Dietary Patterns and Chronic Disease

Ed Giovannucci, M.D., Sc.D.

Professor of Nutrition and Epidemiology

Harvard TH Chan School of Public Health

I have no conflicts of interest to disclose

U.S. Dietary Guidelines: A dietary pattern is the combination of foods and beverages that constitutes an individual's complete dietary intake over time. This may be a description of a customary way of eating or a description of a combination of foods recommended for consumption.

Focus on meeting food group needs with nutrient-dense foods and beverages, and stay within calorie limits.

Limit foods and beverages higher in added sugars, saturated fat, and sodium, and limit alcoholic beverages.

Core elements of dietary patterns

• Vegetables of all types—dark green; red and orange; beans, peas, and lentils; starchy; and other vegetables

• Fruits, especially whole fruit

• Grains, at least half of which are whole grain

• Dairy, including fat-free or low-fat milk, yogurt, and cheese, and/or lactose-free versions and fortified soy beverages and yogurt as alternatives

• Protein foods, including lean meats, poultry, and eggs; seafood; beans, peas, and lentils; and nuts, seeds, & soy products

• Oils, including vegetable oils and oils in food, such as seafood and nuts

Three main approaches to dietary patterns:

Indices or scores based on prior knowledge (A priori)

Empirically derived from dietary data of the study population (e.g., principal components analysis)

Hypothesis oriented (e.g., insulinemia, inflammation)

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Summary of index components that are common across most of the dietary indices

Index components	HEI-2010	AHEI-2010	DASH	Typical MED	WCRF/ AICR	Rec. Food Score
Higher intake rewarded						
Fruits	+	+	+	+	+	+
Vegetables	+	+	+	+	+	+
Nuts or legumes	+	+	+	+	+	+
Whole grains	+	+	+	+	+	+
Low-fat dairy products	+		+	+	+	+
Fish and other seafood				+	+	+
Lower/no intake rewarded						
Red or processed meat	+	+	+	+	+	
Sugared beverages	+	+	+		+	
Alcoholic beverages	+	m		m	+	
Table salt	+	+	+		+	

Dietary indices/scores based on prior knowledge

- **There is a lot of overlap among dietary patterns**
- **They vary how they treat certain items like alcohol, salt, dairy, animal proteins other than red meat**
- **Their correlations are ~ 0.6 to 0.7.**
- **Most are focused on CVD risk reduction** (e.g., lipids, sugars, blood pressure: DASH, Healthy Eating Index, Mediterranean)

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Hypothesis oriented (e.g., insulinemia, inflammation)

Other vegetables
Leafy vegetables
Cruciferous vegetables
Yellow vegetables
Fruit
Fish
Legumes Tomatoes
Poultry
Garlic Salad dressing
Whole grains

→

Refined grains
Red meat
Processed meat
French fries
Condiments
Desserts and sweets
Potatoes
High Fat dairy
Pizza
Sugar beverages
Margarines
Eggs
Snacks
Butter
Cream soups

←

Table 1. Factor Loading Matrix for Dietary Patterns From Food Frequency Questionnaire*

