Health and Nutritional Impact of Increasing Alternative Protein Intake in the Diet

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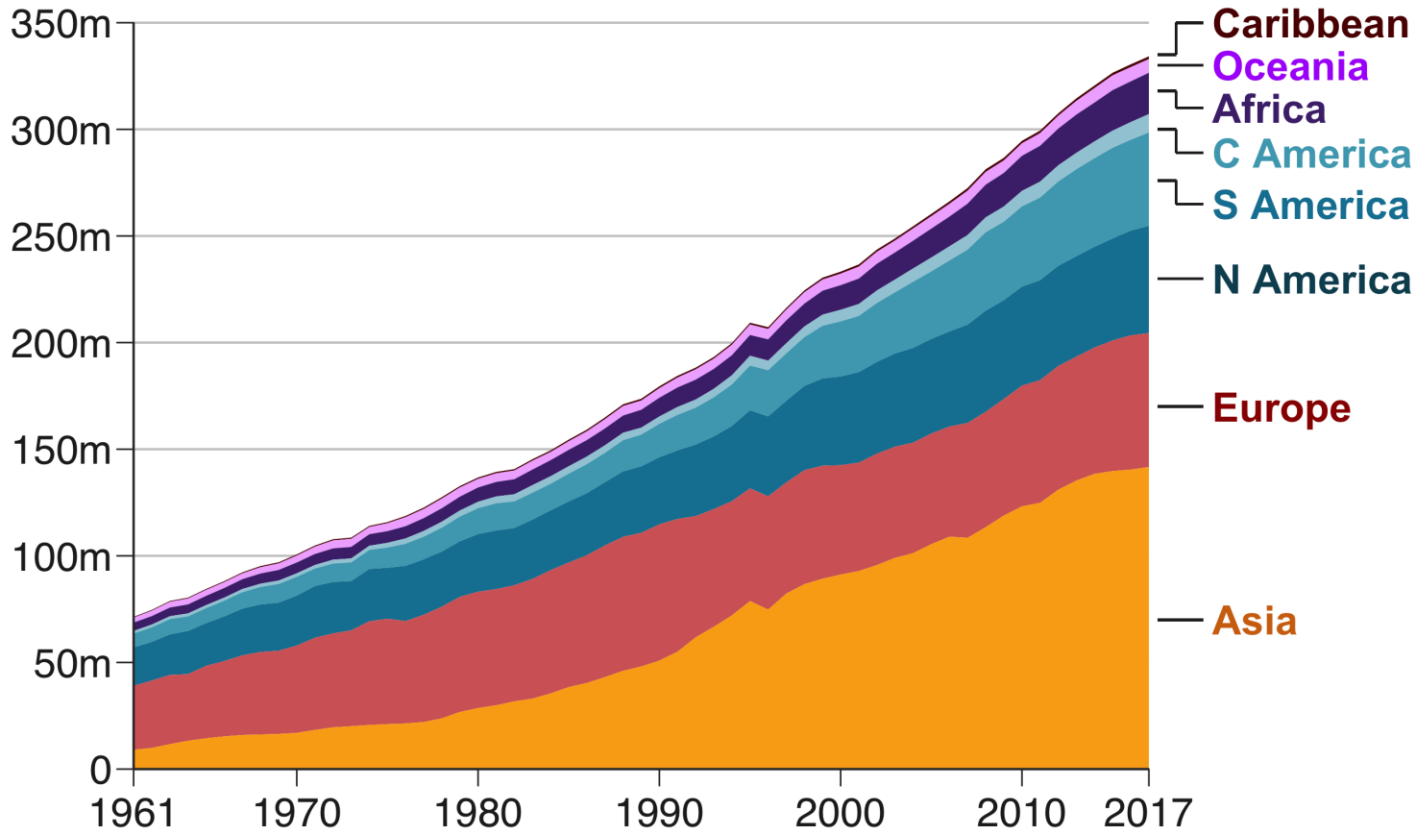
Disclosure Statement

