PROTEIN AND BEYOND:
CONSIDERATIONS FOR DISEASE REDUCTION AND PLANETARY HEALTH

Food Truths Webinar • Hosted by Diet ID • April 28, 2021

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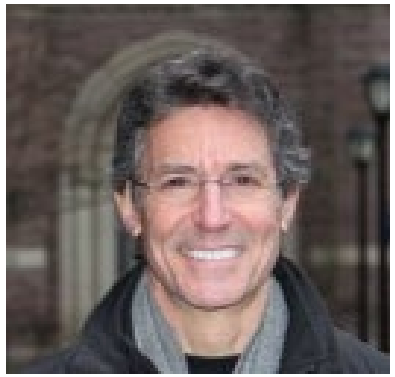

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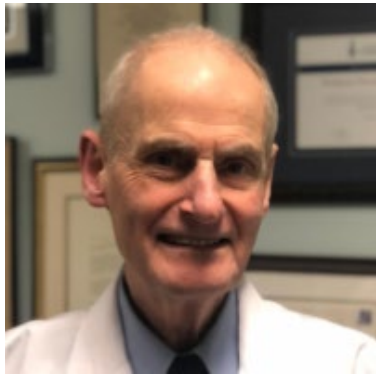

DAVID JA JENKINS, MD, PhD, DSC
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Protein Sources and Chronic Disease and Mortality

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Disclosure

I have no disclosures to declare at this time.

Research on the Topic of Protein Sources

Yangbo Sun, Buyun Liu, Linda Snetselaar, et. al. Association of Major Dietary Protein Sources with All-Cause and Cause-Specific Mortality: Prospective Cohort Study, February 2021, *JAHA*.

Women's Health Initiative (WHI) Study Components

- **Clinical Trial (CT)**
  - Dietary Modification (DM)
    - Dietary Intervention Group
      - 5 servings of fruits and vegetables
      - 6 servings of grains
      - 20 percent of total daily calories from total fat
    - **Comparison Group**
      - General information on diet and cancer at the beginning of the study
  - Hormone
  - Calcium and Vitamin D
- **Observational Study (OS)**
- **CT and OS in WHI Extension Studies (Follow-up through February 2017)**

This JAHA Study

- Secondary analysis of WHI data
- WHI Clinical Trial Comparison Group
- WHI Observational Study Group
- WHI Extension Studies with CT Comparison and OS

WHI DM Comparison Arm

- One pamphlet on diet and cancer, American Cancer Society
- No dietary intervention
- No dietary group sessions
- Data collections at the same points in time as the OS

Observational Arm (OS) of the WHI

- Selected by participants instead of going into the clinical trial arm of the study

- Added to this arm of the study because they were excluded from the Clinical Trial arm of the study

WHI Secondary Analysis

- Large prospective cohort study using OS and CT Comparison arms of the study
- 1993-1998
- Follow-up 2017
- 18 years of follow-up
- Postmenopausal women
- 50-79 y/o

Number of Postmenopausal in This Study

102,521 women

- OS = 63,593
- CT = 38,928

1,876,205 person years of follow-up

- 25,976 deaths

Diet Assessment: Food Fequency Questionnaire (FFQ)

- Analyzed by Nutrient Data System for Research at the University of Minnesota
- Modified Block FFQ
- Included 122 composite and single food items
- Frequency of consumption and portion size

WHI Secondary Analysis: Quintiles of Plant Protein

Highest quintile

- **Lowest all-cause mortality**
- **Lowest CVD**
- **Lowest dementia**

Lowest quintile

- **Highest all-cause mortality**
- **Highest CVD**
- **Highest dementia**

Yangbo Sun, Buyun Liu, Linda Snetselaar, et. al. Association of Major dietary Protein Sources with All-Cause and Cause-Specific Mortality: Prospective Cohort Study, February 2021, JAHA.

Hazard Ratio (HR): Comparing the Highest with the Lowest Quintiles of Plant Protein: Inverse Association

- All-Cause Mortality: 0.91 [0.86, 0.96]
- CVD Mortality: 0.88 [0.079, 0.97]
- Dementia Mortality: 0.79 [0.67, 0.94]

Hazard Ratio (HR): Comparing the Highest with the Lowest Quintiles among Major Protein Sources and Associated ***Higher*** Risk of All-Cause Mortality

- Processed Red Meat: 1.06 [1.01, 1.10]

- Eggs: 1.14 [1.10, 1.19]

Hazard Ratio (HR): Comparing the Highest with the Lowest Quintiles among Major Protein Sources and Associated ***Higher*** Risk of CVD Mortality

- Unprocessed Red Meat: 1.12 [1.02, 1.23]
- Eggs: 1.24 [1.14, 1.34]
- Dairy products: 1.11 [1.02, 1.19]

Hazard Ratio (HR): Comparing the Highest with the Lowest Quintiles on Egg Consumption and Associated ***Higher*** Risk of Cancer Mortality

Eggs: 1.10 [1.02, 1.19]

Hazard Ratio (HR): Comparing the Highest with the Lowest Quintiles for Processed Red Meat and Associated ***Higher*** Risk of Dementia Mortality

Processed Red Meat: 1.20 [1.05, 1.32]

Hazard Ratio (HR): Comparing the Highest with the Lowest Quintiles for Major Protein Sources Associated with ***Lower*** Risk of Dementia Mortality

- Poultry: 0.85 [0.75, 0.97]

- Eggs 0.86 [0.75, 0.98]

Participants Characteristics with a Higher Percent of Energy from Animal Protein

- More likely to be white
- Less heavy alcohol intake
- Higher education and income
- Past smoker
- More likely to have diabetes at baseline
- Family history of heart attack
- Higher % energy from sat fat and lower from poly fat
- Lower intakes of dietary fiber and glycemic load
- Higher BMI

Participants Characteristics with a Higher Percent of Energy from Plant Protein

- More likely to be older
- Lower total energy intake
- Higher intake of dietary fiber
- Higher glycemic load
- Lower percent of energy from sat fat, mono fat and trans-fat
- Lower BMI

Study Summary

- Dietary proteins are not consumed in isolation
- Must consider overall diet
- Dietary Patterns

