

Nutrition, Cardiovascular Health, and Food is Medicine

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A National Nutrition Crisis

- **More U.S. adults sick than healthy:**
  - **1 in 2** have diabetes or prediabetes
  - **3 in 4** have overweight or obesity
  - **14 in 15** have suboptimal cardiometabolic health
- **Sick American teenagers:**
  - **1 in 3** have prediabetes
  - **1 in 4** have overweight or obesity
  - **1 in 4** have fatty liver disease
- **Poor nutrition each year:**
  - Kills **500,000 Americans (16% of total deaths)**
  - Causes **800,000 new cases of diabetes (70% of total cases)**
  - Causes **80,000 new cancers**
- **An economic crisis:**
  - **$2 trillion each year** in healthcare spending and lost productivity
  - Strained **federal and state budgets**
  - Less competitive **U.S. businesses**
  - Reduced **military readiness**

U.S. Burden of Disease Collaborators, JAMA 2018; O'Hearn et al., JACC 2022; Zhang et al., JNCI Cancer Spectr 2019; O'Hearn et al., Nature Med 2023; Centers for Disease Control and Prevention; Rockefeller Foundation, *True Cost of Food*, 2021 (adjusted to 2026)

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Nutrition and Health: Oversimplified Targets



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Single Nutrients, Fat, Calories – *Misleading*

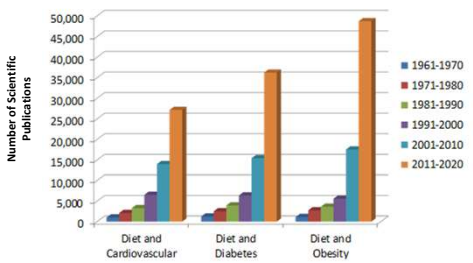


- **Low calorie = "Less weight gain"**
- **Fat free = "Healthy"**
- **Low saturated fat = "Healthy"**
- **Vitamin fortified = "Good for you"**

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Explosion of Nutrition Science

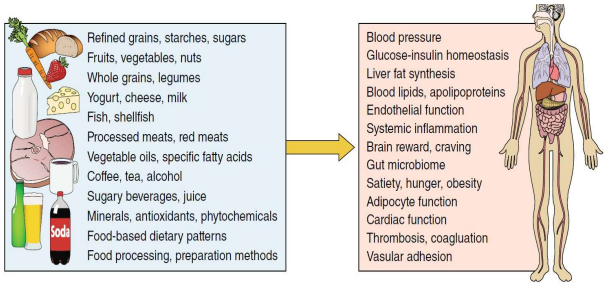


Source: Pubmed/Medline

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Foods and Health – Complex Pathways

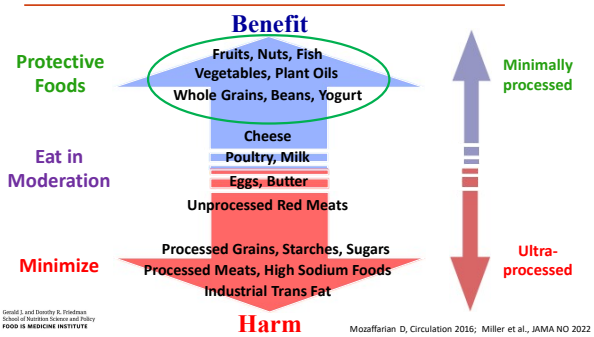


Mozaffarian D, Braunwald's Heart Disease, 2025

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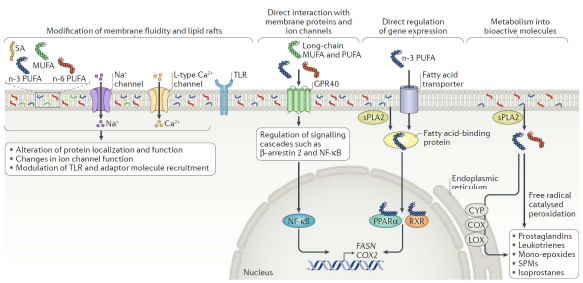
Science-Based Priorities: Healthy Foods