Foods	Prudent				Western			
	1984	1986	1990	1994	1984	1986	1990	1994
Other vegetables	0.68	0.73	0.68	0.69	...	...	...	...
Leafy vegetables	0.63	0.66	0.65	0.58	...	...	...	...
Cruciferous	0.61	0.59	0.61	0.63	...	...	...	...
Yellow vegetables	0.60	0.62	0.65	0.67	...	...	...	...
Fruit	0.60	0.58	0.58	0.62	...	...	...	...
Fish	0.50	0.53	0.51	0.43	...	...	...	...
Legumes	0.55	0.51	0.57	0.61	0.18	0.20	0.15	0.15
Tomatoes	0.45	0.56	0.49	0.43	0.17	0.16	0.16	...
Poultry	0.43	0.42	0.42	0.31	...	...	...	...
Garlic	0.35	NA	NA	0.24	...	NA	NA	...
Salad dressings	0.43	0.40	0.34	0.22	...	...	...	...
Whole grains	0.41	0.38	0.41	0.43	...	...	...	...
Organ meats	0.23	...	...	...	...	...	...	...
Refined grains	...	...	...	...	0.74	0.57	0.52	0.44
Processed meats	...	...	...	...	0.52	0.57	0.58	0.57
Red meat	...	...	...	...	0.56	0.56	0.60	0.61
French fries	−0.15	...	...	...	0.44	0.48	0.46	0.47
Condiments	...	0.17	...	...	0.40	0.33	0.36	0.28
Desserts and sweets	...	...	...	...	0.60	0.49	0.45	0.45
Potatoes	...	...	0.21	0.26	0.39	0.38	0.34	0.34
High fat dairy	...	...	...	...	0.35	0.40	0.46	0.43
Pizza	...	...	...	...	0.36	0.34	0.36	0.33
Sugar beverages	...	...	...	...	0.32	0.34	0.33	0.34
Margarine	...	...	...	...	0.30	0.30	0.32	0.34
Eggs	...	...	...	...	0.25	0.32	0.41	0.42
Snacks	...	...	...	...	0.29	0.31	0.29	0.33
Butter	...	...	...	...	0.23	0.25	0.29	0.27
Cream soups	...	0.15	...	...	0.21	0.30	0.31	0.35
Tea	...	...	...	...	0.15	0.17	...	...
Cereal	...	...	...	0.23	...	...	...	...
Low-fat dairy	0.16	0.30	0.32	0.36	...	...	...	−0.15
Fruit juices	...	0.24	0.21	0.26	...	...	...	0.15
Nuts	0.19	0.21	0.17	...	0.18	0.22	0.23	0.28
Diet beverages	...	...	...	...	...	...	...	...
Coffee	...	...	...	...	...	...	...	...
Water	NA	NA	0.32	0.35	NA	NA	...	...
Mayonnaise	0.17	0.20	...	...	0.31	0.33	0.34	0.27
Olive oil	NA	NA	0.31	0.19	NA	NA	...	...
Other soups	NA	0.27	NA	NA	NA	0.28	NA	NA
Liquor	...	...	...	...	...	...	...	...
Beer	...	...	...	...	...	...	...	...
Wine	...	...	...	...	...	...	...	...

Abbreviation: NA, data not available.
*Ellipses indicate factor loadings less than ± 0.15 were omitted for simplicity.

Principal components analysis in the Nurses' Health Study

Summary of major food groups common in most Principal Components Analysis (PCA)-derived dietary patterns <u>across the world</u>

Food components in dietary patterns derived using PCA	United States	Canada	Argentina	Uruguay	European countries	Sweden	South Korea	Japan	Jordan	Iran
"Healthy" dietary pattern										
Fruits	+	+	+	+	+	+	+	+	+	+
Vegetables	+	+	+	+	+	+	+	+	+	+
Nuts and legumes	+			+	+			+	+	
Whole grains	+	+				+				
Milk dairy & other dairy			+	+		+	+	+	+	+
Fish and poultry	+			+	+	+				+
"Unhealthy" dietary pattern										
Red and processed meat	+	+	+	+	+	+	+	+	+	+
Sugar-sweetened beverages	+		+		+	+	+			+
Refined grains and desserts	+	+	+	+		+	+	+	+	+
Potatoes	+		+		+	+			+	

There is reasonable concordance in derived dietary patterns across diverse countries (though broader studies are required). In most populations, an "unhealthy" (western) and "healthy" dietary patterns emerges in the first two components.

Differences could represent real differences in dietary factors (e.g., some items such as sugar sweetened beverages can be consumed variably across countries), differences in the questionnaires, grouping of food items, statistical methodology, etc.

Three main approaches to dietary patterns:

Indices or scores based on prior knowledge (A priori)

Empirically derived from dietary data of the study population (e.g., principal components analysis)

Hypothesis oriented (e.g., insulinemia, inflammation)

Food groups and intermediate disease markers: a systematic review and network meta-analysis of randomized trials