Modernizing the Definition of Protein Quality

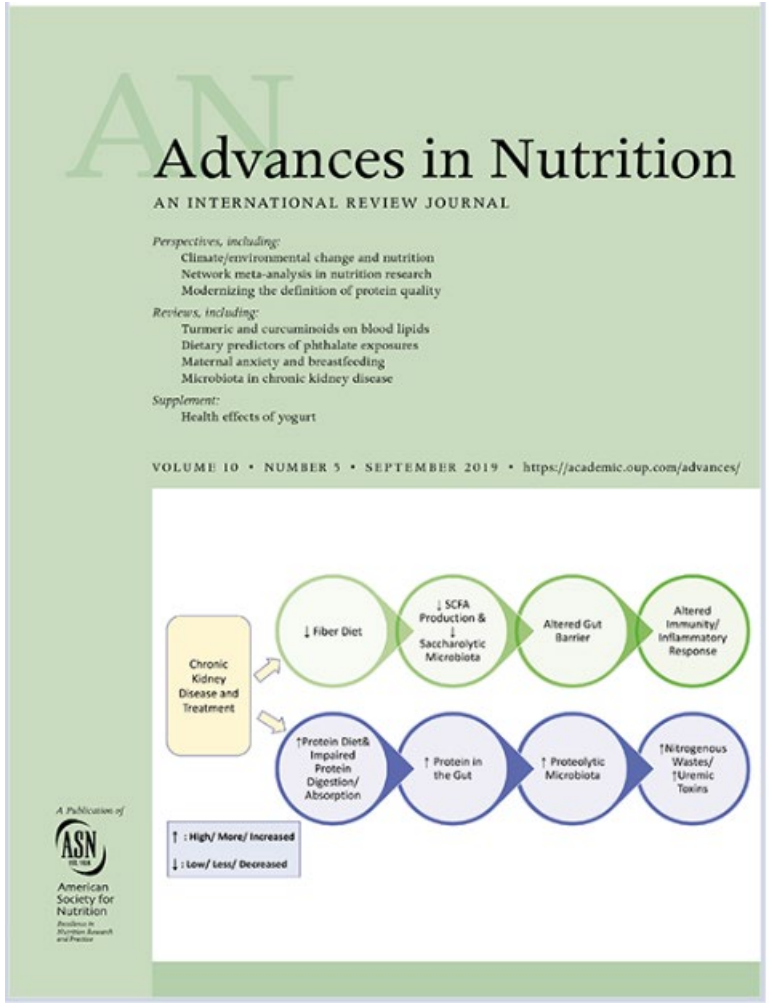
From Amino Acids to Actual Foods

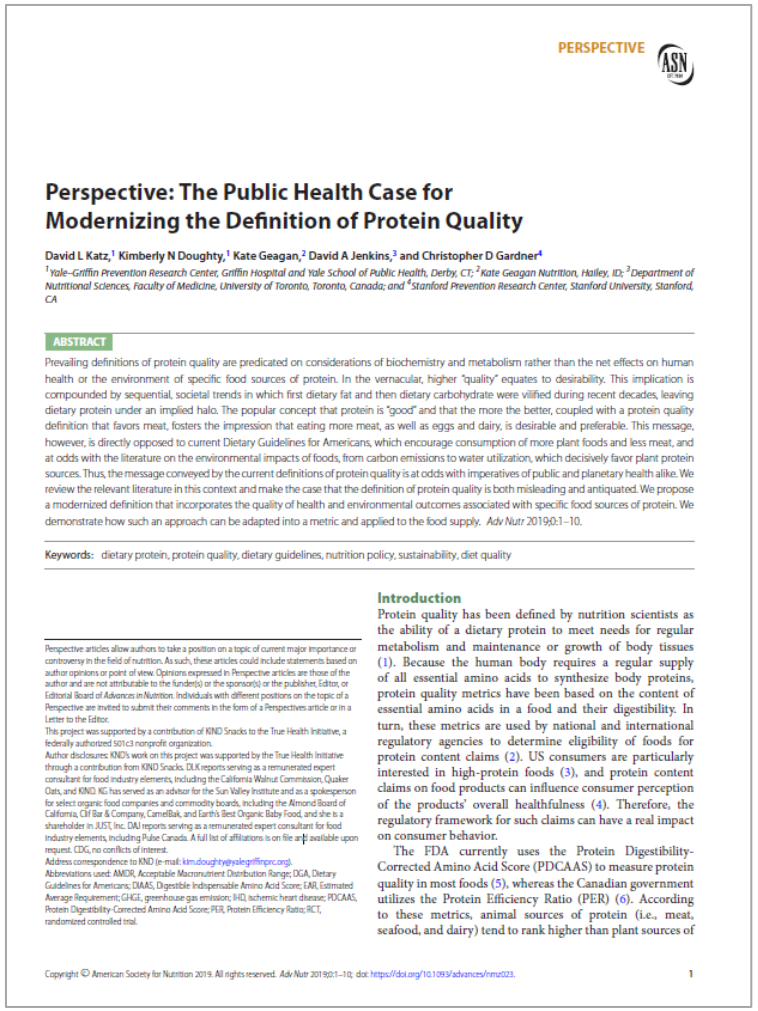
David L. Katz, MD, MPH
Founder & CEO, Diet ID
Founder & President, True Health Initiative

April 28, 2021

GOAL

Define a new, modernized protein quality metric that prioritizes public/planetary health rather than biochemistry





PERSPECTIVE

Perspective: The Public Health Case for Modernizing the Definition of Protein Quality

David L Katz,[1] Kimberly N Doughty,[1] Kate Geagan,[2] David A Jenkins,[3] and Christopher D Gardner[4]

[1] *Yale–Griffin Prevention Research Center, Griffin Hospital and Yale School of Public Health, Derby, CT;* [2] *Kate Geagan Nutrition, Hailey, ID;* [3] *Department of Nutritional Sciences, Faculty of Medicine, University of Toronto, Toronto, Canada; and* [4] *Stanford Prevention Research Center, Stanford University, Stanford, CA*

ABSTRACT

Prevailing definitions of protein quality are predicated on considerations of biochemistry and metabolism rather than the net effects on human health or the environment of specific food sources of protein. In the vernacular, higher "quality" equates to desirability. This implication is compounded by sequential, societal trends in which first dietary fat and then dietary carbohydrate were vilified during recent decades, leaving dietary protein under an implied halo. The popular concept that protein is "good" and that the more the better, coupled with a protein quality definition that favors meat, fosters the impression that eating more meat, as well as eggs and dairy, is desirable and preferable. This message, however, is directly opposed to current Dietary Guidelines for Americans, which encourage consumption of more plant foods and less meat, and at odds with the literature on the environmental impacts of foods, from carbon emissions to water utilization, which decisively favor plant protein sources. Thus, the message conveyed by the current definitions of protein quality is at odds with imperatives of public and planetary health alike. We review the relevant literature in this context and make the case that the definition of protein quality is both misleading and antiquated. We propose a modernized definition that incorporates the quality of health and environmental outcomes associated with specific food sources of protein. We demonstrate how such an approach can be adapted into a metric and applied to the food supply. *Adv Nutr* 2019;0:1–10.

Keywords: dietary protein, protein quality, dietary guidelines, nutrition policy, sustainability, diet quality

Perspective articles allow authors to take a position on a topic of current major importance or controversy in the field of nutrition. As such, these articles could include statements based on author opinions or point of view. Opinions expressed in Perspective articles are those of the author and are not attributable to the funder(s) or the sponsor(s) or the publisher, Editor, or Editorial Board of *Advances in Nutrition*. Individuals with different positions on the topic of a Perspective are invited to submit their comments in the form of a Perspectives article or in a Letter to the Editor.

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Address correspondence to KND (e-mail: kim.doughty@yalegriffinprc.org).

Abbreviations used: AMDR, Acceptable Macronutrient Distribution Range; DGA, Dietary Guidelines for Americans; DIAAS, Digestible Indispensable Amino Acid Score; EAR, Estimated Average Requirement; GHGE, greenhouse-gas emission; IHD, ischemic heart disease; PDCAAS, Protein Digestibility-Corrected Amino Acid Score; PER, Protein Efficiency Ratio; RCT, randomized controlled trial.

Introduction

Protein quality has been defined by nutrition scientists as the ability of a dietary protein to meet needs for regular metabolism and maintenance or growth of body tissues (1). Because the human body requires a regular supply of all essential amino acids to synthesize body proteins, protein quality metrics have been based on the content of essential amino acids in a food and their digestibility. In turn, these metrics are used by national and international regulatory agencies to determine eligibility of foods for protein content claims (2). US consumers are particularly interested in high-protein foods (3), and protein content claims on food products can influence consumer perception of the products' overall healthfulness (4). Therefore, the regulatory framework for such claims can have a real impact on consumer behavior.

The FDA currently uses the Protein Digestibility-Corrected Amino Acid Score (PDCAAS) to measure protein quality in most foods (5), whereas the Canadian government utilizes the Protein Efficiency Ratio (PER) (6). According to these metrics, animal sources of protein (i.e., meat, seafood, and dairy) tend to rank higher than plant sources of

Perspective: The Public Health Case for Modernizing the Definition of Protein Quality

David L Katz, Kimberly N Doughty, Kate Geagan, David A Jenkins, Christopher D Gardner

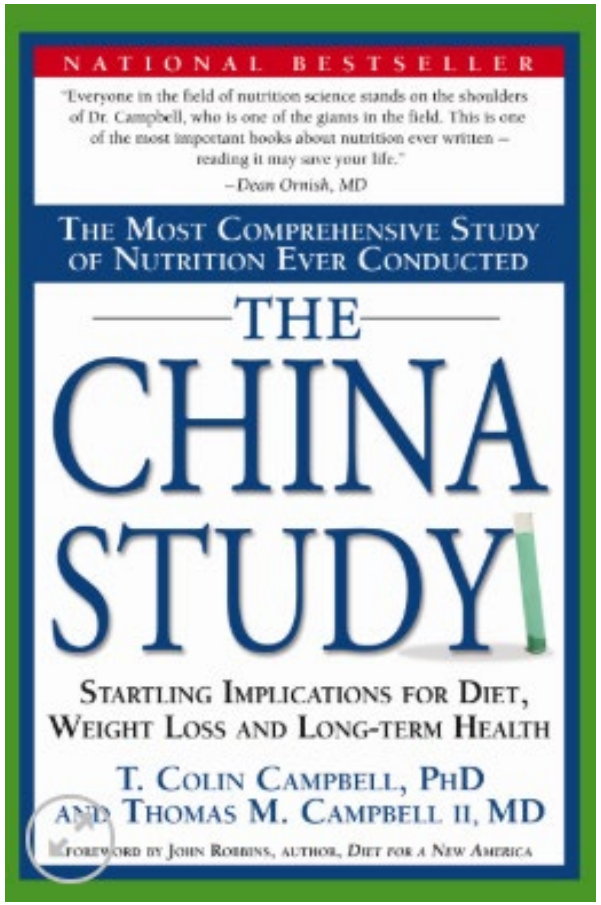
Current Definition of Protein Quality

"The ability of a dietary protein to meet needs for regular metabolism and maintenance or growth of body tissues"

- FDA: Protein Digestibility Corrected Amino Acid Score (PDCAAS)
- Canada: Protein Efficiency Ratio (PER)

Animal proteins get higher ranking

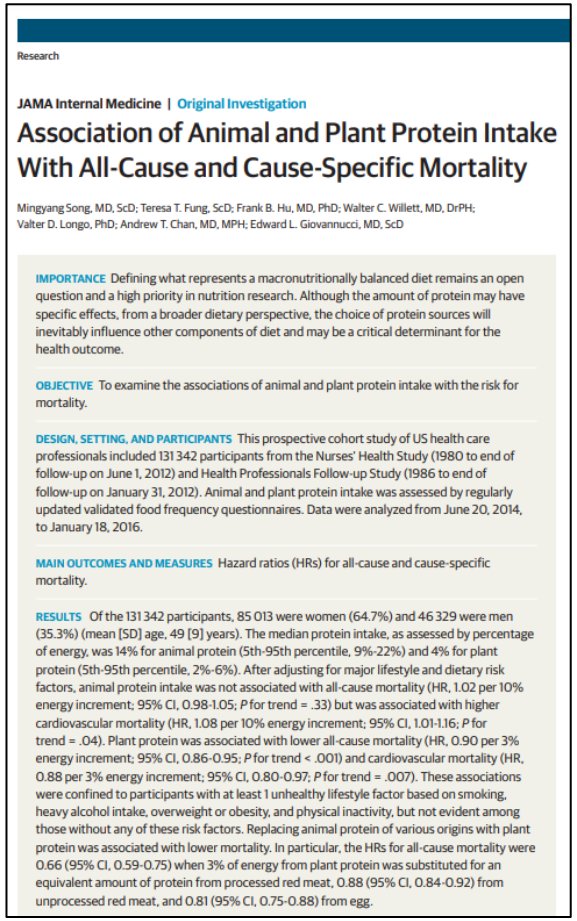
Basis for shift to PLANT proteins



The lower the percentage of animal protein consumed, the greater the health benefits.

