Economic Burden of Noncommunicable Diseases:
The role of nutrition

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From Science to Economics: The potential value of supplementation
Annual Meeting, Prague, Czech Republic, April 26, 2016

The global nutrition imbalance

- The global poor suffer from different forms of malnutrition – both undernutrition and overweight.
- This occurs in LMICs but also in HICs.
- One economic reason for the dual burden of disease is the low cost of empty calories compared to nutrient-rich foods.
- The required nutrients are no longer supplied by low-cost diets.
- Nutrients have been uncoupled from calories.

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The uncoupling of nutrients from calories

- There was a time when eating more food meant consuming more nutrients.
- Dietary guidelines still insist that all nutrients come from foods
- Low-cost diets have calories but few nutrients.
- Paradoxically, eating more can lead to undernutrition.
- We need food *fortification* and supplements – for HIC.

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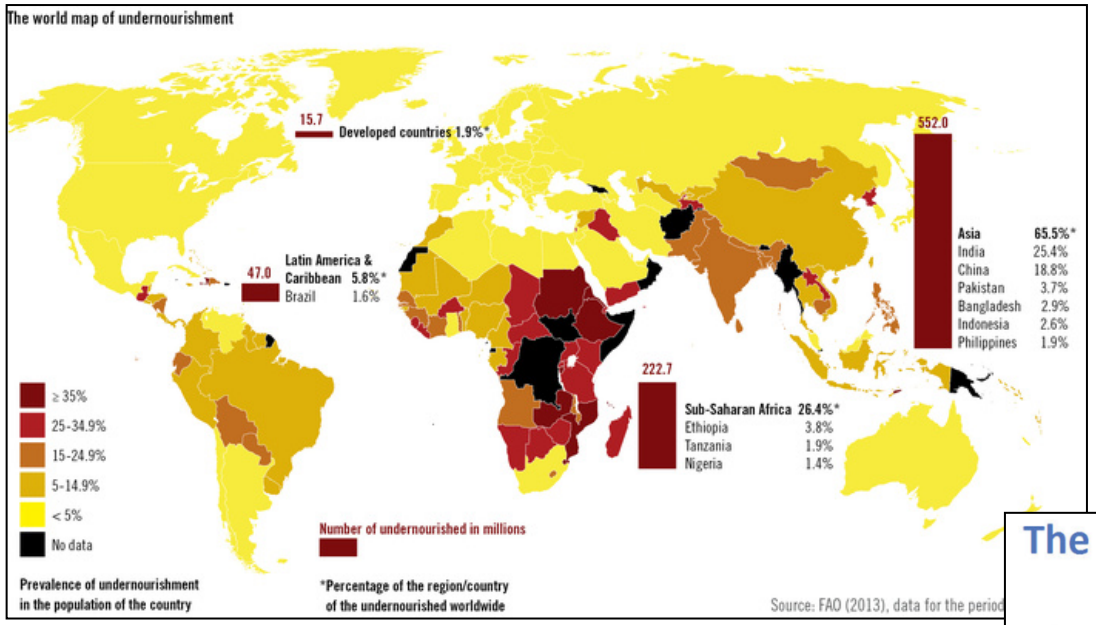
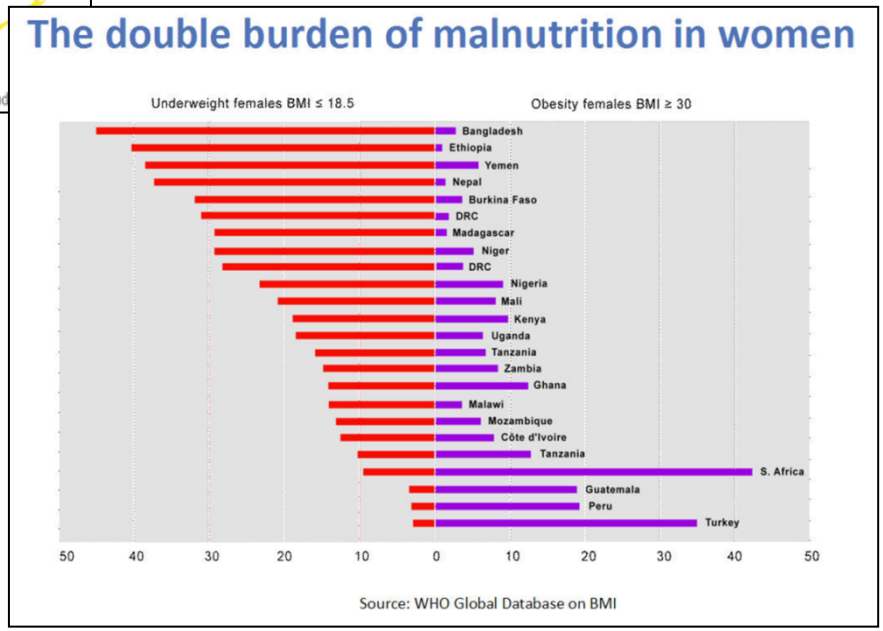
Undernutrition remains a problem

LMIC populations face calorie and nutrient deficiency





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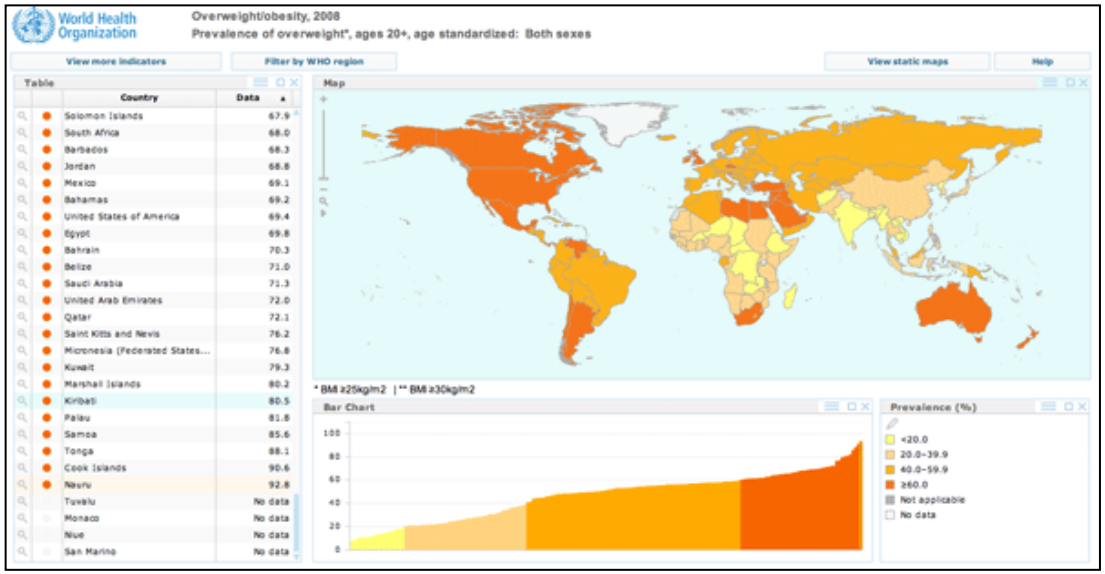
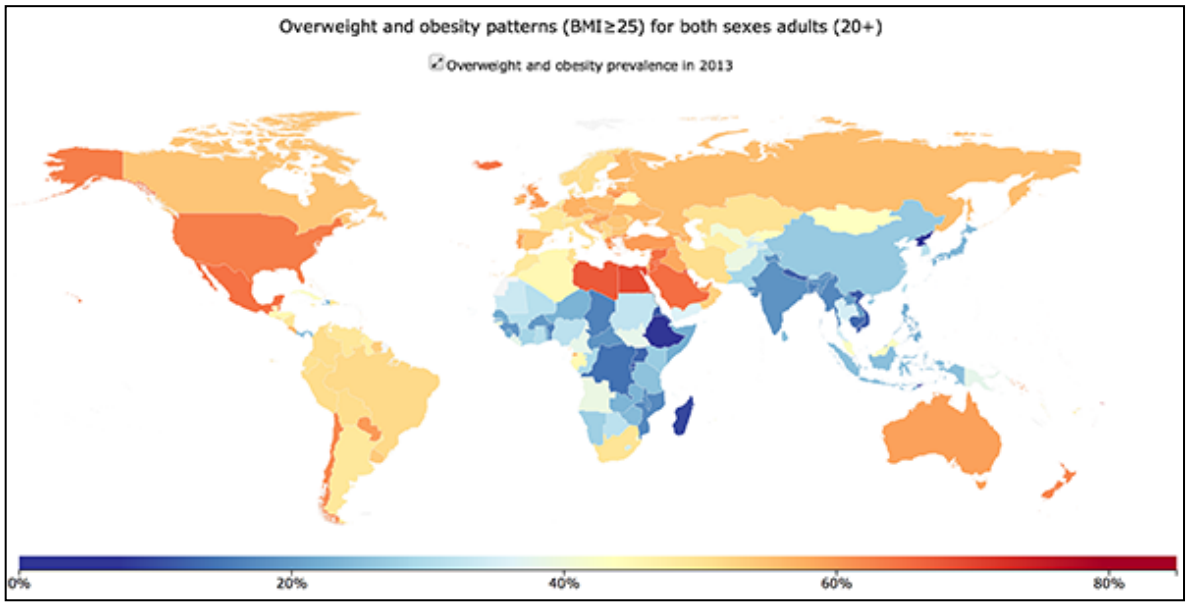
Obesity rates have increased worldwide

Data from the WHO and Institute for Health Metrics and Evaluation





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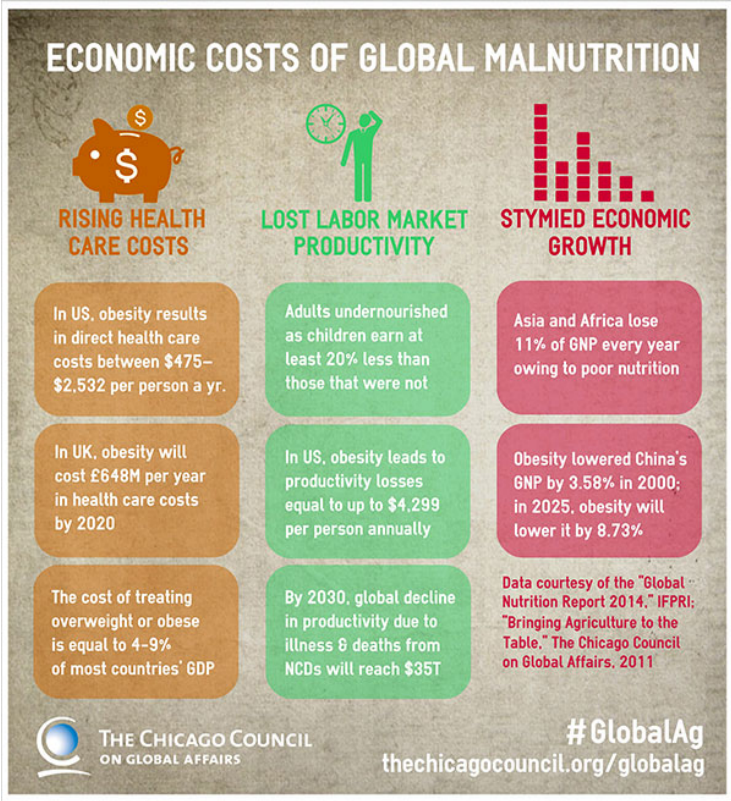
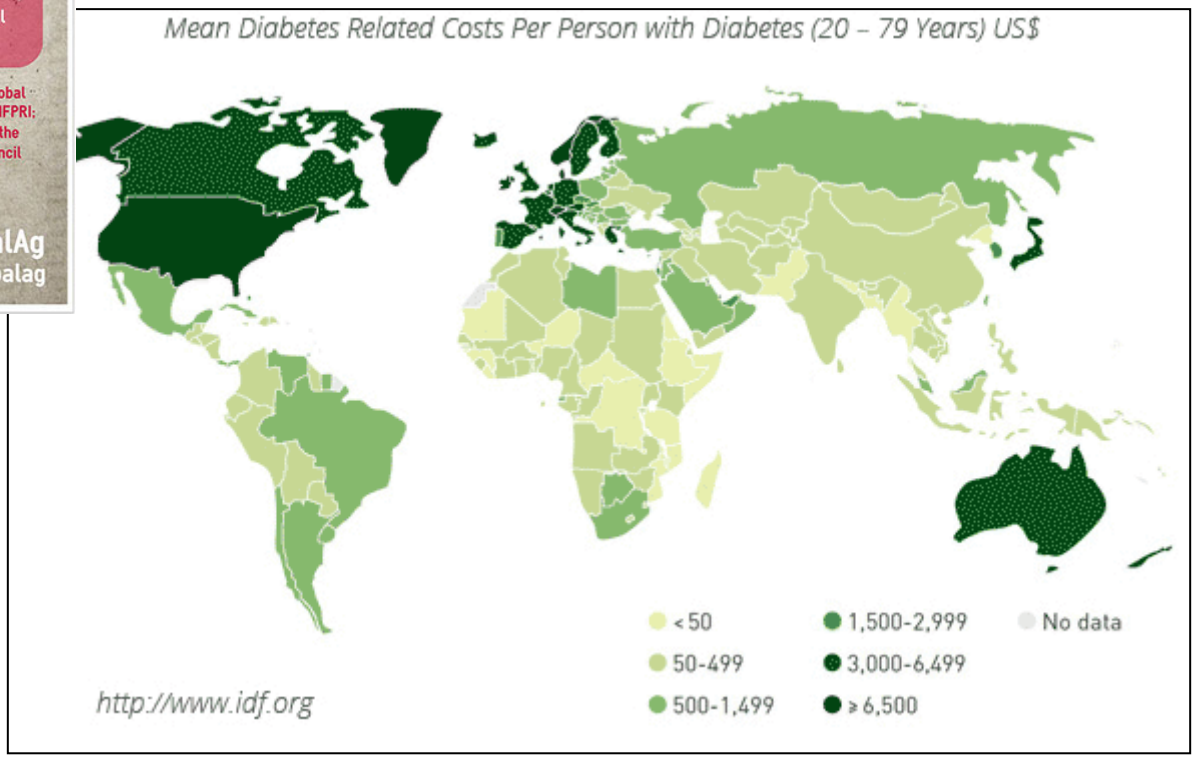
Experts predict enormous economic costs





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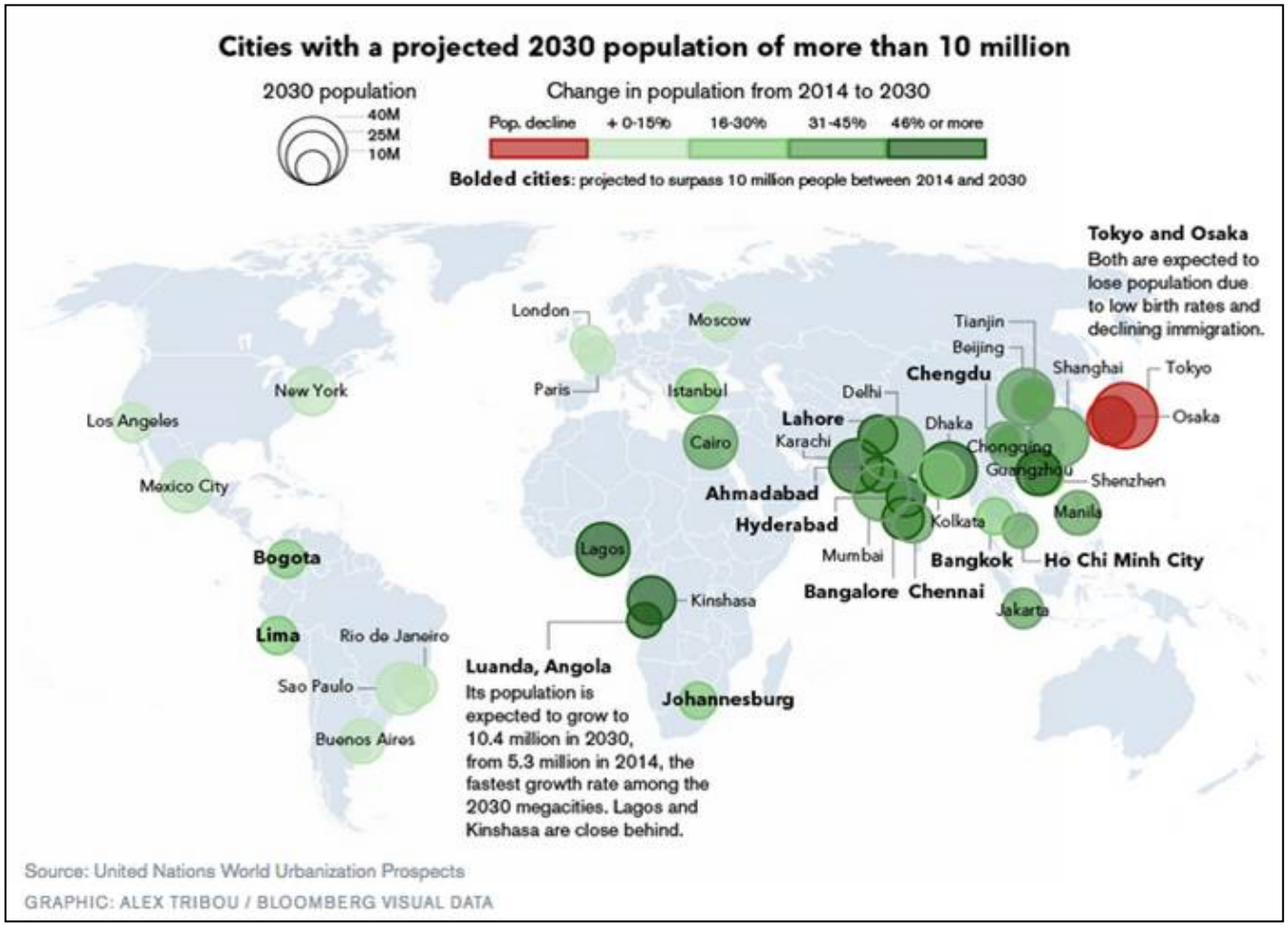
Megacities will become future obesity hotspots

Dwellers of poor megacities are dependent on processed foods



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What must we do?