	Summary	LDL-C	TGs	HOMA-IR	CRP
Nuts	1	1	2	3	2
Whole grains	2	3	5	1	3
Legumes	3	2	4	2	6
Fish	4	9	1	5	8
Fruits/vegetables	5	4	7	6	9
Refined grains	6	5	8	4	7
Red meat	7	10	3	-	5
Eggs	8	6	10	8	1
Dairy	9	7	6	7	4
Sugar Beverages	10	8	9	-	-
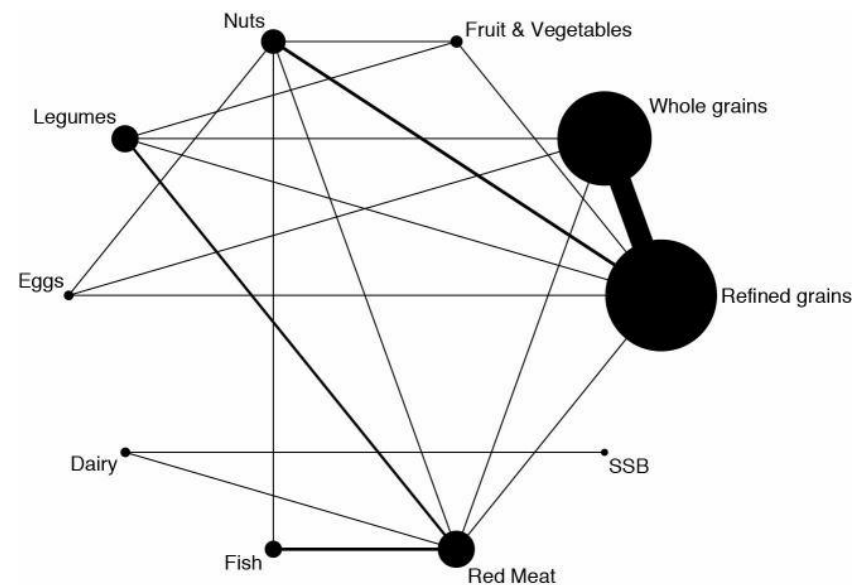
66 randomized trials comparing 10 food groups and enrolling 3595 participants

Schwingshackl et al AJCN 2018

Empirically determined foods that predict hyperinsulinemia and systemic inflammation **(NHS, NHS2, HPFS, WHI)**

Dietary prediction models of biomarkers:
-C-peptide (insulin secretion)
-inflammation (CRP, IL-6, TNF-alphaR2)

Foods and food groups entered the regression models in an <u>unbiased</u> manner

Many common items predicted the 2 biomarkers
(18 individual items overall for each biomarker)

	Pro-Insulinemic	Pro-Inflammatory
Red Meat	+	+
Processed Meat	+	+
Starchy Vegetables	+	+
Refined vs Whole Grains	+	+
Sugar-Sweetened Beverages	+	+
Coffee	-	-
Alcohol (moderate)	-	-
Vegetables (Non-Starchy; green)	-	-
Fruit / Fruit Juice	-	-
Low-fat dairy	+	
Butter	+	
Eggs	+	
Poultry, non-fatty fish	+	

Relevant publications:

F Tabung et al Br J Nutr 2016
F Tabung et al J Nutrition 2017
F Tabung et al J Nutr 2018

Fred Tabung, post doc at HSPH,
Assistant Professor OSU
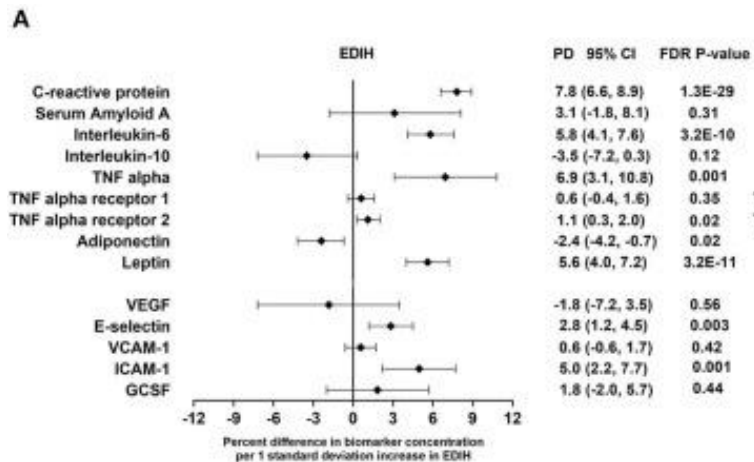
Empirical Hyperinsulinemia Diet   **Empirical Inflammatory Diet**

A (EDIH)

	PD 95% CI	FDR P-value
Glucose	1.3 (1.1, 1.6)	1.3E-29
Insulin	6.5 (5.6, 7.3)	1.3E-29
C-peptide	4.9 (1.7, 8.1)	0.01
HOMA-IR	8.0 (7.1, 8.9)	1.3E-29
HOMA-B	2.9 (2.1, 3.7)	3.7E-11
IGF-1	-0.5 (-3.3, 2.3)	0.78
IGFBP1	-9.7 (-14.5, -4.8)	3.1E-04
IGFBP3	-0.3 (-2.1, 1.5)	0.78
IGFBP4	2.5 (-2.0, 6.9)	0.35
Free IGF-1	0.9 (-3.1, 4.9)	0.71

Percent difference in biomarker concentration per 1 standard deviation increase in EDIH

B (EDIP)