- No conflicts of interest to declare

Meat production by region

Annual production, in tonnes



Source: UN Food and Agriculture Organization / Our World in Data

BBC

The perfect storm: Climate change and the food system

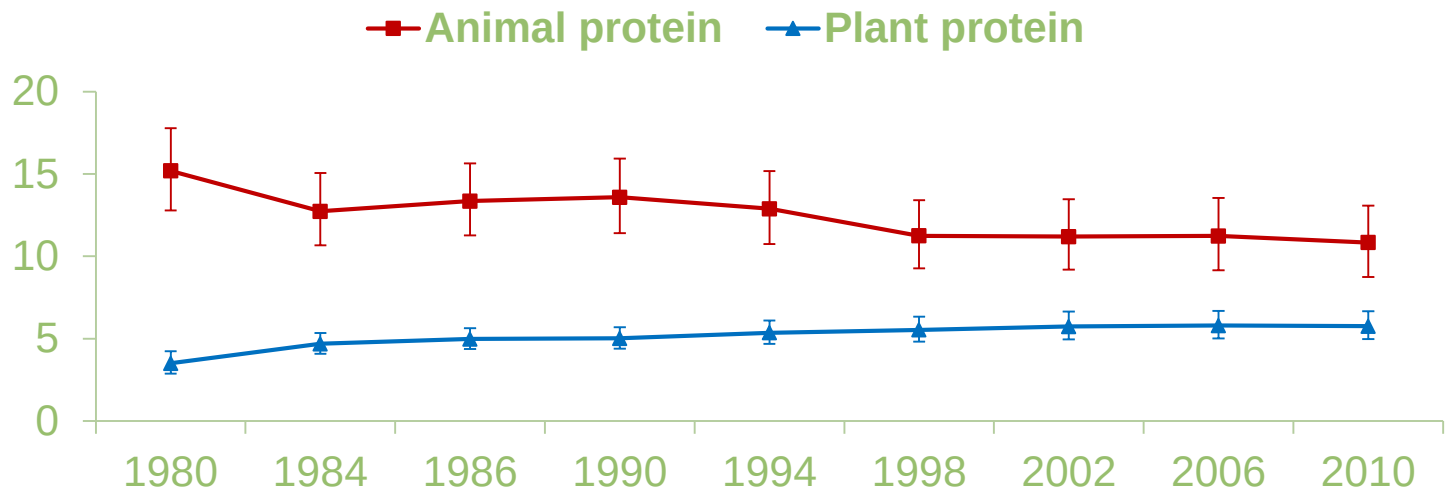
- The global demand for meat production will continue to increase with rapid population growth and economical development

- The current food system is not sustainable:
  - The livestock sector significantly contributes to GHG emissions, land and water use, antibiotics resistance
  - Adverse health consequences such as NCDs
  - Skyrocketing healthcare cost

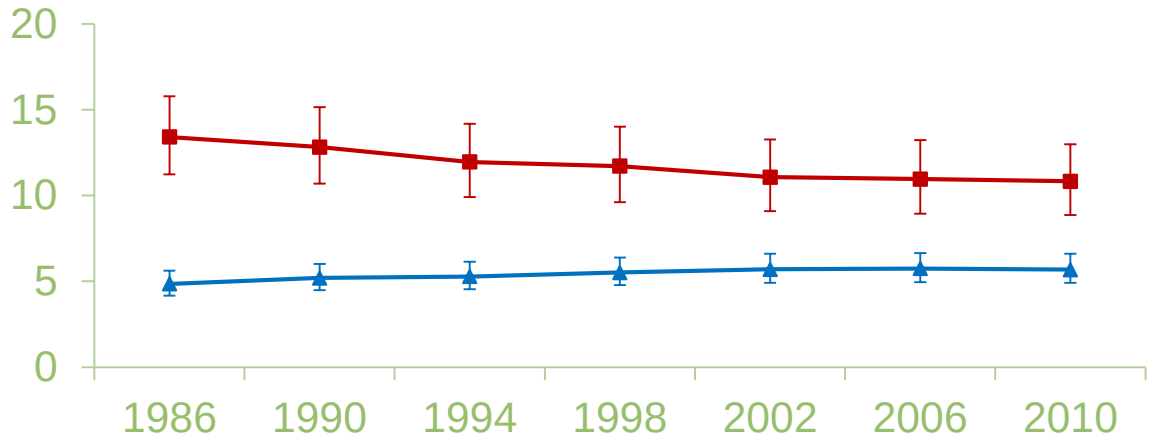
- Increasing consumer demand for alternative proteins especially plant proteins
  - Health reasons, allergy
  - Environmental consciousness
  - Animal welfare

