.5 oz equiv. per 1,000 kcal	No Meat or Beans
Oils	10	≥12 grams per 1,000 kcal	No Oil
Saturated Fat	10	≤7% of energy	≥15% of energy
Sodium	10	≤0.7 gram per 1,000 kcal	≥2.0 g per 1,000 kcal
Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)	20	≤20% of energy	≥50% of energy

The NRFn.3 indices and HEI



The NRF9.3 algorithm

$$NRF9.3 = \Sigma_{i=9}\ (\%DV/100kcal) - \Sigma_{i=3}\ (\%DV100kcal)$$

9 nutrients to encourage

Protein	Fiber	Vitamin A
Iron	Calcium	Vitamin C
Potassium	Magnesium	Vitamin E

3 nutrients to limit

- Saturated Fat
- Added Sugars
- Sodium

NRF9.3 Index components

Based on 9 nutrients to encourage, 3 nutrients to limit

Includes nutrients with a DRI (except added sugars)

Created with open-source, transparent databases

Based on established, authoritative sources

Based on 100 kcal basis

Uses "unweighted" scores

Based reference amount on FDA's Daily Value

Capped nutrient contributions to 100% DV

Validated against USDA's Healthy Eating Index

Is a scientifically valid definition of nutrient density

Regulatory agencies recommend the same science-driven process

efsa
European Food Safety Authority

Food category

Across the board

Encourage

Limit

Iron
Calcium
Vitamin A
Vitamin C
Fiber
Protein
Total fat
Saturated fat
Trans FA
Sugars
Sodium

100 g/100 ml

100 kcal/kJ

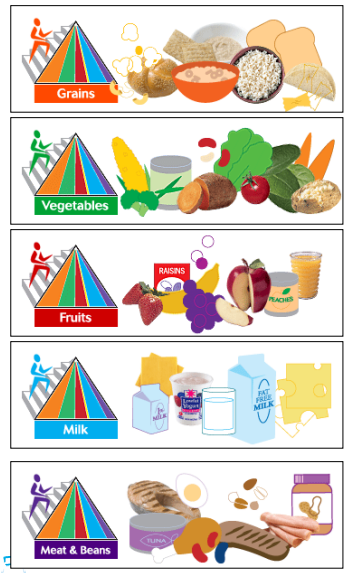
Serving size

Algorithm: Threshold

Algorithm: X Score

Testing & validation

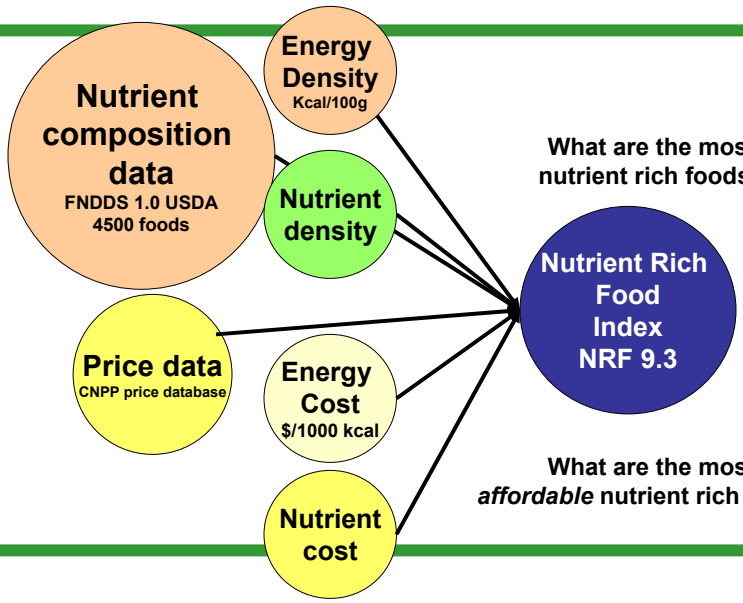
European Food Safety Authority Scheme 2007



Question 1:

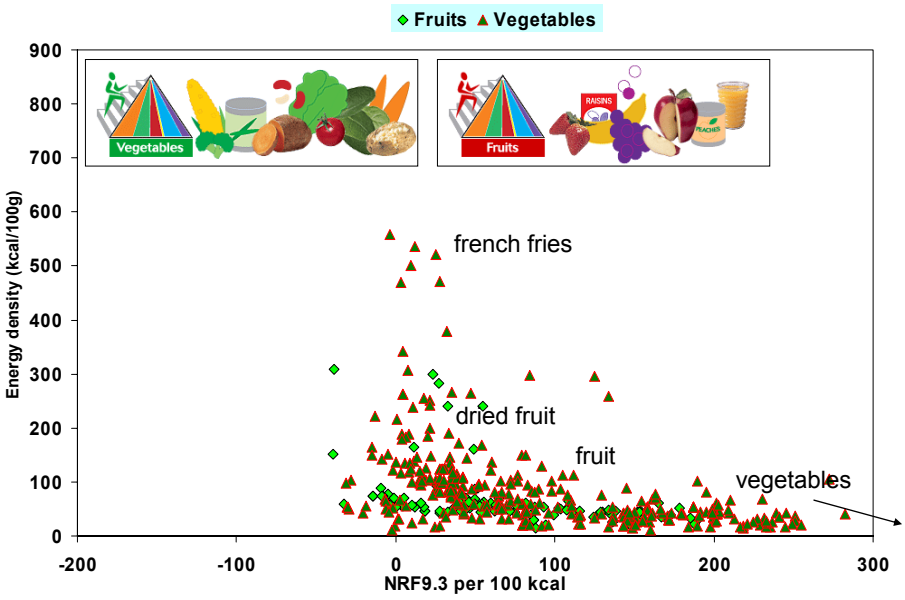
How does the NRF9.3 index perform?

Use open source USDA data sets



Nutrient Density (NR9.3$_{100kcal}$) and Energy Density (kcal/100g)

Data from USDA FNDDS 1.0



Nutrient Density (NR9.3$_{100kcal}$) and Energy Density (kcal/100g)

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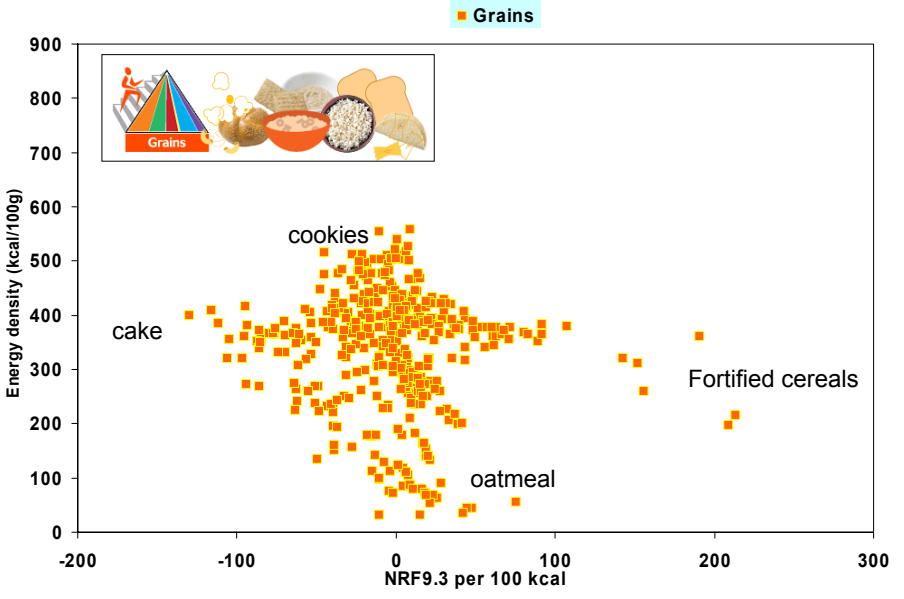