	PD 95% CI	FDR P-value
Glucose	0.9 (0.7, 1.1)	2.3E-14
Insulin	4.9 (4.1, 5.8)	1.0E-28
C-peptide	2.8 (-0.3, 6.0)	0.13
HOMA-IR	6.1 (5.1, 7.0)	1.3E-29
HOMA-B	2.8 (1.9, 3.6)	3.5E-10
IGF-1	0.1 (-2.6, 2.8)	0.96
IGFBP1	-5.3 (-10.3, -0.2)	0.08
IGFBP3	1.0 (-0.8, 2.8)	0.35
IGFBP4	3.9 (-0.8, 8.7)	0.16
Free IGF-1	-2.2 (-6.0, 1.6)	0.35

Percent difference in biomarker concentration per 1 standard deviation increase in EDIP

Glucose
Insulin
C-peptide
HOMA-IR
HOMA-B
IGFBP-1

Insulin Glycemia

A (EDIH)

	PD 95% CI	FDR P-value
C-reactive protein	7.8 (6.6, 8.9)	1.3E-29
Serum Amyloid A	3.1 (-1.8, 8.1)	0.31
Interleukin-6	5.8 (4.1, 7.6)	3.2E-10
Interleukin-10	-3.5 (-7.2, 0.3)	0.12
TNF alpha	6.9 (3.1, 10.8)	0.001
TNF alpha receptor 1	0.6 (-0.4, 1.6)	0.35
TNF alpha receptor 2	1.1 (0.3, 2.0)	0.02
Adiponectin	-2.4 (-4.2, -0.7)	0.02
Leptin	5.6 (4.0, 7.2)	3.2E-11
VEGF	-1.8 (-7.2, 3.5)	0.56
E-selectin	2.8 (1.2, 4.5)	0.003
VCAM-1	0.6 (-0.6, 1.7)	0.42
ICAM-1	5.0 (2.2, 7.7)	0.001
GCSF	1.8 (-2.0, 5.7)	0.44

Percent difference in biomarker concentration per 1 standard deviation increase in EDIH

B (EDIP)

	PD 95% CI	FDR P-value
C-reactive protein	6.7 (5.5, 7.7)	1.3E-29
Serum Amyloid A	2.9 (-1.6, 7.3)	0.31
Interleukin-6	4.3 (2.6, 6.0)	3.3E-06
Interleukin-10	-3.6 (-7.2, -0.1)	0.08
TNF alpha	3.8 (0.2, 7.5)	0.08
TNF alpha receptor 1	0.8 (-0.2, 1.7)	0.17
TNF alpha receptor 2	1.8 (1.0, 2.6)	7.6E-05
Adiponectin	-2.9 (-4.6, -1.2)	0.002
Leptin	3.3 (1.8, 4.8)	7.6E-05
VEGF	-1.6 (-6.6, 3.5)	0.59
E-selectin	3.2 (1.5, 4.8)	0.001
VCAM-1	1.3 (0.3, 2.4)	0.03
ICAM-1	3.5 (1.0, 6.0)	0.02
GCSF	0.5 (-3.2, 4.2)	0.83

Percent difference in biomarker concentration per 1 standard deviation increase in EDIP

CRP
TNF-alpha   **Inflammation**

Adiponectin (-)   **Adipokines**
Leptin

E-selectin   **Endothelial**
I-CAM-1

A (EDIH)

	PD 95% CI	FDR P-value
Total cholesterol	0.3 (0.04, 0.5)	0.05
Triglycerides	2.0 (1.3, 2.7)	4.3E-08
High density lipoprotein	-0.7 (-1.1, -0.4)	0.0003
Low density lipoprotein	0.5 (0.1, 1.0)	0.03
Trig/HDL ratio	3.0 (2.0, 3.9)	4.0E-09
Trig/TC ratio	1.7 (1.1, 2.4)	1.1E-06
Large LDL	-1.1 (-3.7, 1.6)	0.50
Medium LDL	1.2 (-1.3, 3.8)	0.44
Small LDL	1.0 (-1.5, 3.4)	0.50
Very small LDL	1.7 (-0.9, 4.2)	0.30
Total size of all LDL	-0.2 (-0.4, 0.002)	0.09
Intermediate DL	1.6 (-2.4, 5.5)	0.50
Large HDL	0.4 (-3.1, 4.0)	0.83
Medium HDL	5.5 (-3.3, 14.3)	0.31
Small HDL	1.1 (-0.1, 2.4)	0.13
Total size of all HDL	-0.03 (-0.4, 0.3)	0.86