Temporal trend of protein intake (in % energy) in the Nurses Health Study and Health Professionals Follow-up Study

Women

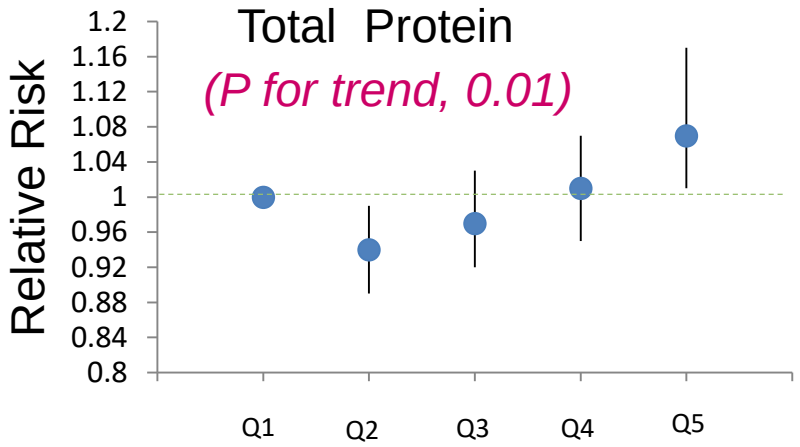


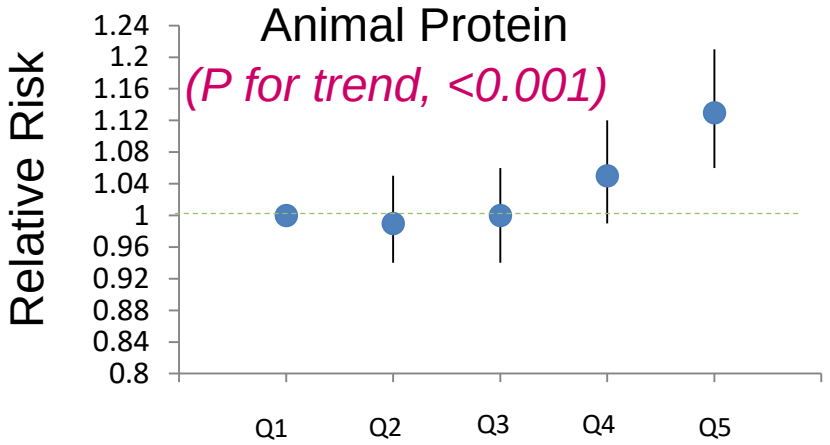
Men

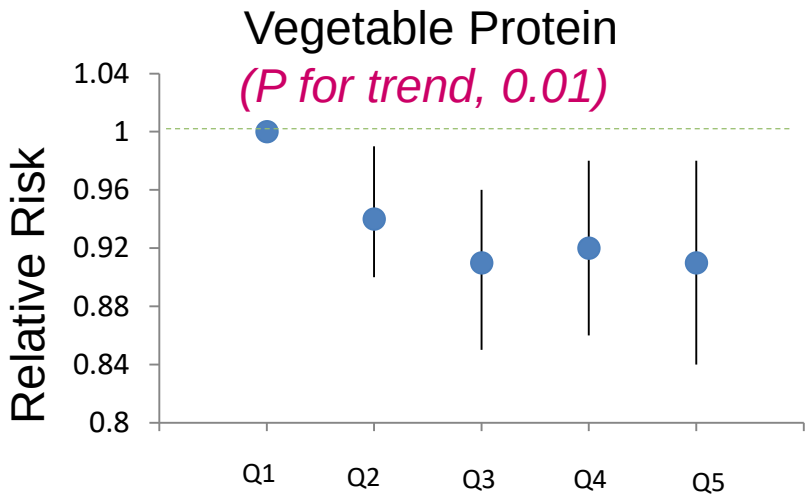


Song M et al. JAMA Intern Med. 2016

Total protein and protein type and risk of type 2 diabetes: Pooled results from 3 cohorts