We need a global nutrition intelligence agency

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What is the future nutrition transition?

Nutrition transition is the process whereby developing countries shift from a traditional diet high in staple grain crops and fiber to a dietary pattern with more animal foods, more added sugars, and more added fats.

The nutrition transition occurs in parallel with economic, demographic, and epidemiologic changes at population level.

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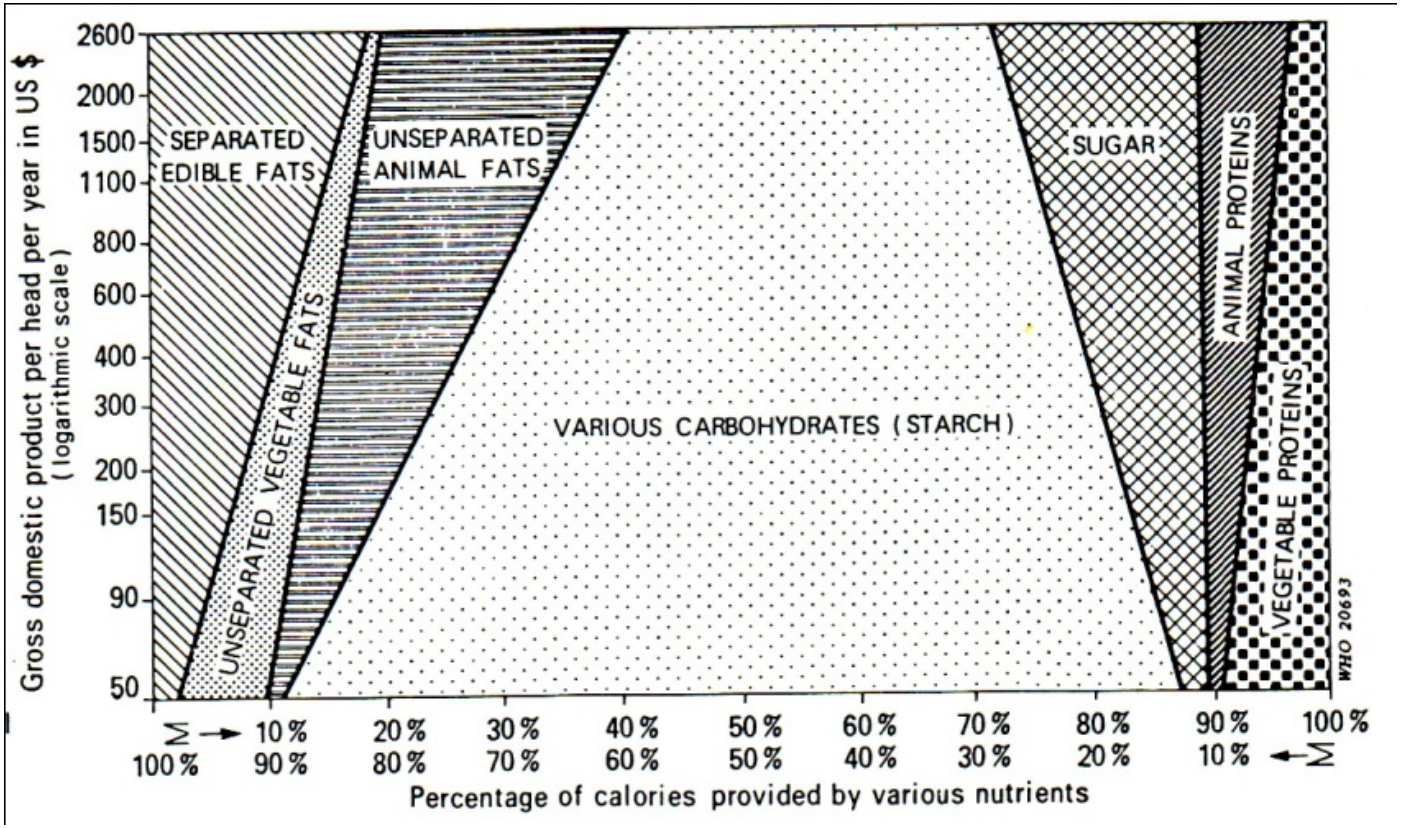
Old relation: GDP and diet quality 1970

FAO 1969/70 - in Nutrition Newsletter, Vol 7, No 3, Jul-Sep 1969 - P. 1-9

HIC

LMIC



In 1970, LMIC consumed diets based around grains, with very few processed foods, animal products or added sugar.

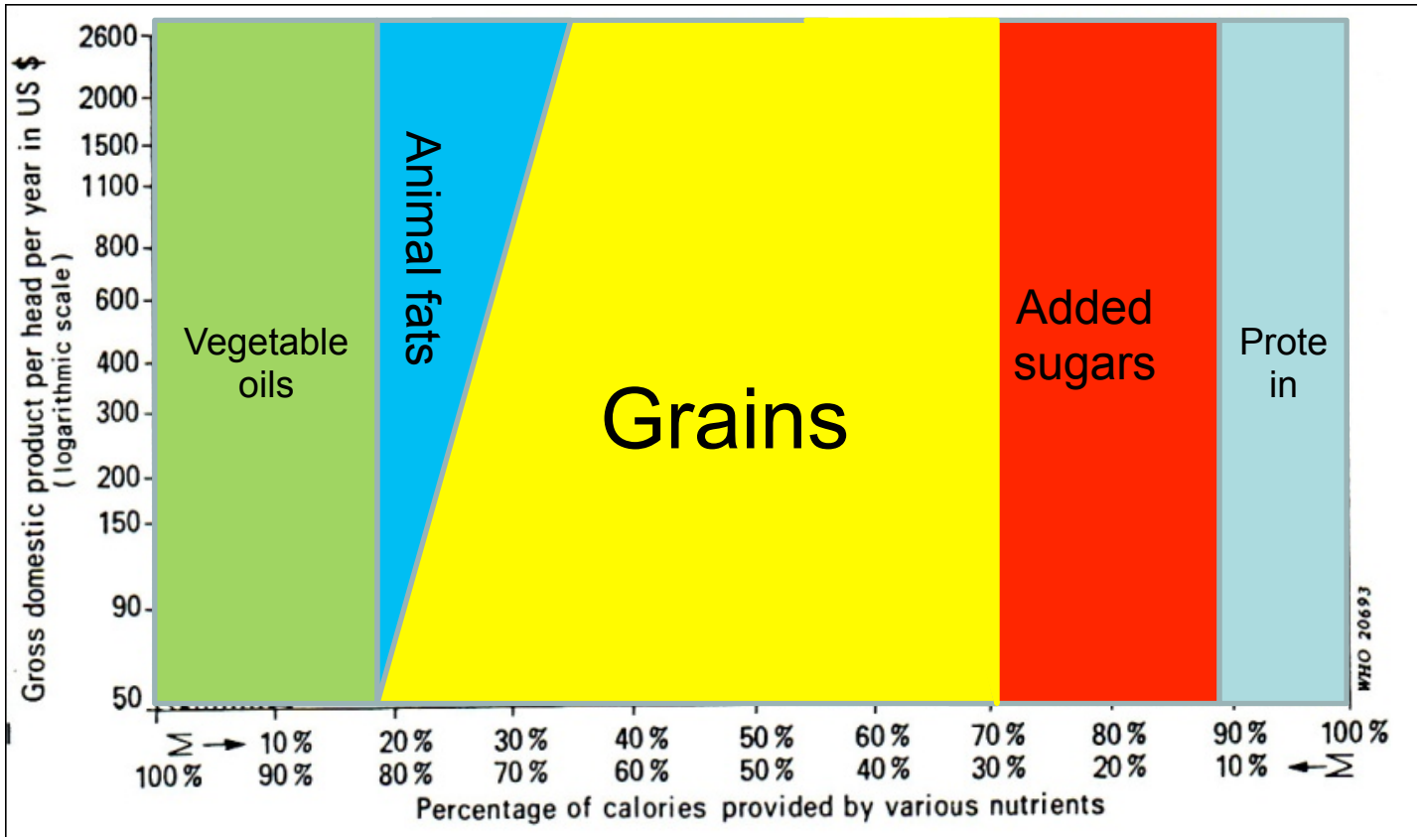
Francois, Perisse, Sizaret 1970 FAO

New relation: GDP and diet quality 2000

Data from Drewnowski and Popkin 1998

HIC

LMIC



By 2000, cheap vegetable oils and added sugars were available even to the lowest income nations. The relation between GDP and diet quality was uncoupled (Drewnowski and Popkin 1998).

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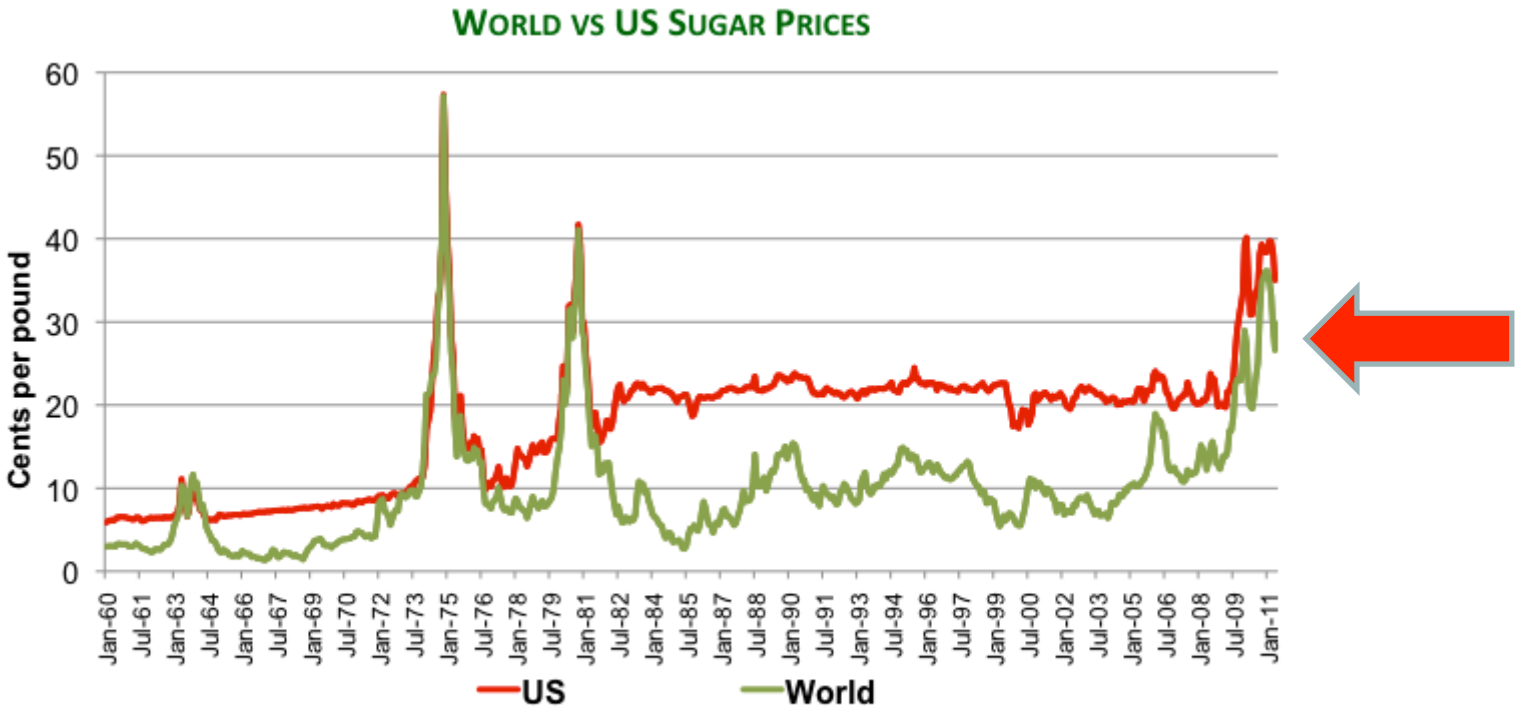
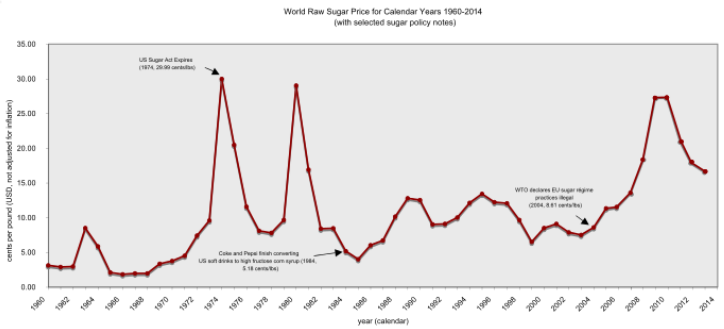
At 20 cents/lb (world market price), sugar provides 9,000 kcal/dollar



U.S. raw sugar price, duty free paid, New York, monthly
World raw sugar price, monthly
Source: USDA



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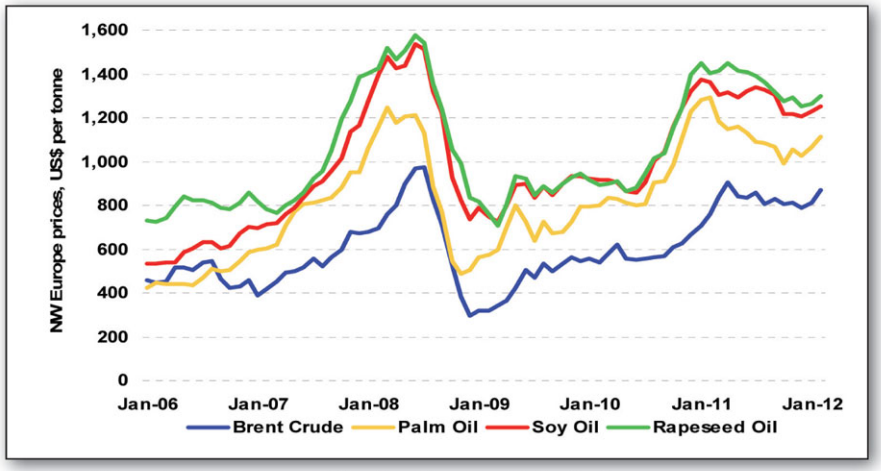
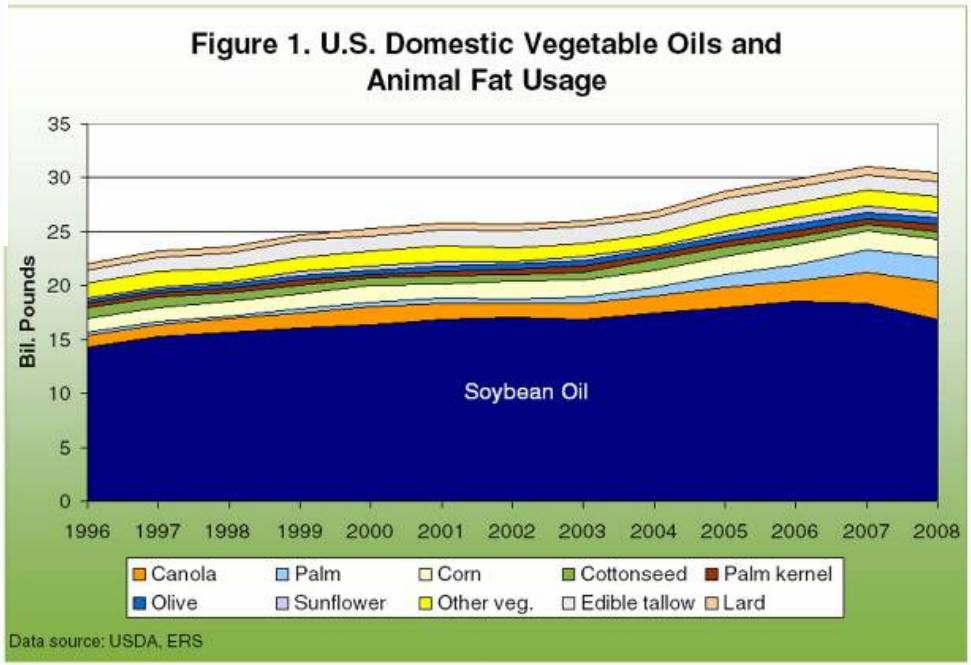
At 1.2 USD/kg (EU price), soybean oil provides 7,500 kcal/dollar



Graph 1: EU vegetable oil prices and Brent crude prices (dollar/ton).