Percent difference in biomarker concentration per 1 standard deviation increase in EDIH

B (EDIP)

	PD 95% CI	FDR P-value
Total cholesterol	0.1 (-0.1, 0.4)	0.46
Triglycerides	3.2 (2.5, 3.8)	2.0E-18
High density lipoprotein	-1.3 (-1.7, -1.0)	1.3E-12
Low density lipoprotein	0.2 (-0.2, 0.6)	0.48
Trig/HDL ratio	4.4 (3.4, 5.3)	2.2E-18
Trig/TC ratio	3.0 (2.4, 3.7)	1.0E-18
Large LDL	-3.0 (-5.6, -0.3)	0.06
Medium LDL	3.0 (0.5, 5.6)	0.04
Small LDL	2.1 (-0.3, 4.6)	0.15
Very small LDL	2.9 (0.4, 5.4)	0.04
Total size of all LDL	-0.2 (-0.4, -0.1)	0.02
Intermediate DL	2.4 (-1.6, 6.4)	0.34
Large HDL	-1.3 (-4.5, 2.0)	0.50
Medium HDL	3.4 (-5.0, 11.9)	0.50
Small HDL	1.5 (0.2, 2.7)	0.04
Total size of all HDL	-0.2 (-0.6, 0.1)	0.18

Percent difference in biomarker concentration per 1 standard deviation increase in EDIP

Triglycerides
HDL-cholesterol   **Lipids**
Triglycerides/HDL ratio
Small/very small LDL

Shi N, et al. Front Nutr 2021

Rationale to study/recommend dietary patterns:

The whole diet would better pick up <u>additive</u> and "<u>synergistic</u>" effects (e.g., many small effects may add up to a substantial one)
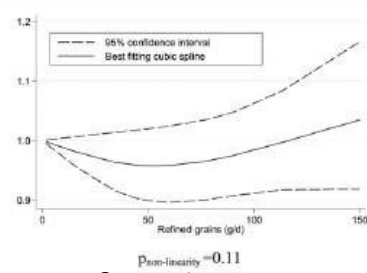
Inherently accounts for substitution (i.e., defines what one eats and does not eat)

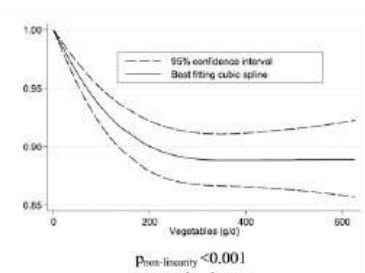**Reduces the problem of confounding in nutritional studies**
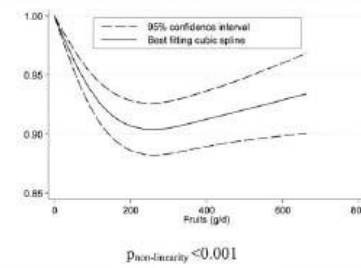
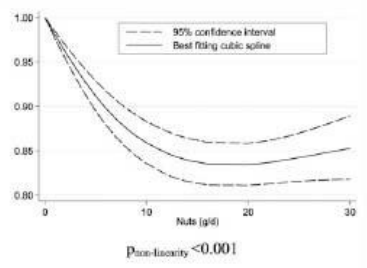**Easier to translate & communicate (people eat foods)**
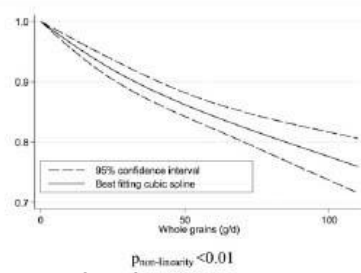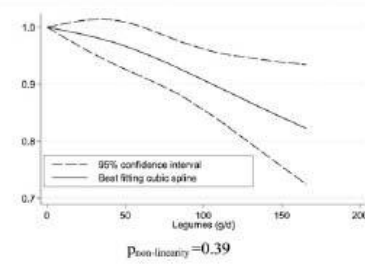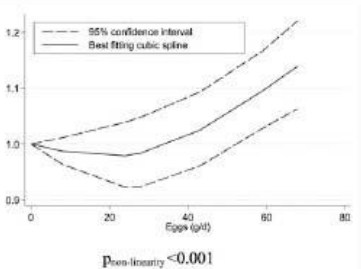
Whole grains   Refined grains   Vegetables