NHS: 1980-2010, N= 72,992

NHSII: 1991-2009, N= 92,088

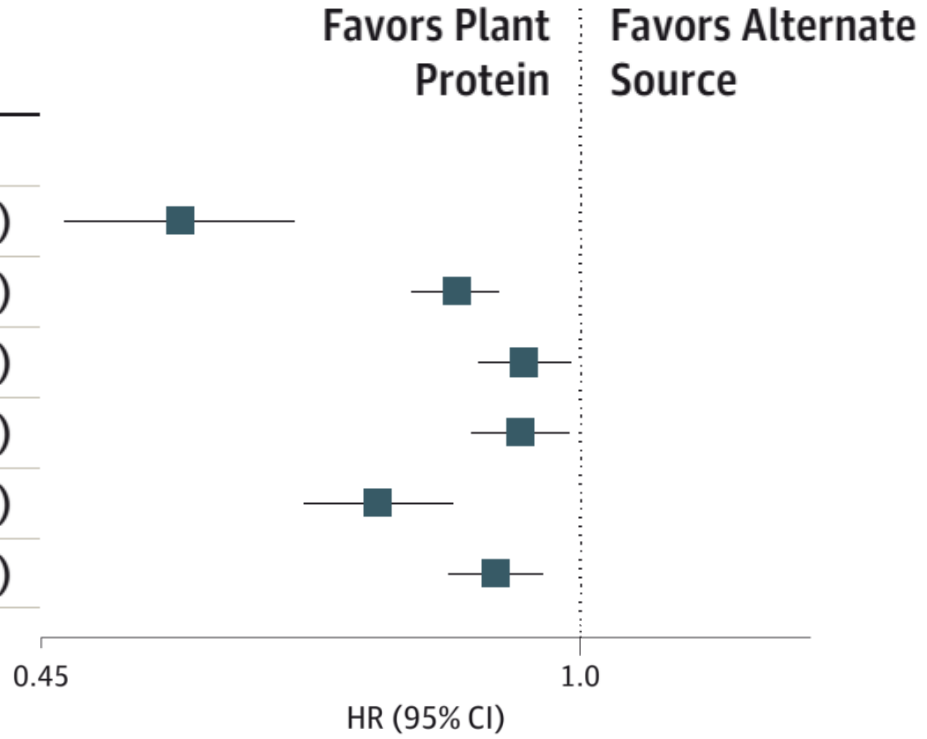
HPFS: 1986-2010, N= 40,722

Adjusted for: age, family history of diabetes, smoking, alcohol, physical activity, race, total energy, post menopausal hormones, oral contraceptives, dietary fiber, glycemic index, dietary cholesterol, percent energy from trans fat saturated fat, MUFA, PUFA, and animal/vegetable protein **+ BMI**

Malik et al, AJE 2016

Replacing 3% energy from various animal protein sources with plant protein on mortality risk

Animal Protein Source by Cause of Death	HR (95% CI)
All cause	
Processed red meat	0.66 (0.59-0.75)
Unprocessed red meat	0.88 (0.84-0.92)
Poultry	0.94 (0.90-0.99)
Fish	0.94 (0.89-0.99)
Egg	0.81 (0.75-0.88)
Dairy	0.92 (0.87-0.96)



Song M et al. JAMA Intern Med. 2016

Circulation
Volume 141, Issue 14, 7 April 2020; Pages 1127-1137
https://doi.org/10.1161/CIRCULATIONAHA.119.041306

American Heart Association.