2010 Study: Major Dietary Protein Sources and the Risk of Coronary Heart Disease in Women (Bernstein, Sun, Willett)

2019 Study: Meta-Analysis of Randomized Controlled Trials of Red Meat Consumption in Comparison With Various Comparison Diets on Cardiovascular Risk Factors (Guasch-Ferre, Satija, Blondin)


Research

JAMA Internal Medicine | Original Investigation

Association of Animal and Plant Protein Intake With All-Cause and Cause-Specific Mortality

Mingyang Song, MD, ScD; Teresa T. Fung, ScD; Frank B. Hu, MD, PhD; Walter C. Willett, MD, DrPH; Valter D. Longo, PhD; Andrew T. Chan, MD, MPH; Edward L. Giovannucci, MD, ScD

IMPORTANCE Defining what represents a macronutritionally balanced diet remains an open question and a high priority in nutrition research. Although the amount of protein may have specific effects, from a broader dietary perspective, the choice of protein sources will inevitably influence other components of diet and may be a critical determinant for the health outcome.

OBJECTIVE To examine the associations of animal and plant protein intake with the risk for mortality.

DESIGN, SETTING, AND PARTICIPANTS This prospective cohort study of US health care professionals included 131 342 participants from the Nurses' Health Study (1980 to end of follow-up on June 1, 2012) and Health Professionals Follow-up Study (1986 to end of follow-up on January 31, 2012). Animal and plant protein intake was assessed by regularly updated validated food frequency questionnaires. Data were analyzed from June 20, 2014, to January 18, 2016.

MAIN OUTCOMES AND MEASURES Hazard ratios (HRs) for all-cause and cause-specific mortality.

RESULTS Of the 131 342 participants, 85 013 were women (64.7%) and 46 329 were men (35.3%) (mean [SD] age, 49 [9] years). The median protein intake, as assessed by percentage of energy, was 14% for animal protein (5th-95th percentile, 9%-22%) and 4% for plant protein (5th-95th percentile, 2%-6%). After adjusting for major lifestyle and dietary risk factors, animal protein intake was not associated with all-cause mortality (HR, 1.02 per 10% energy increment; 95% CI, 0.98-1.05; *P* for trend = .33) but was associated with higher cardiovascular mortality (HR, 1.08 per 10% energy increment; 95% CI, 1.01-1.16; *P* for trend = .04). Plant protein was associated with lower all-cause mortality (HR, 0.90 per 3% energy increment; 95% CI, 0.86-0.95; *P* for trend < .001) and cardiovascular mortality (HR, 0.88 per 3% energy increment; 95% CI, 0.80-0.97; *P* for trend = .007). These associations were confined to participants with at least 1 unhealthy lifestyle factor based on smoking, heavy alcohol intake, overweight or obesity, and physical inactivity, but not evident among those without any of these risk factors. Replacing animal protein of various origins with plant protein was associated with lower mortality. In particular, the HRs for all-cause mortality were 0.66 (95% CI, 0.59-0.75) when 3% of energy from plant protein was substituted for an equivalent amount of protein from processed red meat, 0.88 (95% CI, 0.84-0.92) from unprocessed red meat, and 0.81 (95% CI, 0.75-0.88) from egg.

2016 Harvard Study in JAMA Int Med (Song, Fung, Hu, Willett)

PMC full text:

Circulation. Author manuscript; available in PMC 2011 Aug 31.

Published in final edited form as:

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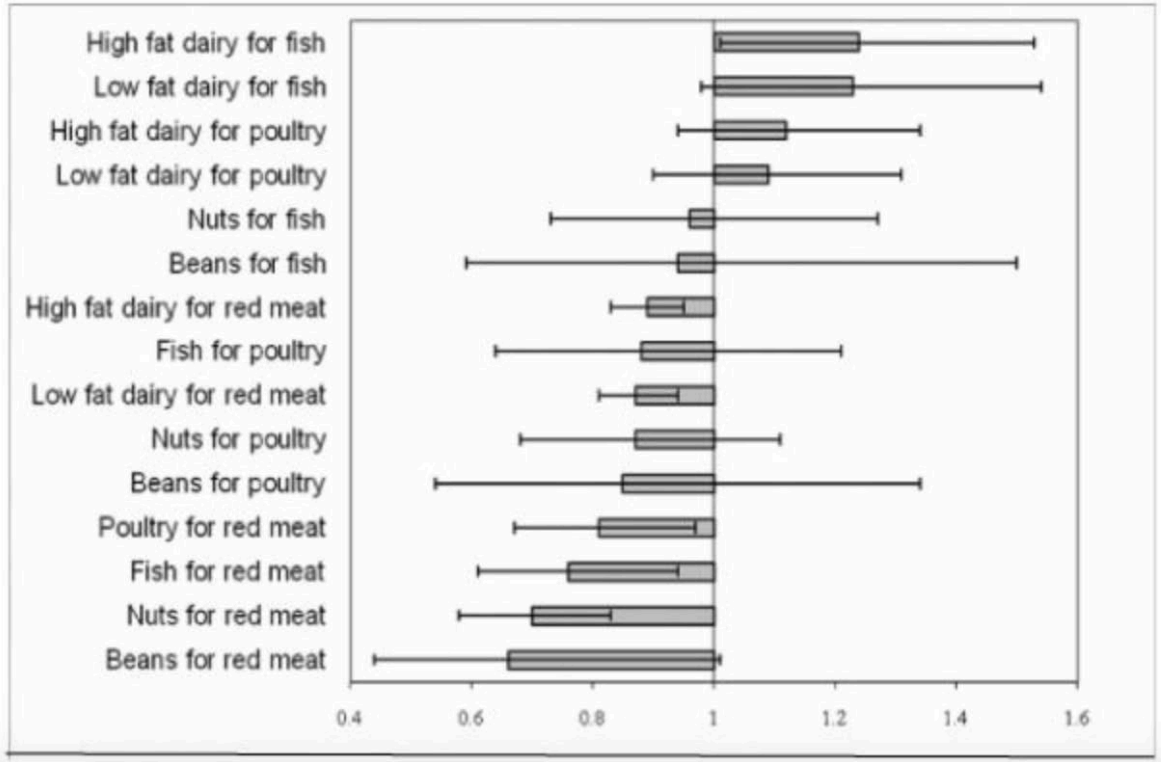
Published online 2010 Aug 16. doi: 10.1161/CIRCULATIONAHA.109.915165

Figure 1



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PDF [602 KB] Figures

Association of sulfur amino acid consumption with cardiometabolic risk factors: Cross-sectional findings from NHANES III

Zhen Dong • Xiang Gao • Vernon M. Chinchilli • Raghu Sinha • Joshua Muscat • Renate M. Winkels • et al.

Show all authors

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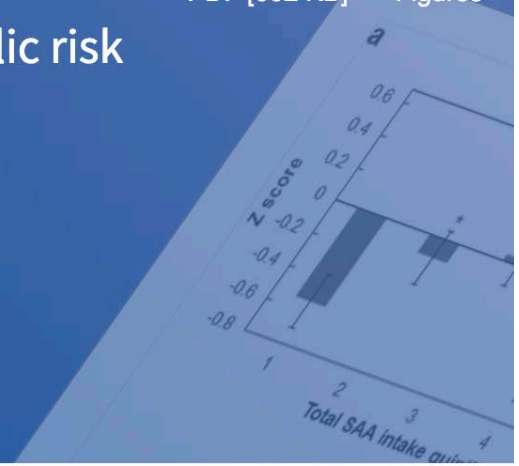


