RCSI

DEVENISH™
Beyond Nutrition

The OFC Science Lecture

Food Quality & Human Health – The Evidence

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Disclosures

Director of Human Health

and

Shareholder of

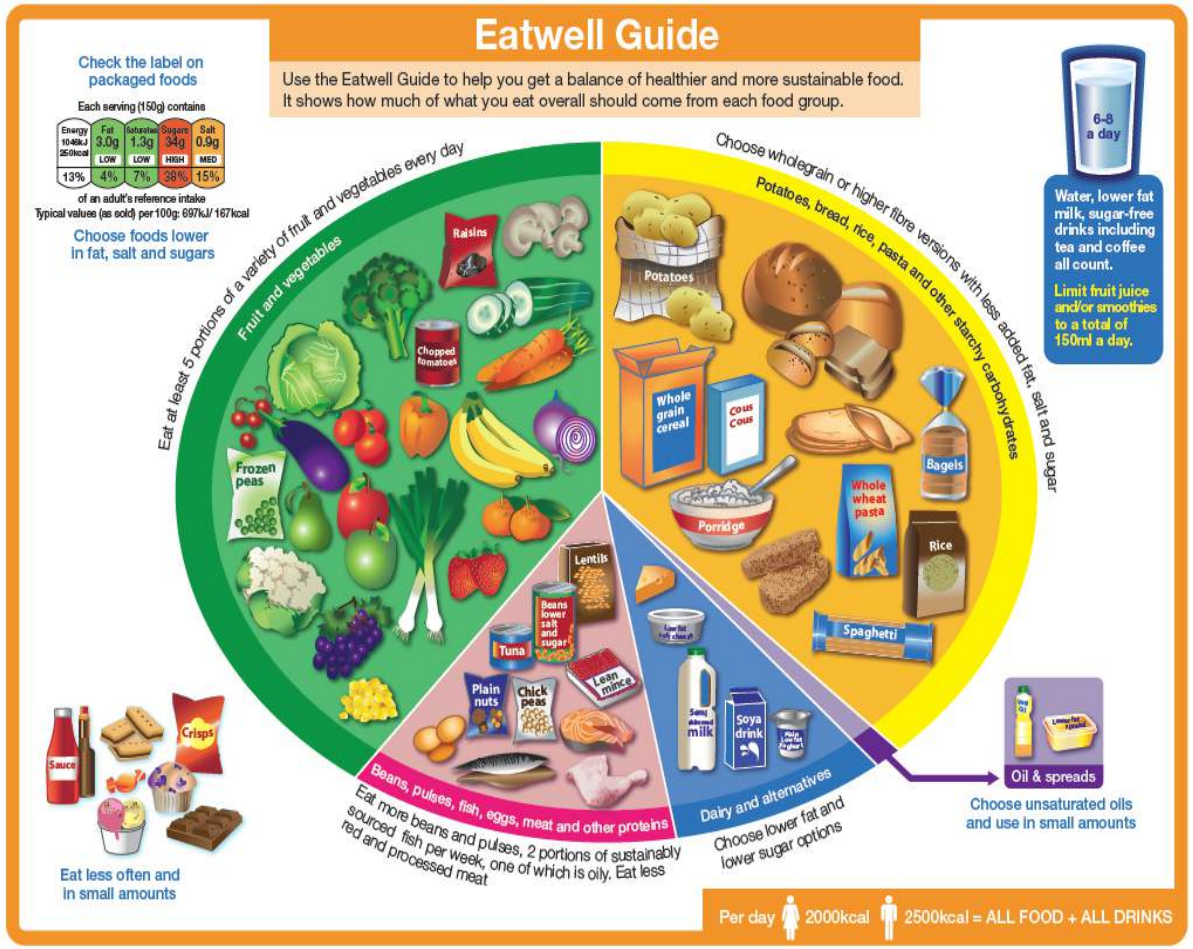
Devenish Nutrition

An Agri-Technology Company

Global Population Growth

Source: UN

The EAT-Lancet Commission Reference Diet
Doubling of Intake of Fruits, Vegetables, Legumes, Nuts & Seeds
Halving of Meat and Dairy Intakes
90% Reduction in Red Meat Consumption



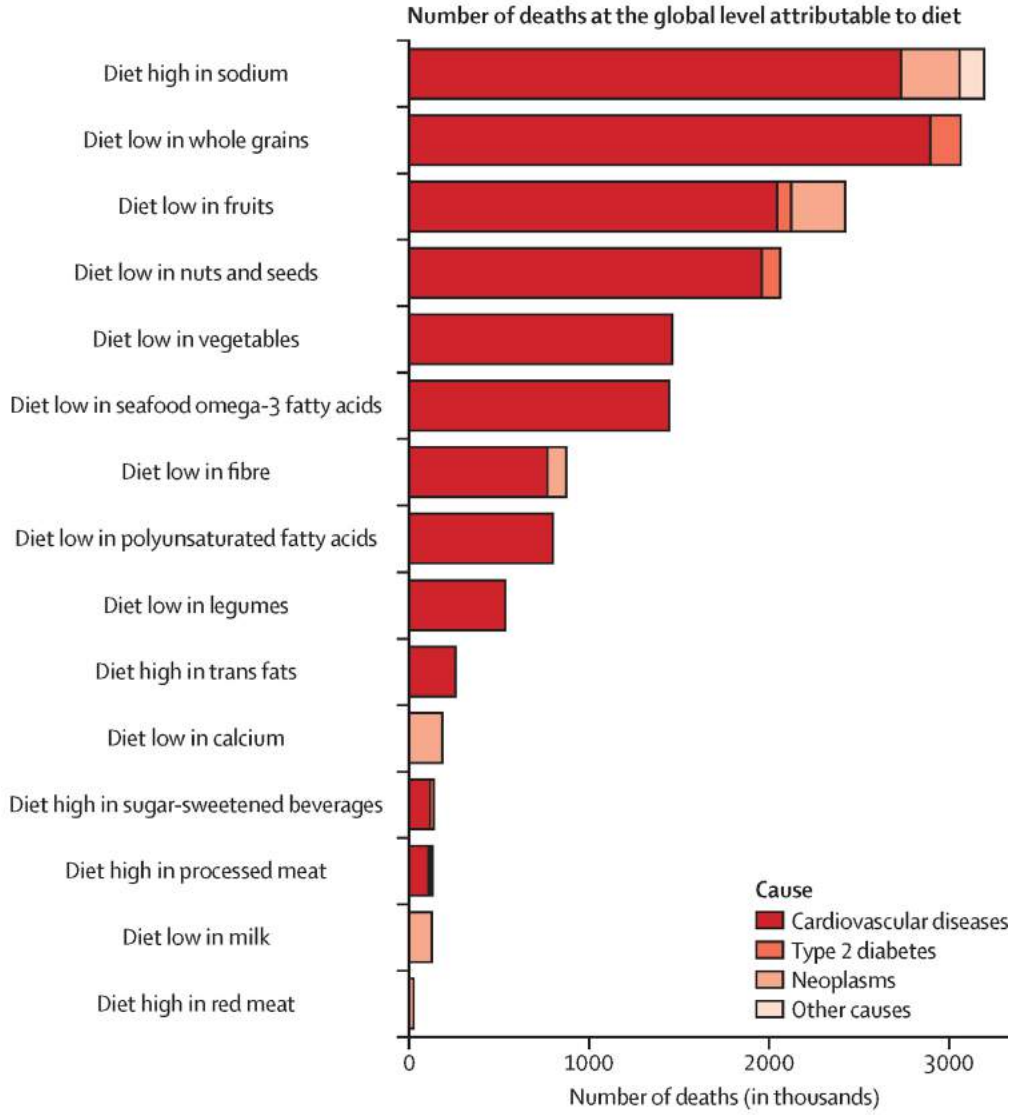
Willett W et al. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet January 2019.

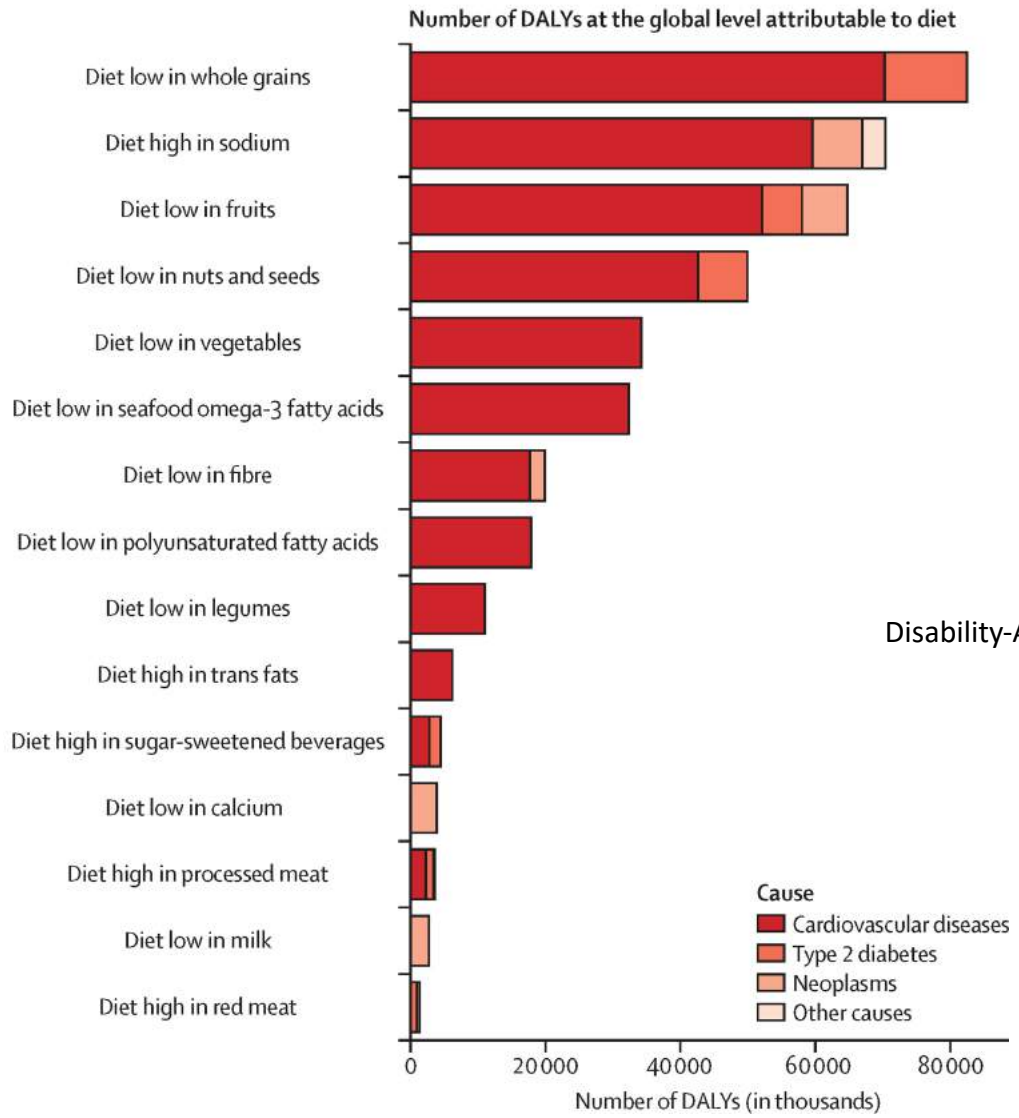
2019 Headlines

EAT-Lancet recommends slashing red meat consumption by 90%

In 2017 Dietary Risks were Responsible for 11 million Deaths (22% of all deaths) & for 255 million DALYS (15% of all DALYs)

Christopher JL Murray & GBD 2017 Diet Collaborators. Health Effects of Dietary Risks in 195 Countries, 1990-2017: A Systematic Analysis for the Global Burden of Disease Study. Lancet 2019





DALY
=
Disability-Adjusted Life-Year

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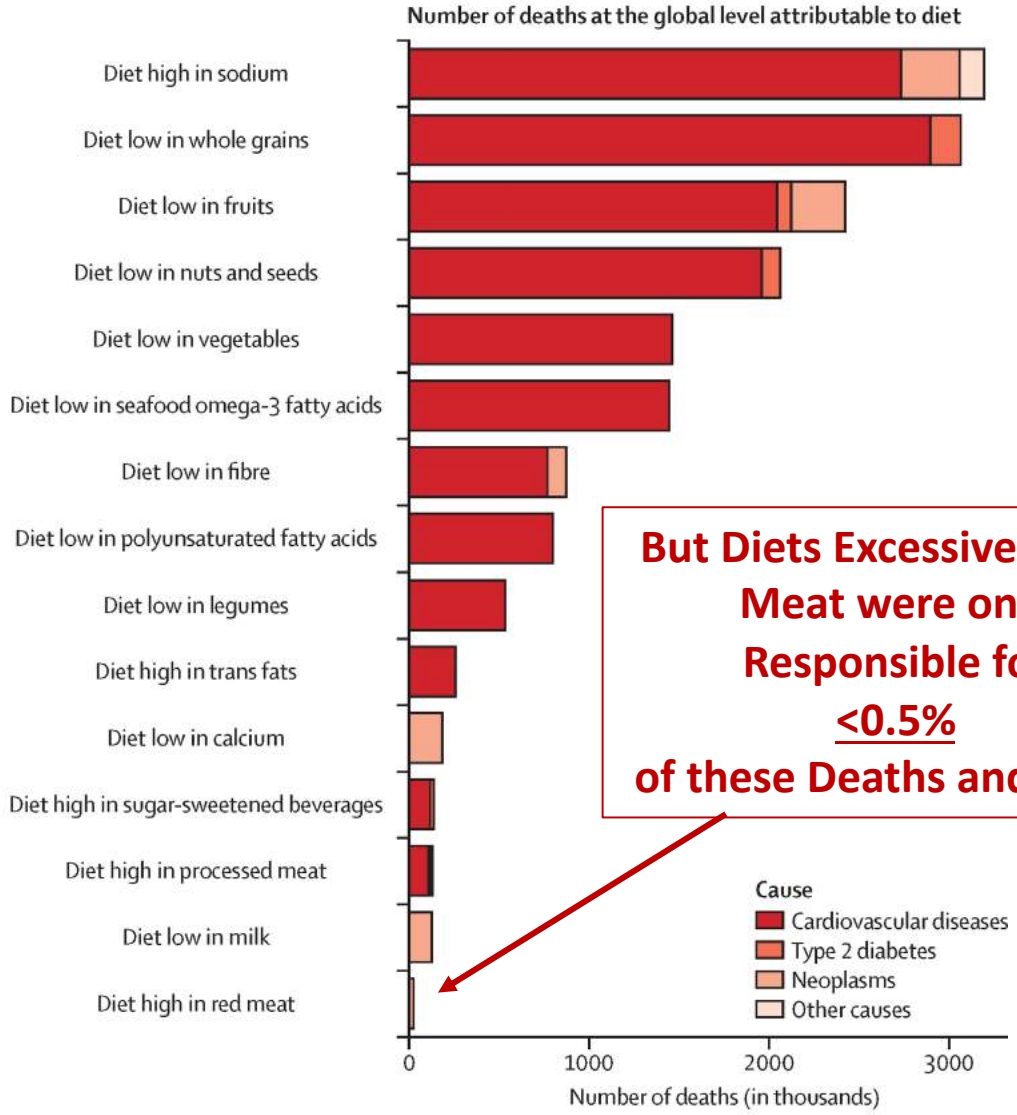
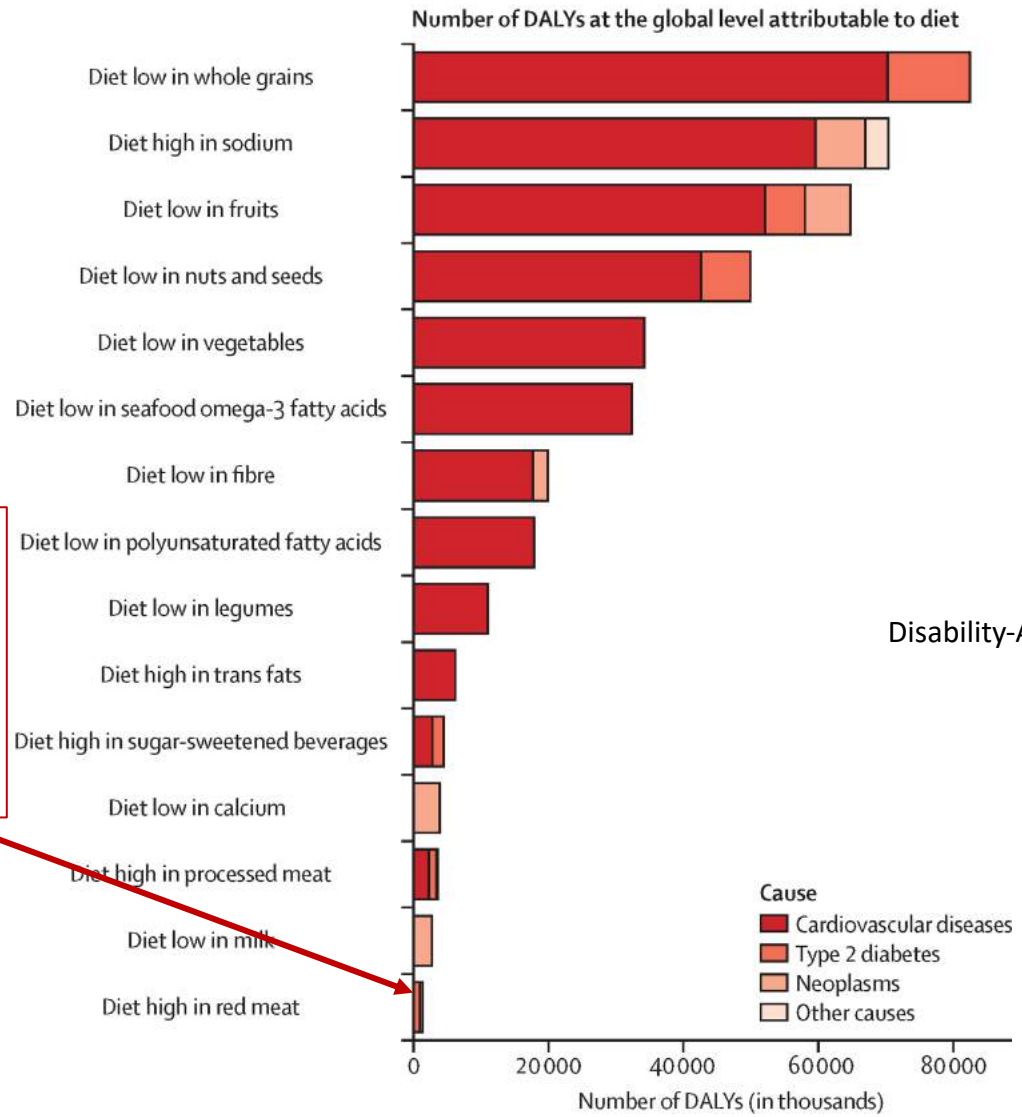