Fruits   Nuts   Legumes
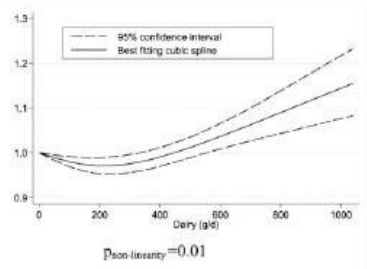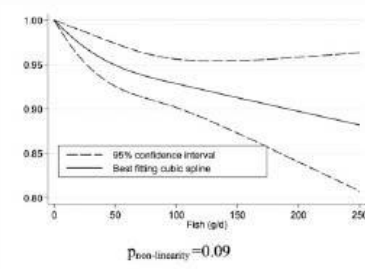
Eggs   Dairy   Fish
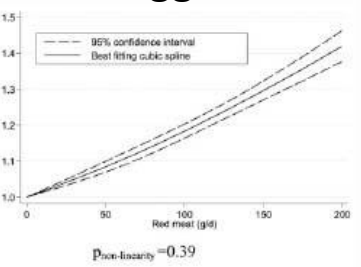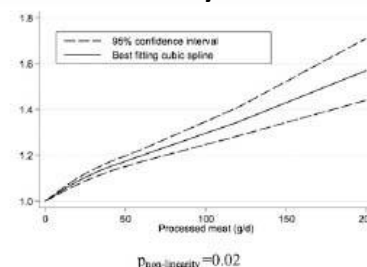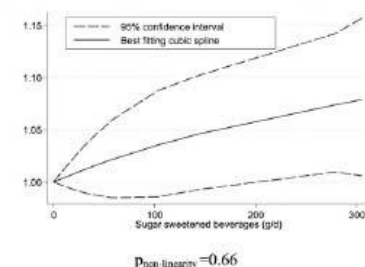
Red Meat   Processed Meat   Sugar Sweetened Beverages

Food groups and risk of all-cause mortality: a systematic review and meta-analysis of prospective studies

L Schwingshackl AJCN 2017

Focus on an individual food item may exaggerate its beneficial effects because it incorporates:

-its direct ("causal") effect (if there is one)
-its correlation with other beneficial foods or patterns
-its displacement of unhealthy foods

Defining the whole dietary pattern is more likely to provide a <u>realistic</u> effect estimate of a healthy dietary pattern
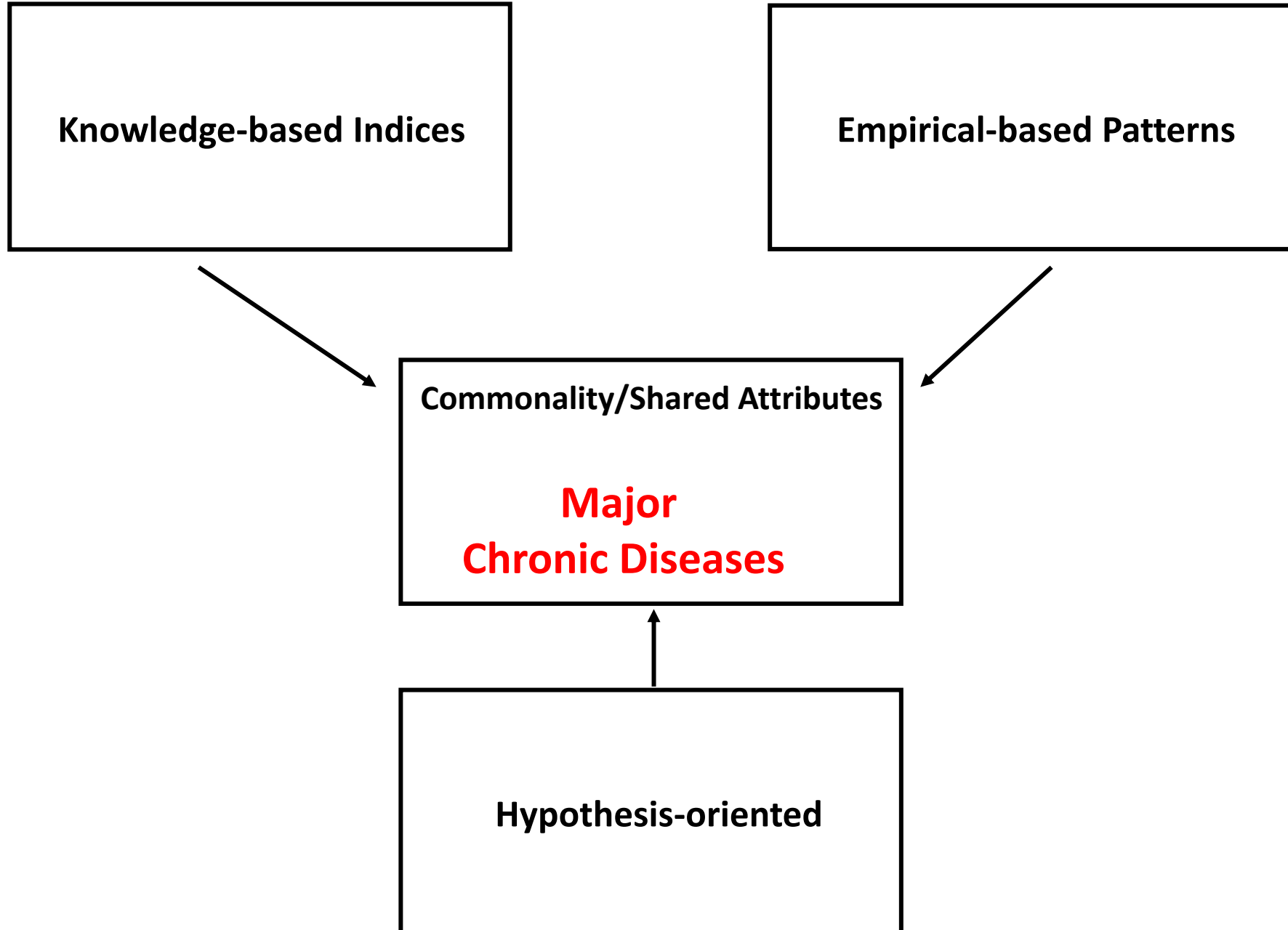
Optimal dietary patterns for prevention of chronic disease. Nature Medicine 2023, Peilu Wang et al.