Mozaffarian D, Circulation 2016; Miller et al., JAMA NO 2022

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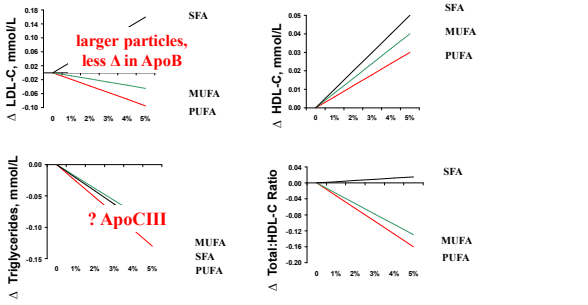
Dietary Fats: Highly Bioactive



Wu, Micha, & Mozaffarian, Nat Rev Cardiol 2019

8

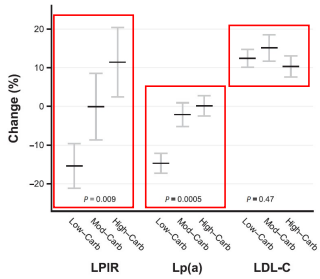
Dietary Fats & Blood Lipids



Meta-analysis of 60 randomized feeding trials. Mensink & Katan, AJCN 2003

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Relative intake matters more than absolute intake



Low-Carb: 20% carb, 21% SFA, 42% unsat
Mod-Carb: 40% carb, 14% SFA, 28% unsat
High-Carb: 60% carb, 7% SFA, 14% unsat

LPIR = Lipoprotein insulin resistance score

Ebbeling et al., AJCN 2021

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Imagine a new cholesterol-lowering drug to FDA …

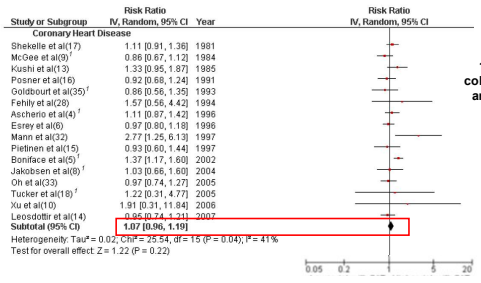
→ **Lowers LDL cholesterol**

But: Many off-target effects…
→ **Partly decreases LDL size, rather than lowering ApoB**
→ **Raises blood triglycerides**
→ **Raises lipoprotein(a)**
→ **Lowers HDL cholesterol**

Would you approve this drug, or want to see evidence for effects on clinical events?

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Saturated Fat & CHD Events: Prospective Cohorts



16 prospective cohort studies from around the world

No Significant Association

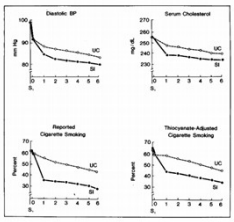
Siri-Tarino et al, AJCN 2010

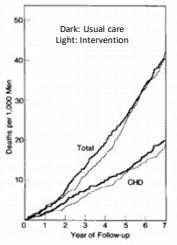
RR comparing highest vs. lowest categories of saturated fat intak

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Saturated Fat & CHD Events: MRFIT

MRFIT Trial





13,000 middle-aged men randomized to a low fat, low saturated fat, low dietary cholesterol diet with smoking cessation and BP control vs. usual care

JAMA, 1982

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Saturated Fat & CHD Events: WHO Collaborative Trial

WHO European Collaborative Trial

50,000 middle-aged men randomized to a low fat, low saturated fat, low dietary cholesterol diet with smoking cessation and BP control vs. usual care

Cumulative Life-Table Incidence (%) of Critical Events (and Numbers of Events)

Interval (years)	Fatal CHD (N = 722)	Fatal CHD + nonfatal MI (N = 1,502)	All deaths (N = 1,921)
2 Control	0.40(88)	1.11(246)	1.11(247)
Intervention	0.40(100)	1.07(262)	1.16(286)
Δ	0%	−3.6%	+4.5%
4 Control	0.98(128)	2.25(252)	2.43(294)
Intervention	0.90(121)	2.14(260)	2.52(335)
Δ	−8.2%	−5.0%	+3.7%
6 Control	1.62(139)	3.31(231)	4.15(383)
Intervention	1.50(146)	3.18(251)	4.04(376)
Δ(SE)	−7.4%(11.2%)	−3.9%(3.22%)	−2.7%(2.27%)