ORIGINAL RESEARCH ARTICLE

Isoflavone Intake and the Risk of Coronary Heart Disease in US Men and Women

Results From 3 Prospective Cohort Studies

- Soy is rich in isoflavones -- phytoestrogens (plant-derived compounds with weak estrogenic action and antioxidant activity)
- Increased intake of soy protein has been shown to reduce blood pressure and LDL cholesterol in RCTs.
- We found that intake of isoflavones and soy products such as tofu was associated with a lower coronary heart disease risk in 3 large prospective cohorts of US men and women (N=200,000; CHD cases 8,400; 28 years of follow-up).
- Soy products such as tofu can be integrated into healthy plant-based diets as an important source of plant proteins and aid in the prevention of heart disease.

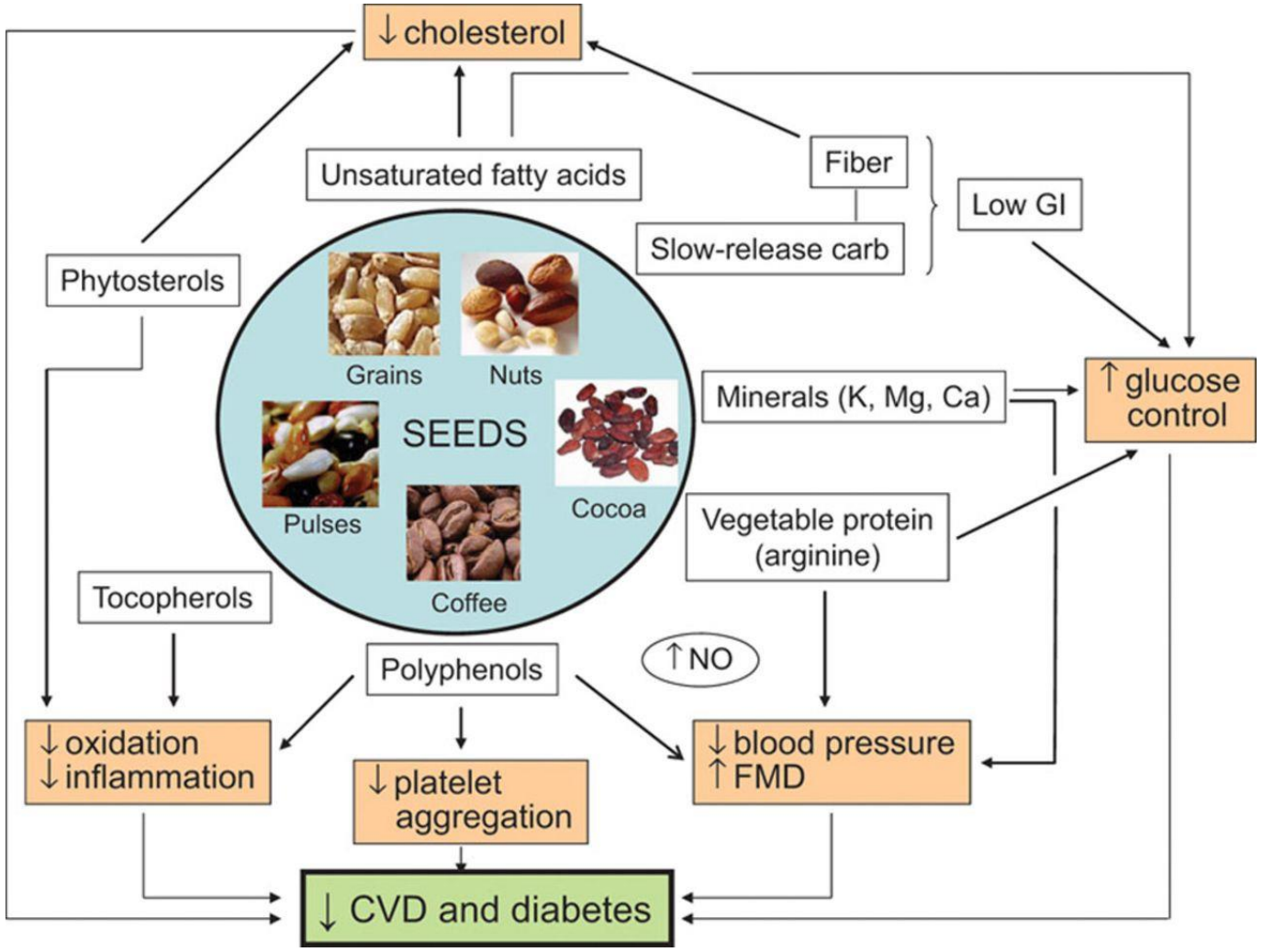
Circulation, 2020

Summary of Published Meta-Analyses of RCTs on Plant Foods and Blood Lipids (Intervention Plant Foods Versus Comparison Diets)