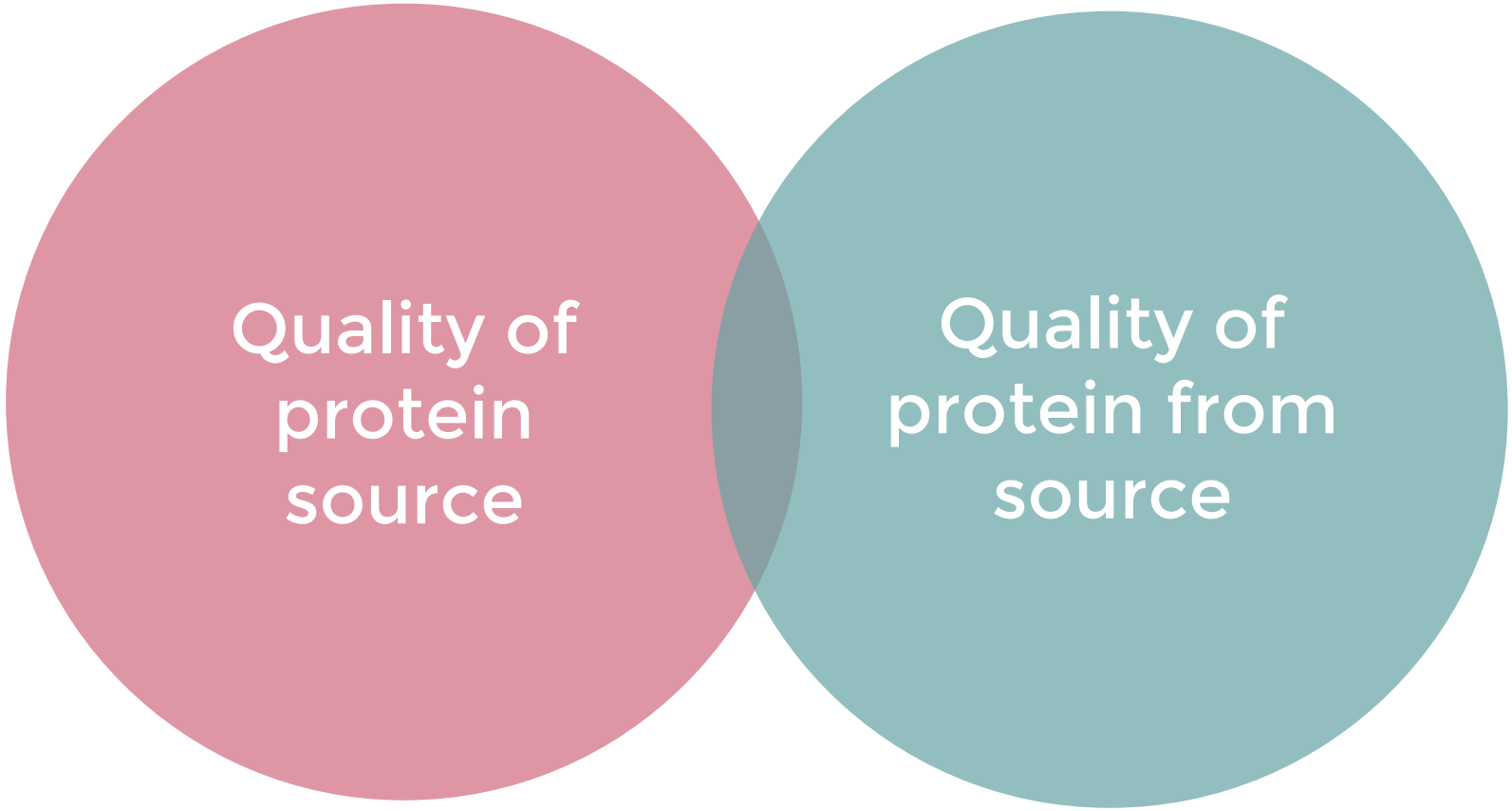
Abstract

Background

An average adult American consumes sulfur amino acids (SAA) at levels far above the Estimated Average Requirement (EAR) and recent preclinical data suggest that higher levels of SAA intake may be associated with a variety of aging-related chronic diseases.

Shift To Whole Food Based Approach

Shift To Whole Food Based Approach



Protein & Human Health

- Diet Quality
- Health Outcomes
- Deficiency vs. Adequacy vs. Overabundance
- Sulfur-containing amino acids
  - Increased risk of cardiometabolic disease, independent of total protein intake

New Definition: 3 Criteria

- The concentration of protein and individual amino acids in the food
- Assessment of the evidence of health outcomes associated with consumption of the food
- Assessment of potential environmental impacts of producing the food (Dr. Gardner's focus today)

RESEARCH ARTICLE

Multiple health and environmental impacts of foods

Michael A Clark, Marco Springmann, Jason Hill, and David Tilman

+ See all authors and affiliations

PNAS November 12, 2019 116 (46) 23357-23362; first published October 28, 2019;
https://doi.org/10.1073/pnas.1906908116

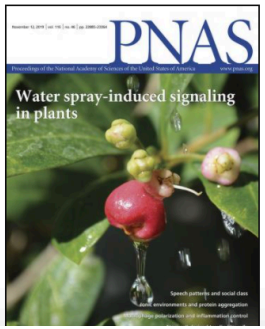
Contributed by David Tilman, September 24, 2019 (sent for review April 23, 2019; reviewed by Tim G. Benton and Joan Sabate)