But Diets Excessive in Red Meat were only Responsible for <0.5% of these Deaths and DALYs



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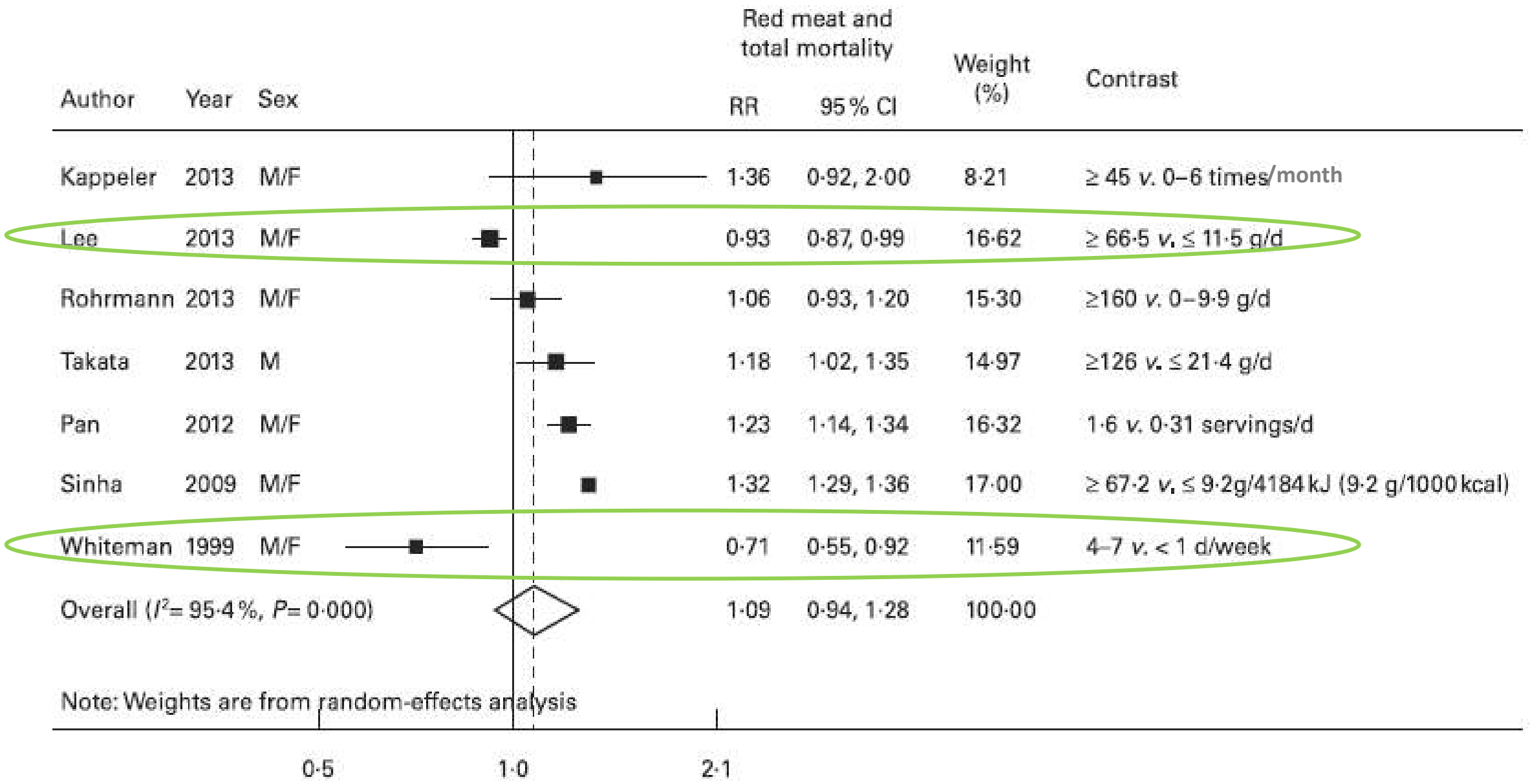
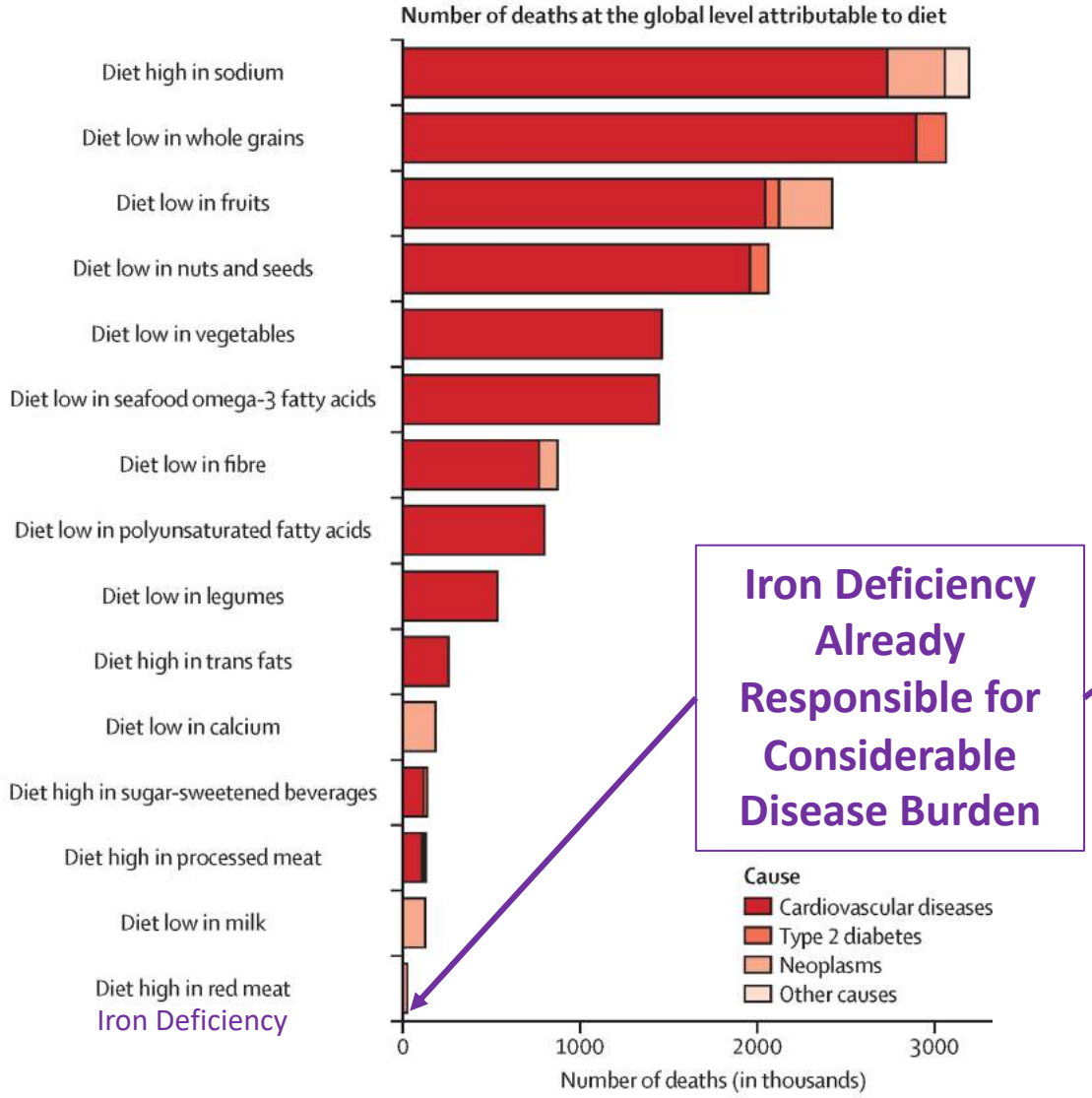
Red Meat Consumption and All-Cause Mortality

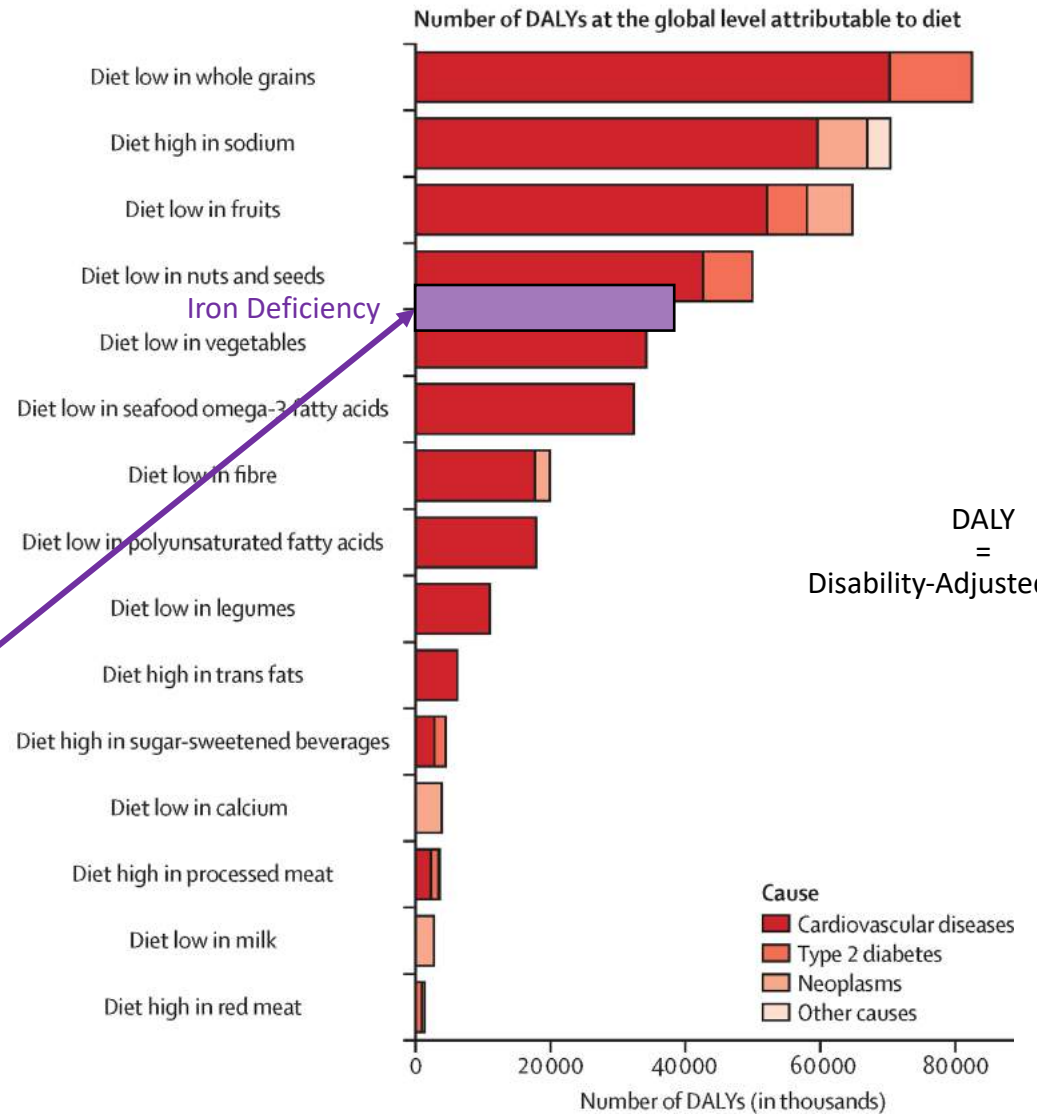
Abete et al British Journal of Nutrition 2014:112:762-775



90% Reduction in Red Meat Consumption will Result in Amino Acid & Micronutrient Deficiencies (B_{12}, D & K, & Minerals Fe, Zn & Selenium) with Disproportionate Effects on Women, Children & the Developing World