Net Percentage Changes in Risk Factors for All Men in the Trial (and High-Risk Men), Averaged over All Examinations

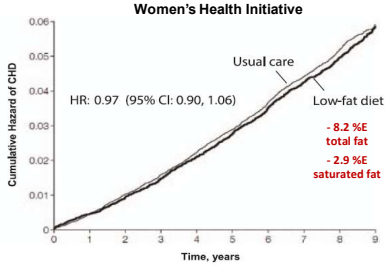
Risk factor	U.K.	Belgium	Italy	Poland	All
Cholesterol	−0.4(−2.7)	−0.9(2.7)	−4.8(−5.5)	−1.0(−5.8)	−1.2(−3.4)
% Smokers	−4.5(−10.2)	−1.7(−6.5)	+2.3(−5.5)	+1.3(+2.0)	−1.9(−6.8)
Cigarettes/day	−15.6(−18.7)	−3.7(−10.8)	−5.5(−9.5)	−5.9(−21.8)	−8.9(−14.2)
Weight	−0.4(−0.5)	+0.2(−0.7)	−1.9(−1.4)	−1.0(−0.8)	−0.4(−0.7)
Systolic BP	−1.6(−2.7)	−2.3(−2.5)	−4.1(−3.2)	−0.6(−4.4)	−2.0(−2.9)

Kornitzer & Rose, Preventive Medicine 1985

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Saturated Fat & CHD Events: WHI RCT

Women's Health Initiative

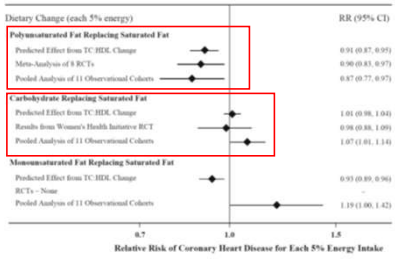


50,000 postmenopausal women randomized to a low fat, low saturated fat, low dietary cholesterol diet vs. usual care

Howard et al., JAMA 2006

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Healthy Fats and Cardiovascular Disease

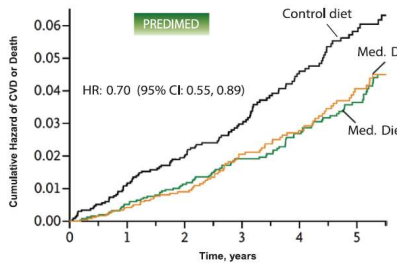




Micha et al., Circulation 2010

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Mediterranean Diet and Cardiovascular Disease



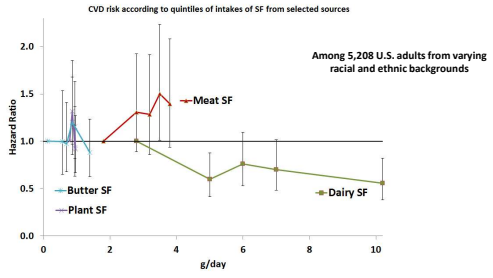
+ 4.4 %E total fat

No change in saturated fat

Estruch et al., NEJM 2018

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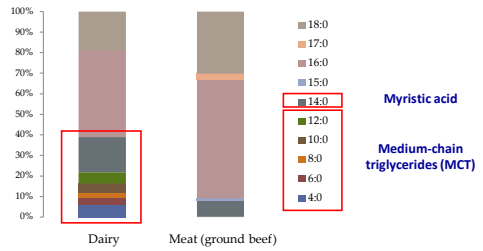
Food Sources of Saturated Fat and Cardiovascular Disease



Otto et al., AJCN 2012

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Fatty Acid Profile of Dairy vs. Beef



Source: USDA National Nutrient Database for Standard Reference, Release 24

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Dairy Foods and Cardiometabolic Health

In meta-analyses of large, prospective cohort studies:

- **Total dairy:** each daily serving, 4% less hypertension, 4% less stroke, 2% less heart disease
- **Milk:** each daily serving, 6% less hypertension, 6% less stroke
- **Cheese:** high vs. low intake, 5% less all-cause death, 7% less CVD death, 7% less diabetes
- **Yogurt:** each daily serving, 7% less all-cause death, 14% less CVD death, 24% less diabetes