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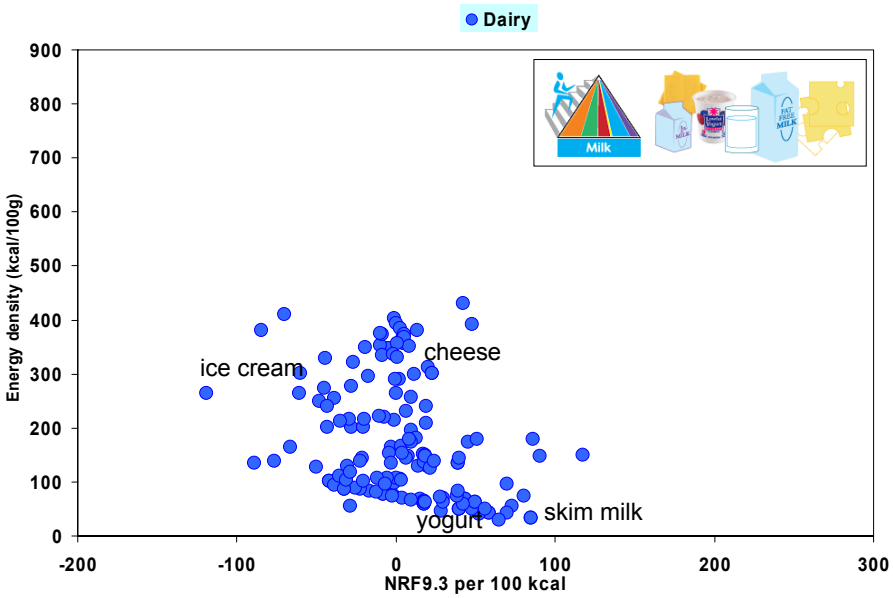
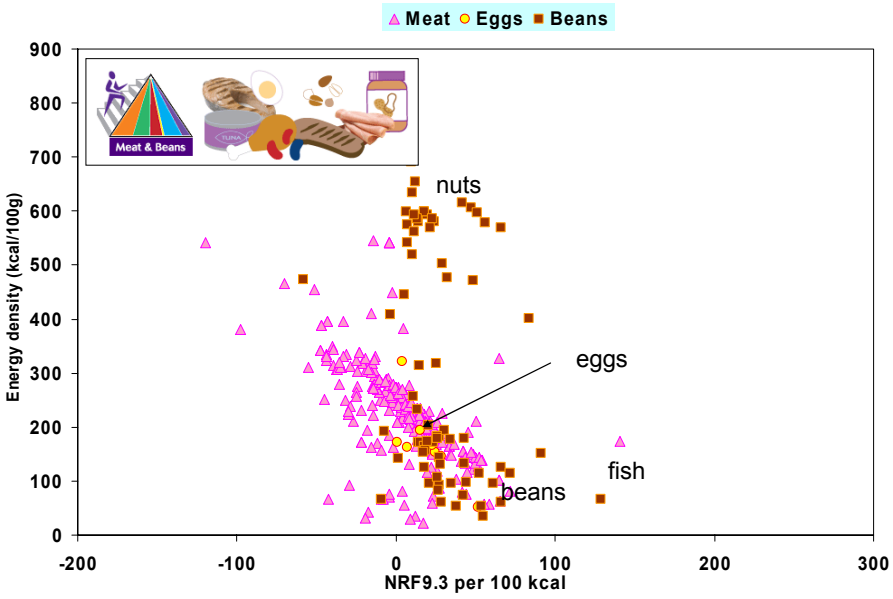
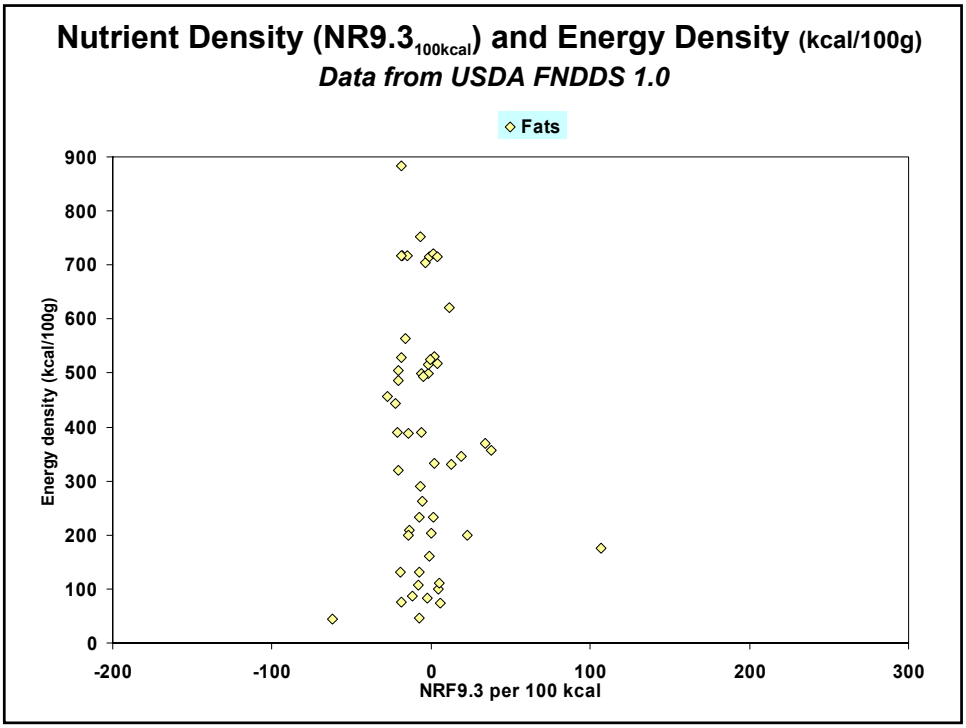
Data from USDA FNDDS 1.0