Iron Deficiency Already Responsible for Considerable Disease Burden



DALY
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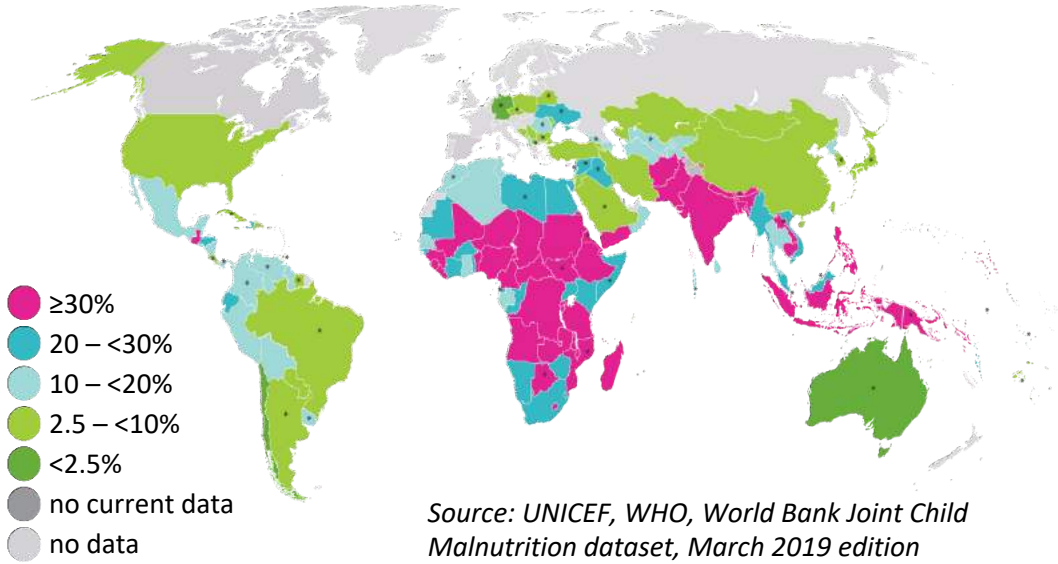
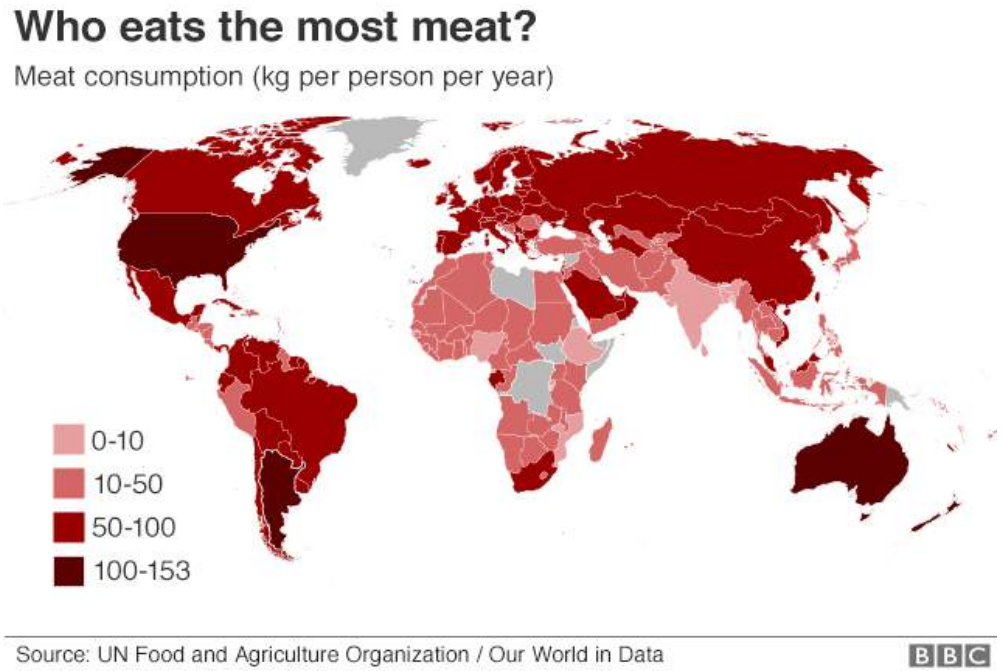
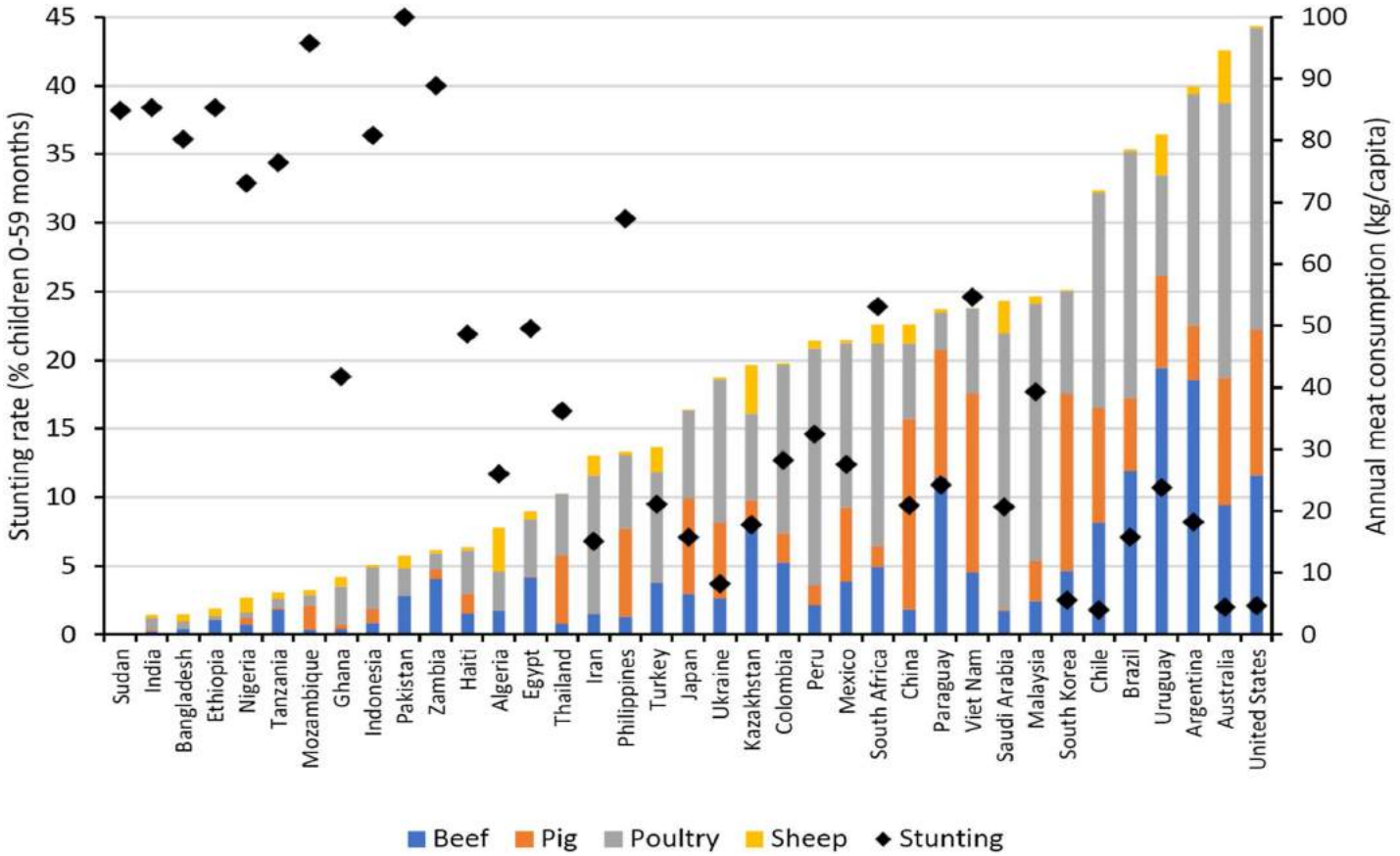
Childhood Stunting Rates & Annual Meat Consumption - an Inverse Relationship

Percentage of children under 5 who are stunted (%), by country



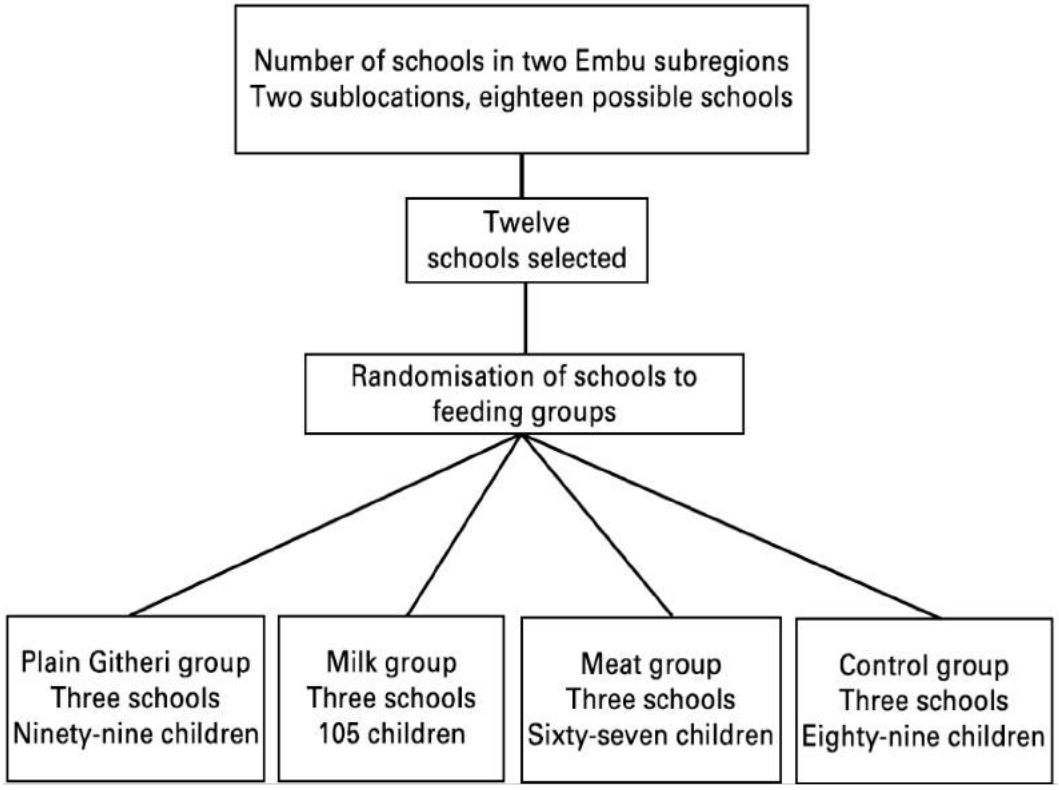
Source: UNICEF, WHO, World Bank Joint Child Malnutrition dataset, March 2019 edition