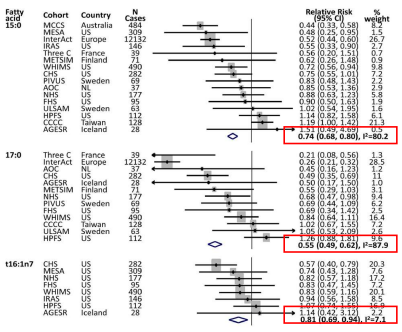
No consistent differences for full-fat vs. low-fat dairy

Feng et al. Adv Nutr 2022; Chen et al., Adv Nutr 2022; Tutunchi te al., Public Health Nutrition 2023; DGAC Report 2025

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Dairy Fat Biomarkers: Lower Risk of Diabetes



63,682 participants

15,180 incident diabetes cases

16 prospective cohorts

12 countries

Imamura et al., Plos Med 2018

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Fermented Dairy Foods and Health

- **Microbiome health:** Fermented dairy (e.g., yogurt, cheese, kefir) increases Lactobacillus and Bifidobacterium species, overall bacterial diversity, and plasma short-chain fatty acids
- **Menaquinones (vitamin K2):** Reduced blood glucose, increased adiponectin in small RCTs
- **Probiotics:** In meta-analysis of 37 RCTs, probiotics lower BMI, glucose, insulin, A1c, HOMA-IR, triglycerides; increase HDL

Chonnacháin et al., Proc Nutr Soc 2023; Jensen et al., Foods 2021; Hariri et al., Open Heart 2021; Yan et al., Food Sci Nutr 2023; Xiao et al., Nutrients 2023

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Red Meats and Cardiovascular Disease

RR per weekly serving (100 g)

Unprocessed red meat:
RR = 1.05 (1.04, 1.06)



Processed meat:
RR = 1.12 (1.10, 1.14)

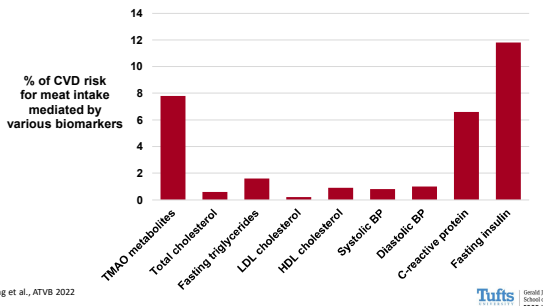


Miller et al., JAMA Network Open 2022

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Red Meats and Cardiovascular Disease



Wang et al., ATVB 2022

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Refined Starch = Hidden "Sugar"



Obesity

Weight Gain

Type 2 Diabetes

Gut Microbiome









Source: Google images

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Refined Acellular Carbs (and Protein ?)

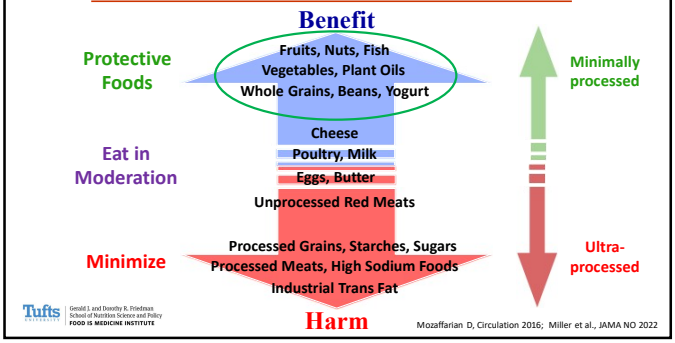
- **Acellular** flours, sugars, and processed foods are rapidly digested in the stomach and small intestine
- This **floods with bloodstream** with excess nutrients, and **starves the microbiome** in the large intestine
- Unhappy bacteria =
  - Pro-inflammatory
  - Increased GI permeability
  - Fewer beneficial metabolites
  - Postprandial "metabolic endotoxemia"

Spreadbury I, Diabetes Metab Syndr Obes 2012
Zinocker & Lindseth, Nutrients 2018

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Science-Based Priorities: Healthy Foods



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Mozaffarian D, Circulation 2016; Miller et al., JAMA NO 2022

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2025 Dietary Guidelines for Americans: Major Updates