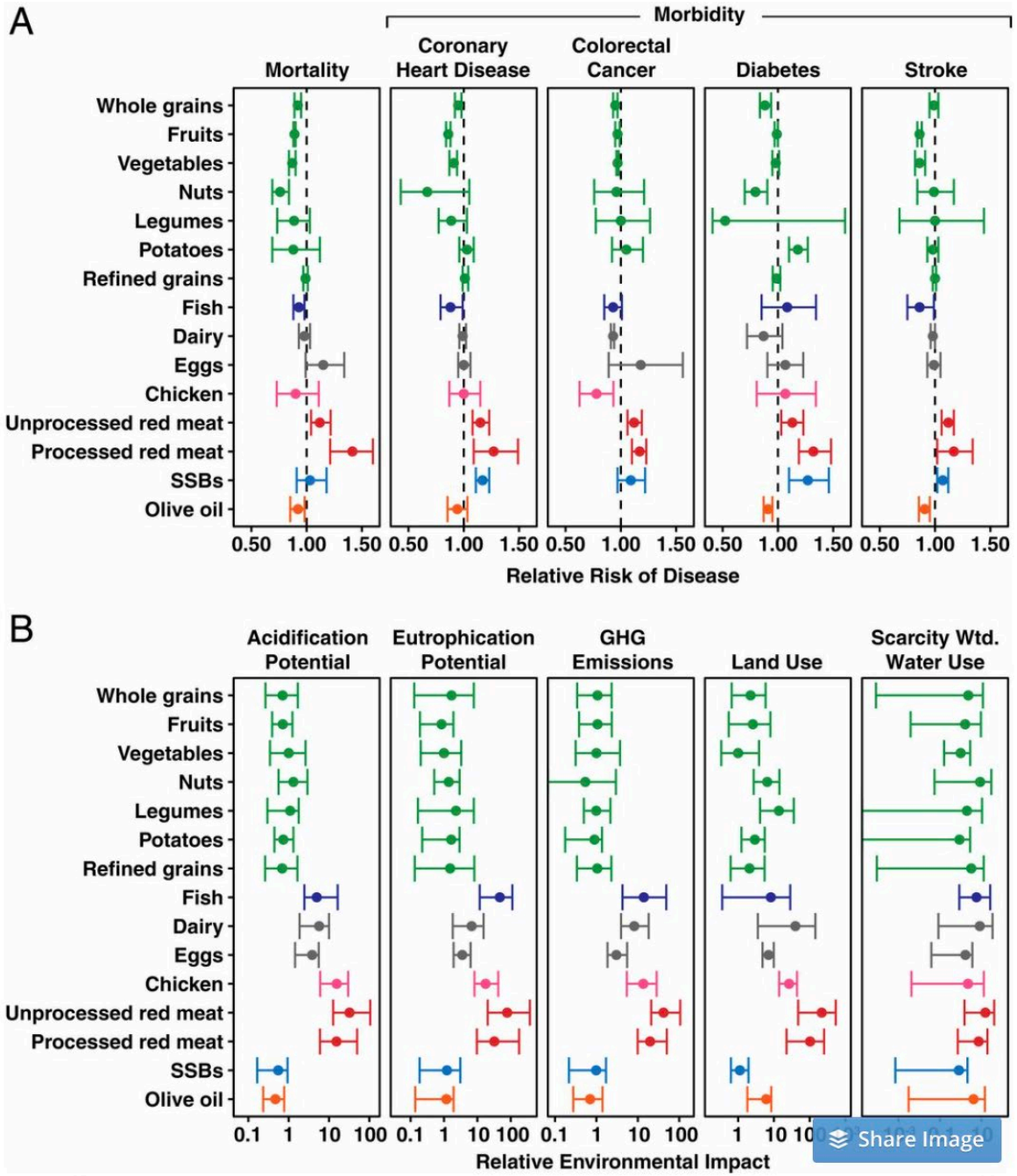
Significance

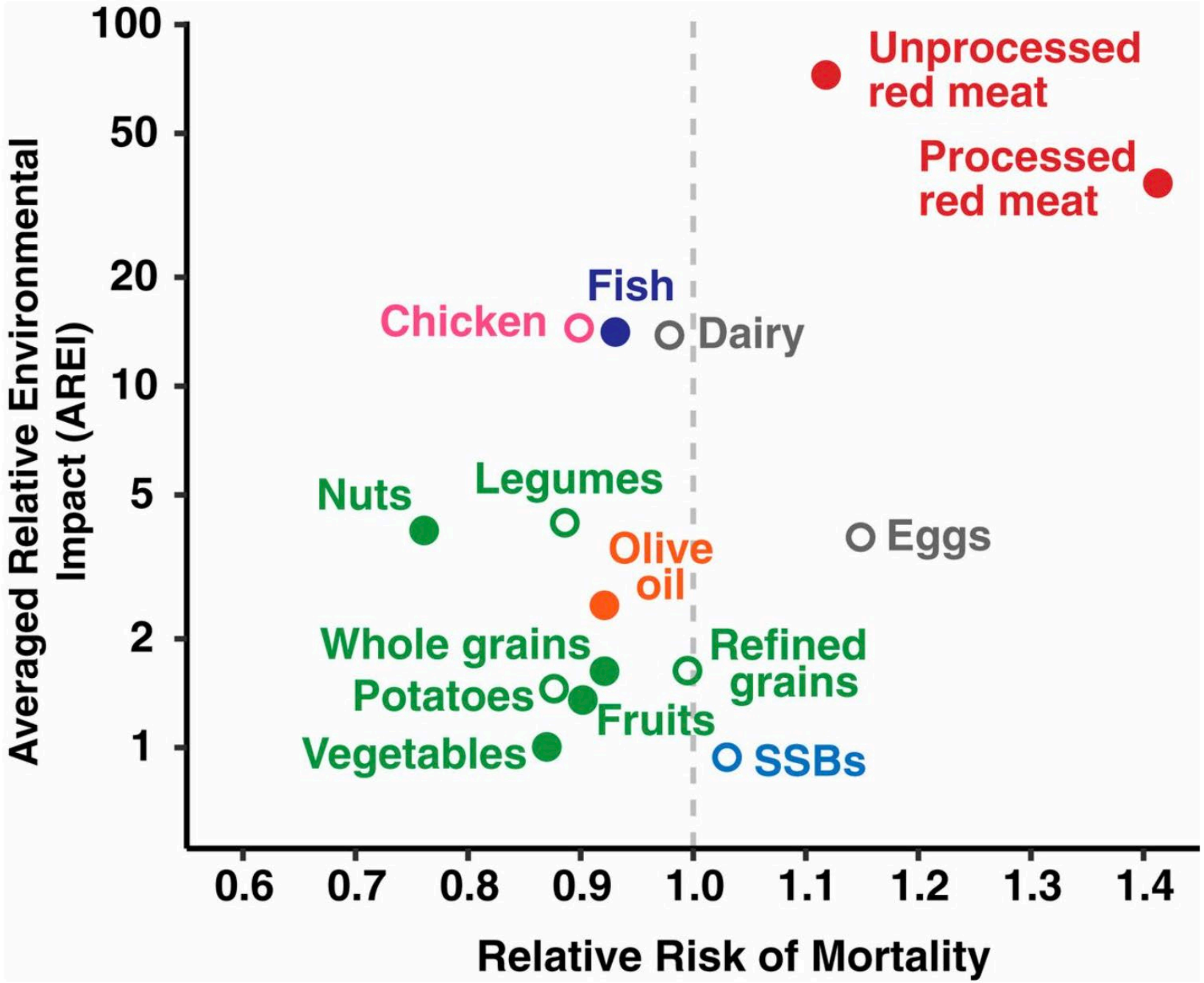
Dietary choices are a leading global cause of mortality and environmental degradation and threaten the attainability of the UN's Sustainable Development Goals and the Paris Climate Agreement. To inform decision making and to better identify the multifaceted health and environmental impacts of dietary choices, we describe how consuming 15 different food groups is associated with 5 health outcomes and 5 aspects of environmental degradation.

ARTICLE CLASSIFICATIONS

Biological Sciences » Sustainability Science
Social Sciences » Sustainability Science




A
Morbidity
Mortality
Coronary Heart Disease
Colorectal Cancer
Diabetes
Stroke
Whole grains
Fruits
Vegetables
Nuts
Legumes
Potatoes
Refined grains
Fish
Dairy
Eggs
Chicken
Unprocessed red meat
Processed red meat
SSBs
Olive oil
0.50 1.00 1.50
Relative Risk of Disease
B
Acidification Potential
Eutrophication Potential
GHG Emissions
Land Use
Scarcity Wtd. Water Use
0.1 1 10 100
Relative Environmental Impact
Share Image


Averaged Relative Environmental Impact (AREI)
100
50
20
10
5
2
1
Unprocessed red meat
Processed red meat
Fish
Chicken
Dairy
Nuts
Legumes
Olive oil
Eggs
Whole grains
Refined grains
Potatoes
Fruits
Vegetables
SSBs
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
Relative Risk of Mortality

Score Comparison Based on Definition

Criterion	Maximum score	Beef, most cuts[2]	Beef, extra lean[2]	Dark meat chicken, with skin[3]	Skinless chicken breast[3]	Low-fat milk[2]	Soy[2]	Chickpeas[4]	Almonds[3]	Pistachios[3]	Whole-grain wheat[2]	Brown rice[3]
Sample metric 1: stand-alone rating system												
PDCAAS (>80: 2; 50 to <80: 1; 30 to <50: 0; <30: −1)	2	2	2	2	2	2	2	1	0	1	0	1
Recommended for health (recommended: 2; no mention: 0; discouraged: −1)	2	−1	2	−1	2	2	2	2	2	2	2	2
Environmental impact (low: 2; medium: 0; high: −1)	2	−1	−1	2	2	0	2	2	2	2	2	2
Total	6	0	3	3	6	4	6	5	4	5	4	5
Sample metric 2: metric used as an adjustment factor												
PDCAAS (range: 0.0–1.0)	1	0.92	0.92	0.94	0.94	1.0	0.92	0.52	0.43	0.73	0.42	0.69
Recommended for health (recommended or no mention: 1; discouraged: 0)	1	0	1	0	1	1	1	1	1	1	1	1
Environmental impact (low: 1; medium: 0.5; high: 0)	1	0	0	1	1	0.5	1	1	1	1	1	1
Average score	1	0.31	0.64	0.65	0.98	0.83	0.97	0.84	0.81	0.91	0.81	0.90

[1] PDCAAS, Protein Digestibility-Corrected Amino Acid Score.
[2] Data from reference 24.
[3] Data from reference 25.
[4] Data from reference 26.

Criterion	Maximum score	Soy[2]	Chickpeas[4]	Almonds[3]	Pistachios[3]	Whole-grain wheat[2]	Brown rice[3]	Beef, extra lean[2]
Sample metric 1: stand-alone rating system								
PDCAAS (>80: 2; 50 to <80: 1; 30 to <50: 0; <30: −1)	2	2	1	0	1	0	1	2
Recommended for health (recommended: 2; no mention: 0; discouraged: −1)	2	2	2	2	2	2	2	2
Environmental impact (low: 2; medium: 0; high: −1)	2	2	2	2	2	2	2	−1
Total	6	6	5	4	5	4	5	3
Sample metric 2: metric used as an adjustment factor								
PDCAAS (range: 0.0–1.0)	1	0.92	0.52	0.43	0.73	0.42	0.69	0.92
Recommended for health (recommended or no mention: 1; discouraged: 0)	1	1	1	1	1	1	1	1
Environmental impact (low: 1; medium: 0.5; high: 0)	1	1	1	1	1	1	1	0
Average score	1	0.97	0.84	0.81	0.91	0.81	0.90	0.64

[1] PDCAAS, Protein Digestibility-Corrected Amino Acid Score.
[2] Data from reference 24.
[3] Data from reference 25.
[4] Data from reference 26.

Applications

- Apply updated definition to product labeling, essentially revamping protein content claims and associated health halos
- Apply to diet quality scoring systems such as Healthy Eating Index
- Farming standards and practices

Lend your support:

- Petition for change:
  - https://www.change.org/p/the-us-must-update-the-definition-of-protein-quality-to-one-that-aligns-with-food-quality-and-supports-optimal-human-health

2019 Apr 1;77(4):197-215

NUTRITION REVIEWS®

Lead Article

Maximizing the intersection of human health and the health of the environment with regard to the amount and type of protein produced and consumed in the United States

Christopher D. Gardner, Jennifer C. Hartle, Rachael D. Garrett, Lisa C. Offringa, and Arlin S. Wasserman

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~50 g/d Recommended

~100 g/d Consumed

2019 Apr 1;77(4):197-215

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Lead Article

Maximizing the intersection of human health and the health of the environment with regard to the amount and type of protein produced and consumed in the United States