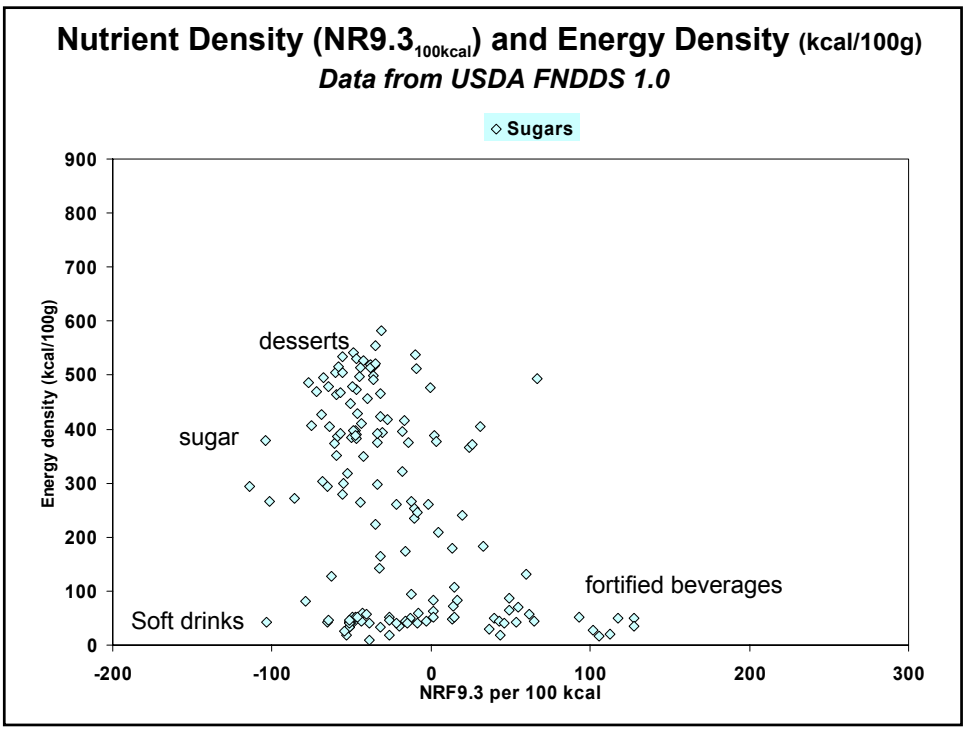


Nutrient Density (NR9.3$_{100kcal}$) and Energy Density (kcal/100g)

Data from USDA FNDDS 1.0

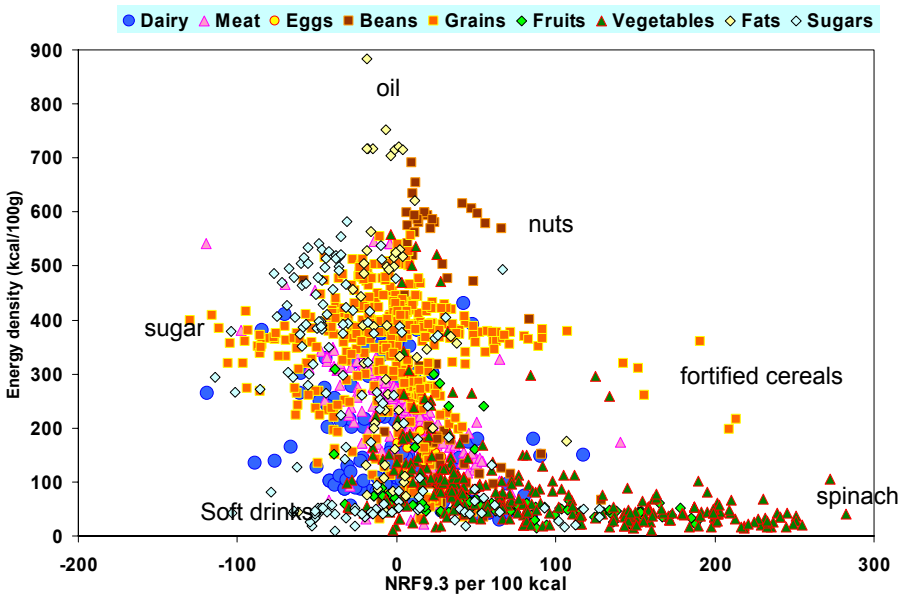


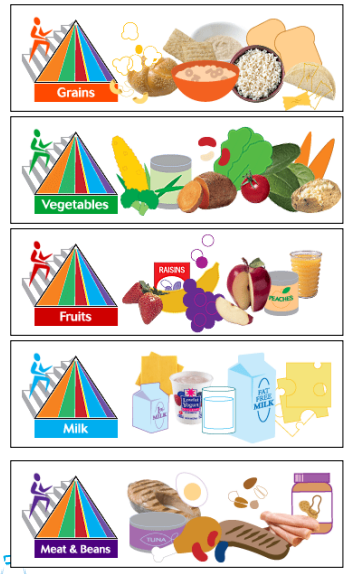

Nutrient Density (NR9.3100kcal) and Energy Density (kcal/100g)
Data from USDA FNDDS 1.0
Fats
Energy density (kcal/100g)
900
800
700
600
500
400
300
200
100
0
-200
-100
0
100
200
300
NRF9.3 per 100 kcal