• Prioritize fiber-rich whole grains • Significantly reduce highly processed, refined carbohydrates	• No prior DGAs have recommended reducing processed or refined carbohydrates (eg, refined wheat, rice, or corn flour); prior DGAs only recommended to partly replace refined grains with whole grains • The new recommendation to significantly reduce refined carbohydrates (roughly 1 in 4 calories in the food supply) is a major change
• Incorporate healthy fats from whole foods such as meats, poultry, eggs, seafood, nuts, seeds, full-fat dairy, olives, and avocados • When consuming dairy, include full-fat dairy with no added sugars • Saturated fat consumption should not exceed 10% of calories	• An emphasis on healthful fats from whole foods could be beneficial, especially if replacing highly processed foods rich in refined carbohydrates, salt, and other additives • Health gains will be greatest if this is translated into foods most strongly linked to health benefits and currently underconsumed by individuals in the US, such as plant and seafood sources • It is unclear how the contradiction will be handled between encouraging full-fat dairy, which is not linked to cardiometabolic harms, and retaining the saturated fat limit (eg, dairy fat could be excluded from the limit as was done for whole milk when it was allowed back into schools as part of the Whole Milk for Healthy Kids Act of 2025)
• Prioritize protein foods at every meal from a variety of foods including animal and plant sources • Aim for protein consumption of 1.2 to 1.6 g/kg of body weight per day	• At a time when most individuals already consume enough protein, this represents a 50% to 100% increase from the current Dietary Reference Intake • If combined with regular strength or resistance training, protein can help build muscle; however, without such training, excess protein can be converted to fat by the liver, increasing visceral adiposity and diabetes risk • Although the DGAs recommend both plant and animal whole foods as protein sources, the higher protein target may result in increased consumption of red meat rather than other more healthful protein sources or consumption of more highly processed foods fortified with protein, which are already rapidly gaining market share • The lack of guidance to limit processed meats, which have been linked to cancer, diabetes, heart disease, and stroke, is an important continuing omission from prior DGAs

Mozaffarian D, JAMA 2026

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2025 Dietary Guidelines for Americans: Major Updates

Recommendations[a]	Implications
• Avoid foods that are highly processed, packaged, or ready to eat • Avoid other foods that are salty or sweet	• Prior DGAs generally presented all food choices as acceptable within overall daily nutrient limits; an approach that was inconsistent with the evidence for harms of certain types of products • No prior DGA has emphasized the dimension of processing separately from nutrients or food groups • This update directly challenges widespread industry products and practices
• Avoid sugar-sweetened beverages • Limit added sugars to no more than 10 g per meal and, in foods, to the US Food and Drug Administration healthy rule (eg, 5 g in grains, 2.5 g in dairy) • No added sugars from birth through 10 y of age	• The 2010 DGA advised against sugar-sweetened beverages, but this recommendation was dropped in subsequent updates • The new recommendations for sugar-sweetened beverages and added sugars are much stronger than in prior editions
• Limit foods and beverages that include artificial flavors, petroleum-based dyes, artificial preservatives, and low-calorie nonnutritive sweeteners	• Although evidence on these additives remains limited and conflicting, emerging studies suggest potential adverse effects on glucose control, microbiome composition, child behavior, and other outcomes • No prior DGAs have recommended their avoidance; indeed, some prior DGA educational materials have promoted nonnutritive sweeteners as a sugar-reduction strategy • The impact will greatly depend on how this is communicated to the public and implemented in agency policy (eg, school meals, early childcare, military nutrition, federal cafeterias)

Mozaffarian D, JAMA 2026

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High Protein: Don't Believe the Hype



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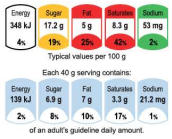
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Effective Food Policy: The Tobacco Playbook ?

Taxation



Warning Labels





Marketing Restrictions



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Food Security

Reliable access to enough safe, affordable food for an active, healthy life.



- Ensures people have enough calories
- Addresses hunger and undernutrition
- Often focuses on quantity and access
- Does not guarantee a healthy diet

A broader, healthier goal

Nutrition Security

Consistent access to nutritious, safe, and culturally appropriate food that supports optimal health and well-being.