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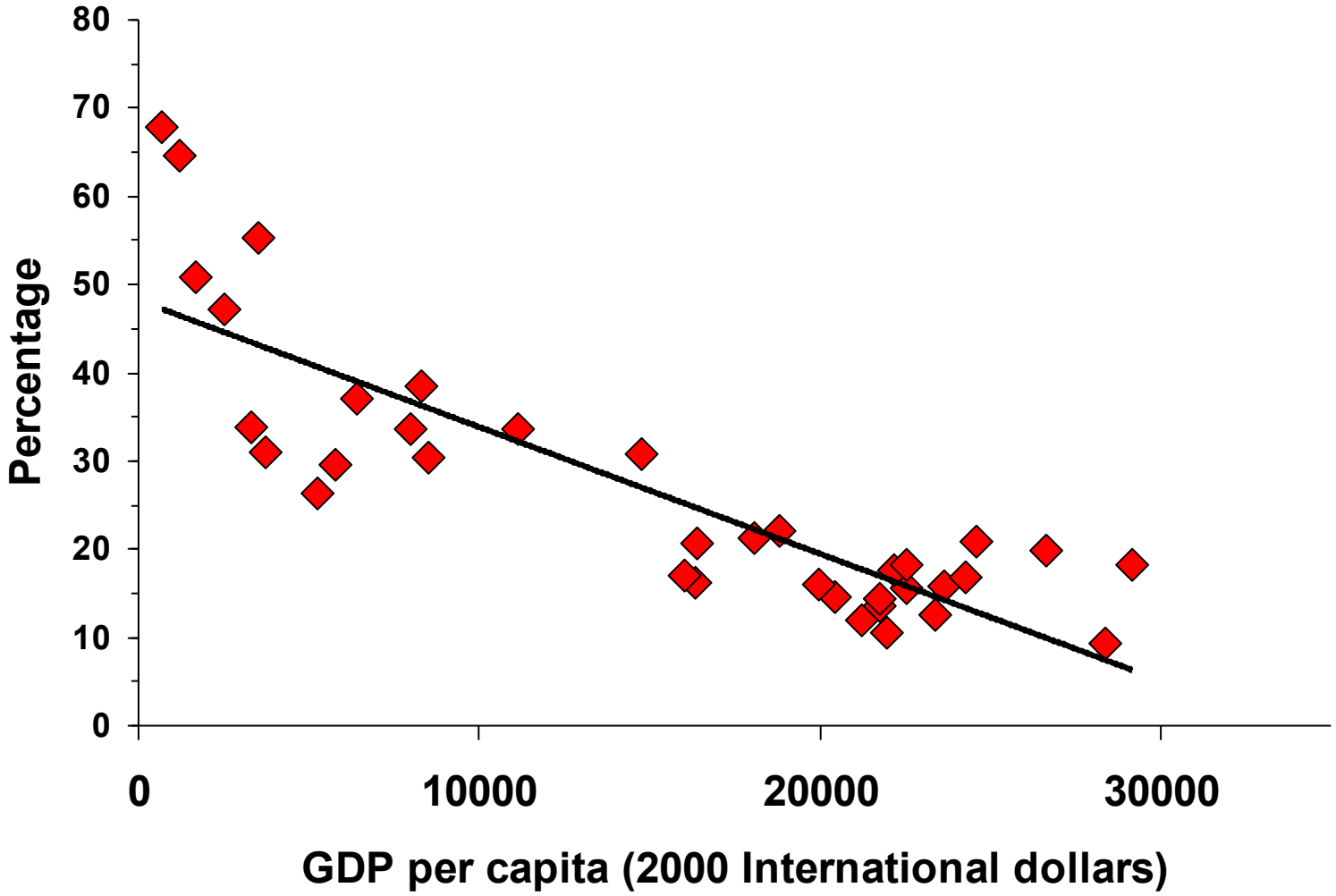
Food spending has decreased 1992-2005

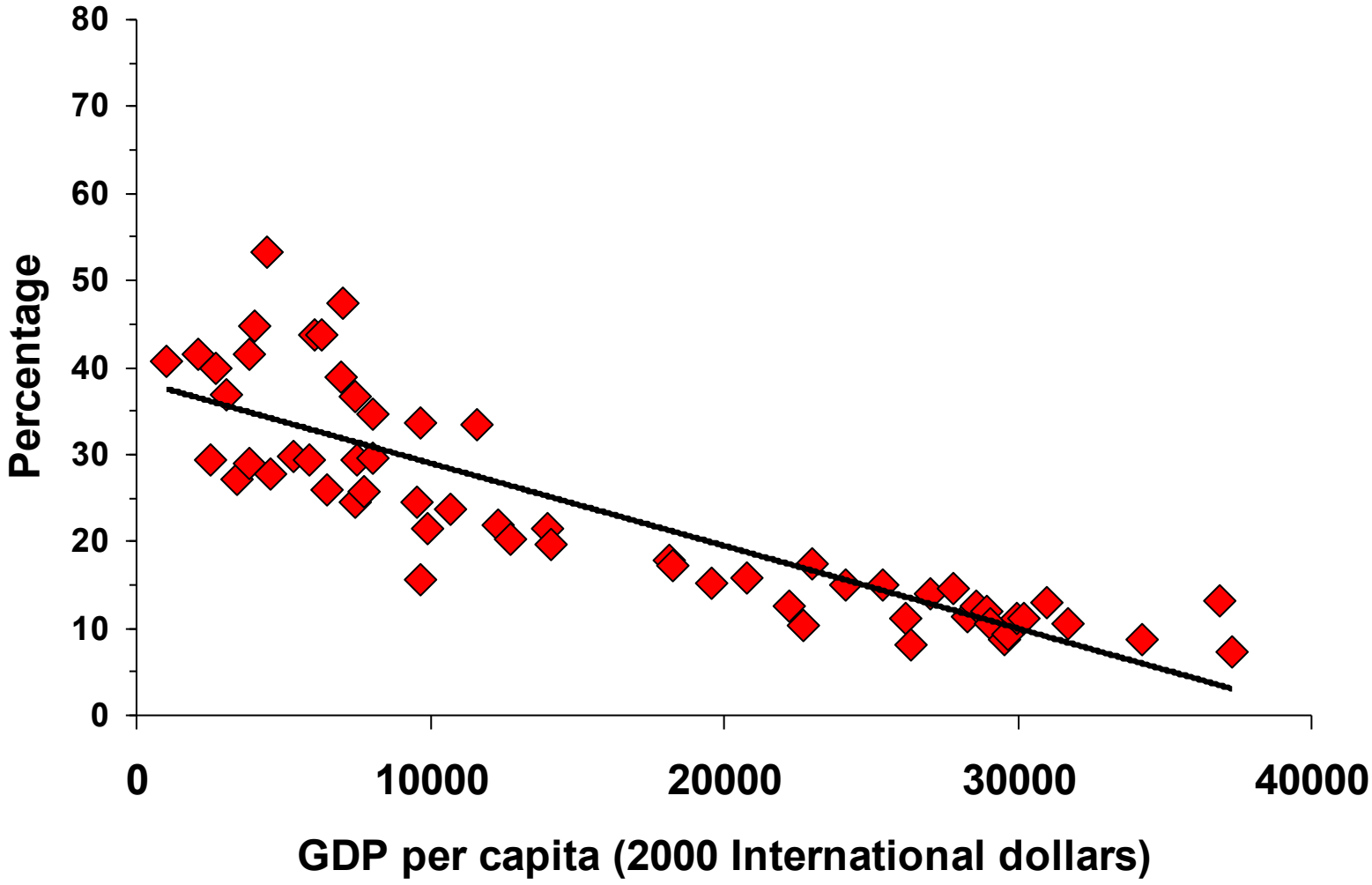
GDP and food expenditures 1992



Source: Euromonitor International – analyses by Trent Smith

Food spending has decreased 1992-2005

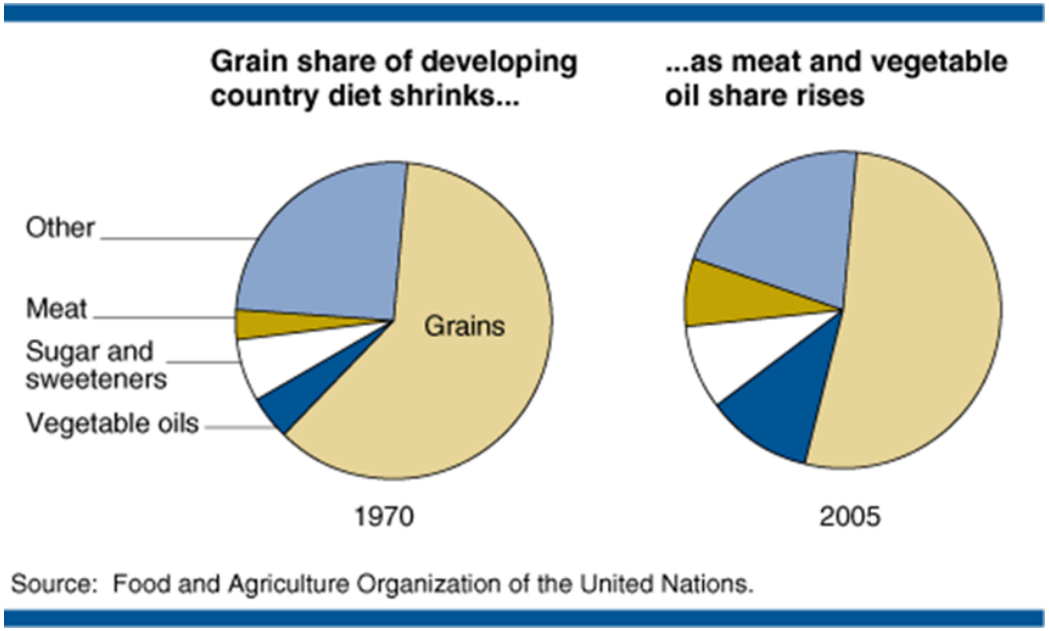
GDP and food expenditures 2005

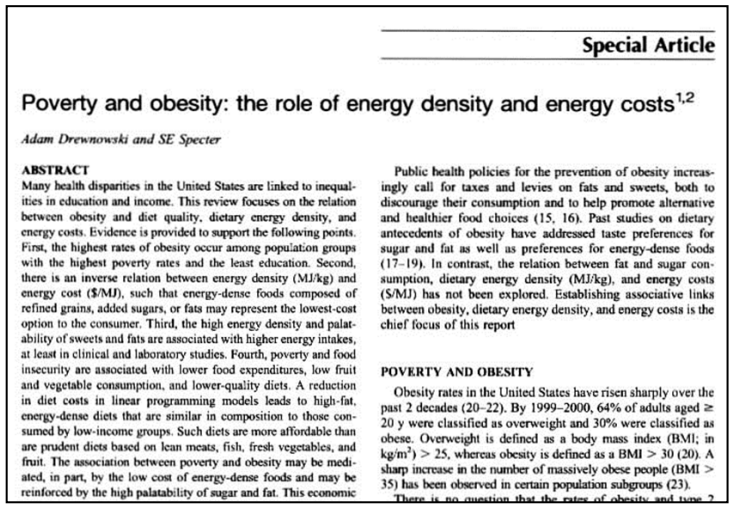


Source: Euromonitor International – analyses by Trent Smith

Sugar and oil calories have increased the most

Solid fats and added sugars are the chief sources of empty calories in the US diet (USDA Dietary Guidelines 2015)





Special Article

Poverty and obesity: the role of energy density and energy costs[1,2]

Adam Drewnowski and SE Specter

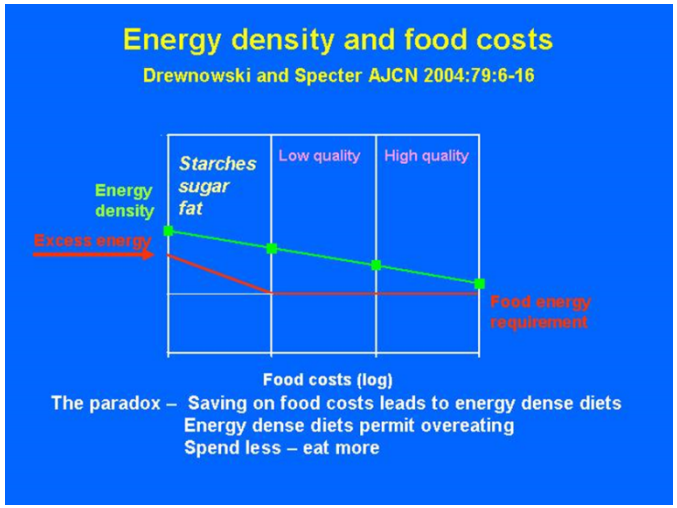
ABSTRACT

Many health disparities in the United States are linked to inequalities in education and income. This review focuses on the relation between obesity and diet quality, dietary energy density, and energy costs. Evidence is provided to support the following points. First, the highest rates of obesity occur among population groups with the highest poverty rates and the least education. Second, there is an inverse relation between energy density (MJ/kg) and energy cost ($/MJ), such that energy-dense foods composed of refined grains, added sugars, or fats may represent the lowest-cost option to the consumer. Third, the high energy density and palatability of sweets and fats are associated with higher energy intakes, at least in clinical and laboratory studies. Fourth, poverty and food insecurity are associated with lower food expenditures, low fruit and vegetable consumption, and lower-quality diets. A reduction in diet costs in linear programming models leads to high-fat, energy-dense diets that are similar in composition to those consumed by low-income groups. Such diets are more affordable than are prudent diets based on lean meats, fish, fresh vegetables, and fruit. The association between poverty and obesity may be mediated, in part, by the low cost of energy-dense foods and may be reinforced by the high palatability of sugar and fat. This economic

Public health policies for the prevention of obesity increasingly call for taxes and levies on fats and sweets, both to discourage their consumption and to help promote alternative and healthier food choices (15, 16). Past studies on dietary antecedents of obesity have addressed taste preferences for sugar and fat as well as preferences for energy-dense foods (17–19). In contrast, the relation between fat and sugar consumption, dietary energy density (MJ/kg), and energy costs ($/MJ) has not been explored. Establishing associative links between obesity, dietary energy density, and energy costs is the chief focus of this report

POVERTY AND OBESITY

Obesity rates in the United States have risen sharply over the past 2 decades (20–22). By 1999–2000, 64% of adults aged ≥ 20 y were classified as overweight and 30% were classified as obese. Overweight is defined as a body mass index (BMI; in kg/m^2) > 25, whereas obesity is defined as a BMI > 30 (20). A sharp increase in the number of massively obese people (BMI > 35) has been observed in certain population subgroups (23).



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How to correct nutrition imbalance
Some key concepts

Energy density
Nutrient density
Energy and nutrient cost

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How to measure energy density?

Energy density is linked to water content of foods

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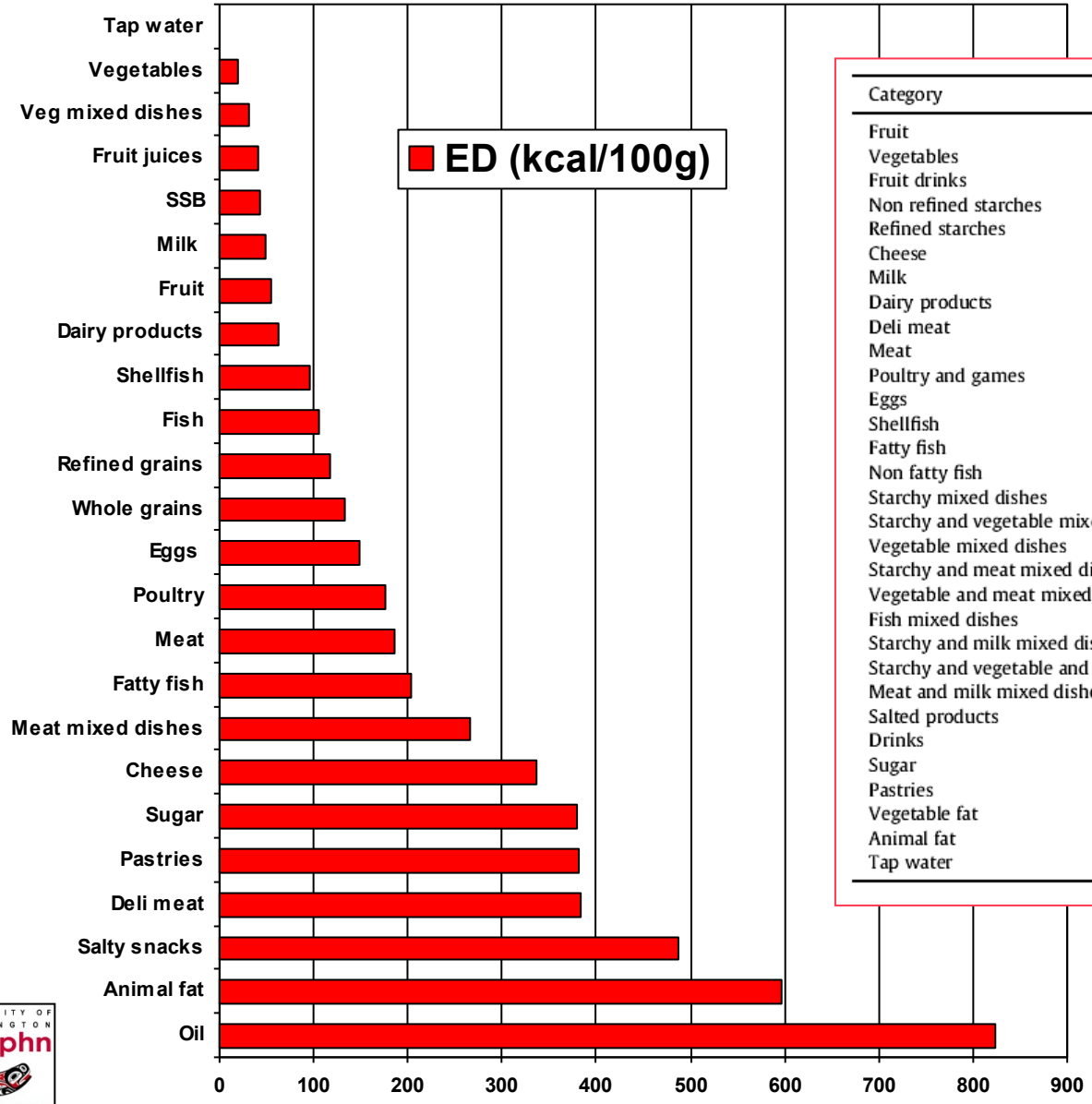
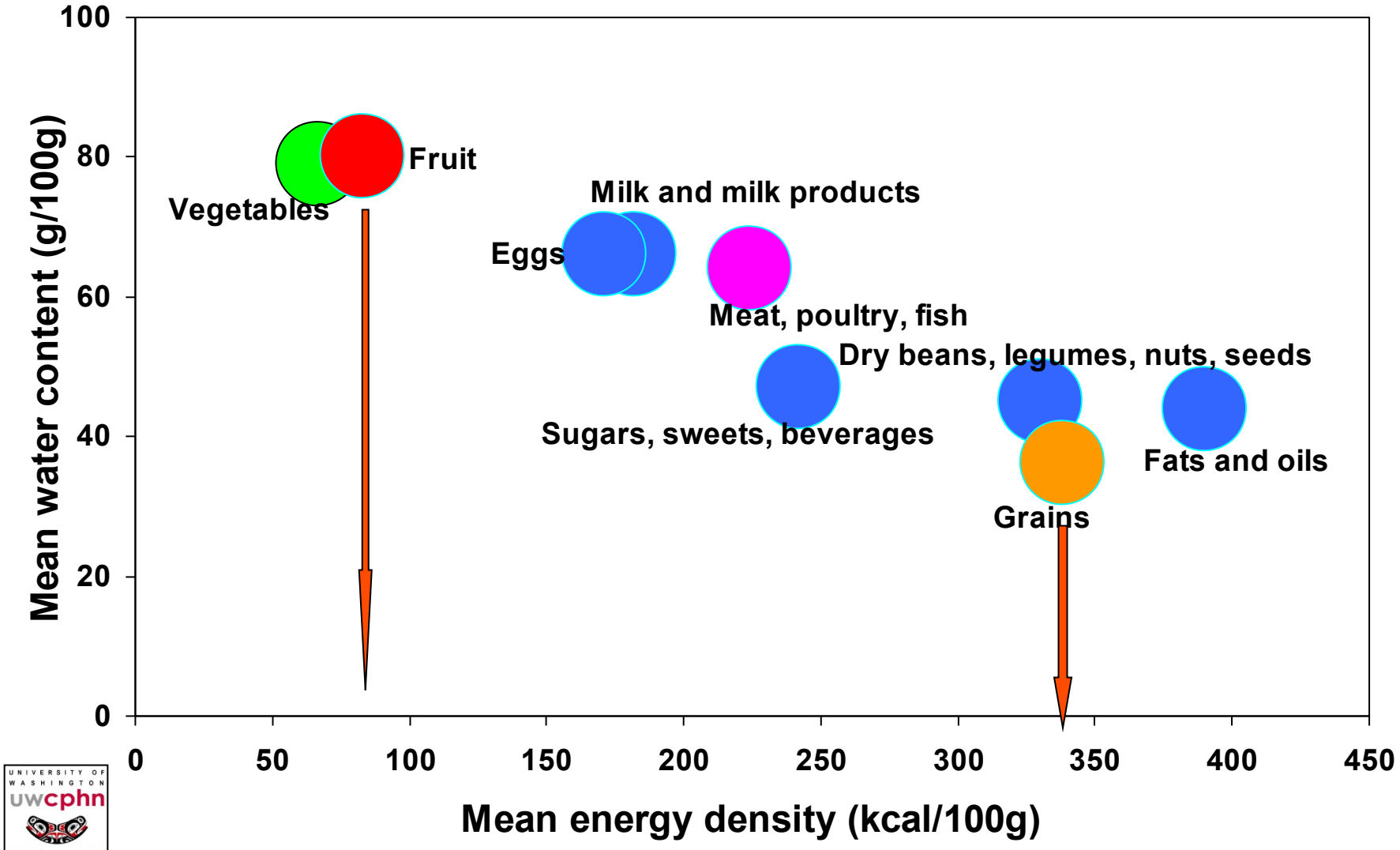
What is energy density? Kcal/100g