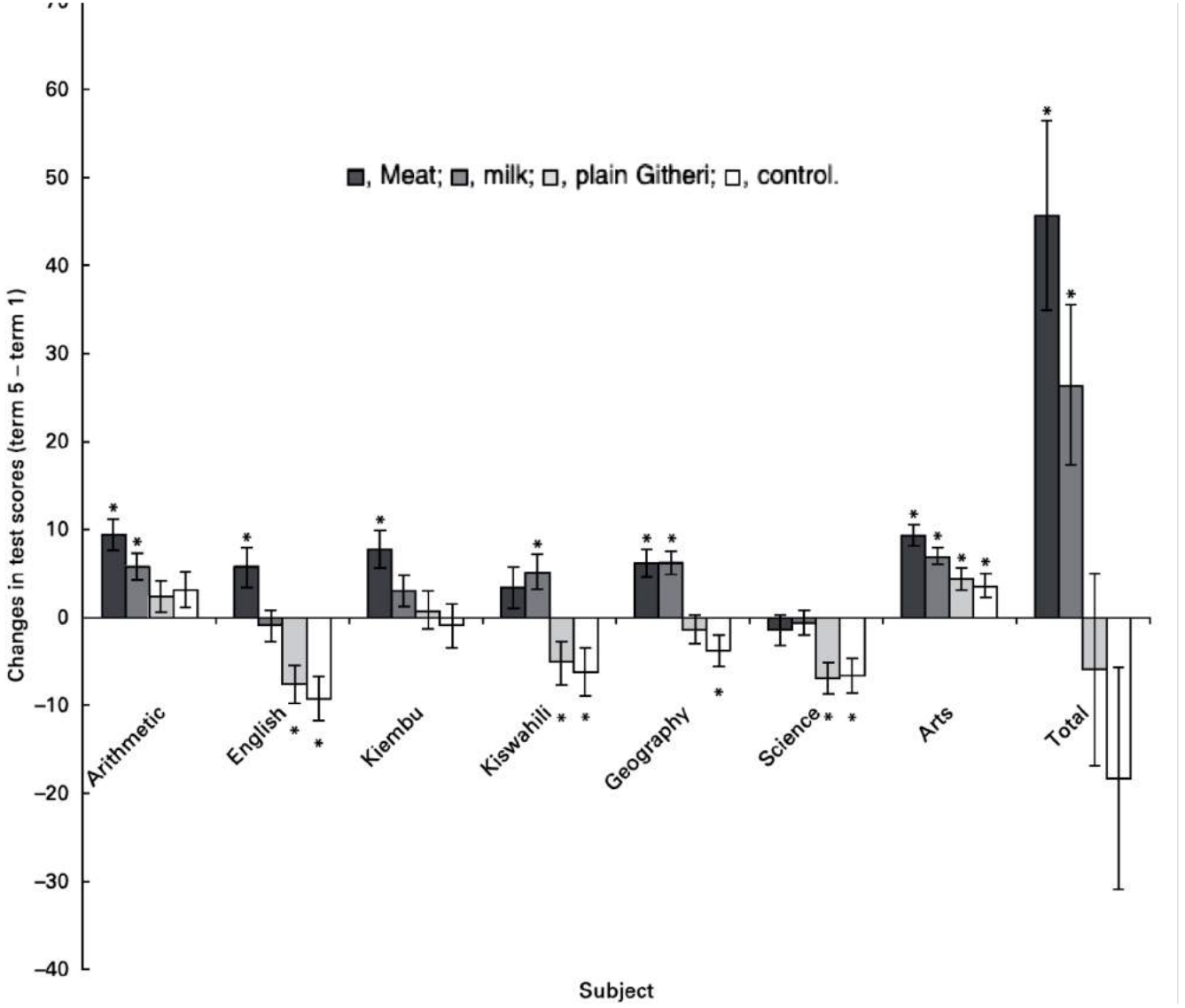




Animal Source Foods and Primary School Test Scores of Kenyan Schoolchildren

Hulett et al. Brit J Nutrition 2014





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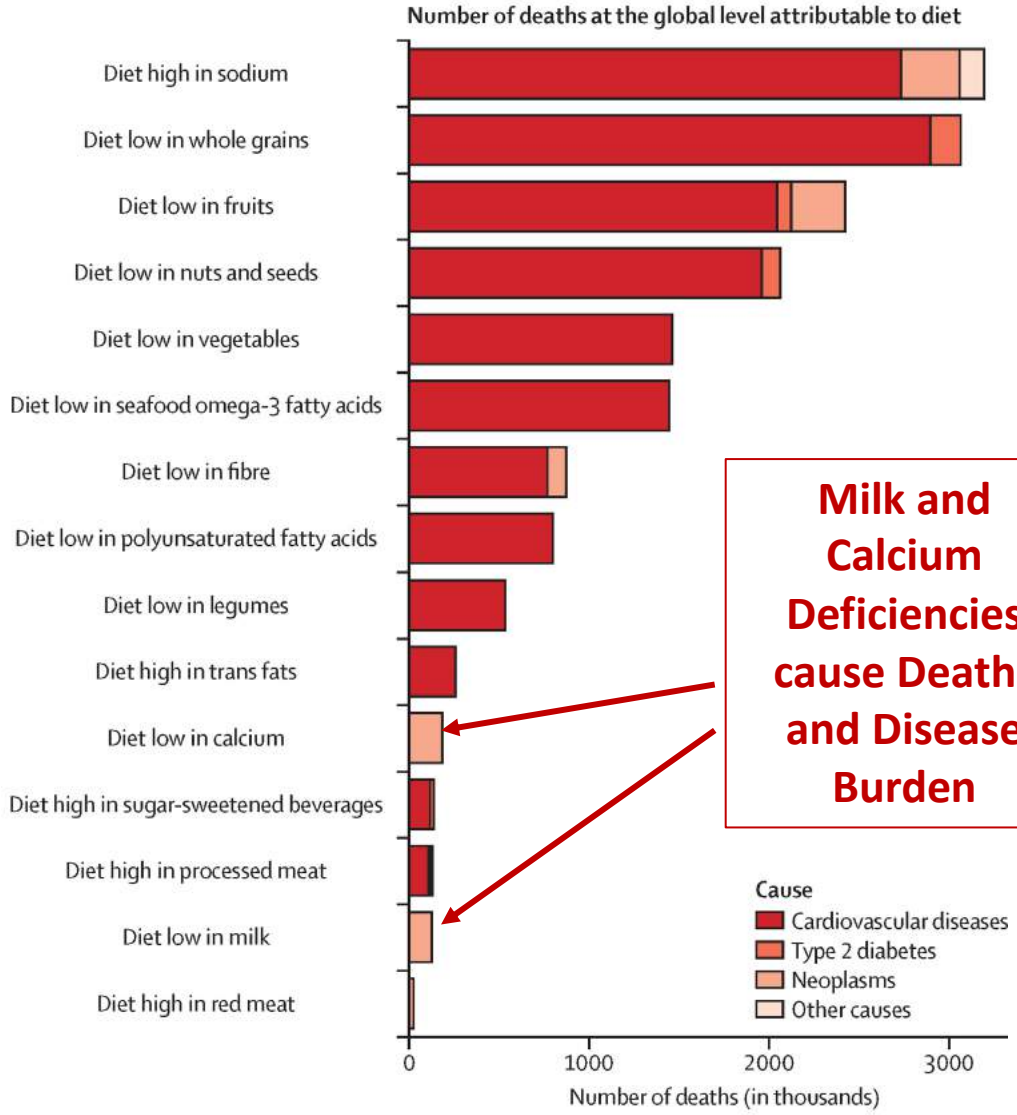
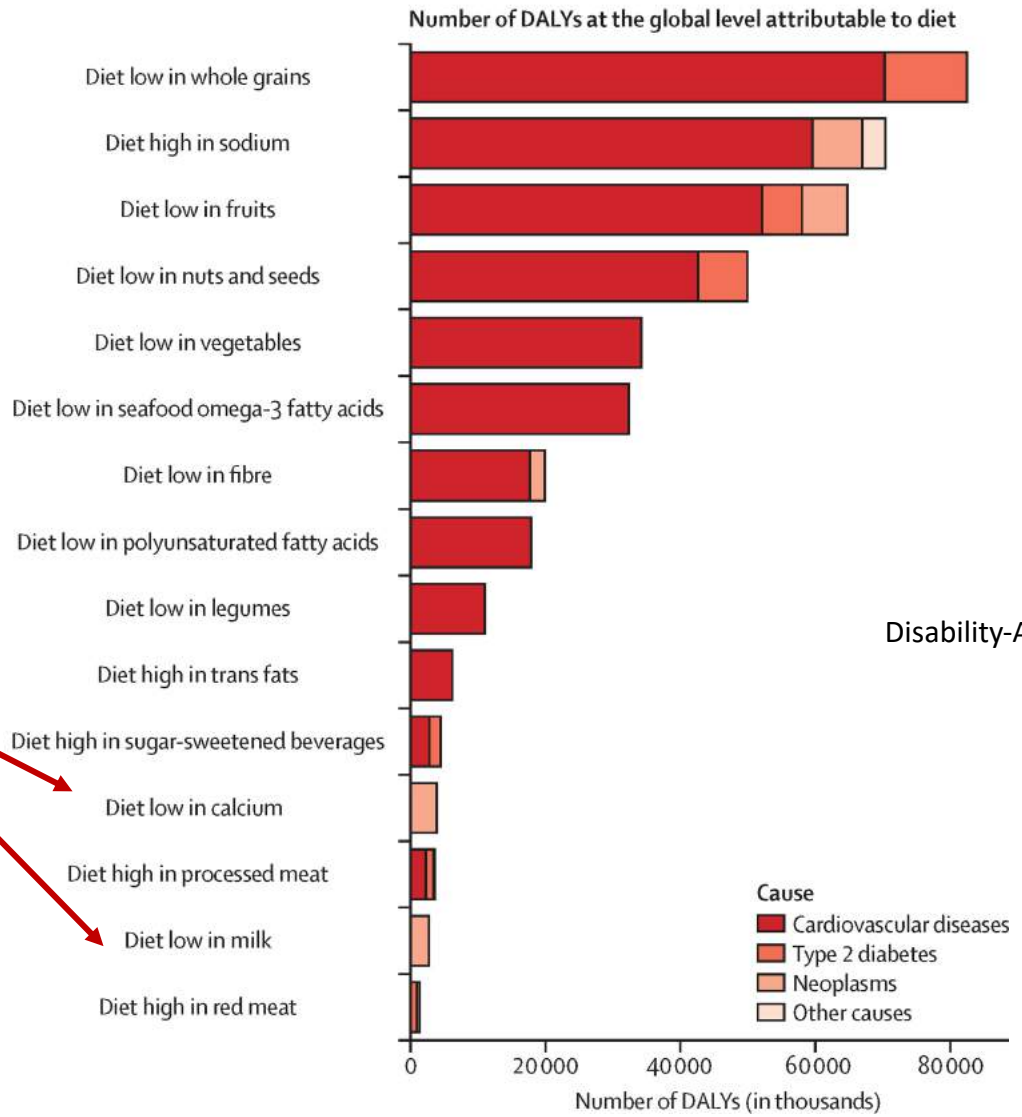


Milk and Calcium Deficiencies cause Deaths and Disease Burden



DALY
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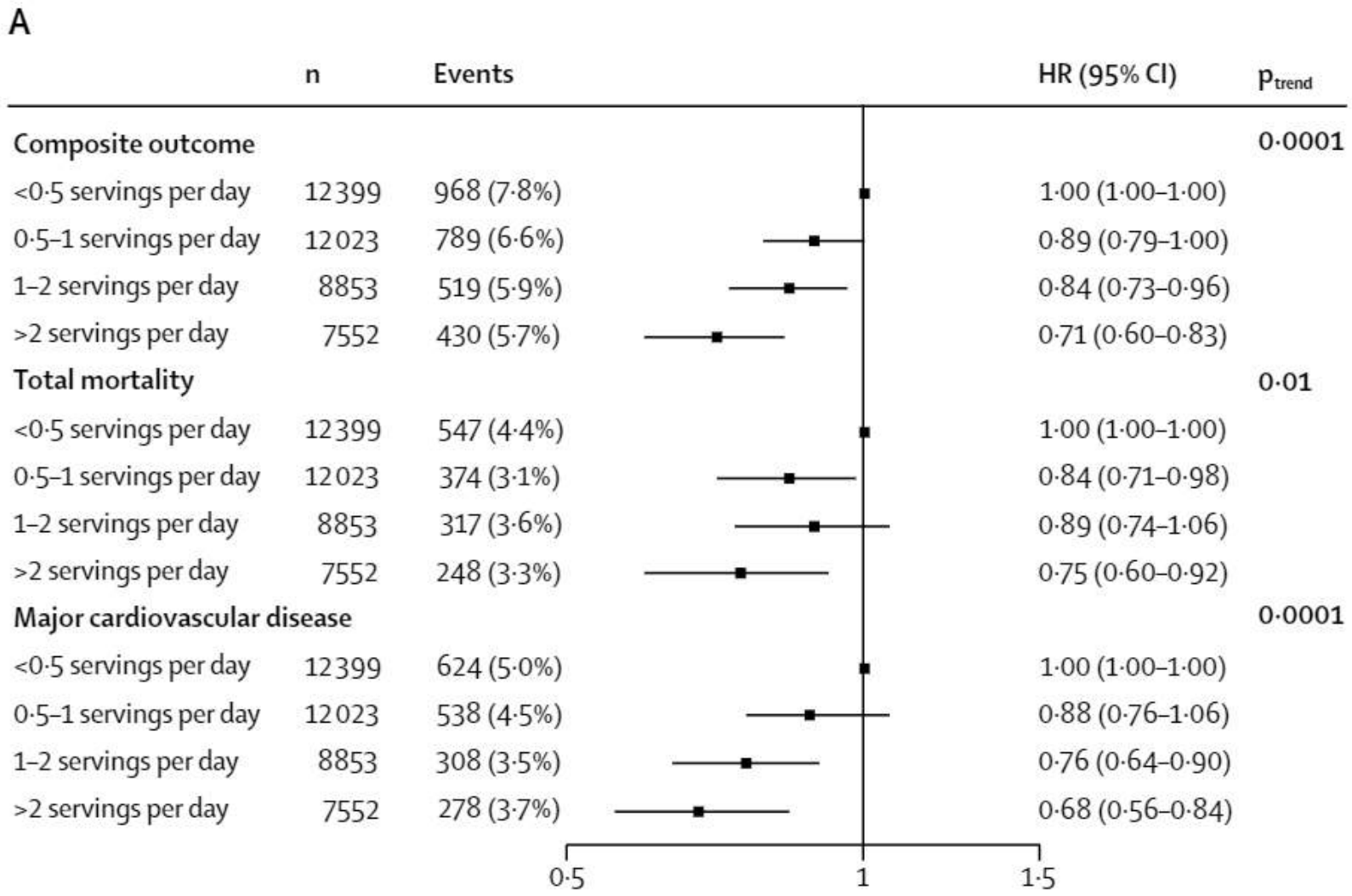
Disability-Adjusted Life-Year

Association of Dairy Intake with Cardiovascular Disease and Mortality in the Prospective Urban Rural Epidemiology (PURE) Study

Lancet 2018

A



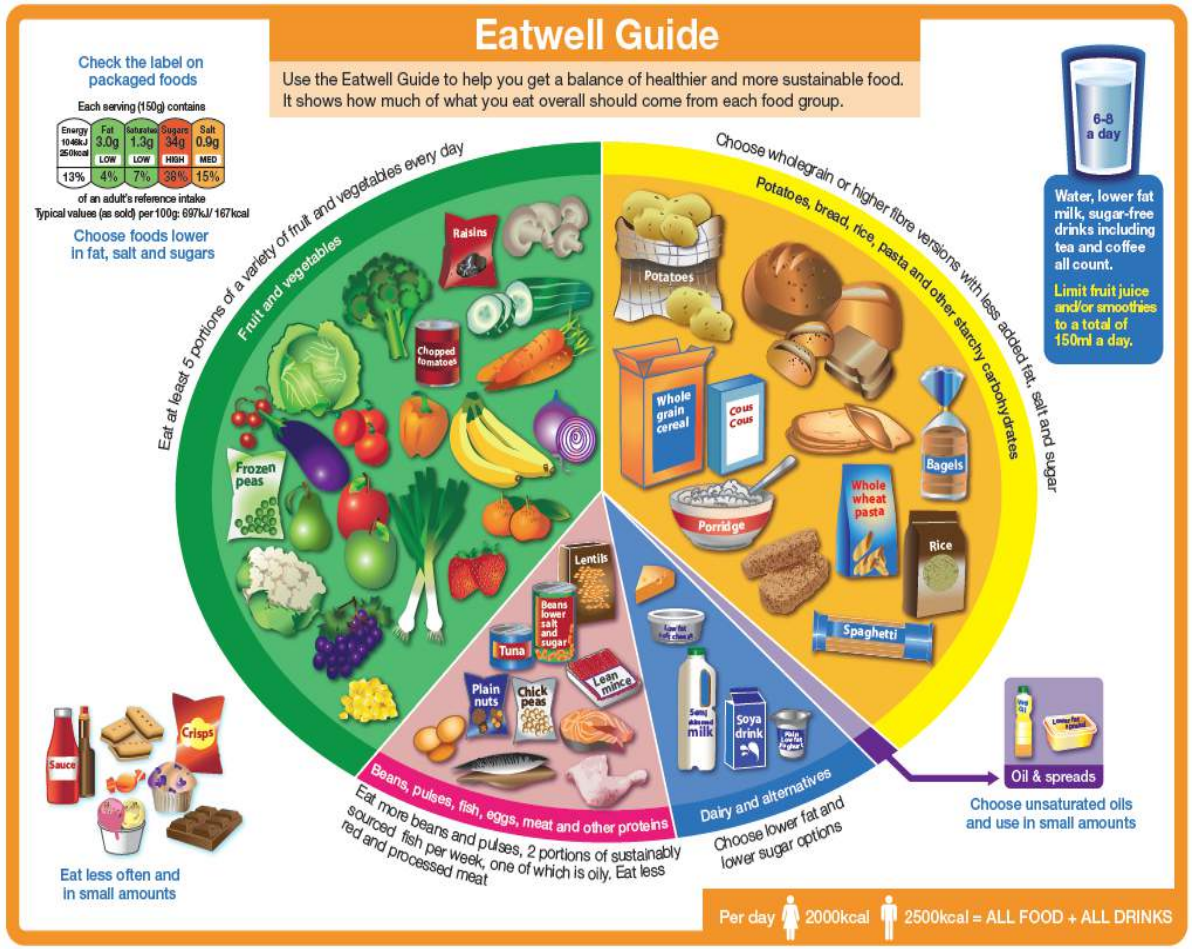
Median intake per day (IQR)

	<0·5 serving	0·5–1 servings	1–2 servings	>2 servings
Only whole-fat dairy	0·2 g (0·10–0·34)	0·9 g (0·81–0·98)	1·4 g (1·14–1·78)	2·9 g (2·45–3·96)

How Many People in this Room are Eating in Accordance with the EatWell Guide?

≥5 Portions of Fruit & Vegetables /day ?

Women & Men 2,000 & 2,500 kcal/day?



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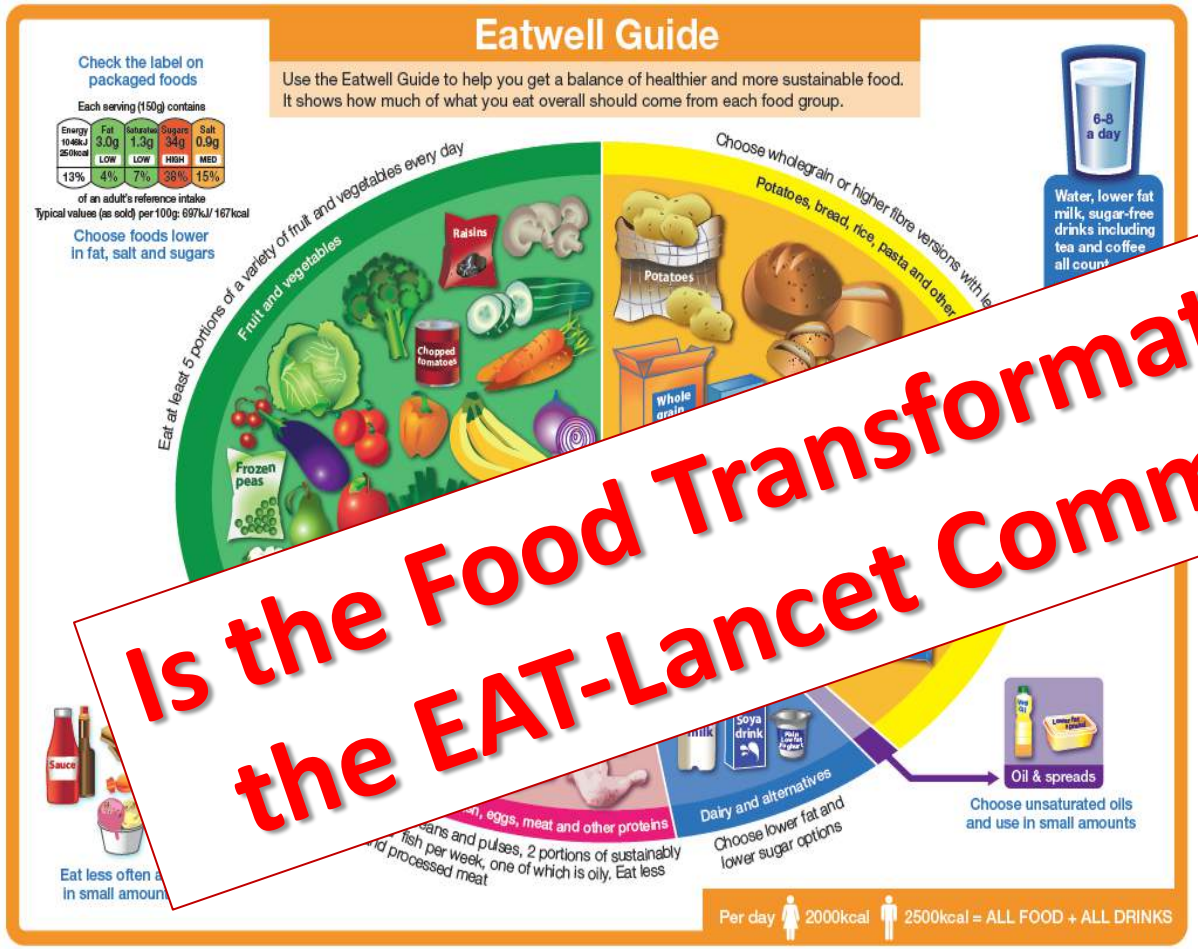


Is the Food Transformation, Proposed by the EAT-Lancet Commission, Feasible?