To determine the superior dietary patterns for general health by focusing on major chronic disease, defined as the first occurrence of incident major CVD, type 2 diabetes, or total cancer (excluding non-melanoma skin cancer and non-fatal prostate cancer).
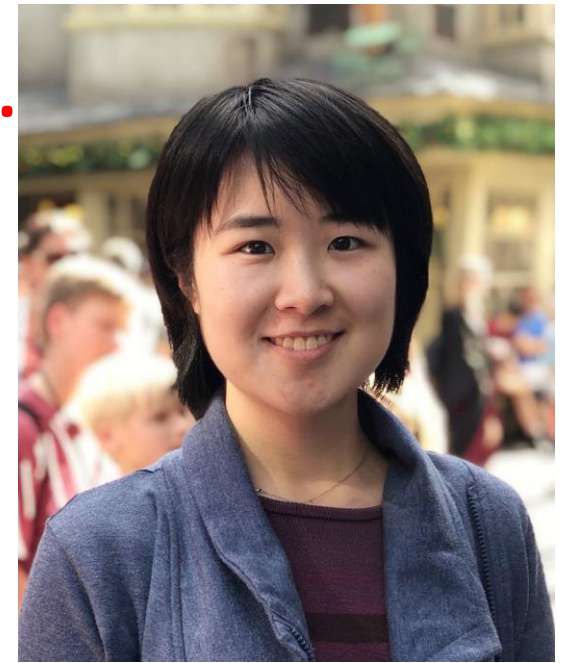
<u>3 cohorts</u> : Nurses Health Study 1   Nurses Health Study 2
Health Professionals Follow-Up Study

~163,000 women and 43,000 men followed up to 32 years with repeated food frequency questionnaires (every 4 y)

~5,000,000 person years with 45,000 major chronic disease endpoints

• Chronic diseases account for more than half of all premature deaths and more than 90% of yearly healthcare spending in the United States.