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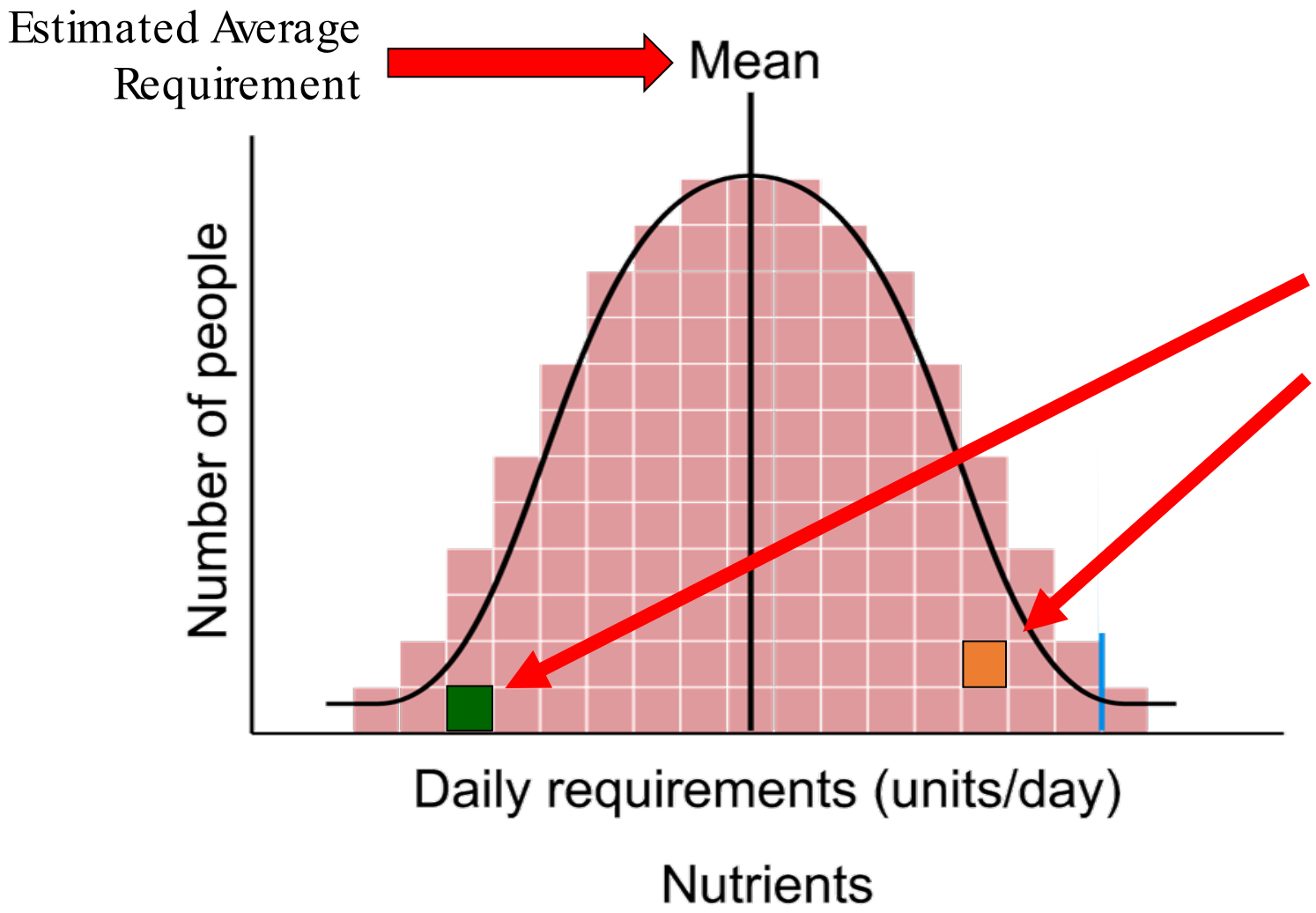
Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)

ISBN
978-0-309-08525-0

1357 pages
6x9
PAPERBACK (2005)

A Report of the Panel on Macronutrients, Subcommittees on Upper Reference Levels of Nutrients and Interpretation and Uses of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes

Estimated Average Requirement (EAR)

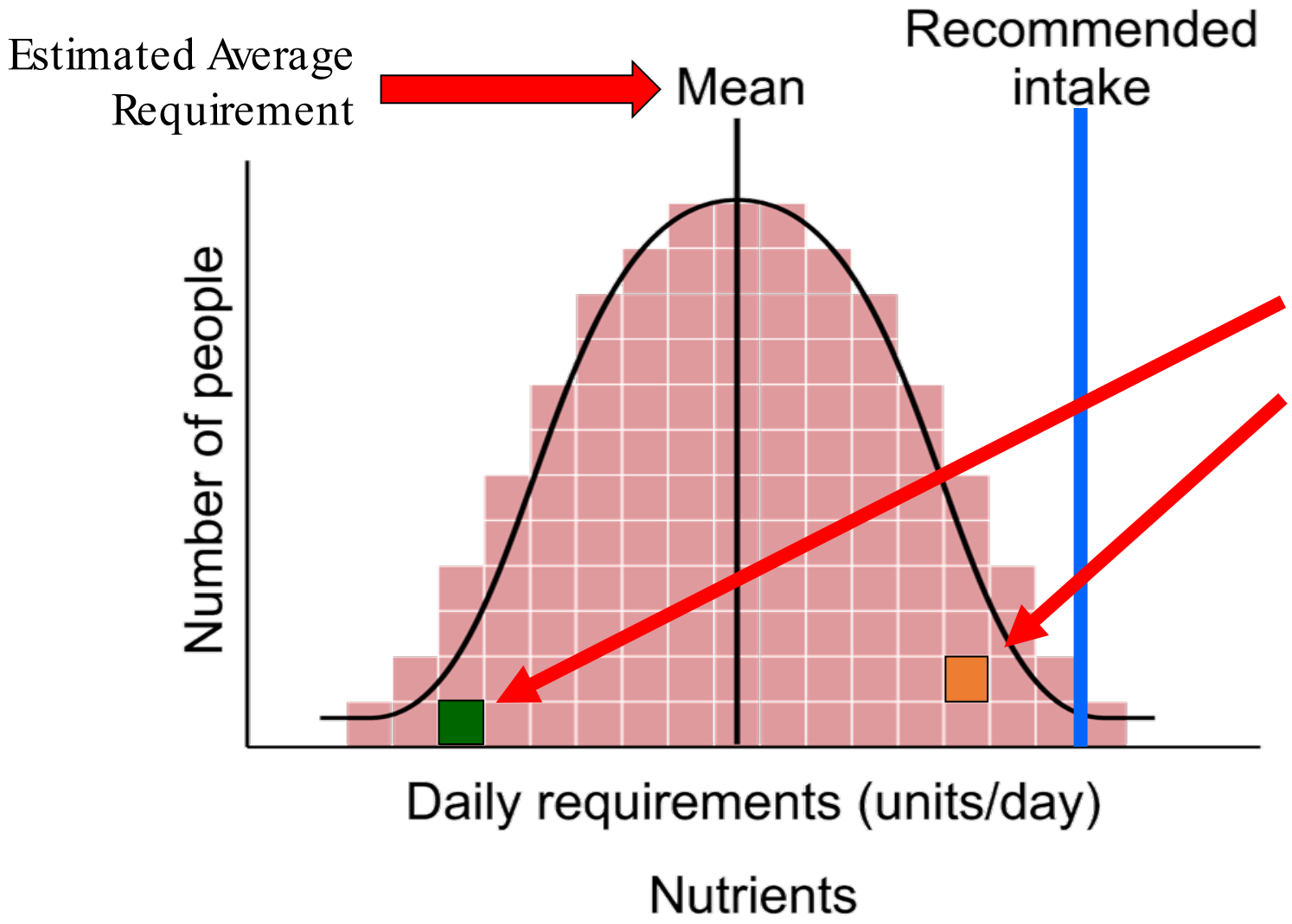


Protein Requirement

25 grams/day

54 grams/day

Recommended Daily Allowance (RDA)



Protein Requirement

25 grams/day

54 grams/day

Req't / Rec / Intake

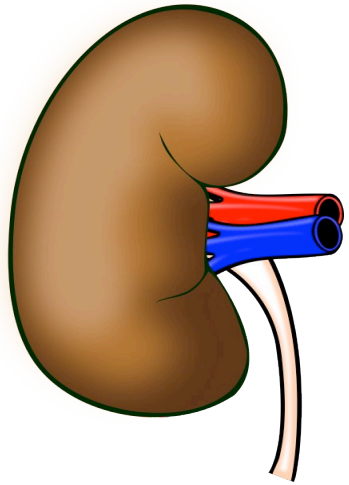
		125 lbs (57 kg)	175 lbs (80 kg)	225 lbs (102 kg)	275 lbs (125 kg)
Estimated Average Requirement	0.66 g/kg	38 g	52 g	67 g	82 g
Recommended Daily Allowance	0.8 g/kg	46 g	64 g	82 g	100 g
Average American Intake	1.2 - 1.5 g/kg (NHANES)	68-86 g	96-120 g	122-153 g	150-187 g

Protein Use

Protein

Nitrogen

NH3
(Ammonia)