Intervention Food/Food Group	Total Cholesterol, mmol/L	LDL Cholesterol, mmol/L	HDL Cholesterol, mmol/L	Triglycerides, mmol/L
Tree nuts	–0.09	–0.11	0.00	–0.02
Walnuts	–0.18	–0.14	0.002	–0.05
Almonds	–0.18	–0.15	–0.05	–0.04
Soy protein or products	−0.22	−0.23	0.07	−0.09
Dietary pulses	–0.14	–0.13	0.04	–0.06

Guasch-Ferré et al. Circulation. 2019.

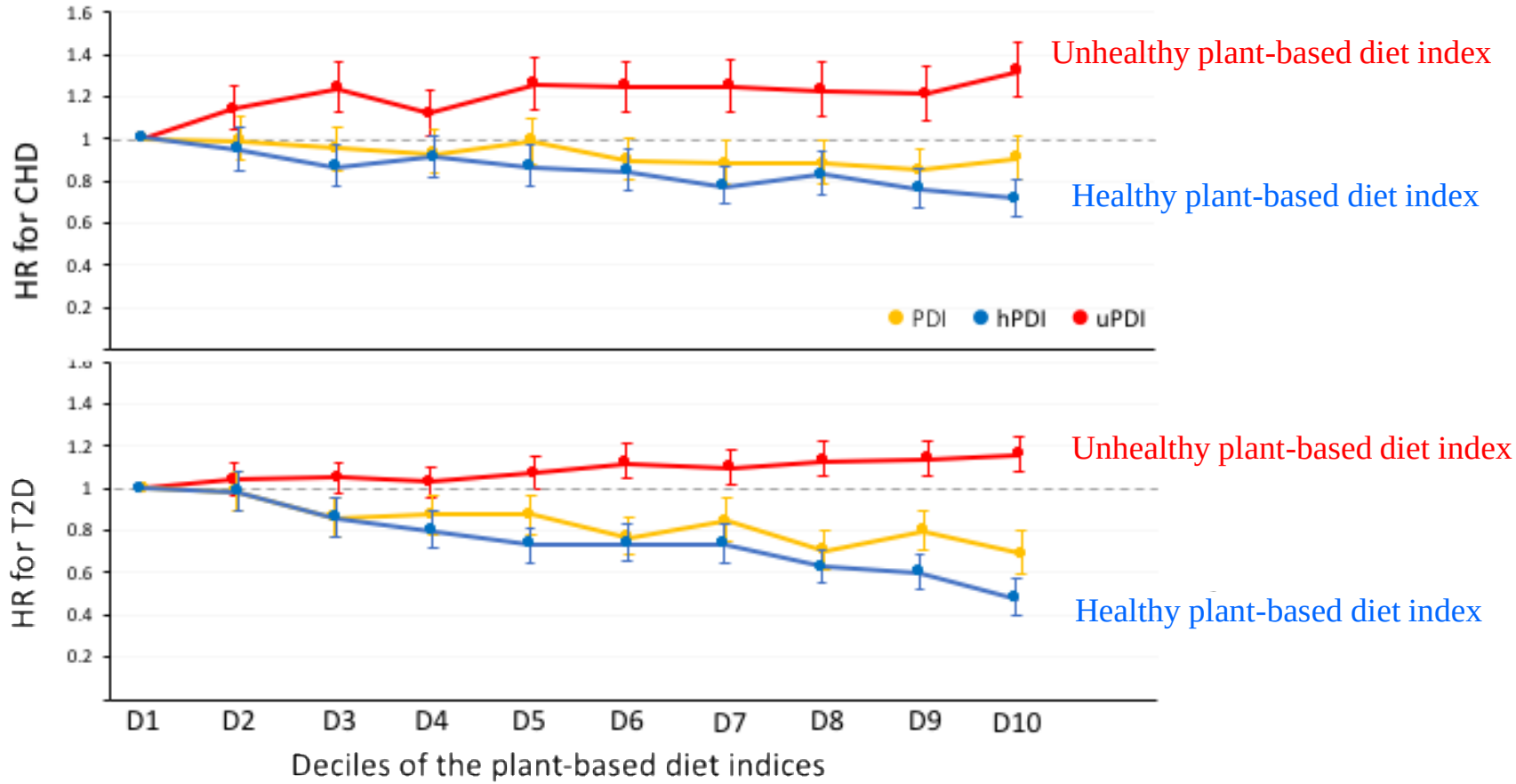
The consumption of plant food improves metabolic and cardiovascular health