Nutrient Density (NR9.3100kcal) and Energy Density (kcal/100g)
Data from USDA FNDDS 1.0
Sugars
Energy density (kcal/100g)
900
800
700
600
500
400
300
200
100
0
desserts
sugar
fortified beverages
Soft drinks
-200
-100
0
100
200
300
NRF9.3 per 100 kcal

Nutrient Density (NR9.3$_{100kcal}$) and Energy Density (kcal/100g)

Data from USDA FNDDS 1.0





Question 2:

What happens when indices are based on nutrients to limit only?

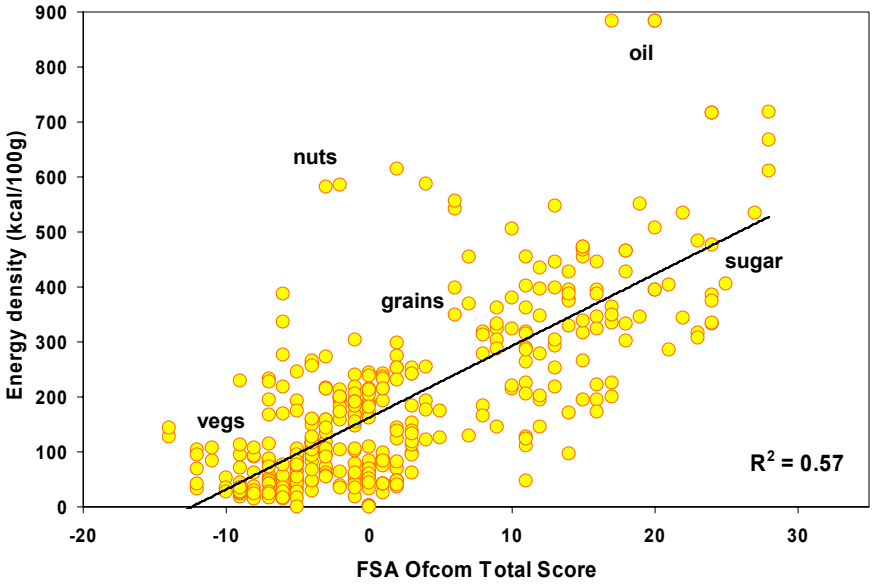
Scores based on what *not* to eat

Contrast positive and negative approaches

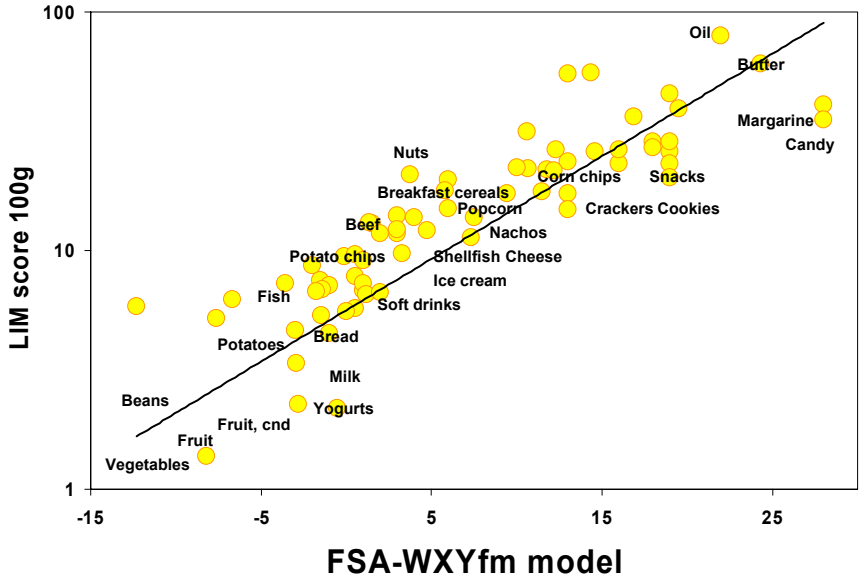
Nutrient profile model	Nutrients/Foods to encourage	Nutrients to limit	Reference
LIM		Sat fat, added sugar, Na	Maillot 2007
Unilever		Sat fat, *trans* fat, sugar (total + added), Na	
Kellogg		Energy, sat fat, *trans* fat, total sugar, Na (cholesterol)	
WXYfm	Protein, fiber, fruit, veg, nuts	Energy, sat fat, total sugar, Na	
Keystone	>10%DV of fiber, Ca, K, Mg, Vits A, C, or E Fruit, Veg, whole grain, low fat dairy	Total fat, sat fat, trans fat, cholesterol, added sugar, Na	website
A balanced score includes nutrition but need not exclude taste, cost, or convenience			
Nutrient Rich Foods 9.3	Protein, fiber, Vit A, C, E, Ca, Fe, Mg, K	Sat fat, added sugar, Na	Drewnowski 2008