1. Functional
   No Storage

2. Carbohydrate
   (for immediate need, or conversion to glycogen)

3. Fat (conversion for energy storage)

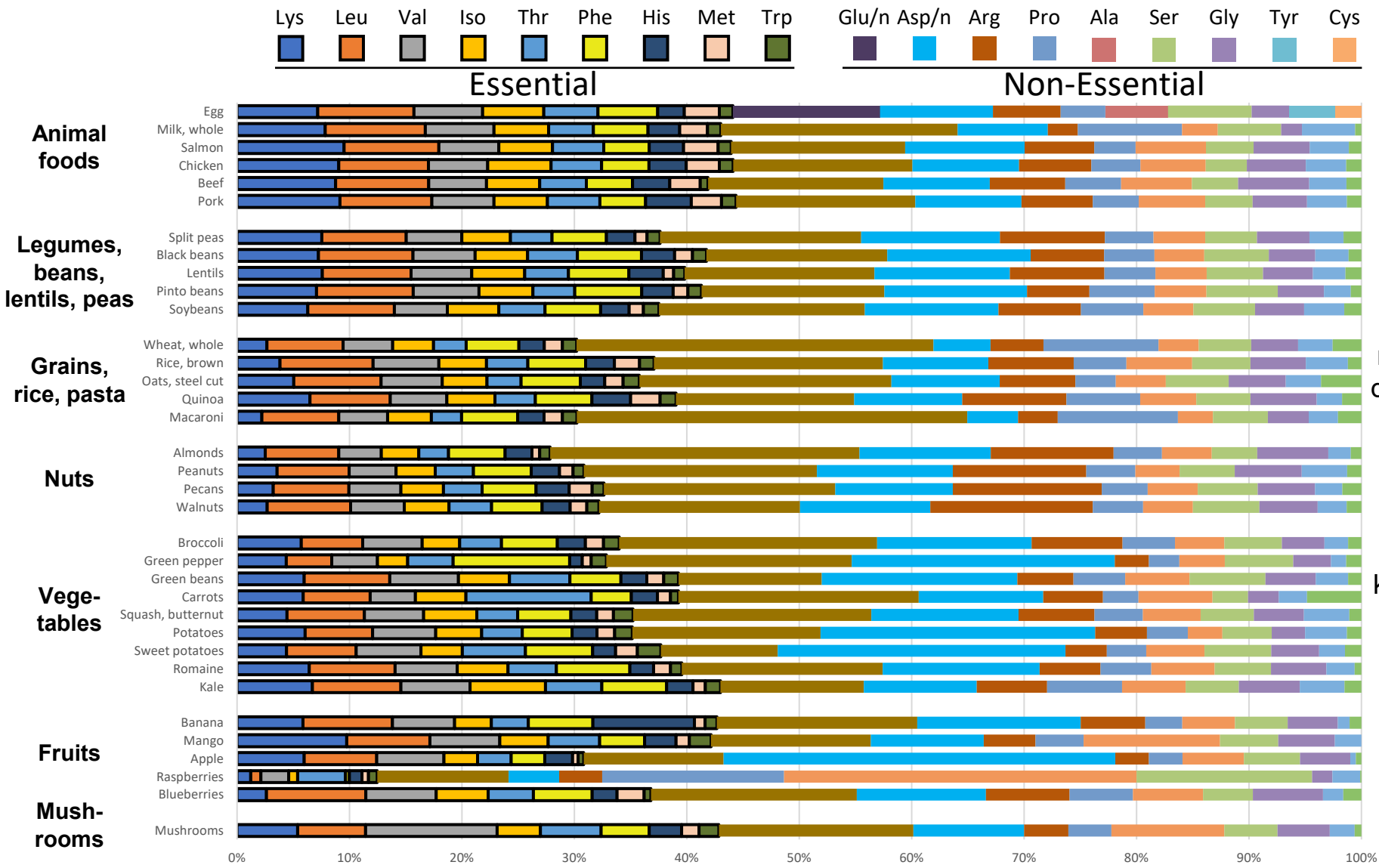


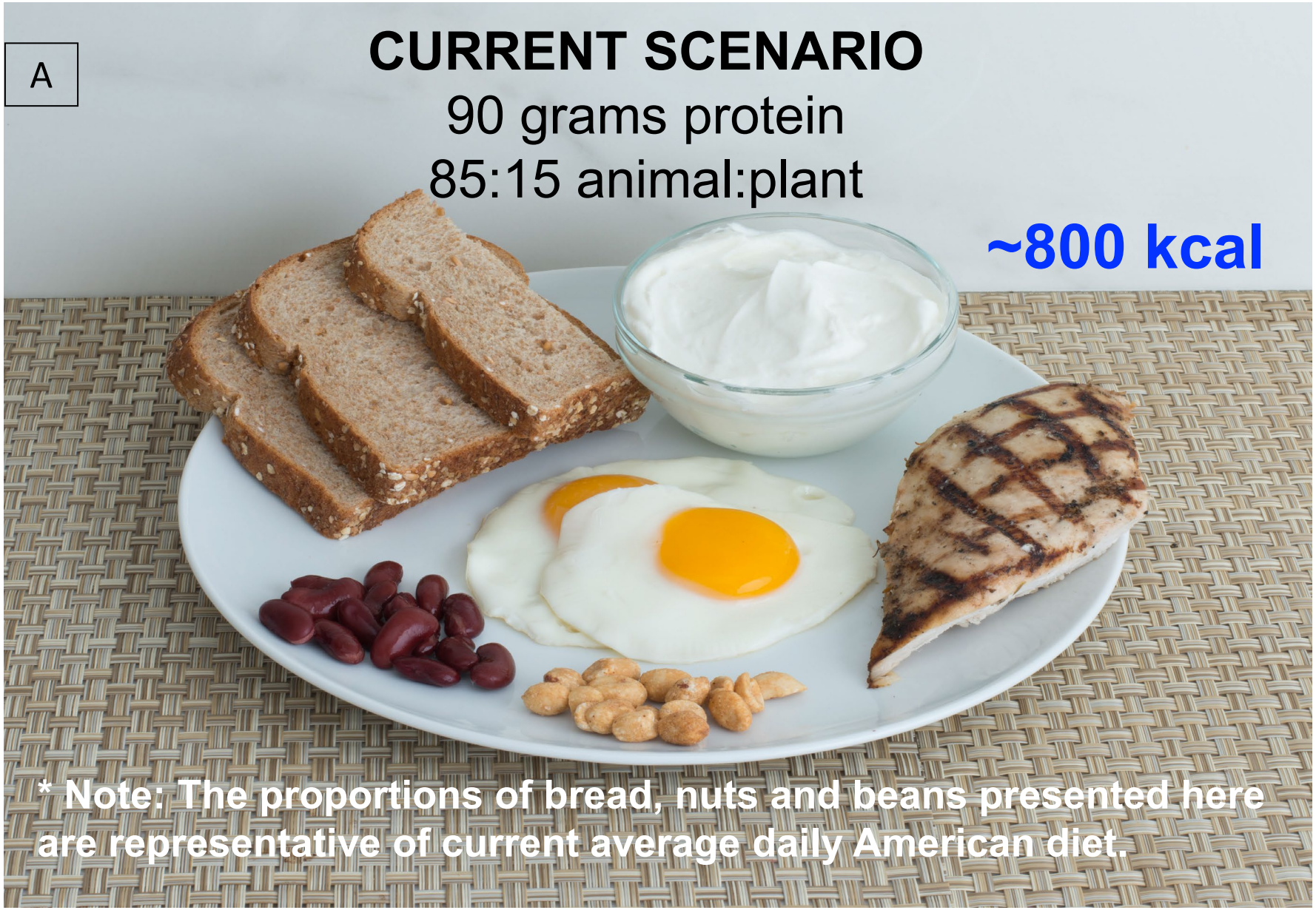
Figure 1. Proportions of amino acids in selected foods across food groups. Grouped by essential and non-essential, in descending order of prevalence within groups.

Amount of protein per 100 kcal presented in Supp Table 1.

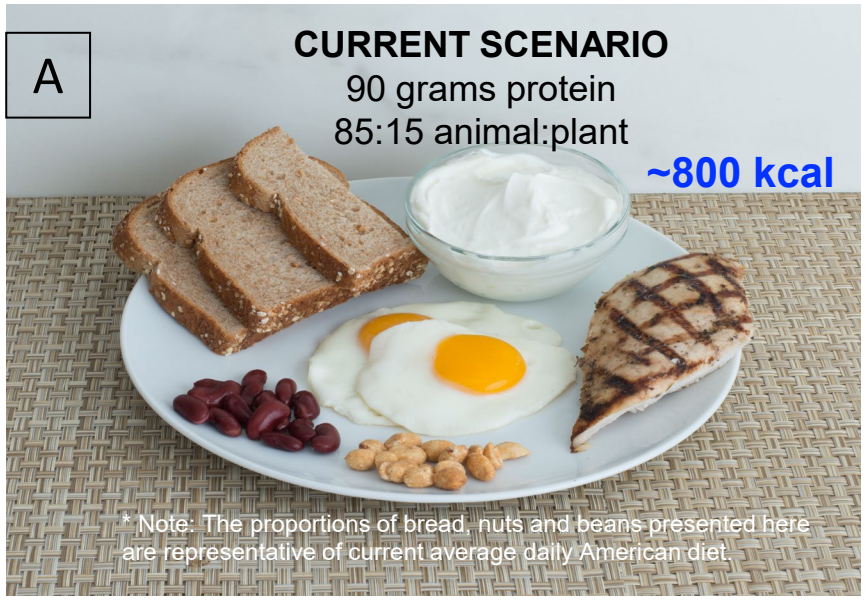
(Source: Nutrition Database System for Research, University of Minnesota)

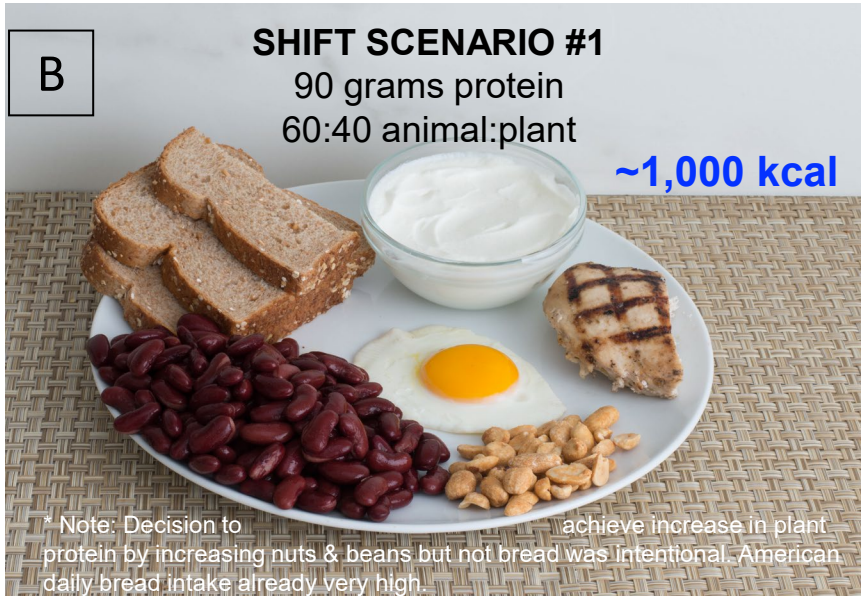
Which of the following statements is most accurate regarding protein derived from plant foods (e.g., grains, vegetables, beans)