Category	Energy density
Fruit	54.0
Vegetables	20.3
Fruit drinks	42.4
Non refined starches	134.3
Refined starches	116.8
Cheese	336.5
Milk	48.5
Dairy products	62.7
Deli meat	384.6
Meat	186.9
Poultry and games	177.1
Eggs	148.0
Shellfish	96.3
Fatty fish	203.2
Non fatty fish	104.5
Starchy mixed dishes	124.0
Starchy and vegetable mixed dishes	148.0
Vegetable mixed dishes	32.2
Starchy and meat mixed dishes	180.3
Vegetable and meat mixed dishes	128.0
Fish mixed dishes	202.0
Starchy and milk mixed dishes	111.0
Starchy and vegetable and meat mixed dishes	148.0
Meat and milk mixed dishes	266.3
Salted products	487.0
Drinks	44.1
Sugar	380.3
Pastries	382.4
Vegetable fat	824.4
Animal fat	596.1
Tap water	0

Energy dense foods are dry

Data for 1387 foods by USDA 9 major food groups



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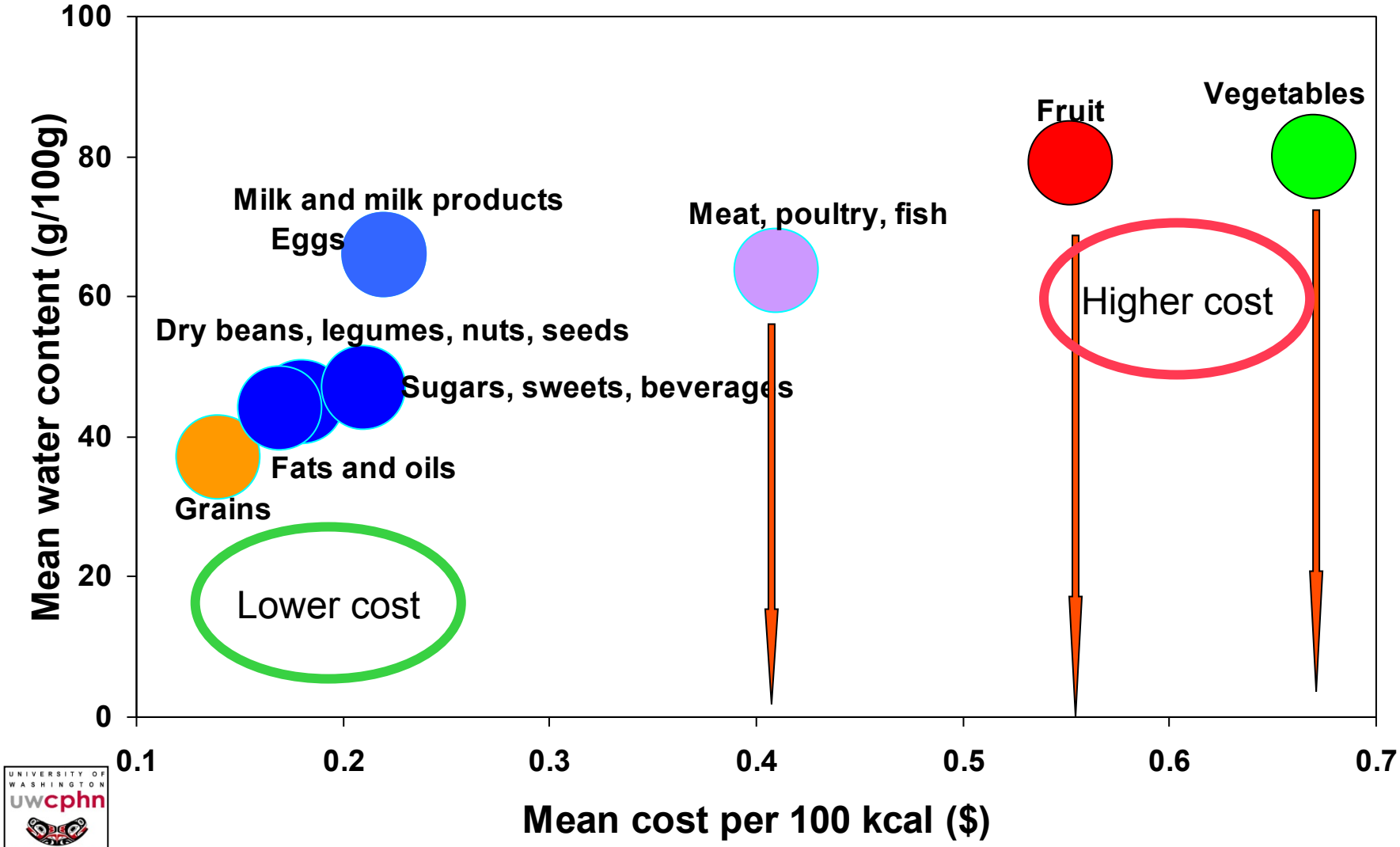
Dry foods are usually cheaper per 100 kcal

Data for 1387 foods by USDA food group



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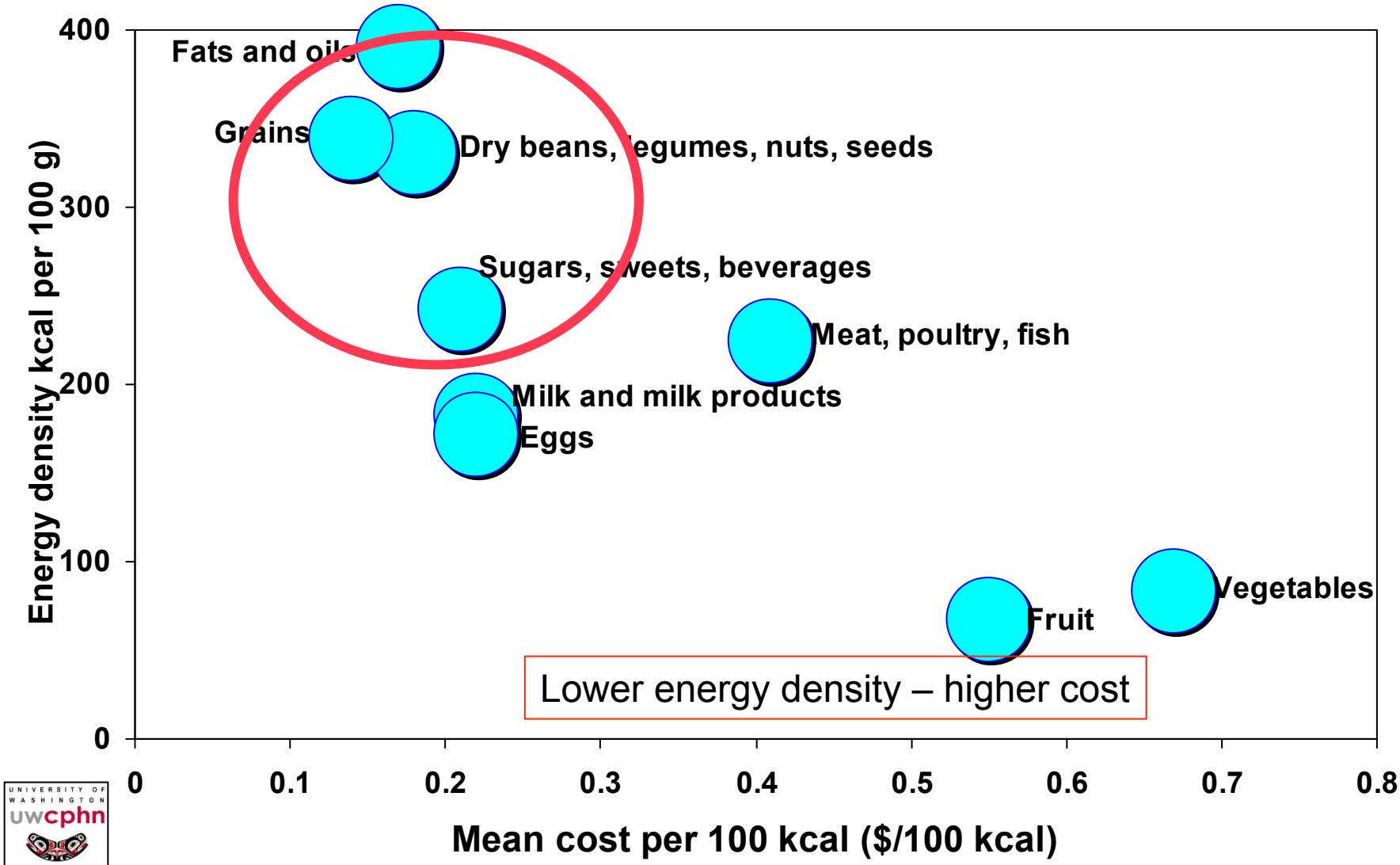
Cheaper foods can be *nutrient-poor*

Data for 1387 foods by USDA food group



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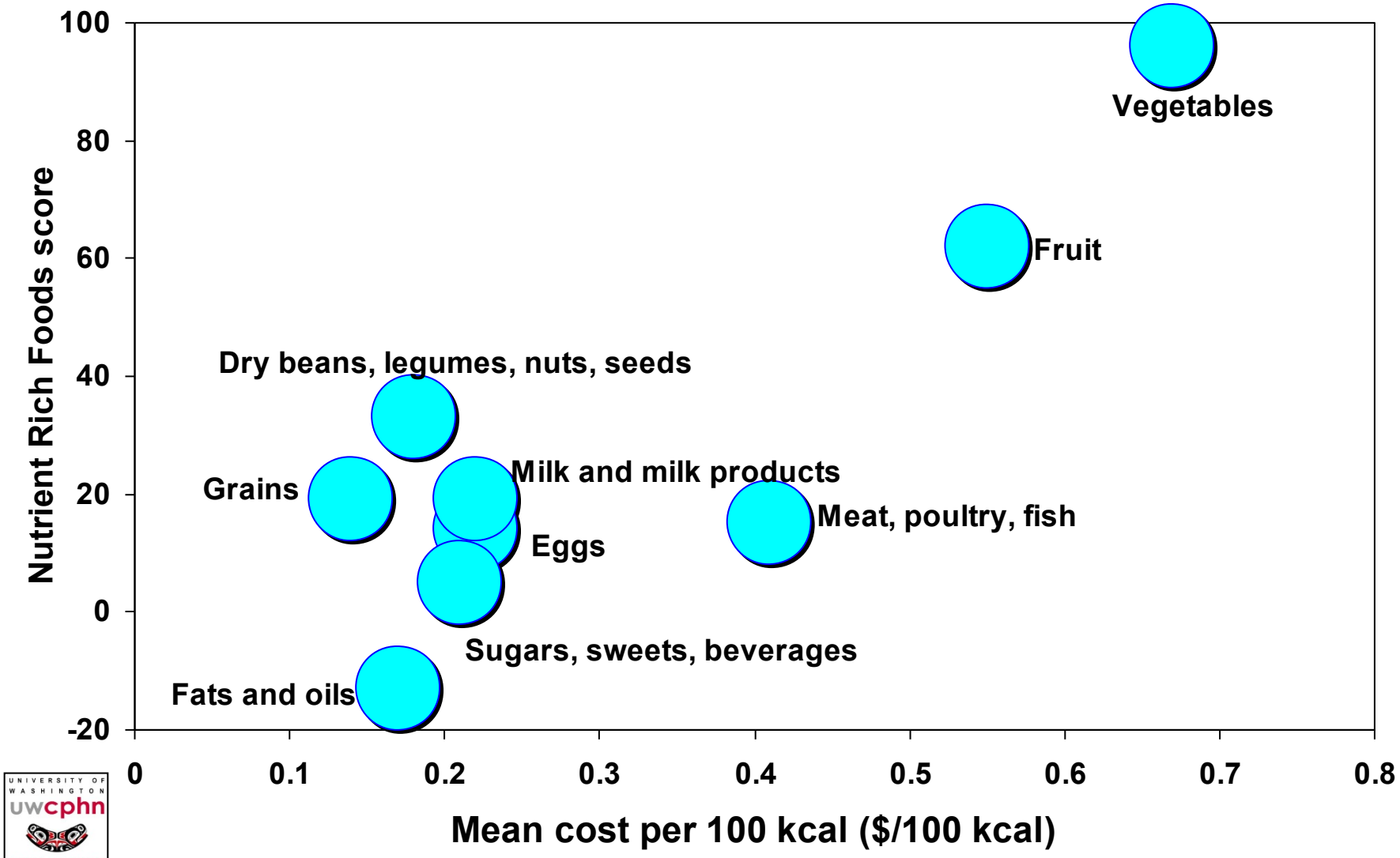
Nutrient-rich foods cost more per 100kcal

Data for 1387 foods by USDA food group



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How to measure nutrient density?