Willett W et al. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet January 2019.

Reliance on this Food Transformation is likely to Result in Continued Climate Crisis

Continued Polar Ice Cap Melting

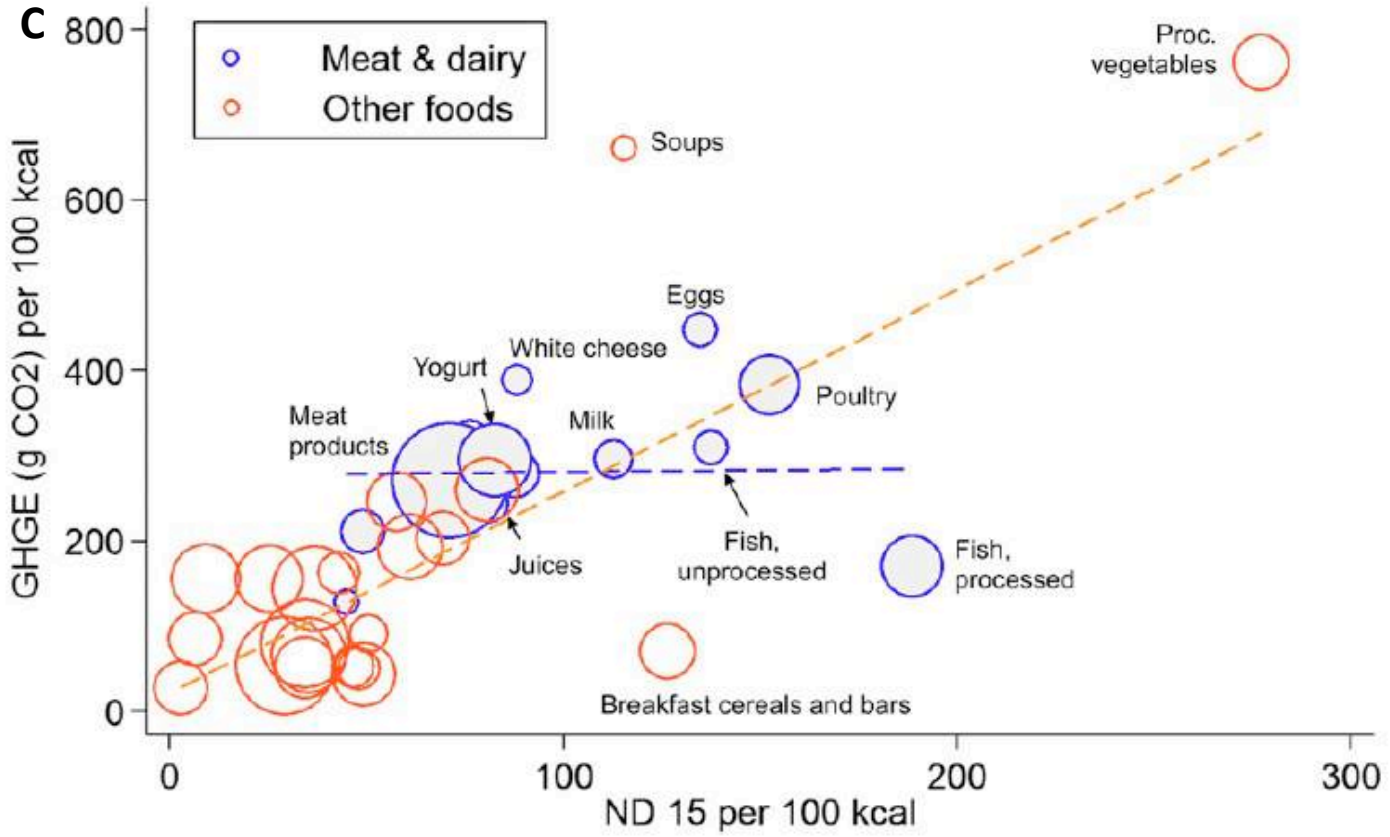
Flooding

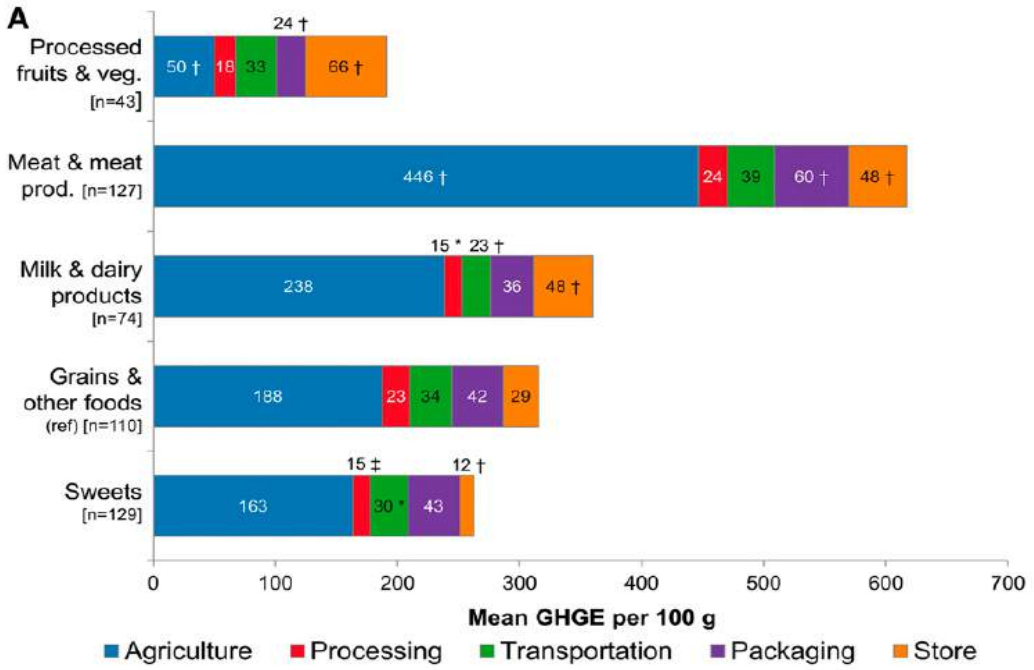
Droughts & Desertification

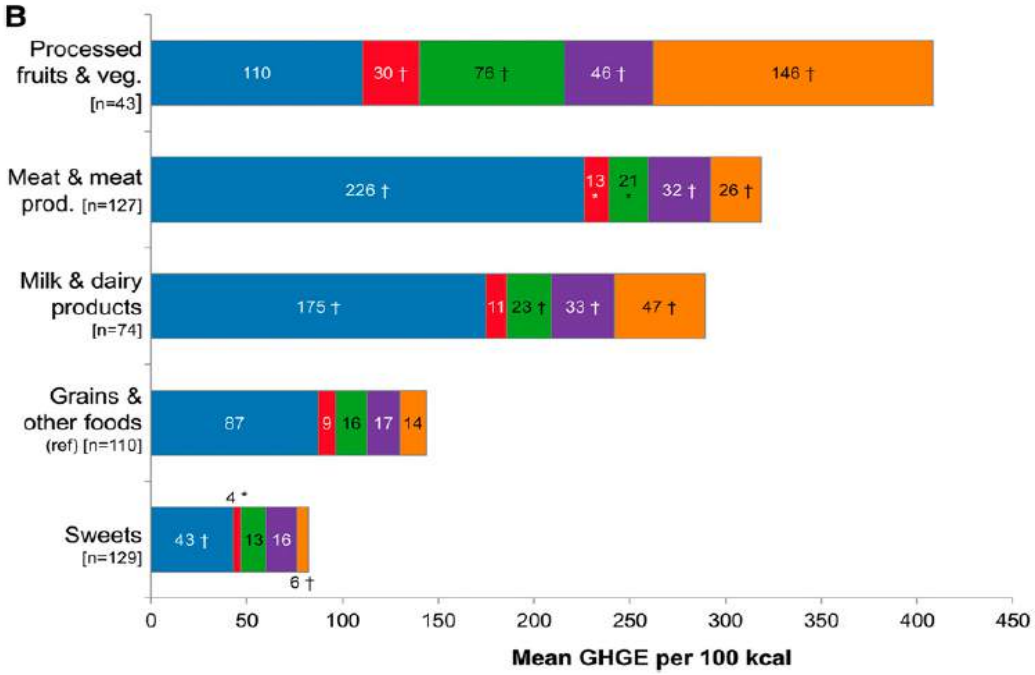
Extensive Bushfires

An Alternative Solution is to Balance & Optimize Human Nutrition & Carbon Footprint - Which is the Best Metric to Use

Grams vs Kcal Vs Nutrient Density

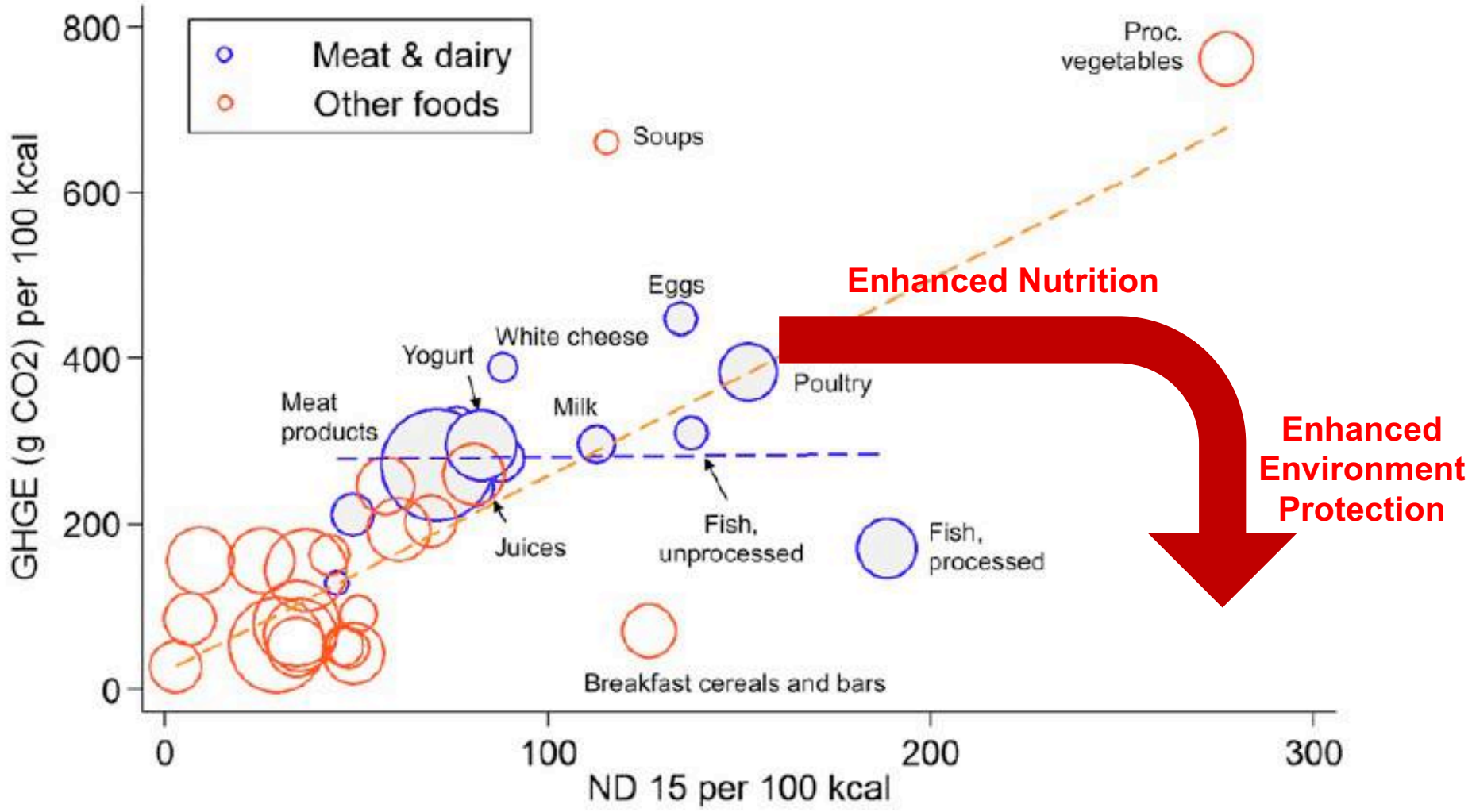






Drewnowski et al. Energy and nutrient density of foods in relation to their carbon footprint. Am J Clin Nutr 2015;101:184–91.

Optimization of Nutritional Quality and GHGE Reductions "From Farm to Fork"



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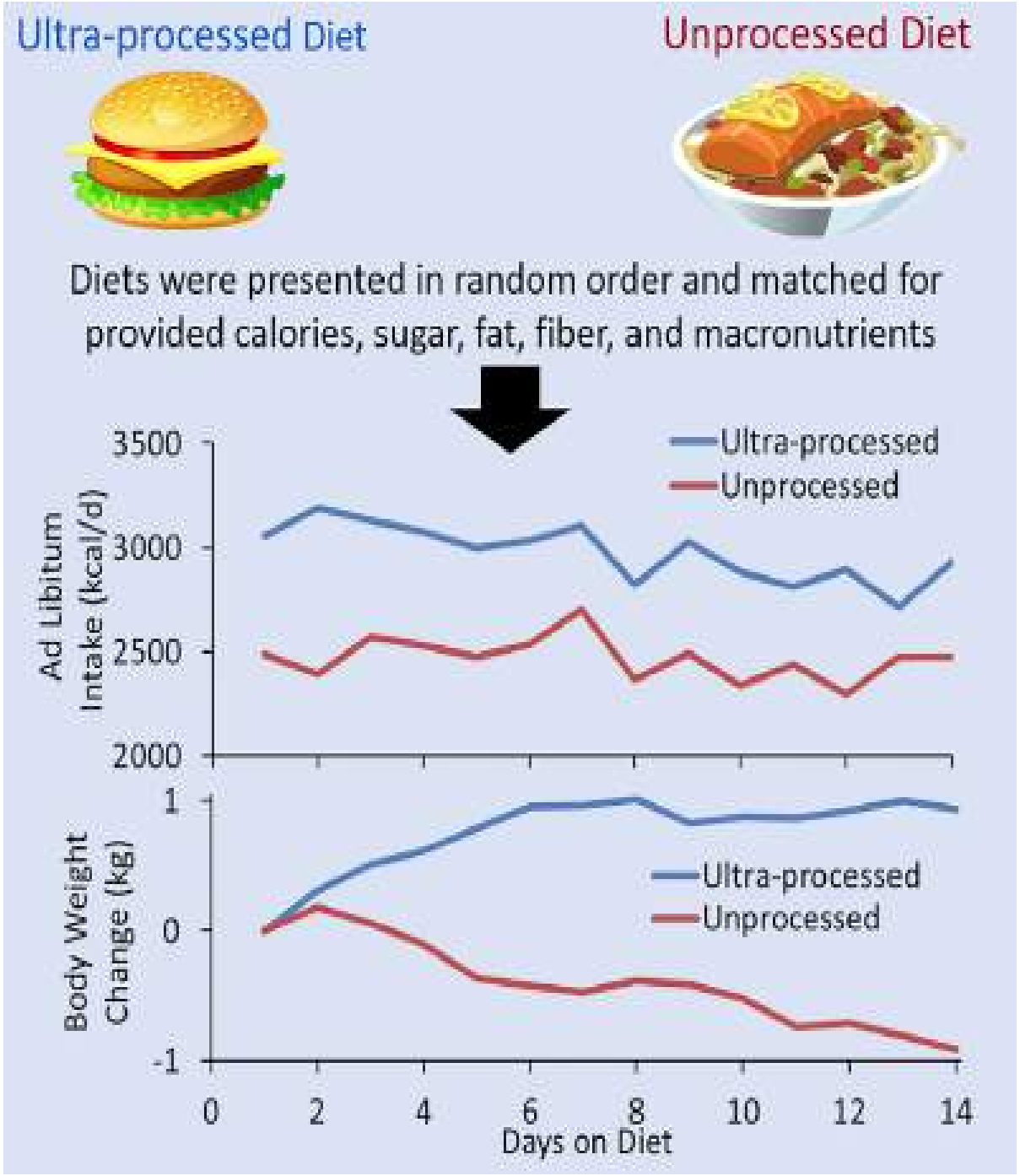
Nutritional Quality of Steak *Versus* Plant-Based Burgers
(4 Ounce = 115g)