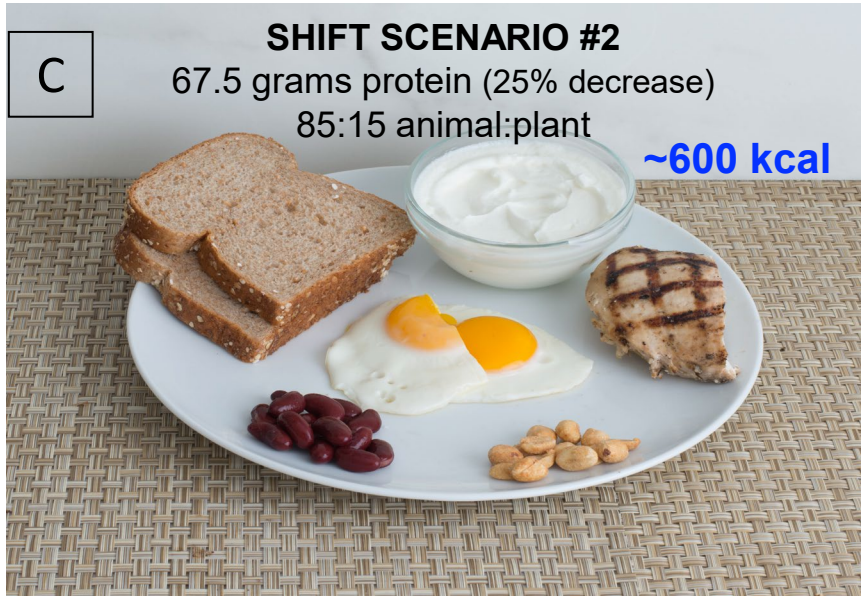
1. Plant foods do not have protein
2. All plant foods are missing some essential amino acids
3. Some plant foods are missing some essential amino acids
4. All plant foods contain all 20 amino acids, essential and non-essential


A
CURRENT SCENARIO
90 grams protein
85:15 animal:plant
~800 kcal
* Note: The proportions of bread, nuts and beans presented here are representative of current average daily American diet.


D
SHIFT SCENARIO #3
67.5 grams protein (25% decrease)
60:40 animal:plant
~775 kcal
* Note: Decision to achieve increase in plant protein by increasing nuts & beans but not bread was intentional. American daily bread intake already very high.



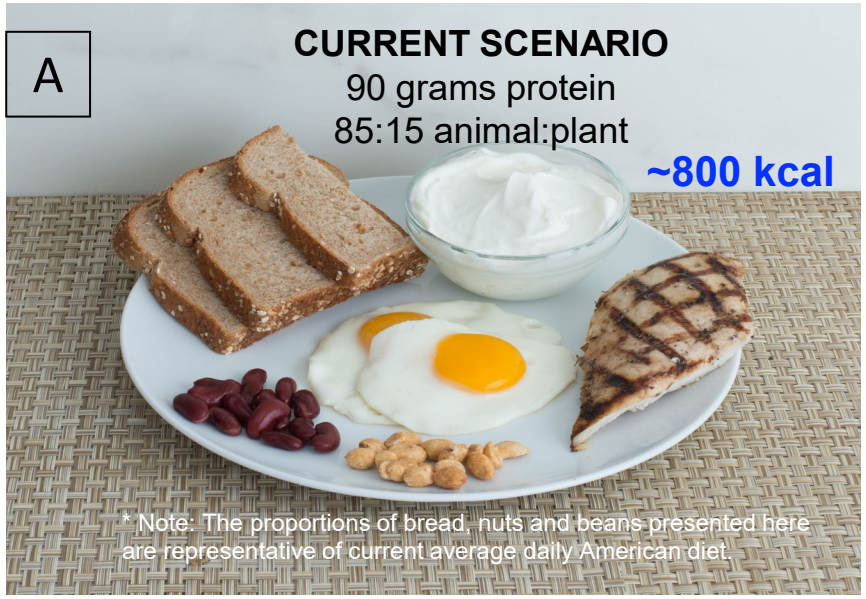




A Day's Worth of Protein on One Plate.

Calories for each plate range from ~600 to ~1,000 kcals (25-40% of total kcals for a 2,500 kcal diet)

Since all whole foods have protein, additional foods would provide additional protein



25% less protein

Shift 25% from animal to plant

A Day's Worth of Protein on One Plate.

Calories for each plate range from ~600 to ~1,000 kcals (25-40% of total kcals for a 2,500 kcal diet)

Since all whole foods have protein, additional foods would provide additional protein

Lead Article

Maximizing the intersection of human health and the health of the environment with regard to the amount and type of protein produced and consumed in the United States

Christopher D. Gardner, Jennifer C. Hartle, Rachael D. Garrett, Lisa C. Offringa, and Arlin S. Wasserman

1. **Reduce protein intake by 25%**
   Still exceeds RDA, RDA has safety buffer
2. **Shift from 85:15 to 60:40 animal:plant**
   Plant protein quality higher than many people believe
3. **>300 M people in United States**
4. **Green House Gas Emissions decrease 40%**
   129 B Kg $CO2_{eq}$
   8% pledged under Paris Agreement
5. **Consumptive Water Use decrease 10%**
   3.1 T gallons

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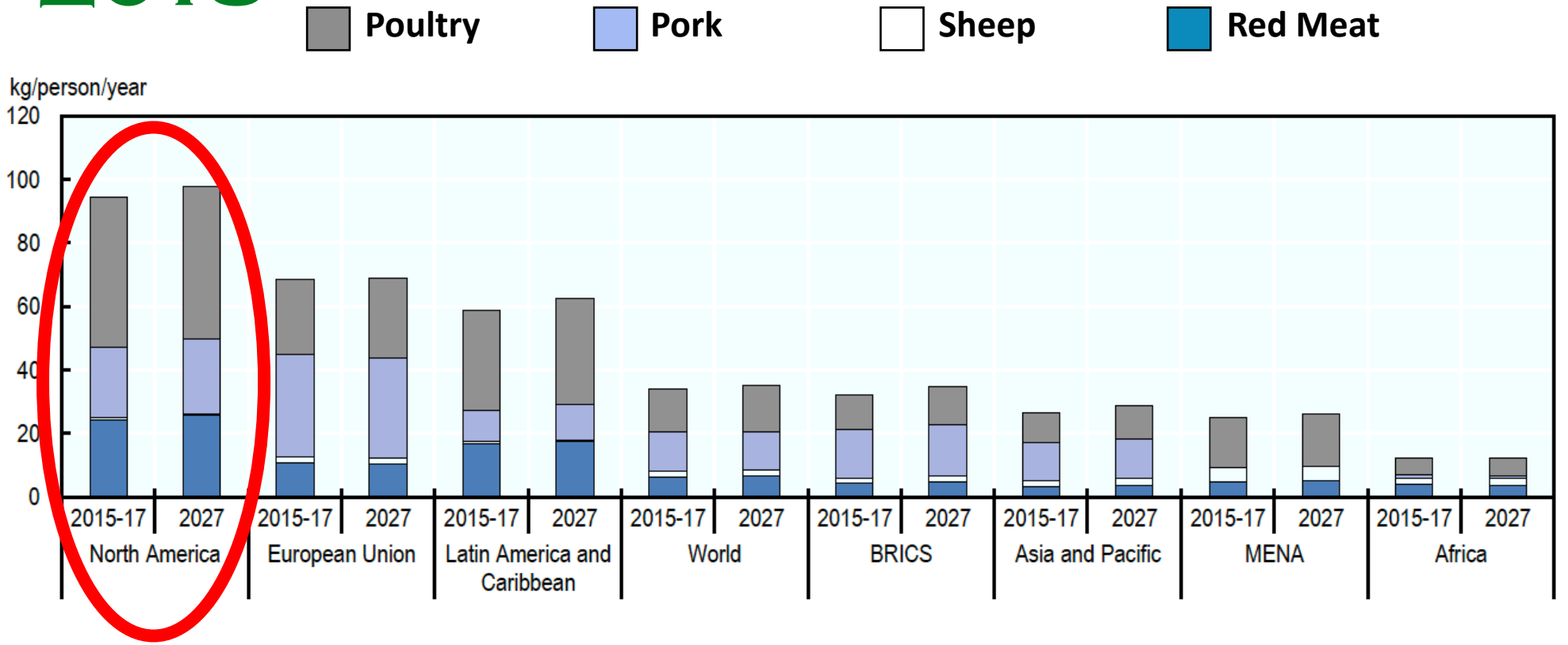
2018

Figure 6.7. Per capita meat consumption by region



Note: Per capita is expressed in retail weight.
Source: OECD/FAO (2018), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

BRICS: *Emerging economies of Brazil, Russian Federation, India, China and South Africa*
MENA: *Middle East & Northern Africa*

Take Home Messages

Most people believe their requirement is higher than it is.

Most people believe they eat less than they do.

It is easier to meet your requirement than most people think

Extra protein beyond needs is not stored, it is converted to carbs and fat

All plants have all 20 amino acids and despite the proportions not being ideal in plants, the amounts and proportions are easily adequate to support optimal health

Americans eat more meat than any other country in the world

Shifting to less animal protein and more plant protein is optimal for human health and environmental health

PERSPECTIVE

Perspective: The Public Health Case for Modernizing the Definition of Protein Quality

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