Emilio Ros, and Frank B. Hu Circulation. 2013;128:553-565

Not all plant-based diets are healthy

Pooled Hazard Ratios (HRs) and 95% CIs for Coronary Heart Disease (CHD) and Type 2 Diabetes (T2D) according to deciles of overall, healthy and unhealthy plant-based diet indices



Satija et al. 2016, 2017

2015 Dietary Guidelines Advisory Committee Report

- **Plant-based dietary patterns**
  - Vegetables, fruits, whole grains, legumes, nuts, and seeds
  - Less environmental impact than current average U.S. diet
  - U.S. population should eat more plant-based foods and less meat while decreasing total calories
    - Don’t need to go completely vegetarian
  - Examples of dietary patterns
    - Dietary-guidelines based
    - Healthy Vegetarian
    - Mediterranean-style
    - Dietary Approaches to Stop Hypertension (DASH)

Scientific Report of the 2015 Dietary Guidelines Advisory Committee. Part D. Chapter 5

Planetary Health Diet

◆Compared with current diets, this shift will require global consumption of foods such as red meat and sugar to decrease by 50%, while consumption of fruits, nuts, vegetables, and legumes must double.

◆It is important to tailor these targets to local situations. For example, while North American countries currently consume almost 6.5 times the recommended amount of red meat, countries in South Asia eat only half the recommended amount.

Willett et al, EAT Lancet Commission Report 2019.

Animal protein alternatives

- Whole or minimally processed plant protein sources (nuts, seeds, legumes, soy products)
- **Novel plant-based meat (or dairy or seafood) alternatives**
- Mycoprotein (fungal protein)
- Insect protein
- Algae protein
- Lab-grown or cultivated meat/seafood

VIEWPOINT

Can Plant-Based Meat Alternatives Be Part of a Healthy and Sustainable Diet?

Hu et al. JAMA 2019

VIEWPOINT

Can Plant-Based Meat Alternatives Be Part of a Healthy and Sustainable Diet?

Environmental impact of plant-based burgers

- An analysis commissioned by Beyond Meat found that the Beyond Burger generates 90% less greenhouse gas emissions, requires 46% less energy, 99% less water, and 93% less land use than a burger made from U.S. beef.

Nutrient composition of plant-based burgers is not optimal

- High amounts of sodium and saturated fat in many products.

Highly processed nature of the plant-based burgers

- These products are generally using purified plant protein, with vitamins and other ingredients added to the patty. They are often consumed in fast-food settings.

Heme iron concern

- Impossible Foods adds heme from the roots of soy plants to the burger. One potential concern is that higher intake of heme iron has been associated with increased body iron stores and risk of diabetes.

Modelling nutritional Impact of Switching from Animal- to Plant-Based Diets in the US

- Modelled a reference omnivore diet using NHANES data and compared it to diets that substituted animal products in the reference diet with either traditional or novel PBMAs to create flexitarian, vegetarian and vegan diets.

- With the exception of the traditional vegan diet, all diets with traditional plant-based foods met daily requirements for vitamins and minerals and were lower in saturated fat, sodium and sugar than the reference diet.

- Diets based on PBMAs were below daily requirements for calcium, potassium, magnesium, zinc and B12 and exceeded the reference diet for saturated fat, sodium and sugar.