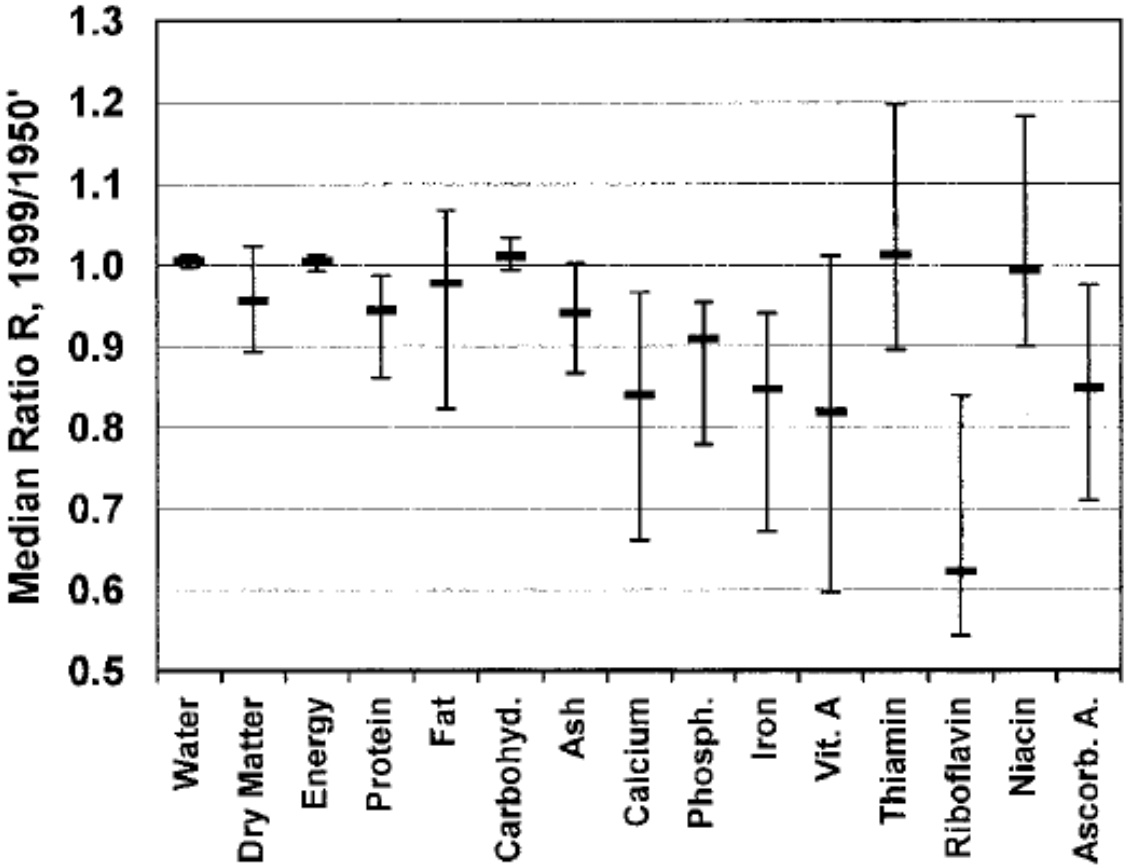
	Steak (80% Lean)	Beyond Meat Burger	Impossible Burger
Calories	287	270	220
Fat (g)	23	20	13
Saturated fats (g)	9	6	10
Carbohydrates(g)	0	5	5
Sugars	0	0	<1
Protein (g)	19	20	20
Sodium (mg)	75	380	430
Fibre (g)	0	3	0
Protein source	100% beef	Pea, mung bean, brown rice	Soy protein concentrate (GM), Soy leghemoglobin (GM), Soy protein isolate (GM), Potato protein,
Fat source		Cocoa butter, coconut oil, sunflower oil & canola oil	Coconut oil, Sunflower oil,
Additional Ingredients		Potato starch, Natural flavor, Yeast, Salt & Beet juice extract	8 added vitamins, Natural flavors, salt, Yeast extract, Methylcellulose, Food starch modified, Cultured dextrose & Water

Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain

Hall KD et al.
Cell Metabolism 2019; 30: 67–77.



What about the Quality of Fruits, Vegetables, Grains & Legumes Today?



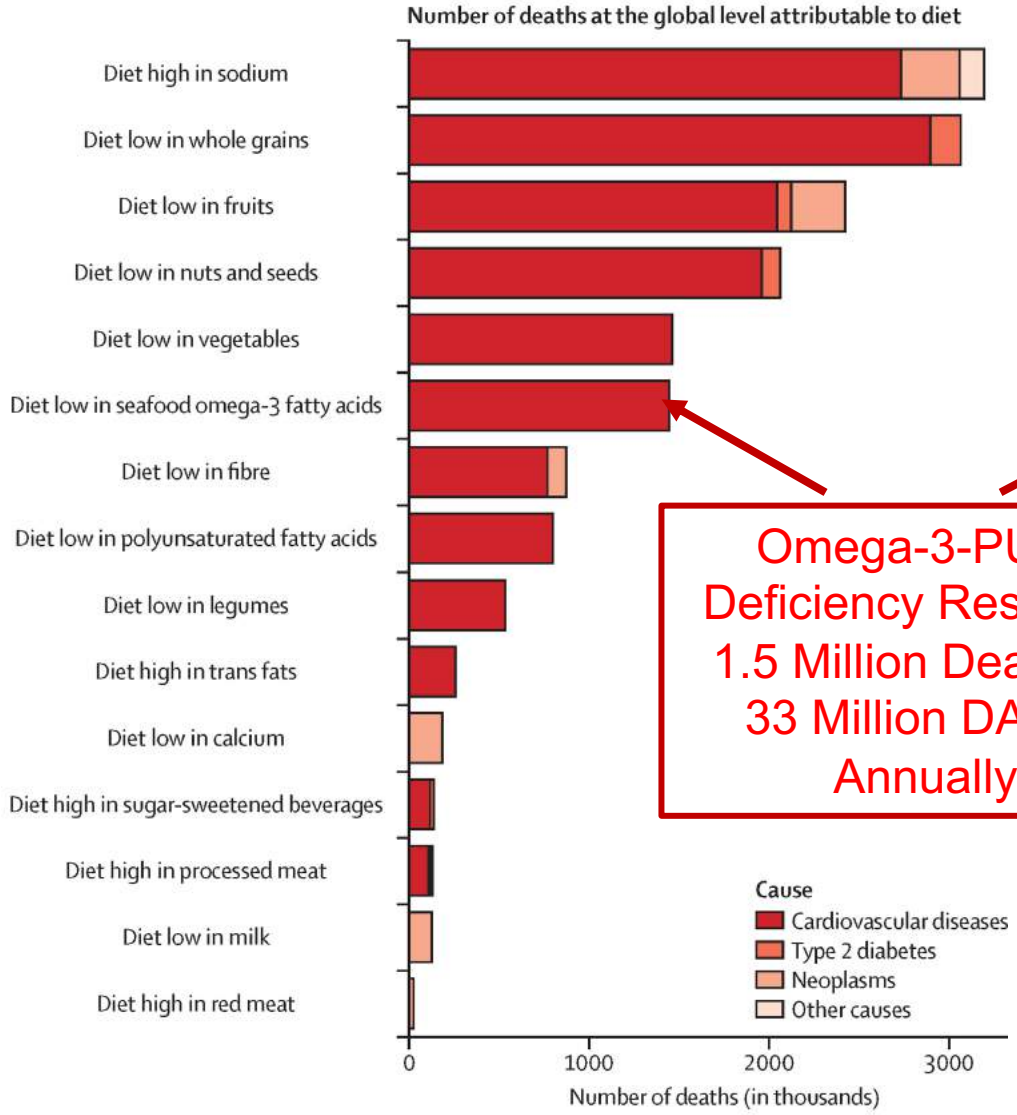
20-40% Decreases in Protein, Ca, P, Fe, Riboflavin and Ascorbic acid Content for 43 Garden Crops over 50 years (1950– 999)

Davis DR et al. J Amer Coll Nutrition 2004; 23: 669–682.

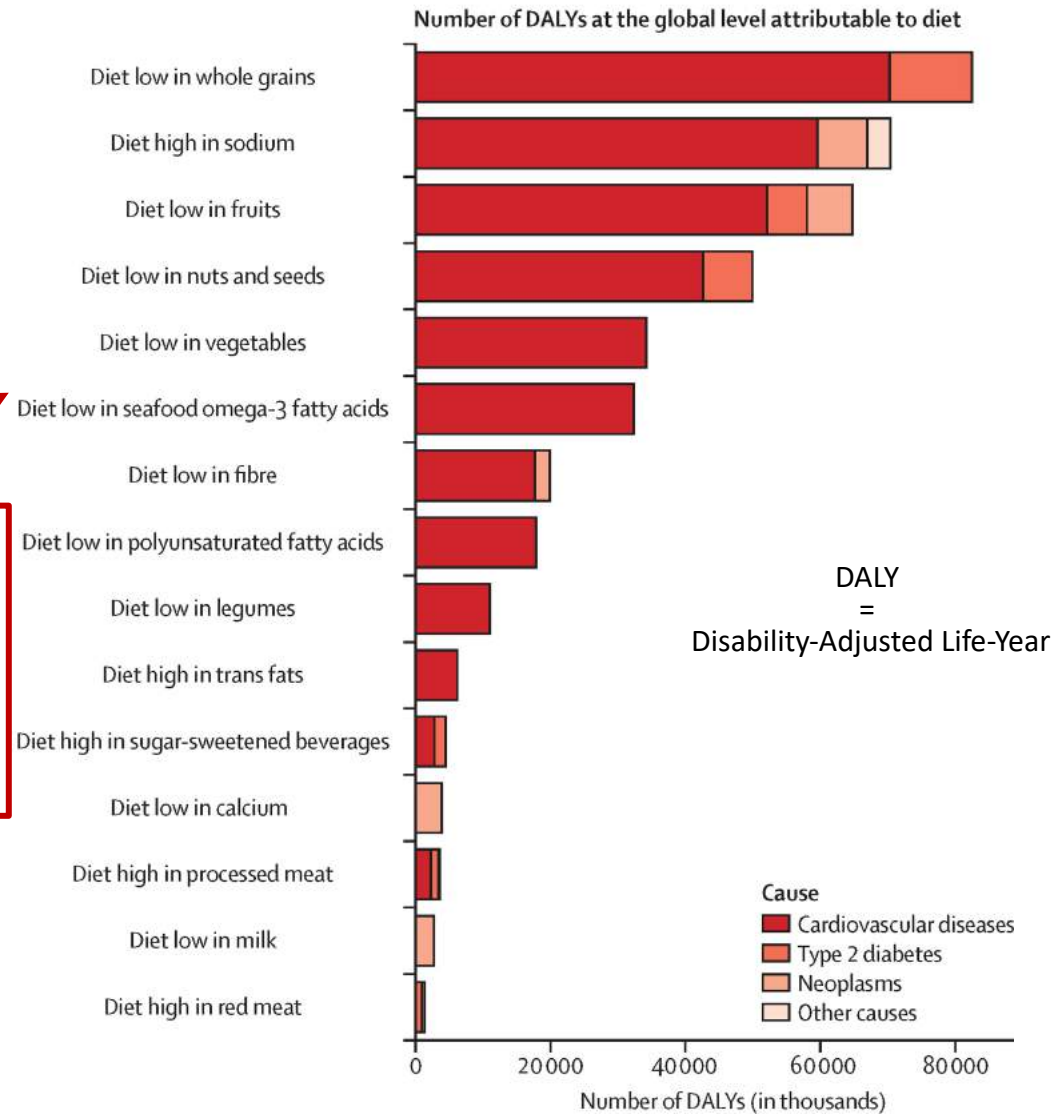
- A consequence of selection for rapid growth & appearance rather than for nutritional quality
- Increased atmospheric CO_2 will result in further decreases in crop protein, minerals & vitamins.
- Should new breeding techniques, such as the CRISPR-Cas Gene Editing Tool, be Considered as mitigating solutions?
  - Cereal seeds with increased fibre & minerals
  - Enhanced vitamin C and carotenoids in tomatoes
  - Camelina plants engineered to accumulate long chain omega-3-PUFAs in their seeds

Number of Deaths at the Global Level Attributable to Diet

Christopher JL Murray & GBD 2017 Diet Collaborators. Health Effects of Dietary Risks in 195 Countries, 1990-2017: A Systematic Analysis for the Global Burden of Disease Study. Lancet 2019

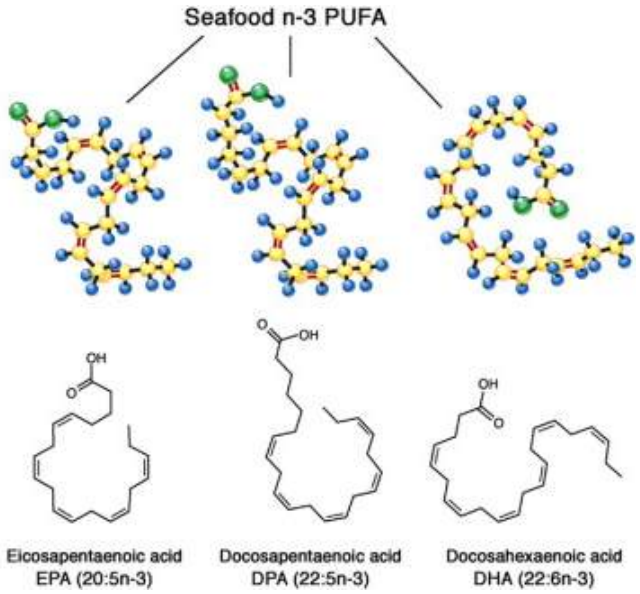


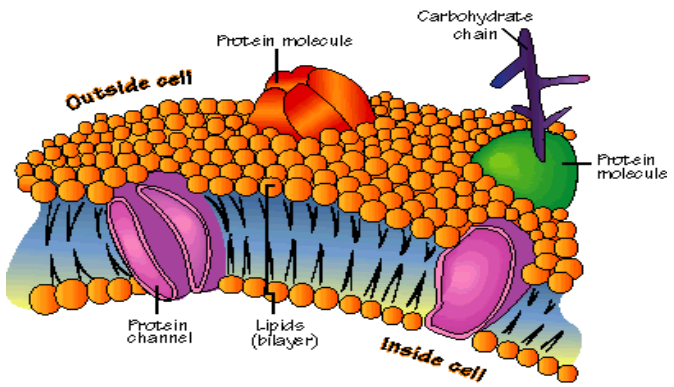
Omega-3-PUFA Deficiency Results in 1.5 Million Deaths & 33 Million DALYs Annually



DALY
=
Disability-Adjusted Life-Year

Consumption of Oily Fish and/or Elevated Plasma Levels of Omega-3-PUFAs Associated with Improved Human Health