Drewnowski, Fulgoni. Nutr Rev 2008

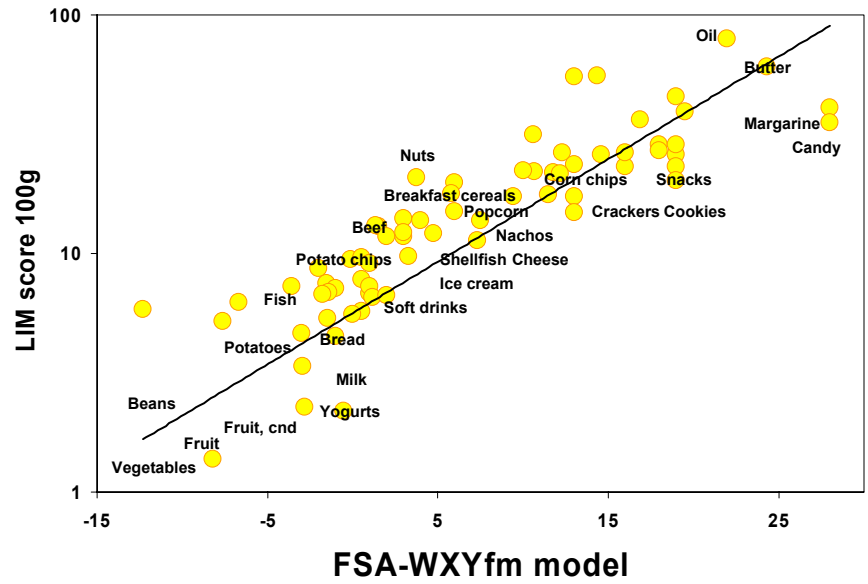
WXYfm model mostly reflects ED

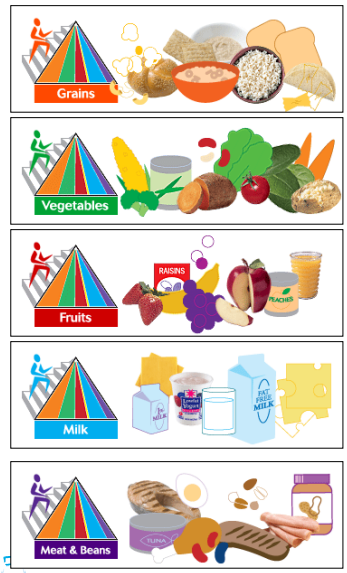


WXYfm plotted against LIM score



WXYfm plotted against LIM score



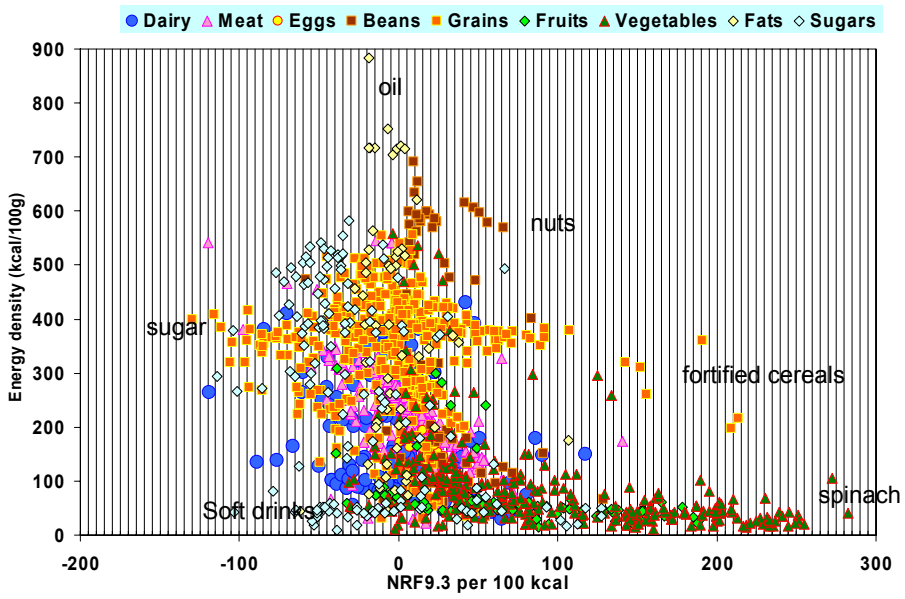


Question 3:

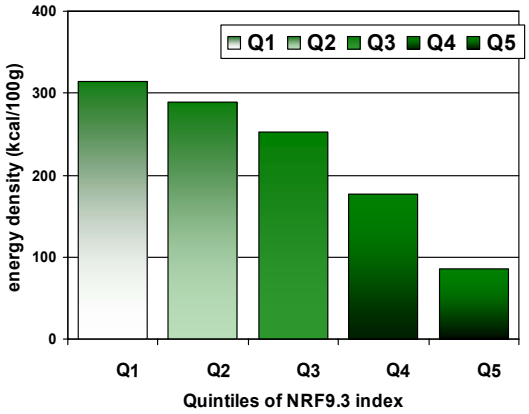
What do consumers want?

100 point scale – too much information?

Data from USDA FNDDS 1.0



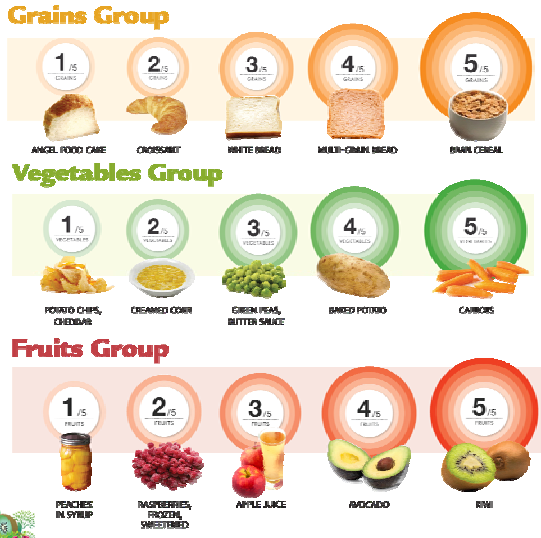
Quintiles show that high scoring foods are high in nutrients and low in calories



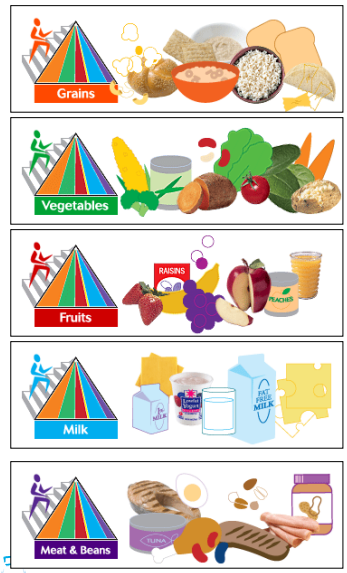
Best Grouping: 5 Categories

- **Consumer research identified 5-point scales as a better choice than 10 or 100 categories**
- **Results in 5 statistically distinct groups**
- **Is best predictor of Healthy Eating Index scores**
- **Scoring system based on the nutrient content of foods in the USDA FNDDS and *MyPyramid* servings databases**

Individual Foods



Individual Foods

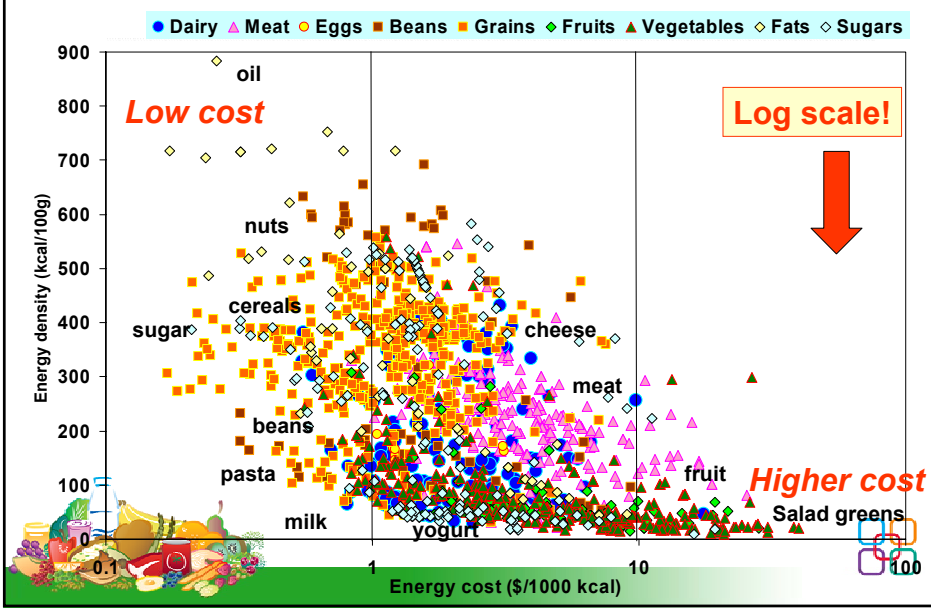


Question 3:

What about cost?