Nutrient profiling methods rate foods based on their nutrient content
relative to calories

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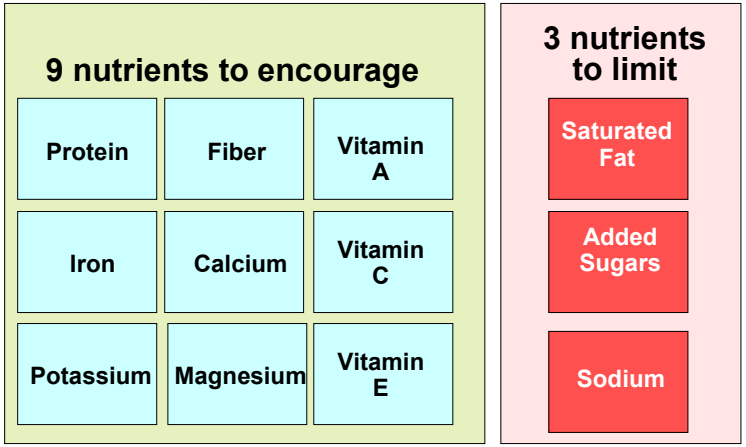
How to create nutrient profile models

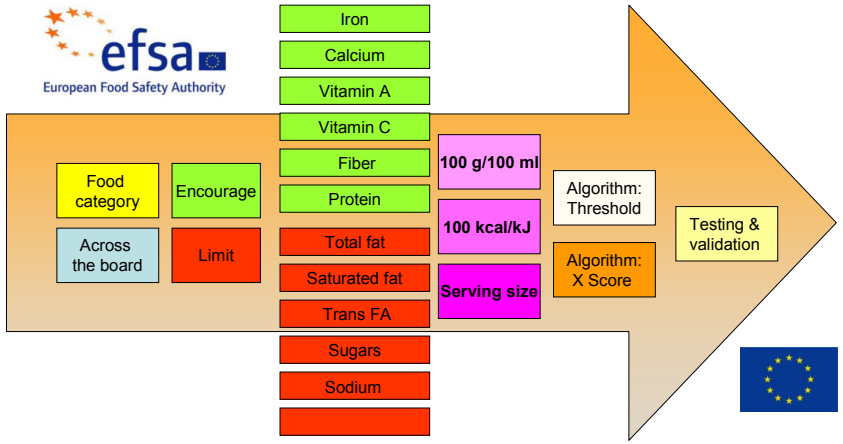
Regulatory agencies separate energy-dense from nutrient-rich foods

The Nutrient Rich Foods (NRF) Index
Is a nutrient profiling system

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



Drewnowski, Fulgoni. Nutr Rev 2008



Energy density and nutrient density are inversely linked

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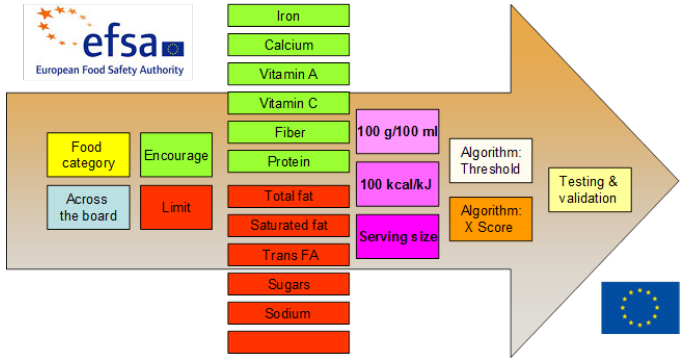
Secrets of nutrient profiling: Follow EFSA lead

- **Select nutrients to encourage**
  - Fiber, vitamins A, C, E, Ca, K, Mg, vit D
- **Select nutrients to limit**
  - Saturated fat, added (free) sugars, sodium, (total sugar, energy)
- **Select base of calculation**
  - 100g, 100 kcal or serving
- **Select algorithm**
  - Many options: arithmetic, ratio, weigted?
- **Select method of validation**
  - Many options
- **Select score, label or logo**



Drewnowski, Fulgoni. Nutr Rev 2008

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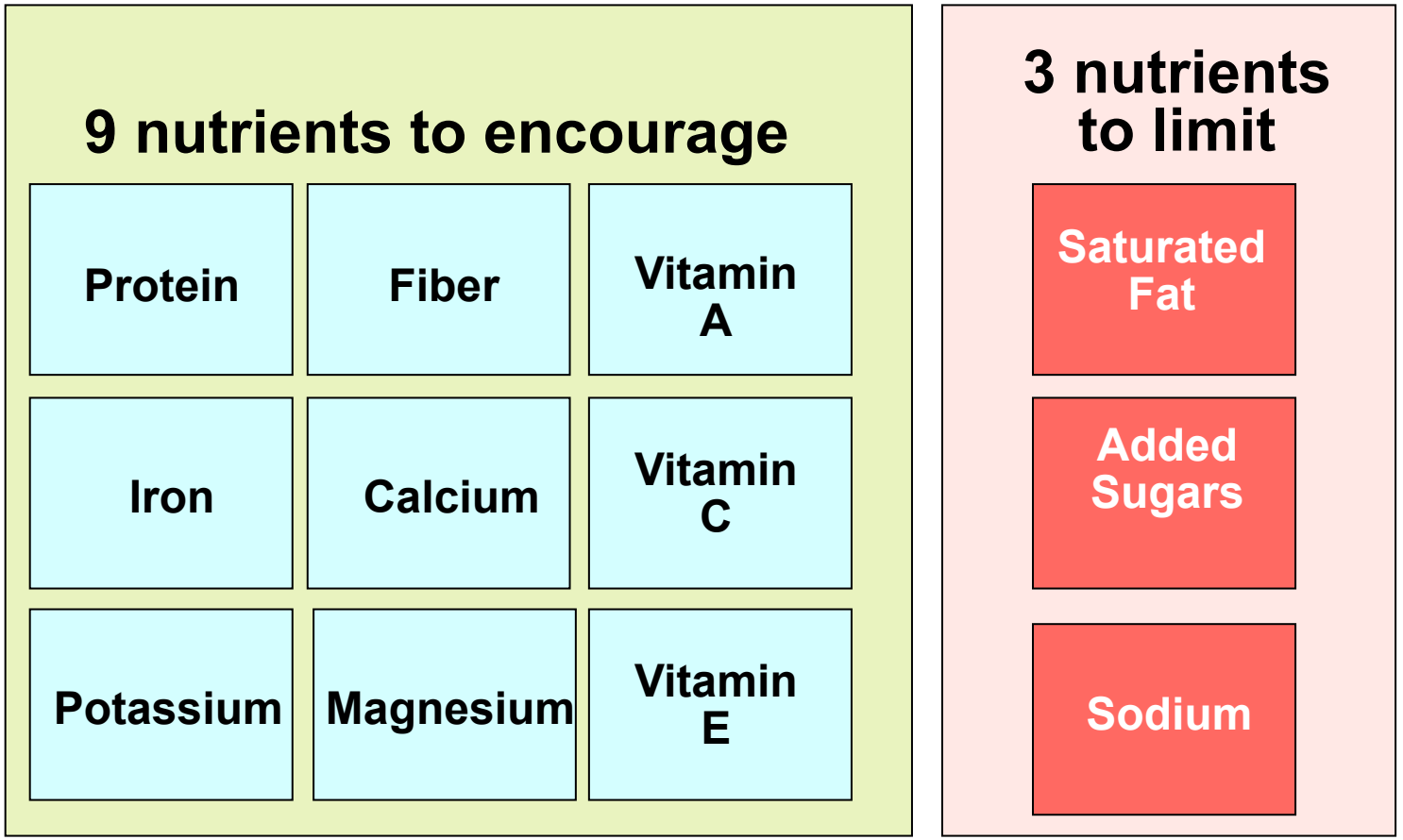
Select reference amounts from the FDA

FDA	DV 2000		FDA	DV 2000
Protein	50 g		Folate	400 μg
Fiber	25 g		Pantothenic acid	10 mg
*Linoleic acid **	*9 g*		Calcium	1,000 mg
*Linolenic acid **	*1.8 g*		Iron	18 mg
*DHA**	*0.11 g*		Magnesium	400 mg
MUFA	20 g		Zinc	15 mg
Vitamin A	5000 IU		Phosphorus	1000 mg
Vitamin C	60 mg		Selenium	70 mg
Vitamin D	400 IU (10μg)		Copper	2.0 mg
Vitamin E	20 mg		Potassium	3500 mg
Vitamin K	80 μg		Iodine	150 μg
Thiamin	1.5 mg			
Riboflavin	1.7 mg			
Niacin	20 mg			
Vitamin B_6	2.0 mg			
Vitamin B_{12}	6 μg		* French RDI values	

The Nutrient Rich Foods Index

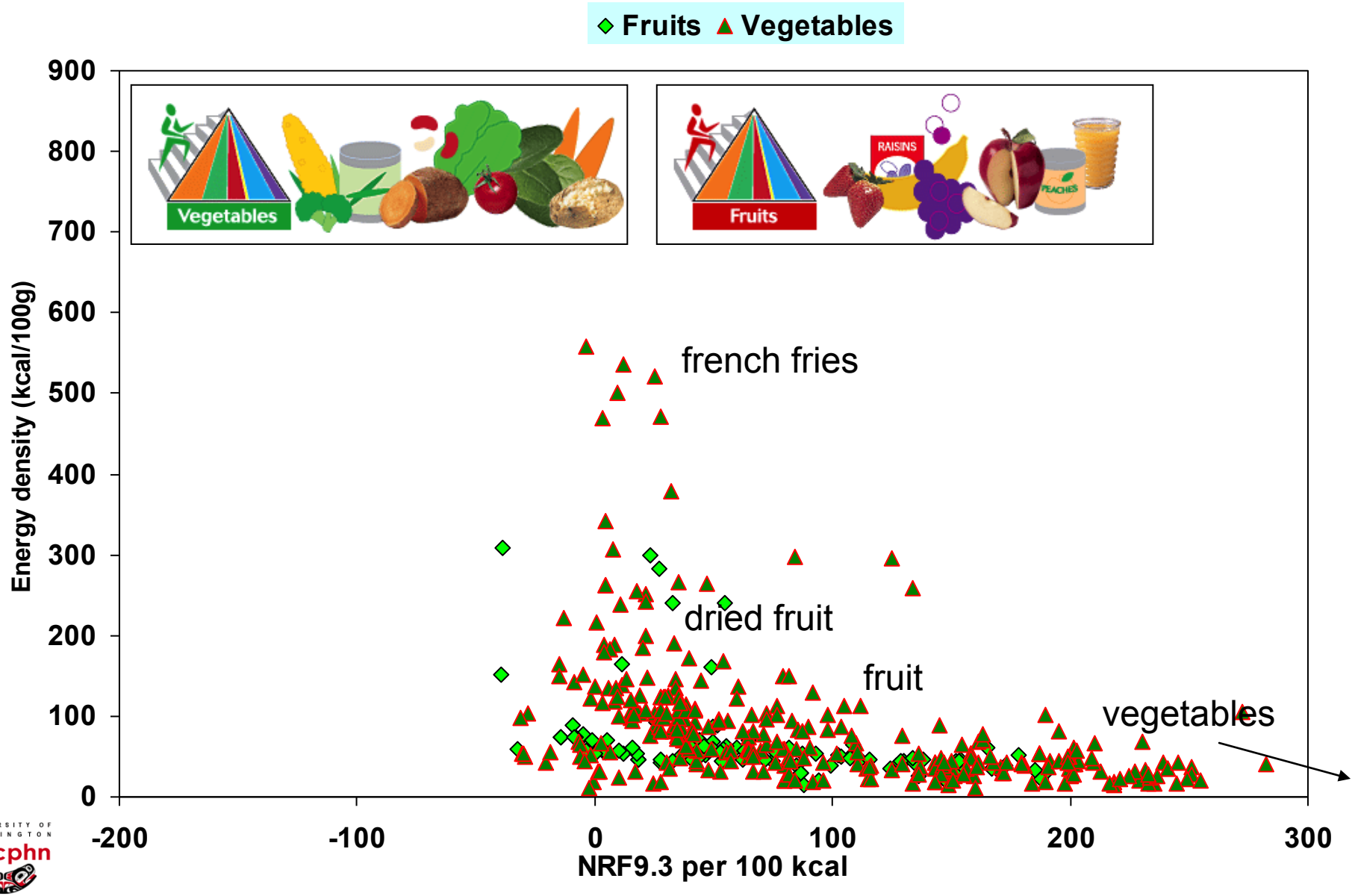
$$NRF9.3 = \Sigma_{i=9}\ (\%DV/100kcal) - \Sigma_{i=3}\ (\%DV100kcal)$$



Drewnowski, Fulgoni. Nutr Rev 2008

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

Data from USDA FNDDS 1.0



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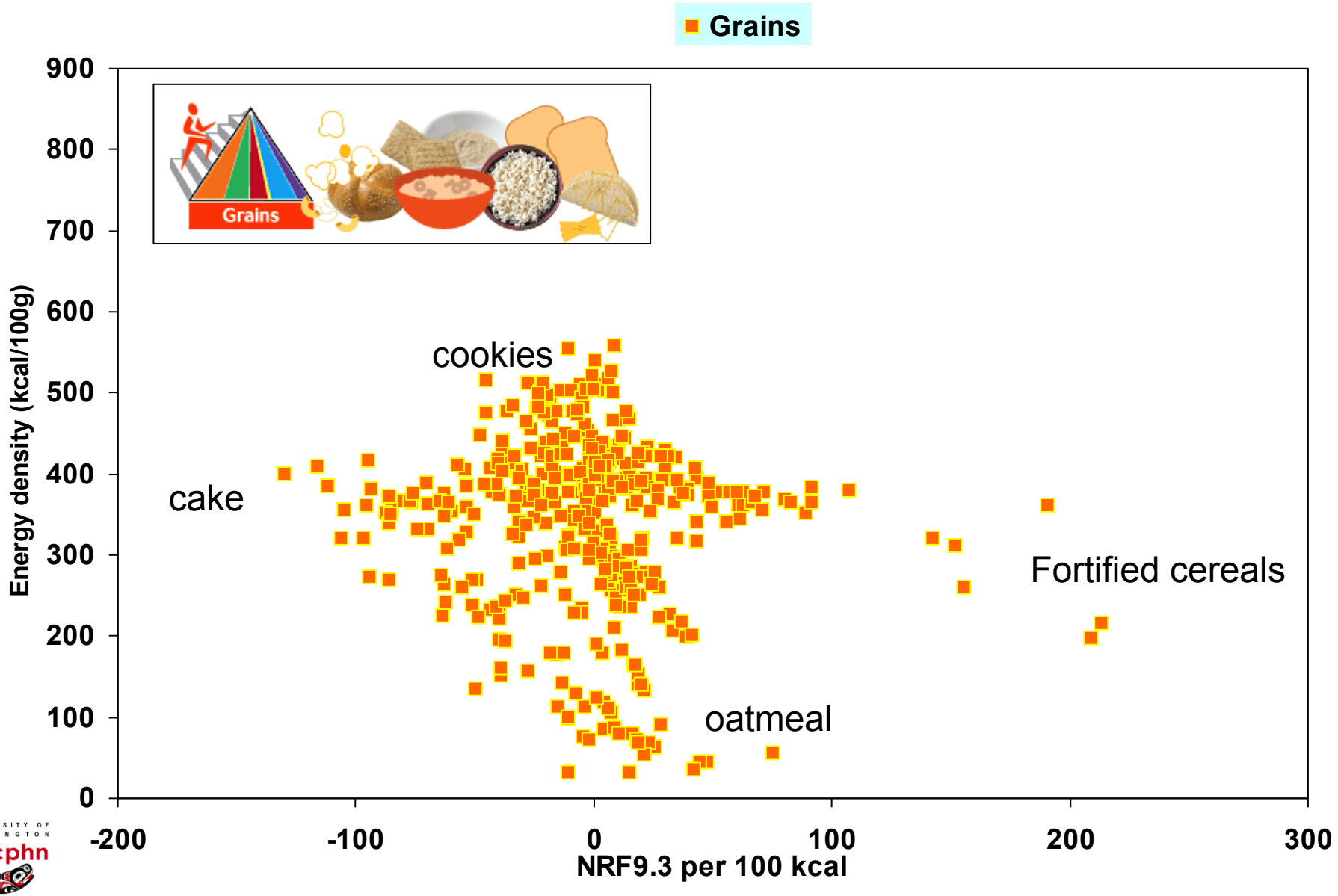

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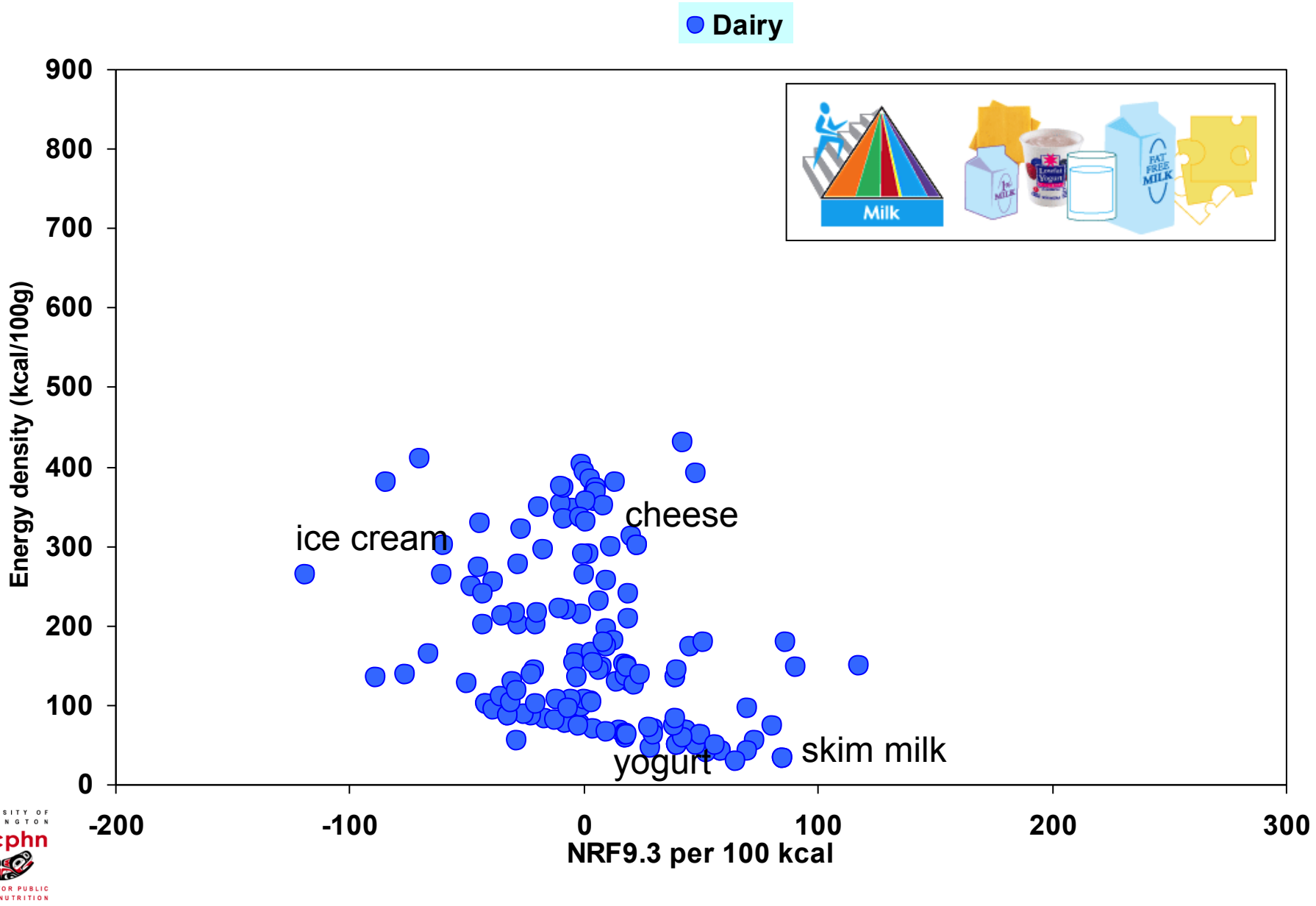