Key Roles of Omega-3-PUFAs

- Stabilise cell membranes
- Anti-inflammatory

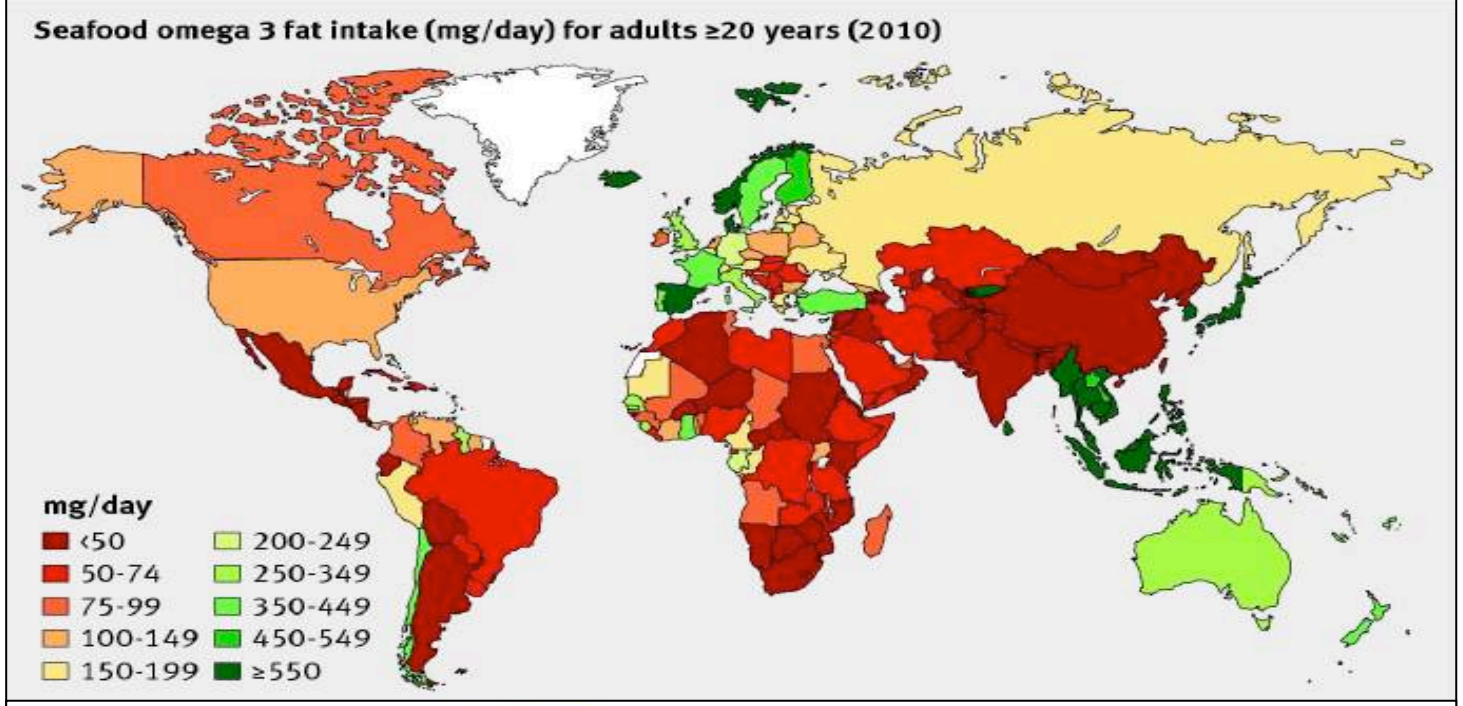
Providing Protection from

- Heart attacks and strokes
- Cancer
- Diabetes mellitus

& Improved

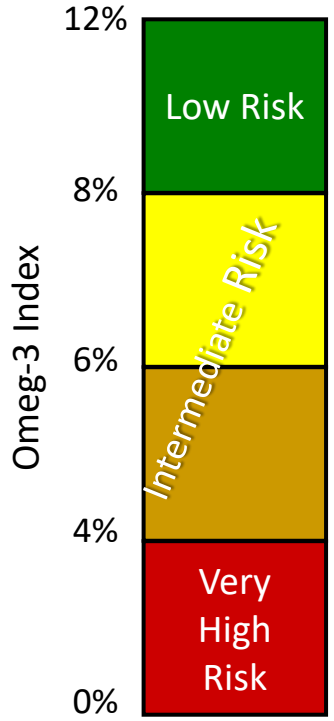
- Brain health
- Vision
- Muscle and joint health

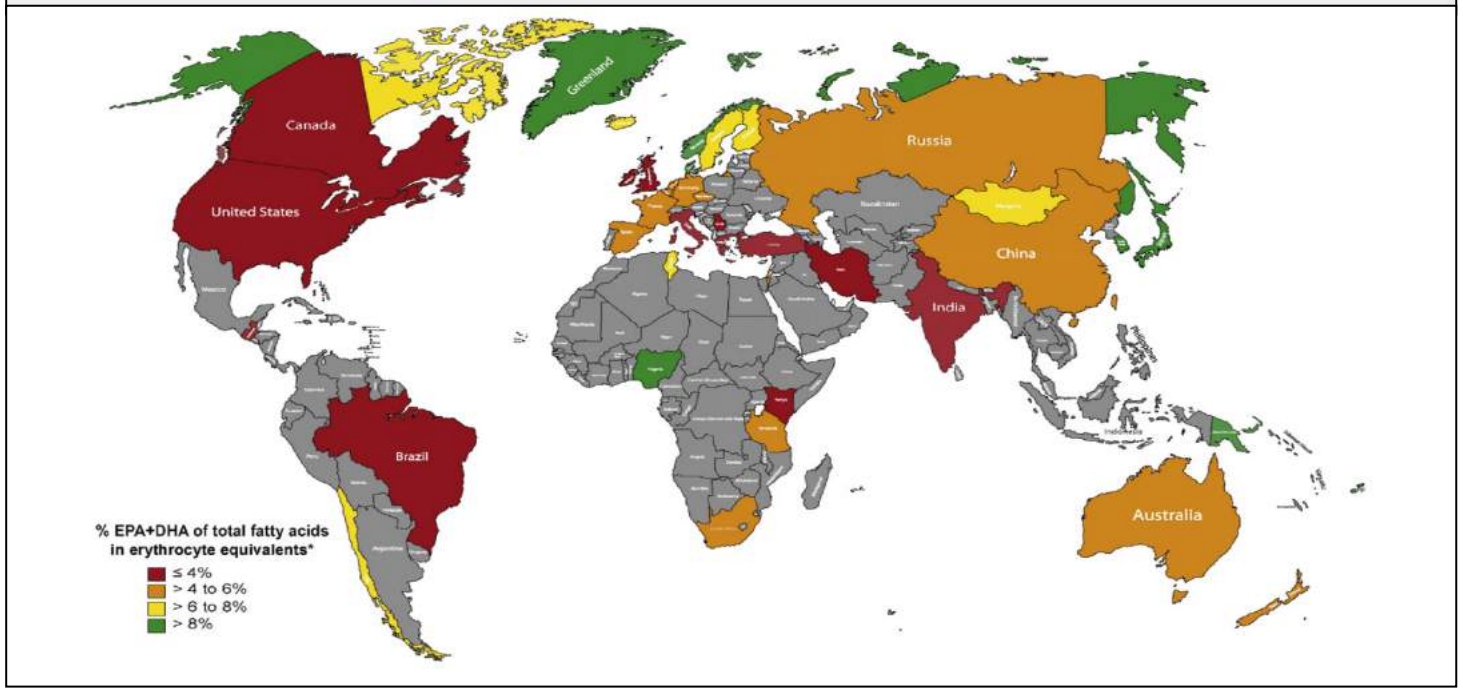
Only 20% of World's Populations Report Consumption of the Recommended Intake of Seafood Derived Omega-3-PUFAs (≥ 250 mg/day)



Even less have an optimal Tissue Levels of Omega-3-PUFAs

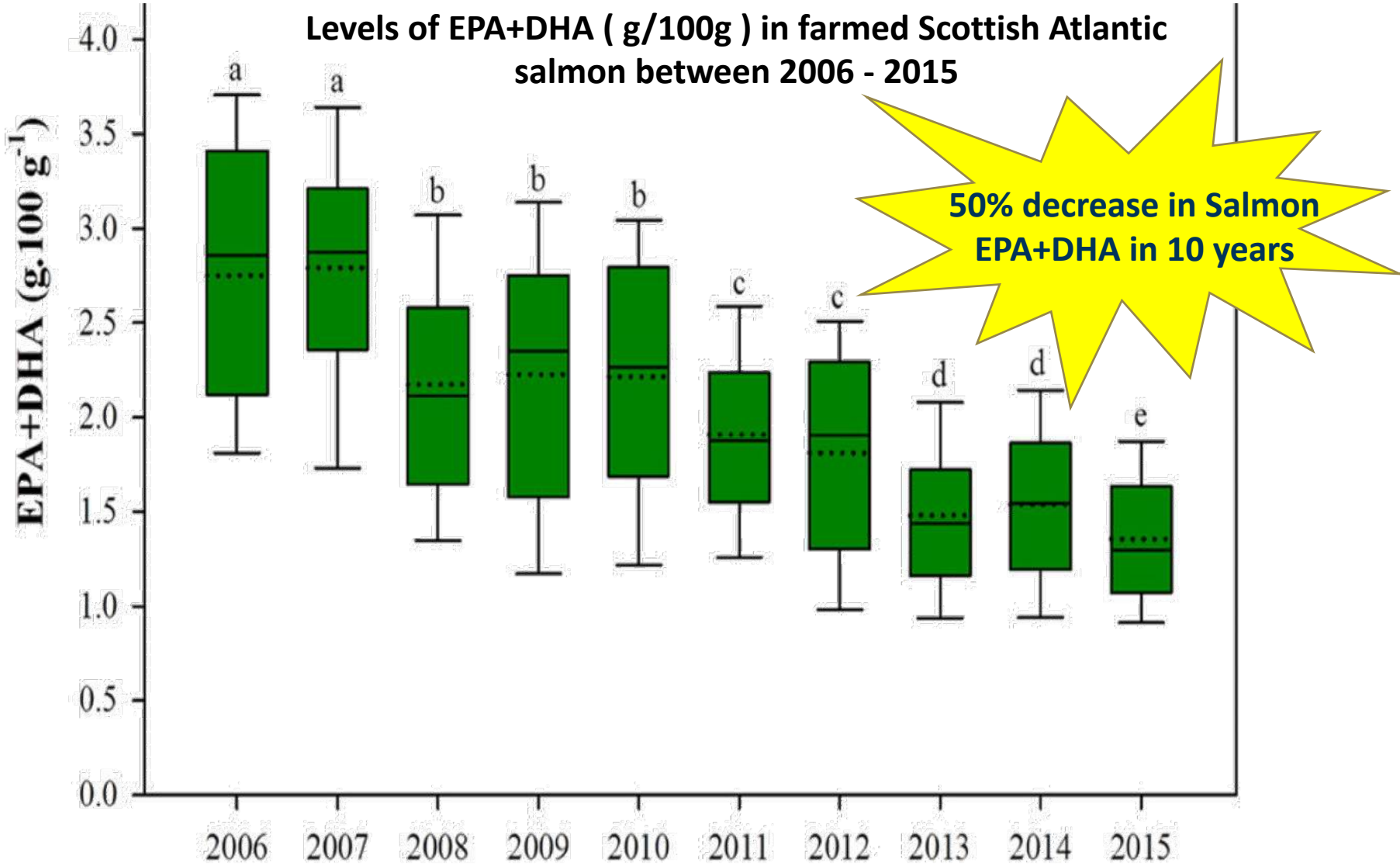
(Red cell Omega-3 Index = % EPA+DHA in red blood cell membranes)





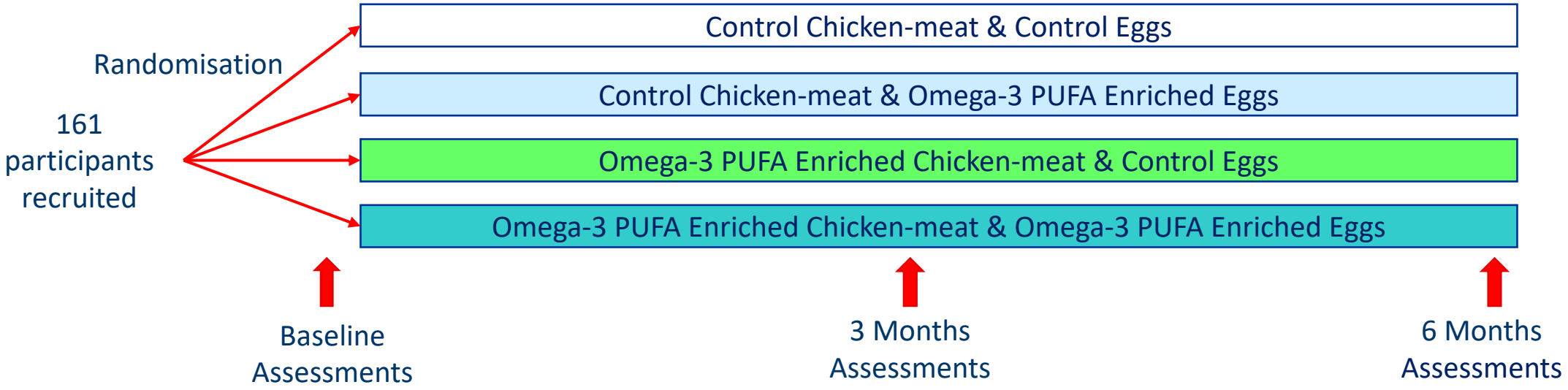
K.D. Stark et al. / Progress in Lipid Research 63 (2016) 132 - 152

Changes in the Nutrient Content of Oily Fish in last Ten Years



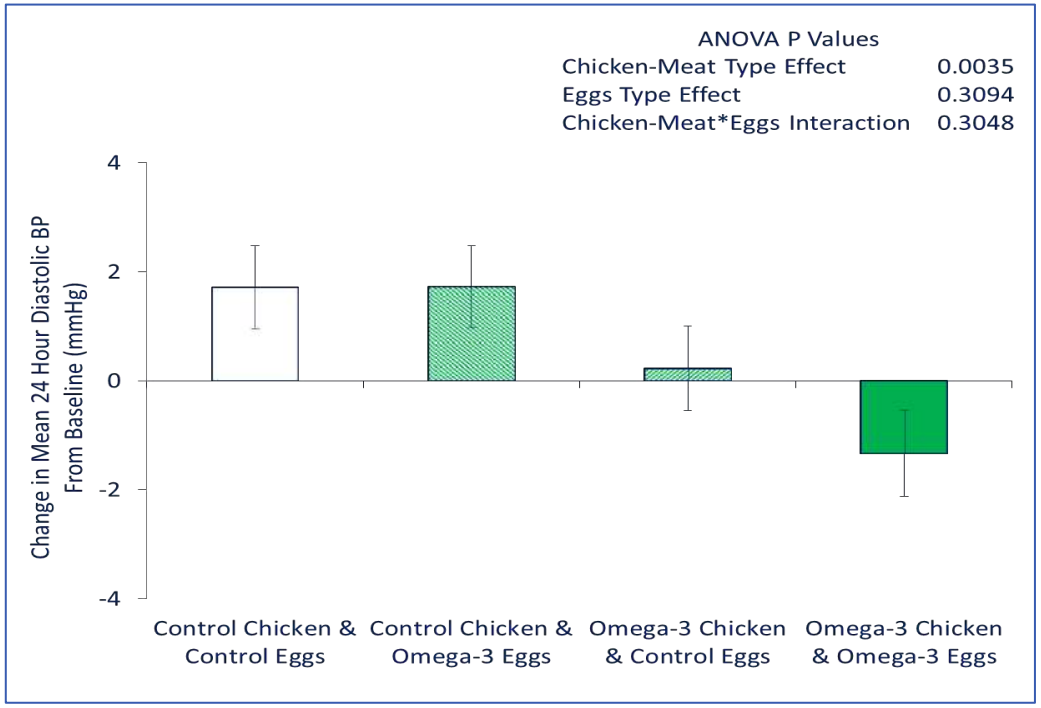
Sprague et al., 2016 Nature

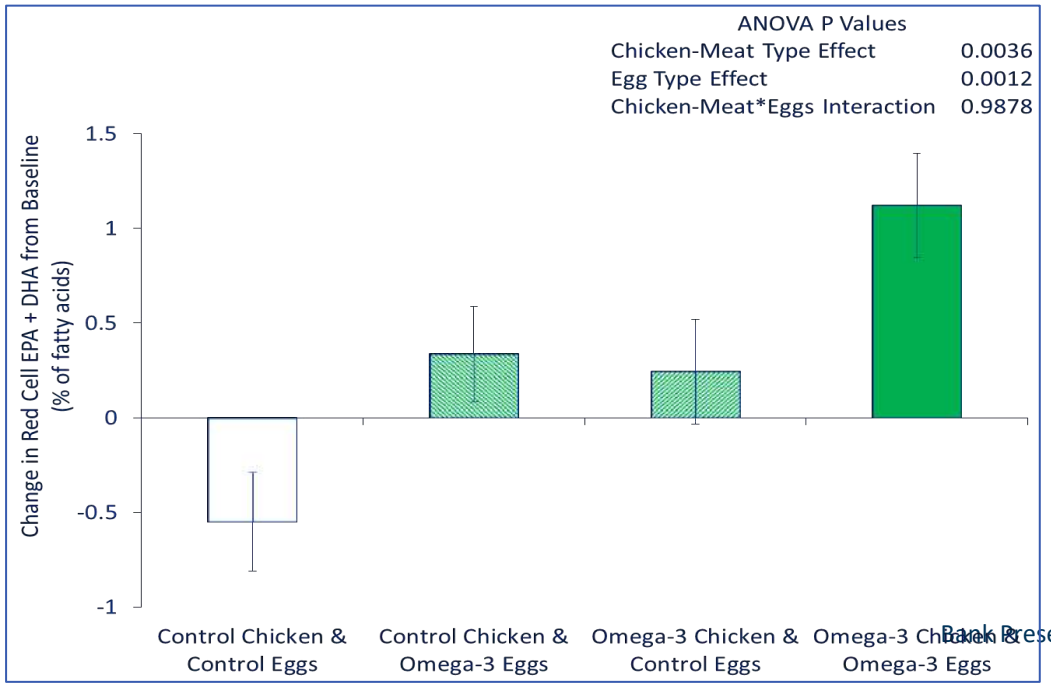
Natural Enrichment of Commonly Eaten Foods with Algae-Sourced Omega-3 PUFAs. (Devenish OmegaPro) Provides Alternative/Additional Sources