- Plant-based diets with larger proportions of novel PBMAs and vegan diets in the absence of nutritional supplements run the risk of being inadequate in several important micronutrients.

Tso and Forde, Nutrients 2021

The nutritional impact of replacing dietary meat with meat alternatives in the UK: a modelling analysis using nationally representative data

- Modelled the projected nutritional impact of a shift in the culinary practices of the meat-eating UK population towards more meat alternative products (vegetable proteins, mycoprotein, a combination of bean and pea, tofu, nut and soya).

- The models predicted significant increases in fiber intake and a significant decrease in saturated fat intake as people switch from meat to meat-alternatives.

- Projected reductions in total protein and vitamin B12 and increases in the intake of Na and added sugars.

- Recommending using a variety of protein alternative products; choosing products high in protein and fiber and low in saturated fat and sugar; where possible, choosing products that are good sources of Fe and vitamin B12.

Farsi et al. BJN 2022

SWAP-MEAT trial (AJCN 2020)

- A single-site, randomized crossover trial with no washout period – funded by Beyond Meat.
- 36 participants were instructed to consume ≥2 servings/d of Plant meat compared with red meat for 8 wk each, while keeping all other foods and beverages as similar as possible between the 2 phases.
- TMAO concentrations were significantly lower overall for Plant (2.7 ± 0.3) than for Animal (4.7 ± 0.9) (P = 0.012), but a significant order effect was observed.
- LDL-cholesterol concentrations and weight were reduced during the Plant meat phase.

Mycoprotein and Health Biomarkers: A Systematic Review

- Mycoprotein is fungal-derived protein through fermentation that was first discovered in the early 1960's.
- Sixteen controlled trials, totaling 432 participants were included – of these 5 studies reported total cholesterol, 5 reported on energy intake, 7 on insulin levels, 8 on glucose levels
- Acute mycoprotein ingestion appears to consistently lower later *ad libitum* meal and 24-h energy intake.
- Short-term interventions with mycoprotein reduced total cholesterol levels, particularly among those with hyperlipidemia.
- Evidence was less conclusive for effects on blood glucose and insulin levels.

Derbyshire & Delange, Front. Sustain. Food Syst., 2021

How healthy are alternative proteins?

The Pros		The Cons
•Comparable protein content to meat •More fiber and less saturated fat; no cholesterol •No added hormones and antibiotics	Plant-based meat	•May contain high amounts of sodium and additives •Lower amounts of B12, zinc, iron if not added •Highly processed
•Contain all essential amino acids; high digestibility/bioavailability •Low in saturated fat, cholesterol; high in fiber, zinc, B12, choline	Mycoprotein	•Possibility of allergy (rare)
•Good source of protein, PUFA, vitamins and minerals	Insects	•Nutritional values vary •Possibility of allergy •The yuck factor
•Good source of protein, PUFA & fiber •Source of vitamin B12 and iodine	Algae	•Low raw digestibility and may contain some pollutants •Nutritional values vary
•Foodborne diseases can be eliminated •Nutritional composition can be tailored	Lab-grown meat	•Little is known about its health effects •Cost

Adapted from https://www.eitfood.eu/blog/are-alternative-proteins-good-for-you

Summary and Policy Implications

- The current animal protein-oriented food system is not sustainable due to population growth and health and environmental impacts.
- Diets rich in minimally processed plant foods tend to have the largest health benefits and lowest environmental impacts
- As the global demand for meat continue to increases, alternative proteins will have an important role to play in meeting the demand. However, plant-based meats are not a substitute for minimally processed plant foods
- Diversify protein sources: No single technology is a silver bullet
- The longer-term impacts of alternative proteins on human and planetary health remain to be seen: Need more research and be vigilant about unintended consequences
- Overall diet quality is critical: quality and quantity of protein is just one piece of the puzzle
- A fundamental change in the food system requires not just technological innovations, but also policies that help to create a food environment in which healthy and sustainable food choices are accessible and affordable

Today: Meat alternatives

The Future:

Meat becomes the alternative