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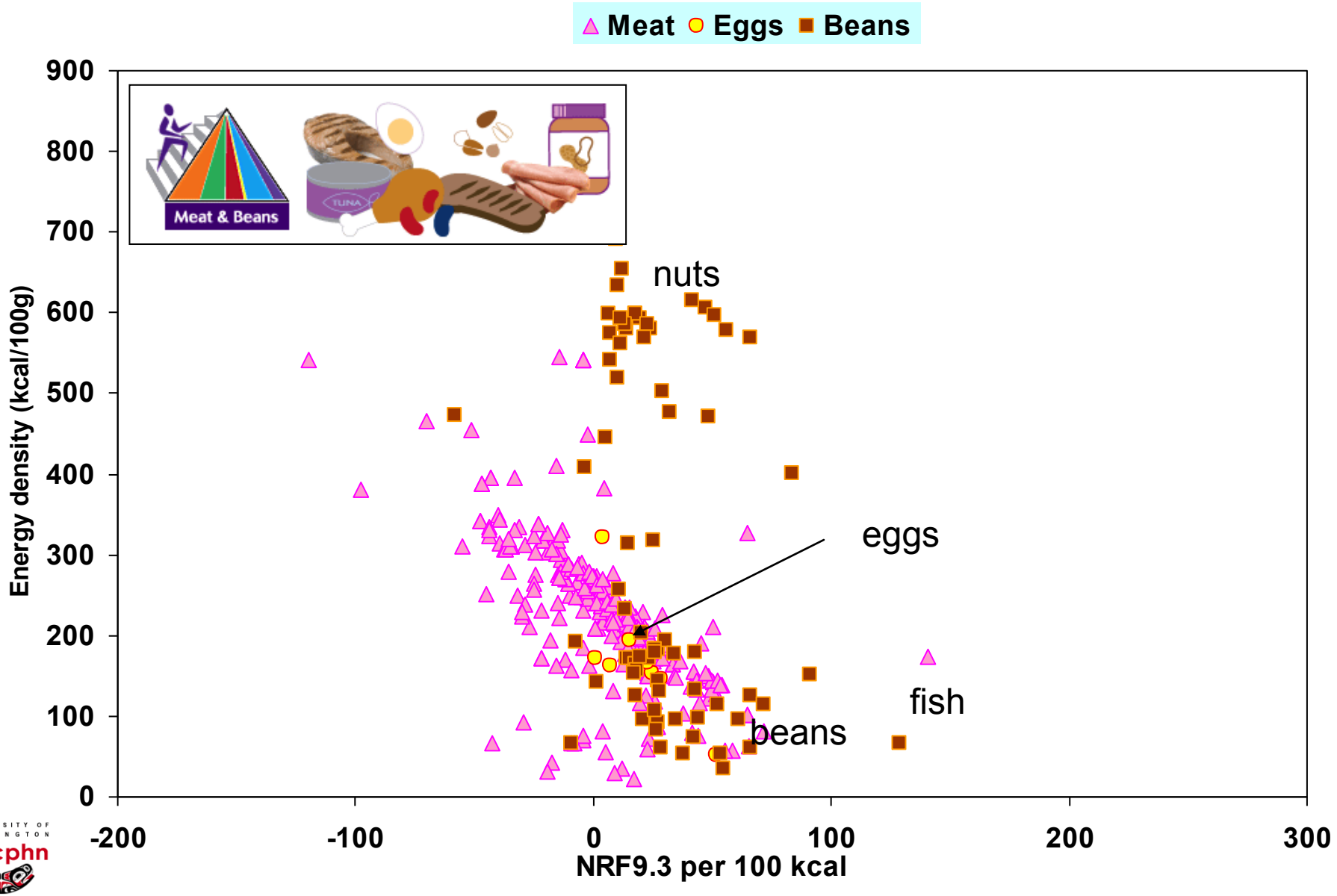

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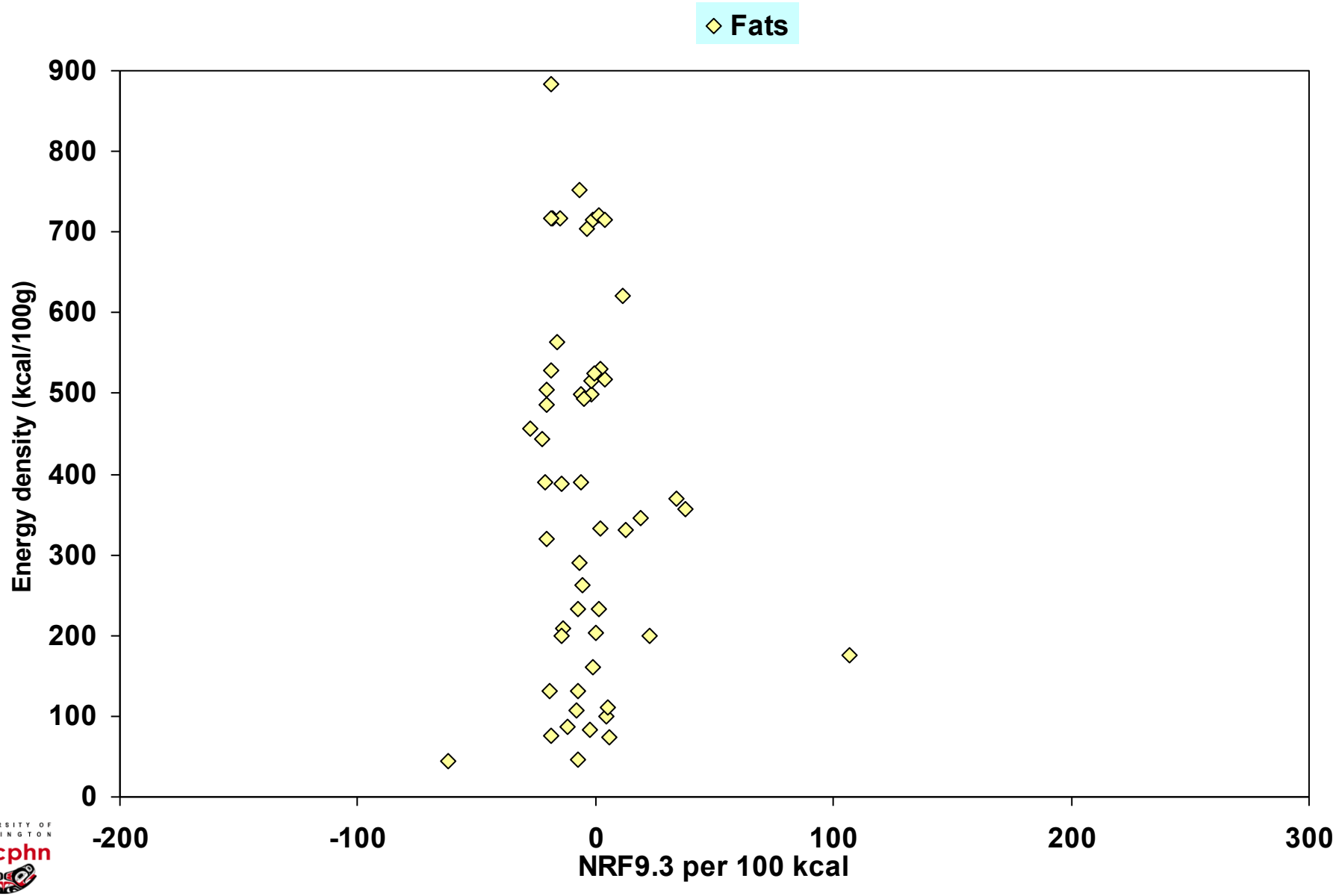

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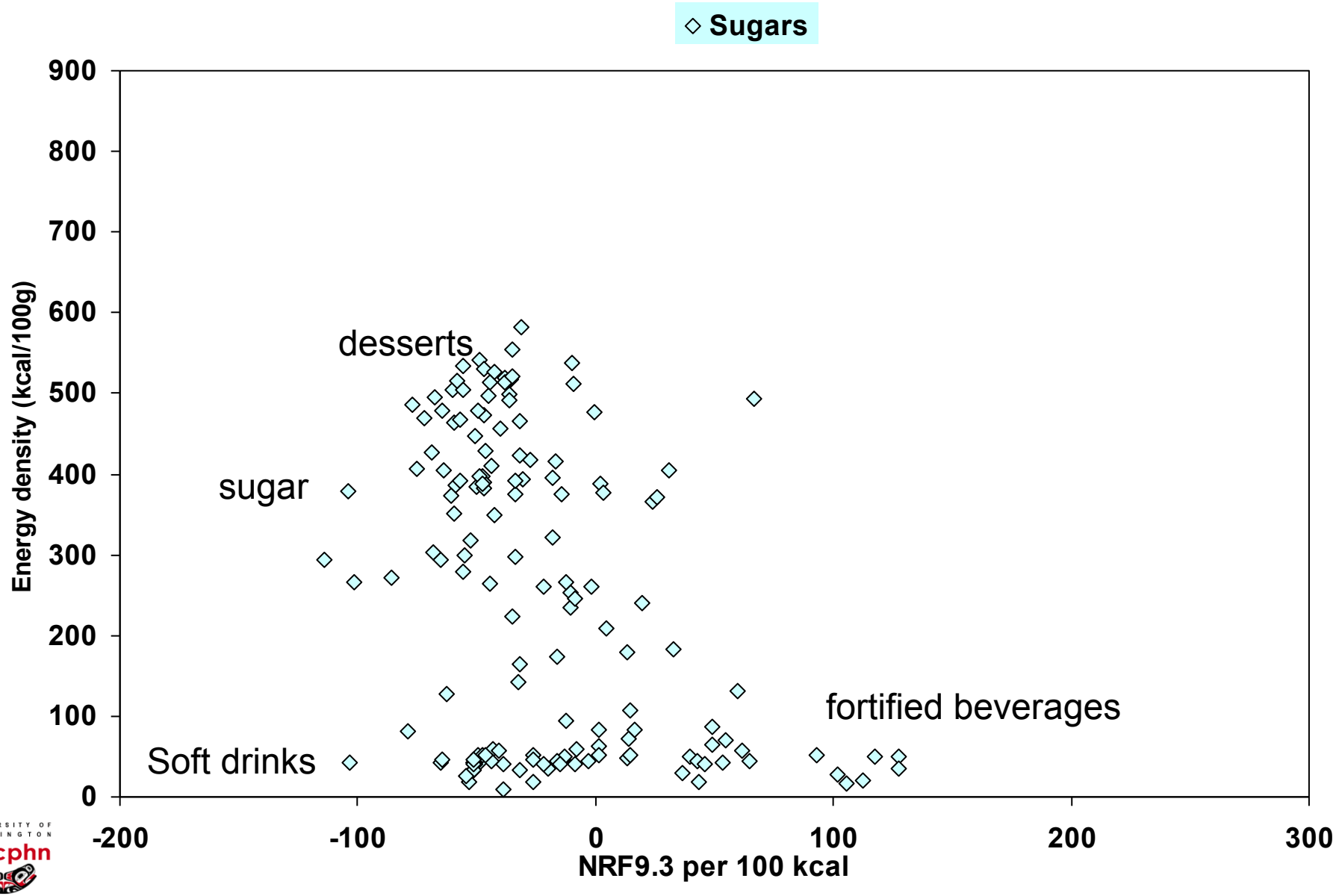

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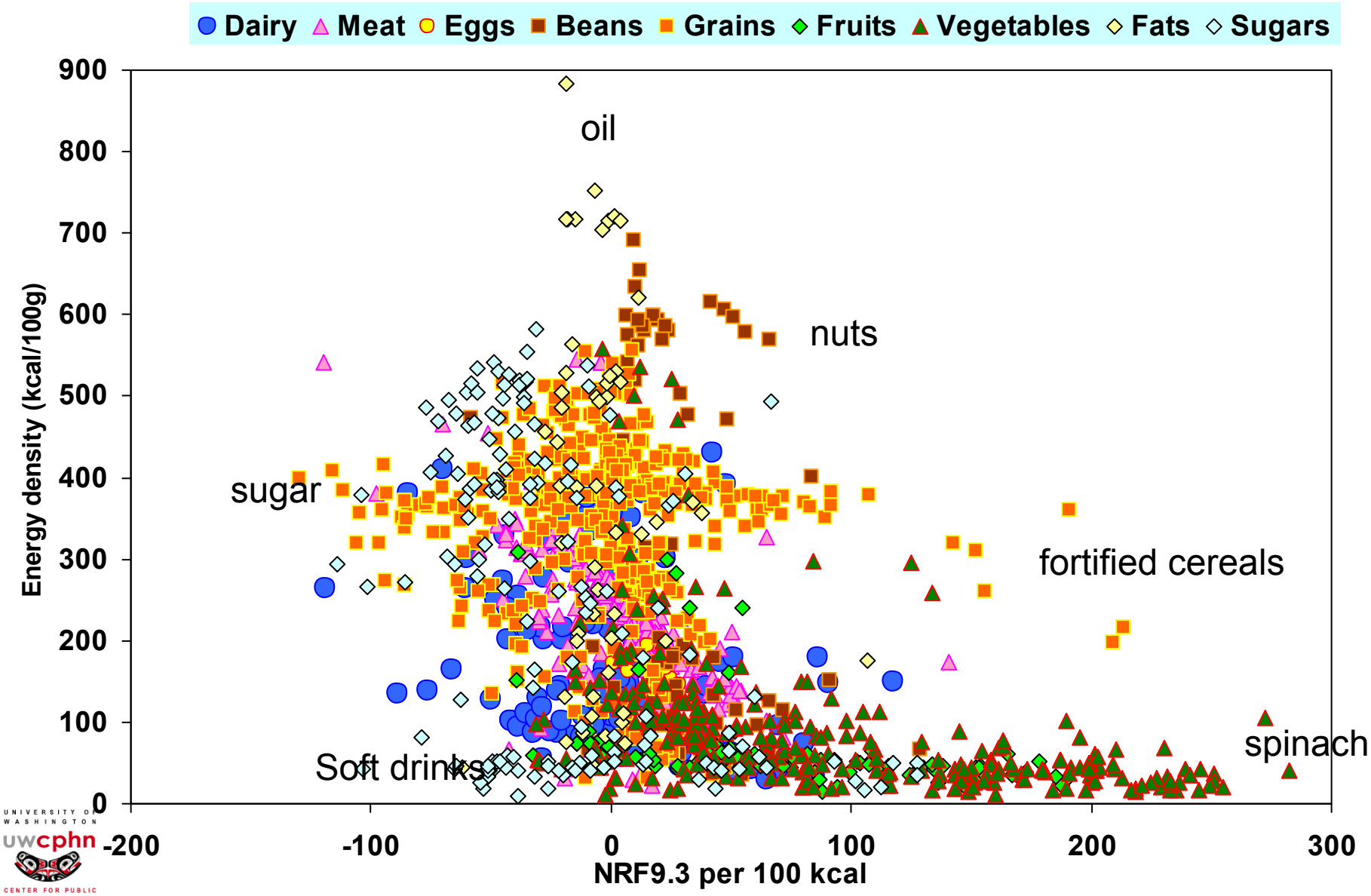