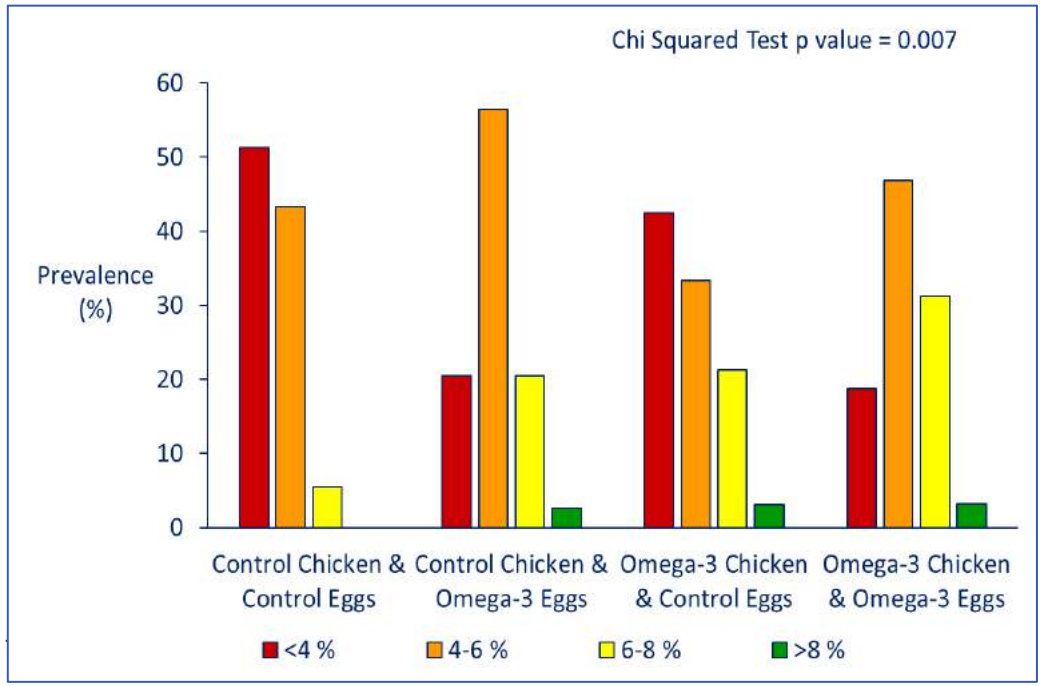


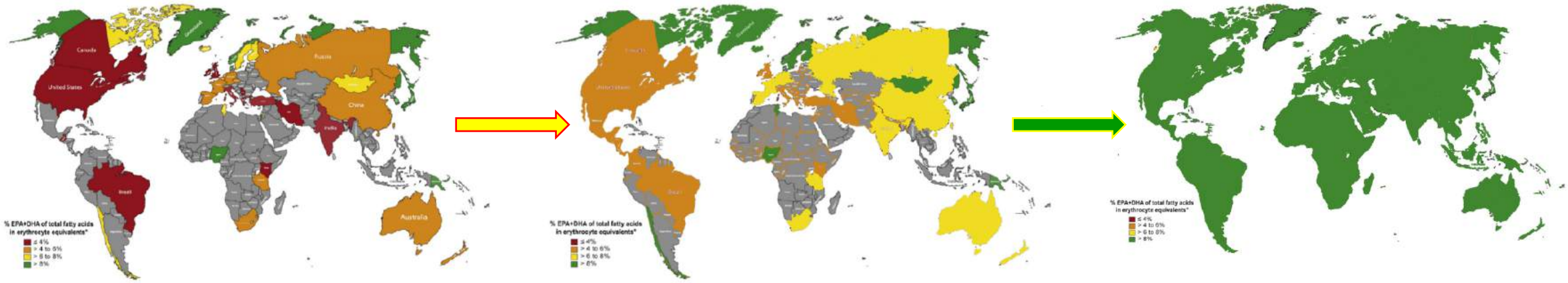
Eating Both Enriched Foods for 6 Months

- Red cell omega-3 index increased by 1.7%
- There was a halving of the number of subjects with a very high risk omega-3-index (Omega-3-Index < 4%)
- Mean 24-hour ambulatory diastolic BP decreased by 3 mmHg.





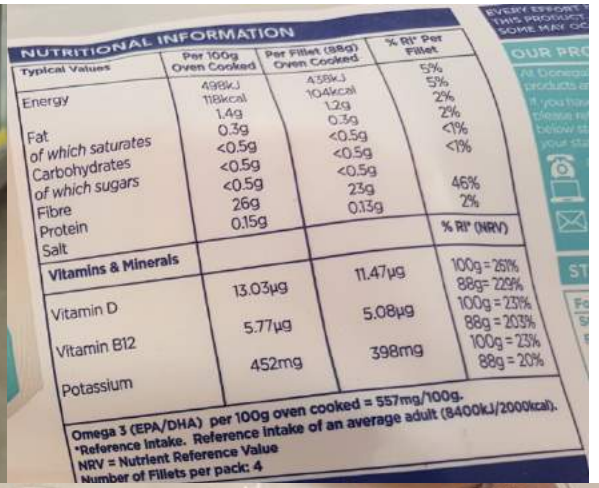




Recolouring the World Omega 3 Map **Green** will Require Multiple Contributing Sources

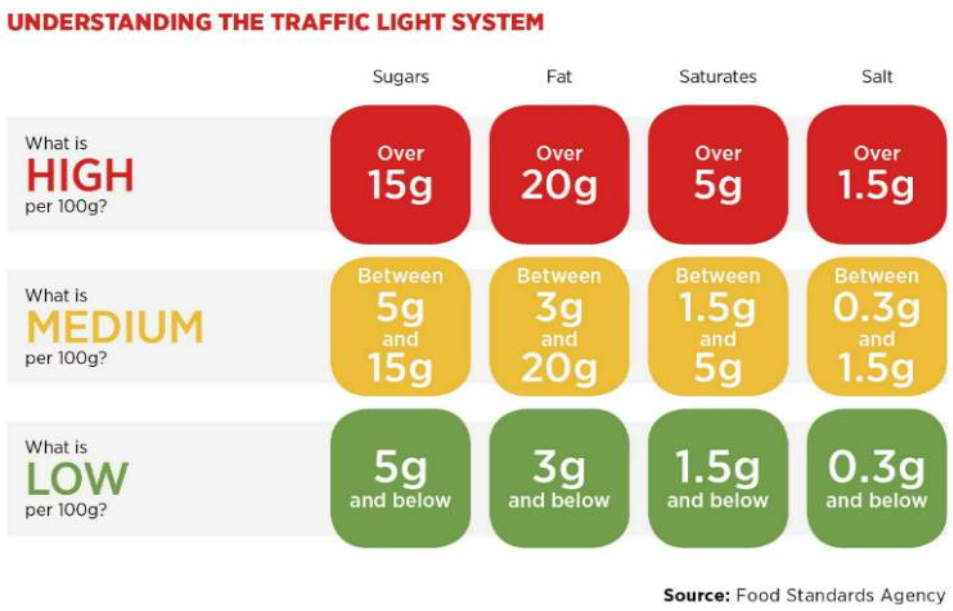
	Wild Oily Fish	Farmed Oily Fish	Naturally Enriched Meats	Naturally Enriched Eggs	Biofortified Food Coatings	Biofortified Dairy Foods (Milk, Cheese)	Supplements
EPA+DHA Content (mg/100g or mg/pill)	**500-2000**	**0-2000**	**100-250**	**100-250**	**100-250**	**20-100**	**250-4000**
Sustainable Environmentally Friendly Source	**++ (at limit)**	**++**	**++++**	**++++**	**++ / ??**	**++ / ??**	**++ / ??**
Freedom from Toxins	**++ / ??**	**++ / ??**	**++++**	**++++**	**++ / ??**	**++ / ??**	**++ / ??**
Stability (Protected from Oxidant Damage)	**++++**	**++++**	**++++**	**++++**	**??**	**??**	**++ / ??**
Bioavailability	**++++**	**++++**	**++++**	**++++**	**??**	**??**	**++ / ??**
Component of Healthy Balanced Diet	**++++**	**++++**	**++++**	**++++**	**++**	**+++**	**--**
Likely Lifelong Adherence	**++**	**++**	**++++**	**++++**	**++**	**+++**	**--**

Huge Confusion Concerning Long Chain Omega-3-PUFA (DHA+EPA) Content in Oily Fish



Front of Pack Labelling Should Provide Greater Consumer Awareness Concerning Nutritional Content & Sustainability

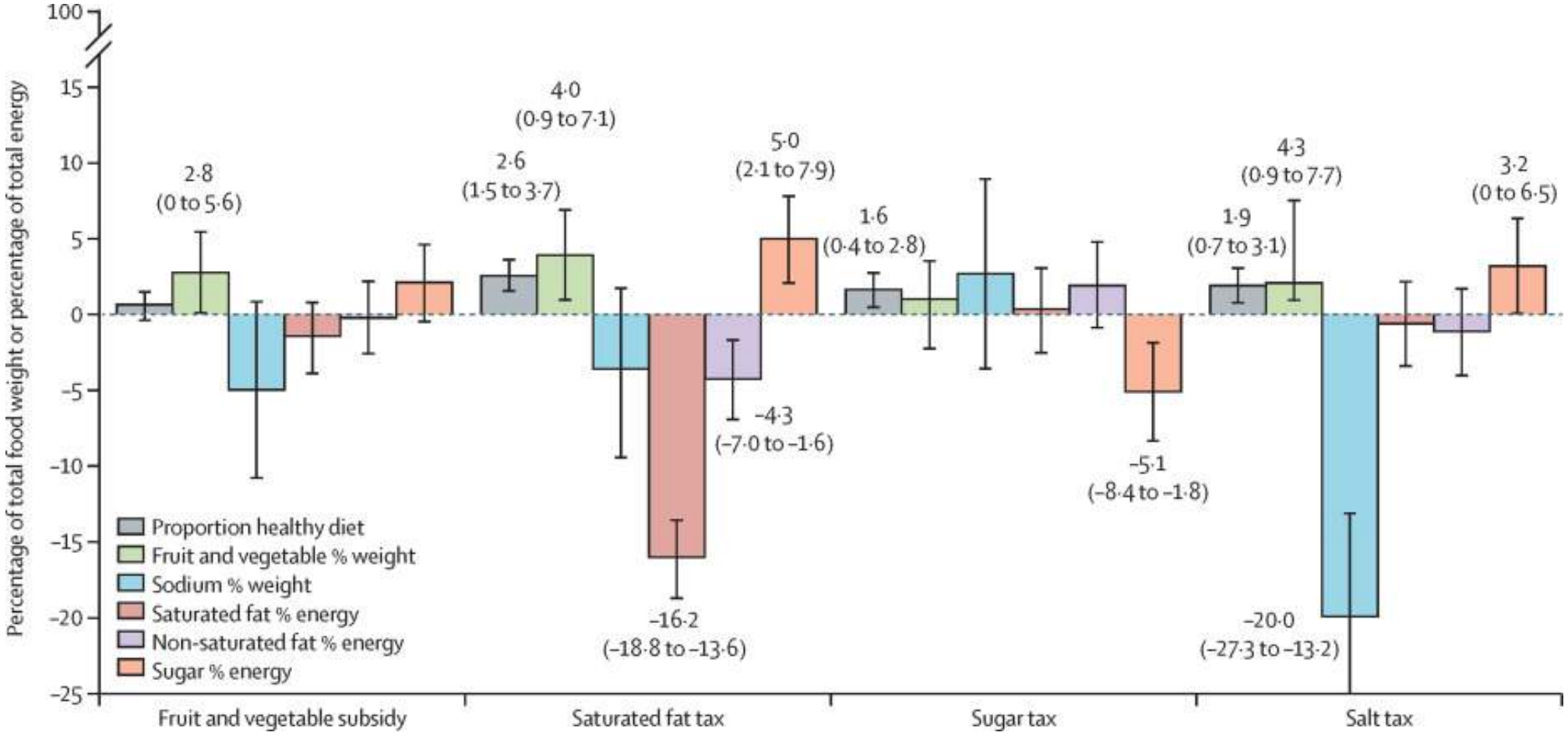
Traffic Light System for Disadvantageous Excesses



Potential Front of Pack Labeling for Nutrient Density & Beneficial Nutrients that are Common Deficiencies

Nutrient Density	Long-Chain Omega-3-PUFAs (DHA&EPA)	Bioavailable Iron	Bio-Effective Vitamin D
ND 15/100kcal	Content/100g (% Daily or Weekly Guideline)		
Low 50	40 mg (15% Daily)	mg (15% Daily)	mg (15% Daily)
Intermediate 100	125 mg (50% Daily)	mg (50% Daily)	mg (50% Daily)
High 150	300 mg (15% weekly)	mg (15% weekly)	mg (15% weekly)
Very High 200	1 g (60% Weekly)	mg (60% Weekly)	mg (60% Weekly)

Taxes on Disadvantageous Foods & Subsidies for Advantageous Foods Changes Consumer Behaviour



Wilma E Waterlander, Yannan Jiang, Nhung Nghiem, Helen Eyles, Nick Wilson, Christine Cleghorn, Murat Genç, Boyd Swinburn, Cliona Ni Mhurchu, Tony Blakely. The effect of food price changes on consumer purchases: a randomised experiment. The Lancet Public Health Aug 2019; 4: e394.

Cost-effectiveness of financial incentives for improving diet and health through Medicare and Medicaid: A microsimulation study

30% subsidies on healthy foods (seafood rich in omega-3-PUFAs, fruit, vegetables, whole grains, nuts and seeds), through the Medicare and Medicaid Systems in the US estimated to;

- Prevent 3.3 million cardiovascular events,
- Gain 8.4 million quality adjusted life years (QALYs), and
- Save $100.2 billion in formal healthcare costs.

Lee Y et al PLOS Medicine 2019

Key Take Home Messages

- Major reductions in ruminant agriculture (red meat & dairy), so as solve greenhouse gas emissions is very likely to harm human health.
- Alternative suggested solution is to optimize both
  - Nutritional quality of unprocessed foods and
  - Sustainable agriculture practices

  Using measurement and technology solutions
- Promotion of greater consumer awareness of the health benefits of advantageous nutrients, through colour-coded easily understood front-of-pack labeling.
- Consideration of providing
  - Subsidies for sustainably produced nutritious foods, and
  - Taxes on disadvantageous foods that are commonly eaten to excess.

Association of Dietary Quality with Cardiovascular Disease and Mortality in the Prospective Urban Rural Epidemiology (PURE) Study

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