- Delivers a variety of nutrient-dense foods
- Supports physical and mental health
- Prevents diet-related chronic disease
- Builds long-term health and resilience

The Rationale

Healthier People — Better nutrition reduces risk of chronic disease, improves mental health, and increases healthy life expectancy.

More Equitable — Addresses disparities in diet-related disease and helps level the playing field for all communities.

Lower Health Care Costs — Prevents illness, reduces hospitalizations, and decreases reliance on high-cost care.

Stronger Communities — Supports productivity, learning and development, and economic stability across the lifespan.

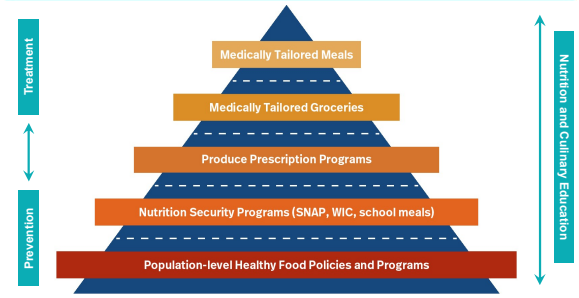
A Healthier Future — Builds a more resilient food system and a healthier population for generations to come.

Mozaffarian et al., JAMA 2021; Craig et al., AJCN 2025; Owens et al., JAMA Netw Open 2026; Ridberg et al., AJCN 2026

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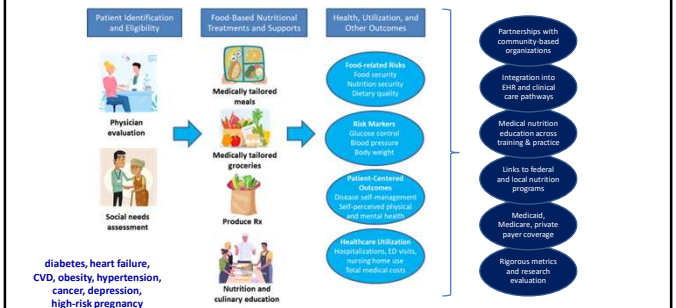


Mozaffarian et al., Nature Medicine 2022

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diabetes, heart failure, CVD, obesity, hypertension, cancer, depression, high-risk pregnancy

Mozaffarian et al., JACC 2024

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Food is Medicine: National Momentum

- State Medicaid 1115 Waivers, ILOS
- Medicare Advantage Plans
- Private Health Plans
- Community Health Centers, HRSA funding
- State Rural Health Transformation Funds
- Feeding America Food Banks
- Community Pharmacies
- Rockefeller Foundation/AHA $250M funding
- National Institutes of Health Research

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Nutrition Education for Doctors

- **Medical schools: 76 medical schools** in **36 states** have committed to **40+ hours of nutrition education** or **equivalent competency training**
- **Culinary medicine:** Growing **hands-on** training programs
- **USMLE:** Nutrition to be **15-20% of all content**, focusing on health, disease, and clinical decision-making
- **ACGME: New proposed guidance for residency and fellowship programs** for nutrition education and competencies, to be finalized soon
- **CME:** Texas, Louisiana, New Mexico, US Public Health Service requirements; NY and CA recommendations

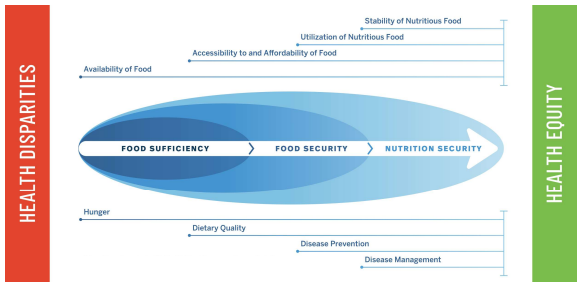




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Food is Medicine: Centered in Health Equity



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Mozaffarian et al., JACC 2023

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Food is Medicine: Resilient Food Systems

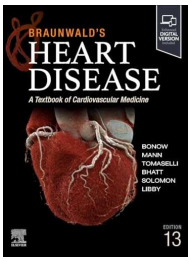


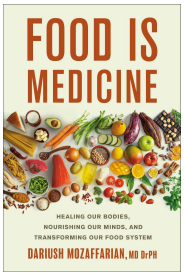
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Further Reading





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