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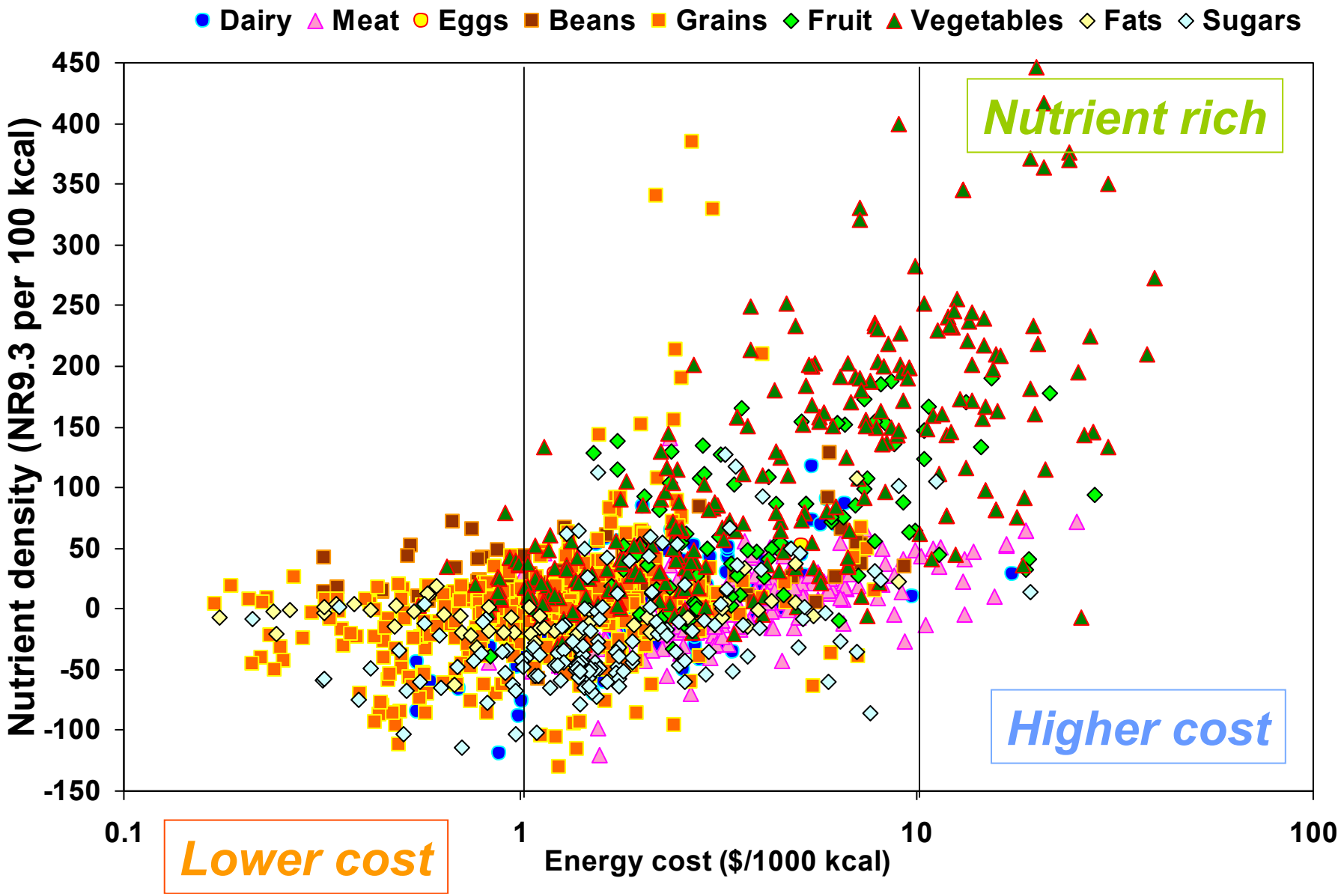
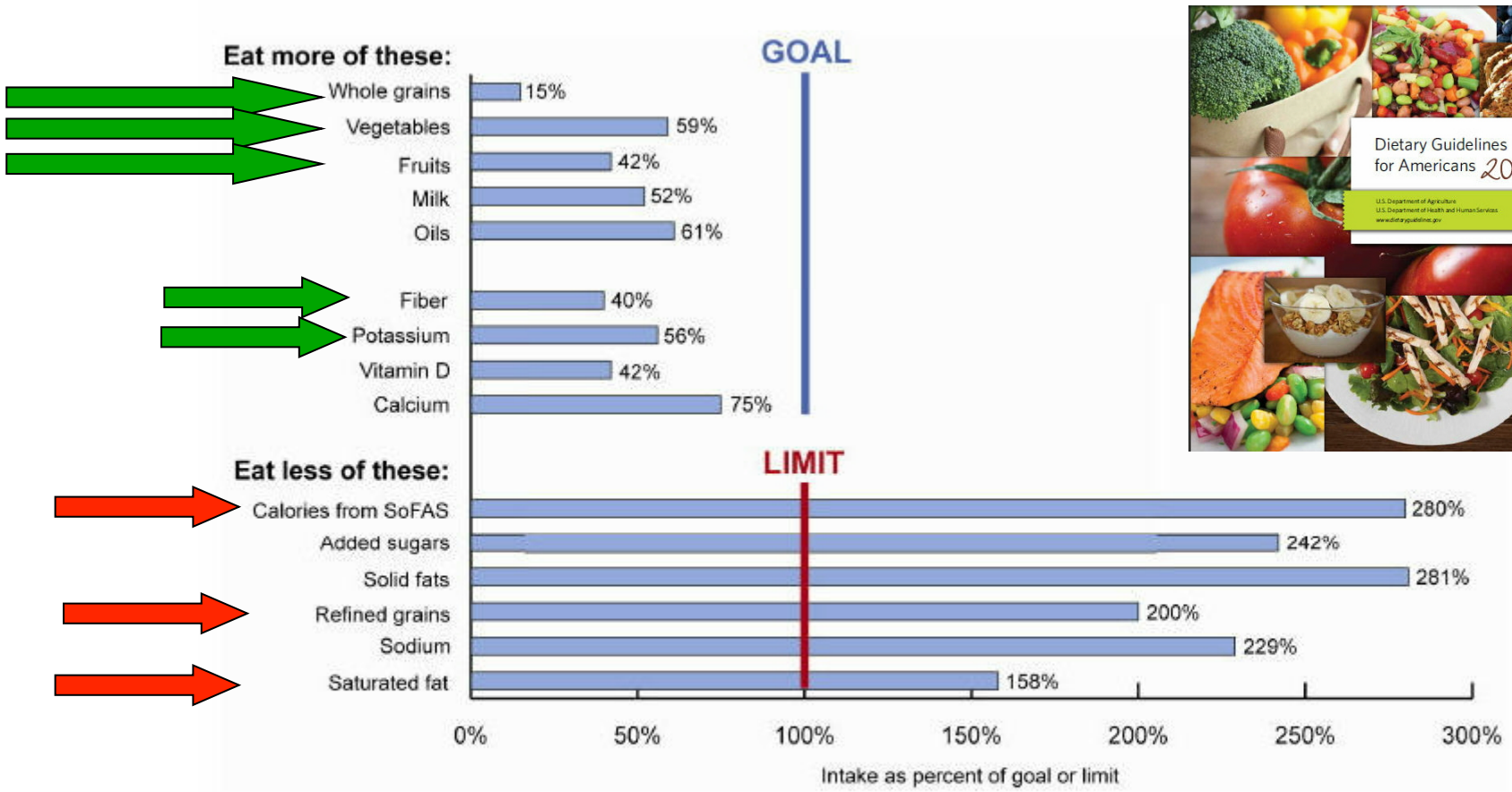
Fruits, vegetables, meats, fish cost more per kcal

($/1000 kcal)

Data from USDA FNDDS 1.0 and CNPP prices database



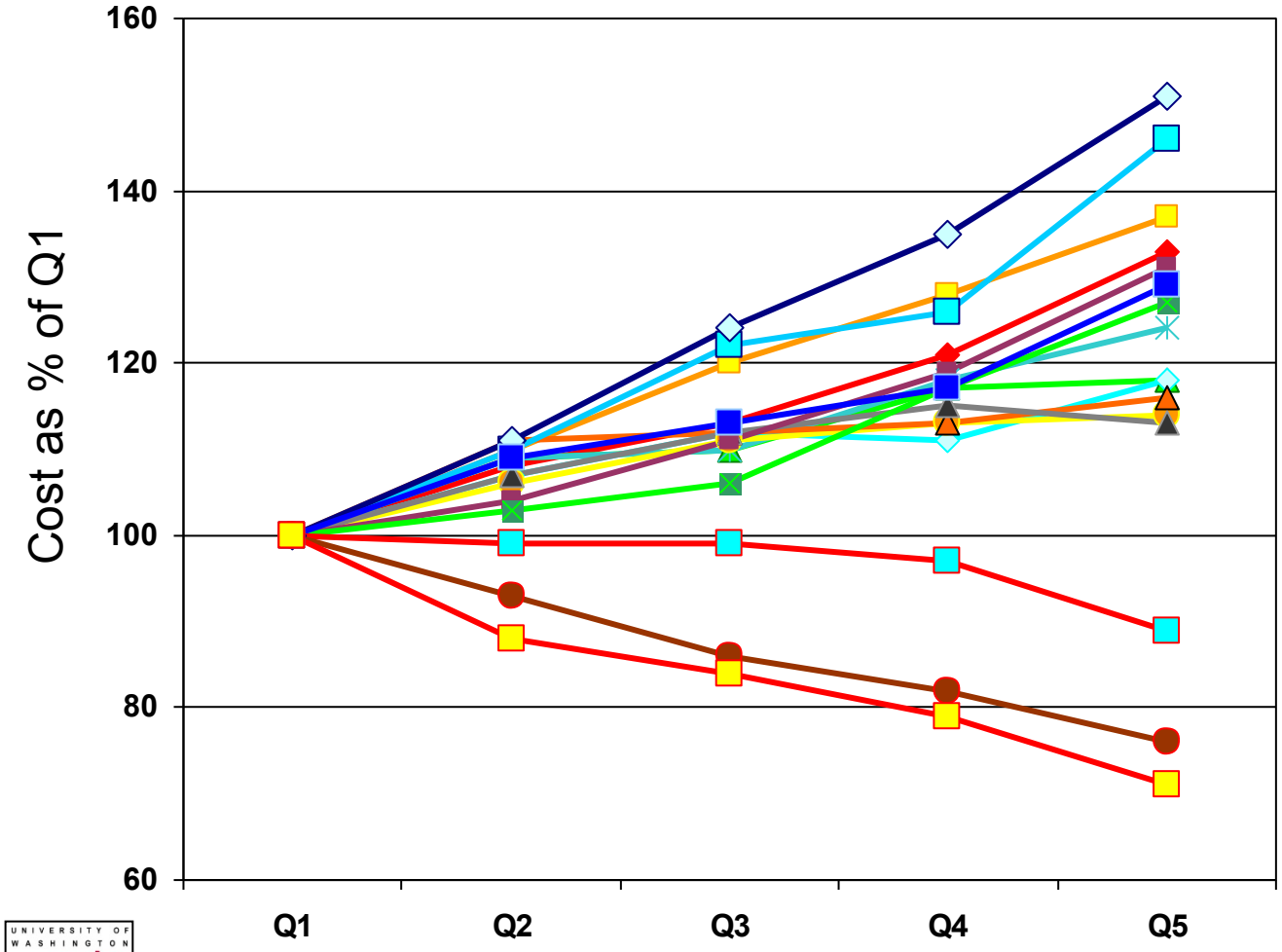
Following dietary guidelines can cost money



Note: Bars show average intakes for all individuals (ages 1 or 2 years or older) as a percent of the recommended intake level or limit. Recommended intakes for food groups and limits for refined grains, SoFAS, solid fats, and added sugars are based on the USDA 2000-calorie food patterns. Recommended intakes for fiber, potassium, vitamin D, and calcium are based on the highest AI for ages 14 to 70 years. Limits for sodium are based on the AI and for saturated fat on 7 percent of calories.

Data source: What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2001-2004 or 2005-2006.

SOS I - Nutrient-rich diets cost more; fats and sugars cost less (women)



Aggarwal et al. PLoS One 2012

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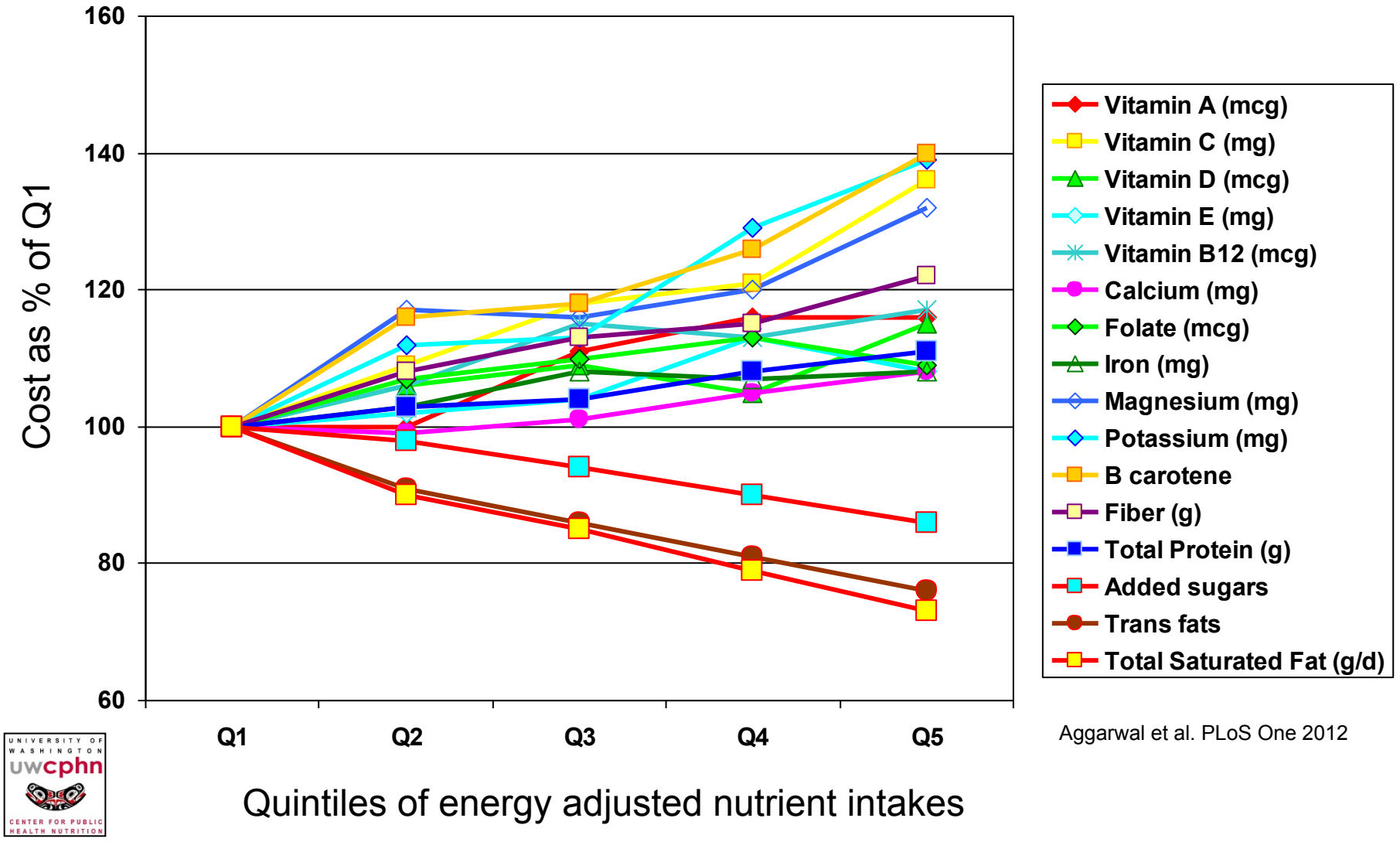
SOS I - Nutrient-rich diets cost more; fats and sugars cost less (men)



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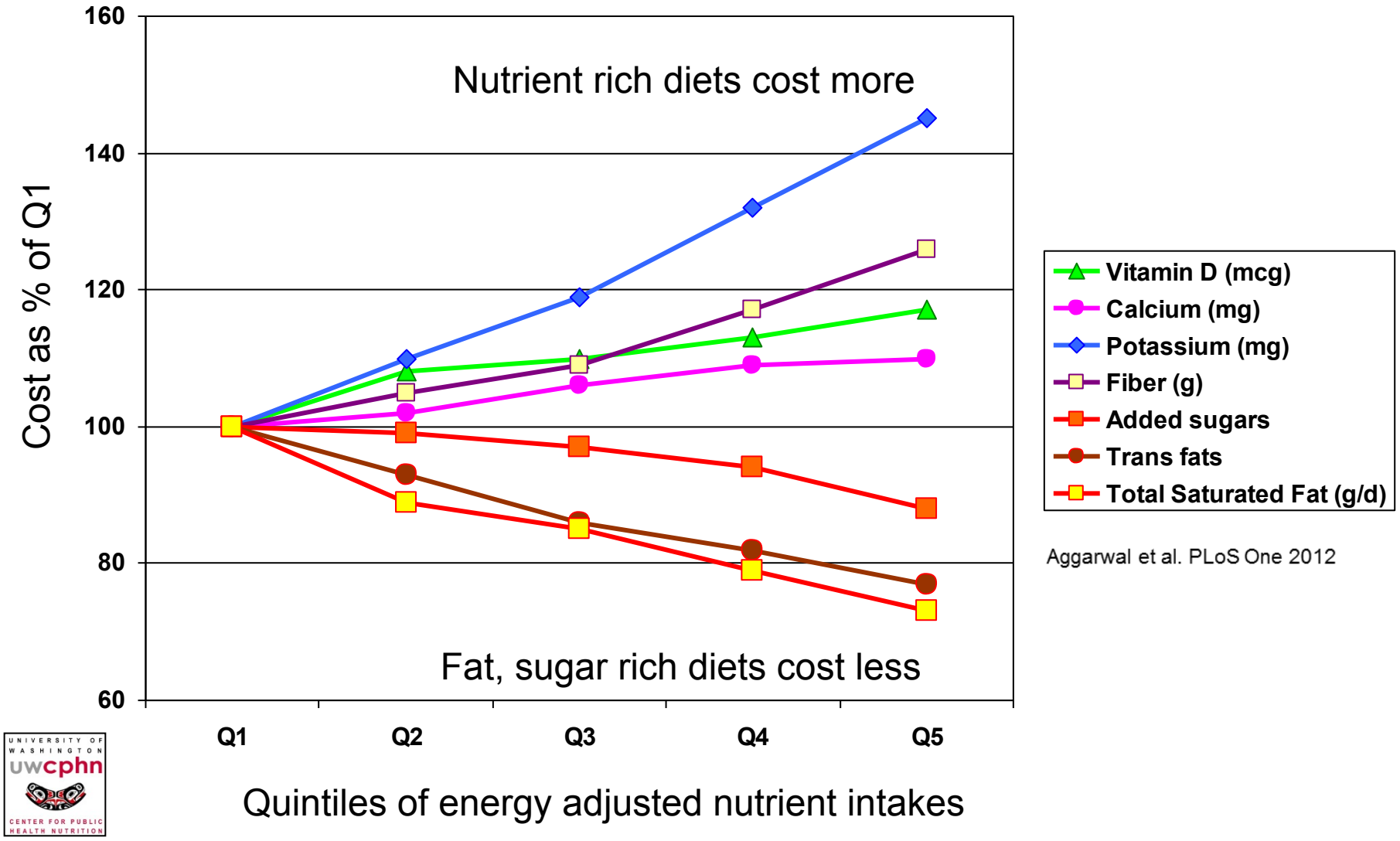
Some nutrients cost more than others