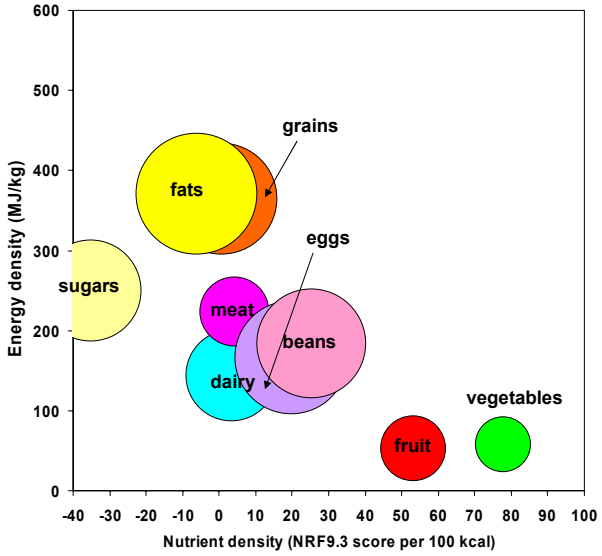
Energy density (kcal/100g) and energy cost ($/1000 kcal)

Data from USDA FNDDS 1.0 and CNPP prices database



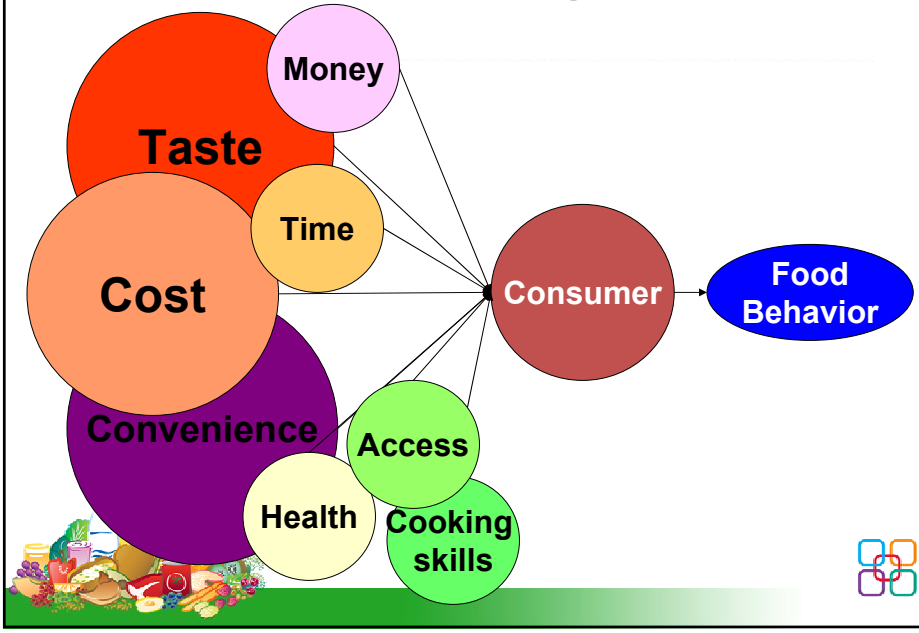
NRF9.3 score and ED by food group

size of circle = calories per dollar



Fats
Eggs
Grains
Beans
Sweets
Dairy

What drives food purchases?



The Nutrient Rich Foods Index is:

- ***Objective*** **- based on 2005 Dietary Guidelines; 2005 MyPyramid and other expert panel data**
- ***Simple*** **– based on FDA percent Daily Values and FDA serving sizes and on USDA nutrient data sets**
- ***Balanced*** **– based on nutrients to encourage and on nutrients to limit**
- ***Validated*** **– against 2005 Healthy Eating Index (HEI)**
- ***Transparent*** **– algorithms published in peer-review journals**
- ***Consumer-driven*** **– research on helping consumers to build healthier diets is in progress**

Drewnowski, Fulgoni. Nutr Rev 2008

Thank you!

For more information about the
Nutrient Rich Foods Coalition visit
www.NutrientRichFoods.org