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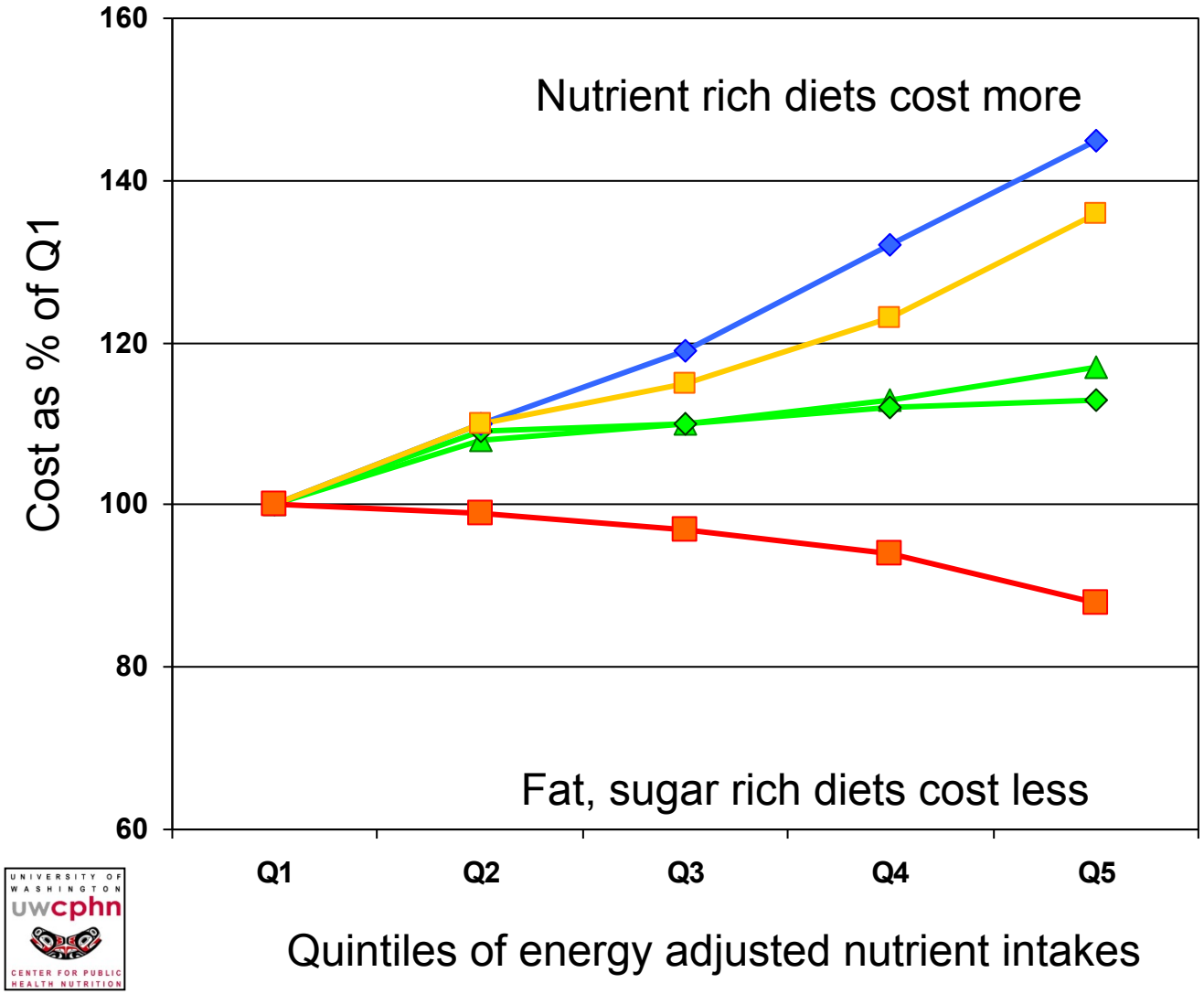
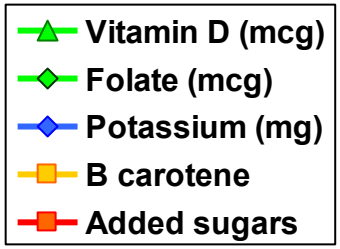
Potassium and Beta-carotene – and folate and vitamin D have different cost gradients





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Healthy Eating Index - 2010

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
Greens and beans	5	≥0.2 cup equiv. per 1,000 kcal	No Dark Green Vegetables or beans and peas
Whole Grains	10	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Dairy	10	≥1.3 cup equiv. per 1,000 kcal	No Dairy
Total Protein Foods	5	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
Seafood and plant proteins	5	≥0.8 oz equiv. per 1,000 kcal	No seafood/plant proteins
Fatty acids	10	(PUFA+MUFA)/SFA>2.5	Ratio <1.2
Refined grains	10	<1.8 oz equiv per 1000 kcal	≥4.3 oz equiv
Sodium	10	≤1.1 gram per 1,000 kcal	≥2.0 g per 1,000 kcal
Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)	20	≤19% of energy	≥50% of energy

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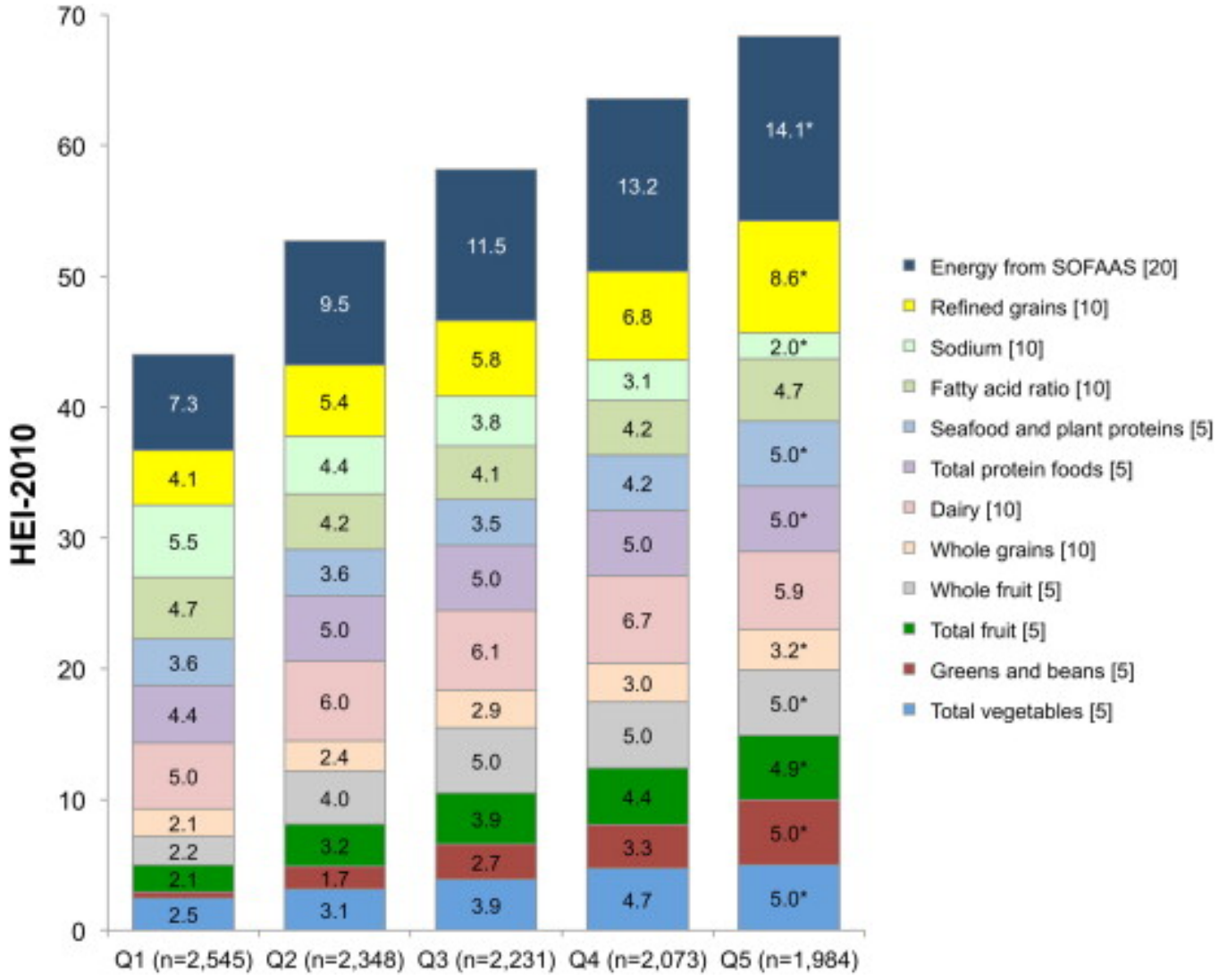
HEI 2010 scores by diet cost quintiles: women

Rehm et al (Preventive Medicine 2015)



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HEI 2010 scores by diet cost quintiles: Men

Rehm **et al (Preventive Medicine 2015)**

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Linking food, health, and incomes

Poverty and obesity may be linked by the low cost,
high reward value, and easy access to energy-dense foods

Special Article

Poverty and obesity: the role of energy density and energy costs[1,2]

Adam Drewnowski and SE Specter

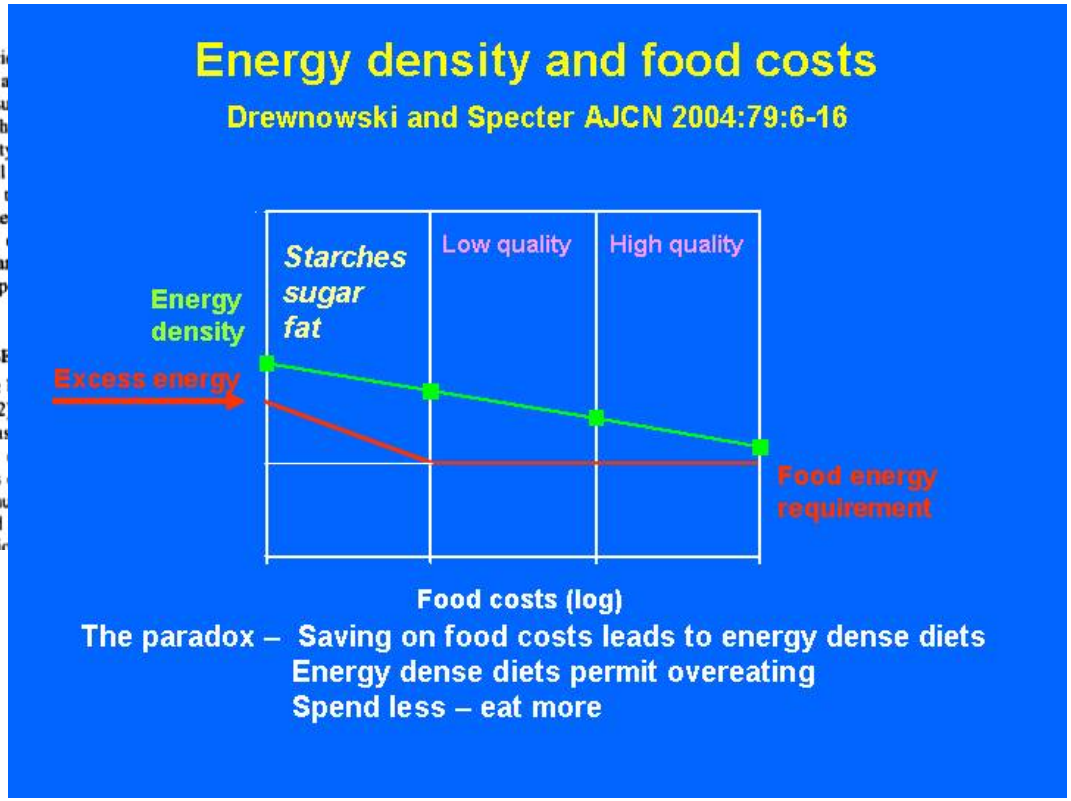
ABSTRACT

Many health disparities in the United States are linked to inequalities in education and income. This review focuses on the relation between obesity and diet quality, dietary energy density, and energy costs. Evidence is provided to support the following points. First, the highest rates of obesity occur among population groups with the highest poverty rates and the least education. Second, there is an inverse relation between energy density (MJ/kg) and energy cost ($/MJ), such that energy-dense foods composed of refined grains, added sugars, or fats may represent the lowest-cost option to the consumer. Third, the high energy density and palatability of sweets and fats are associated with higher energy intakes, at least in clinical and laboratory studies. Fourth, poverty and food insecurity are associated with lower food expenditures, low fruit and vegetable consumption, and lower-quality diets. A reduction in diet costs in linear programming models leads to high-fat, energy-dense diets that are similar in composition to those consumed by low-income groups. Such diets are more affordable than are prudent diets based on lean meats, fish, fresh vegetables, and fruit. The association between poverty and obesity may be mediated, in part, by the low cost of energy-dense foods and may be reinforced by the high palatability of sugar and fat. This economic

Public health polici
ingly call for taxes
discourage their consu
and healthier food ch
antecedents of obesity
sugar and fat as well
(17–19). In contrast,
sumption, dietary ene
($/MJ) has not been
between obesity, dietar
chief focus of this rep

POVERTY AND OBE

Obesity rates in the
past 2 decades (20–22
20 y were classified as
obese. Overweight is
kg/m^2) > 25, whereas
sharp increase in the nu
35) has been observed
There is no questio



Drewnowski & Specter, Am J Clin Nutr 2004;79:6-16

This nutrition dogma no longer holds:

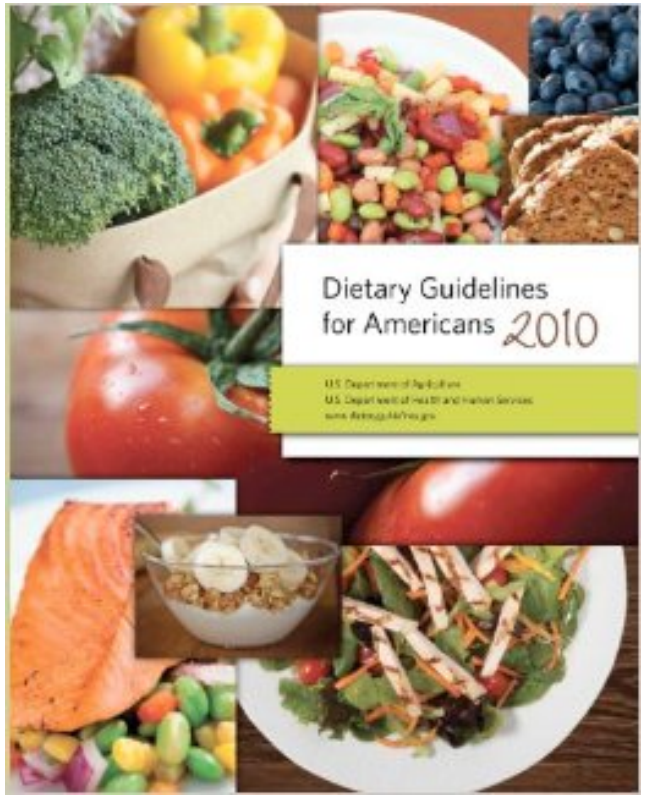
The more food you eat, the more nutrients you get

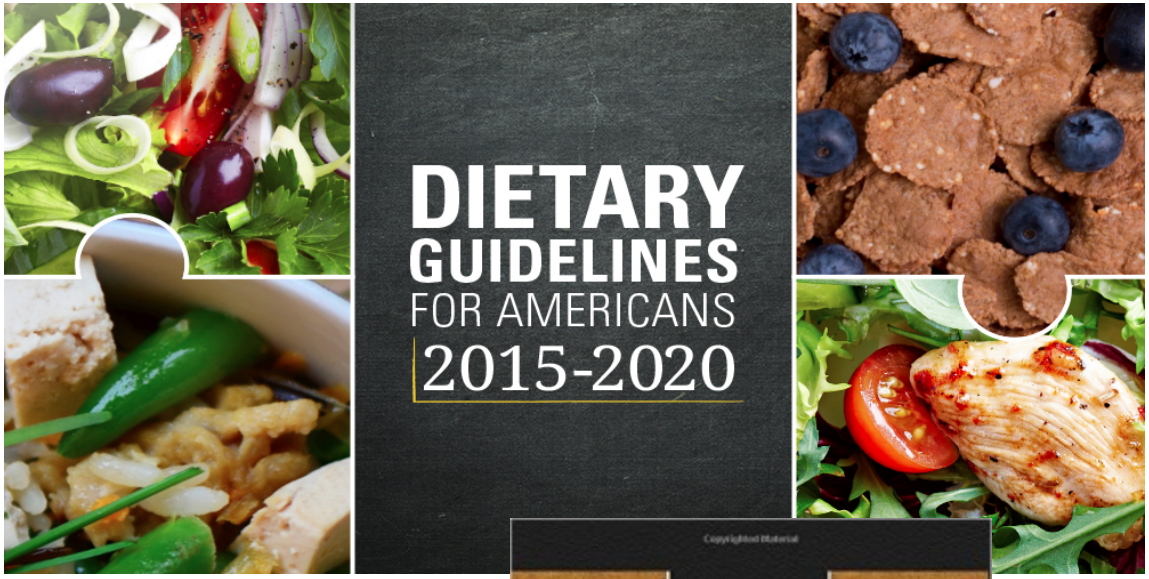
The relation was uncoupled by the low cost of empty calories

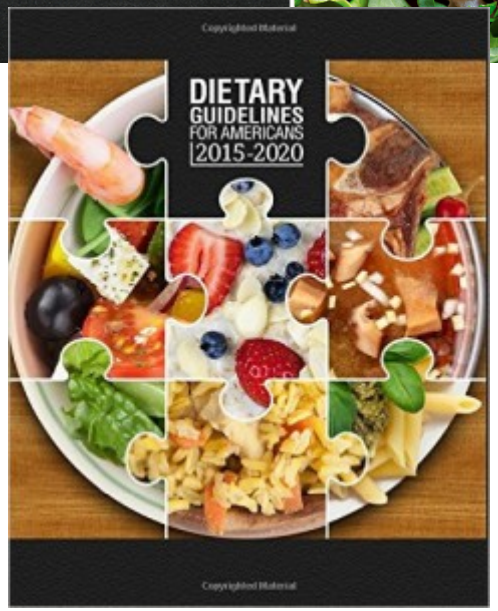
It is now possible to be undernourished yet overfed

Can nutrient supplementation help?

Dietary Guidelines for Americans insist that all nutrients come from foods







How realistic is that?

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Thank you

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