Figure 4. Age-adjusted death rates for the 10 leading causes of death in 2020: United States, 2019 and 2020
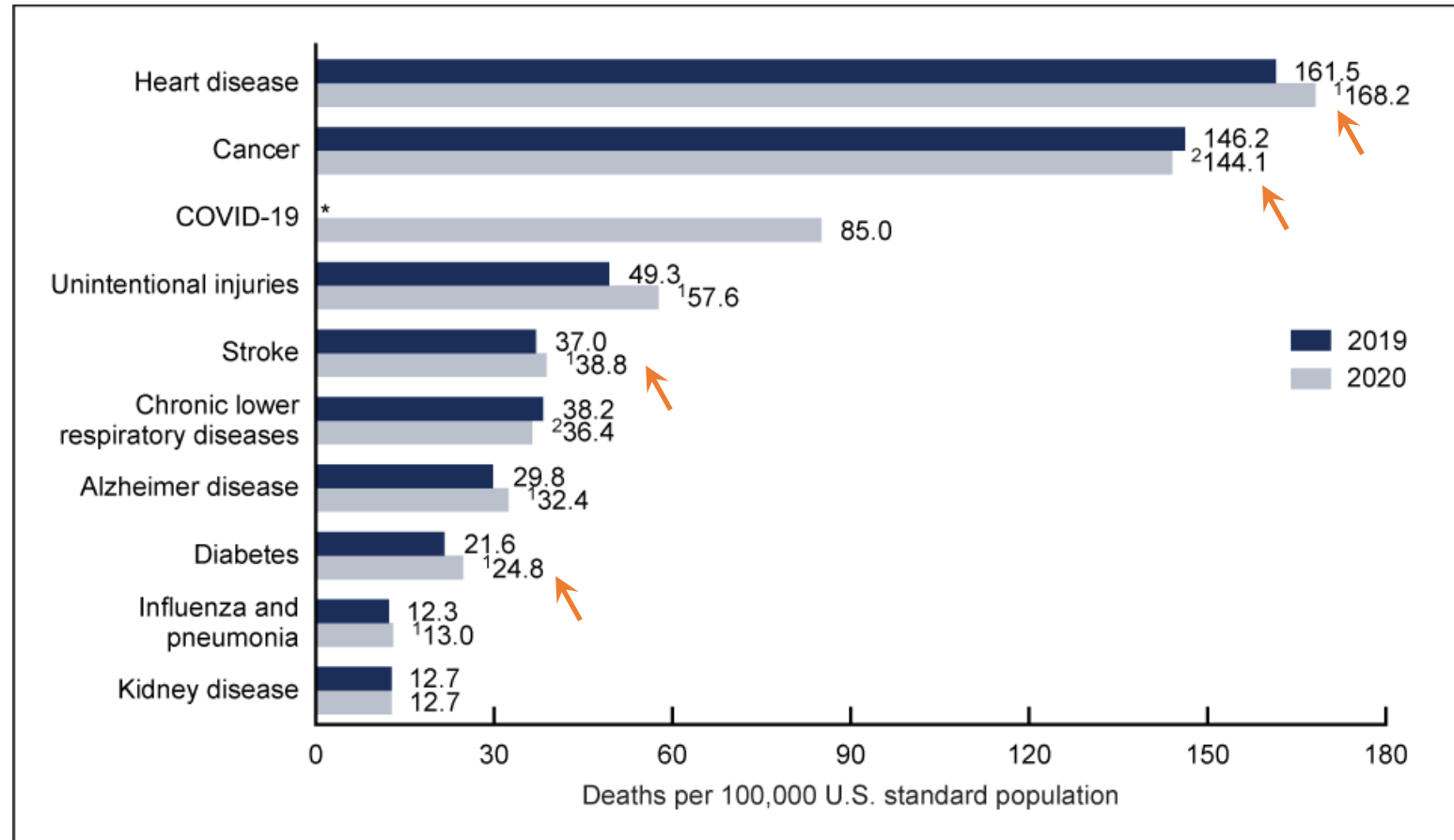
* COVID-19 became an official cause of death in 2020; rates for 2019 are not applicable.
[1]Statistically significant increase in age-adjusted death rate from 2019 to 2020 ($p < 0.05$).
[2]Statistically significant decrease in age-adjusted death rate from 2019 to 2020 ($p < 0.05$).
NOTES: A total of 3,383,729 resident deaths were registered in the United States in 2020. The 10 leading causes of death accounted for 74.1% of all deaths in the United States in 2020. Causes of death are ranked according to number of deaths. Rankings for 2019 data are not shown. Data table for Figure 4 includes the number of deaths for leading causes and the percentage of total deaths. Access data table for Figure 4 at:
https://www.cdc.gov/nchs/data/databriefs/db427-tables.pdf#4.
SOURCE: National Center for Health Statistics, National Vital Statistics System, Mortality.

44,975 major chronic disease events
- **11,007 major CVD (24.5%)**
- **16,223 total cancer (36.1%)**
- **17,857 diabetes (39.7%)**

**Major chronic disease
+ Non-traumatic death**

Major Chronic Disease

	Value
AHEI-2010	0.76–0.80
DRRD	0.70 (0.69–0.72)
rEDIH	0.58 (0.57–0.60)
rEDIP	0.61 (0.60–0.63)

Alternative Major Chronic Disease
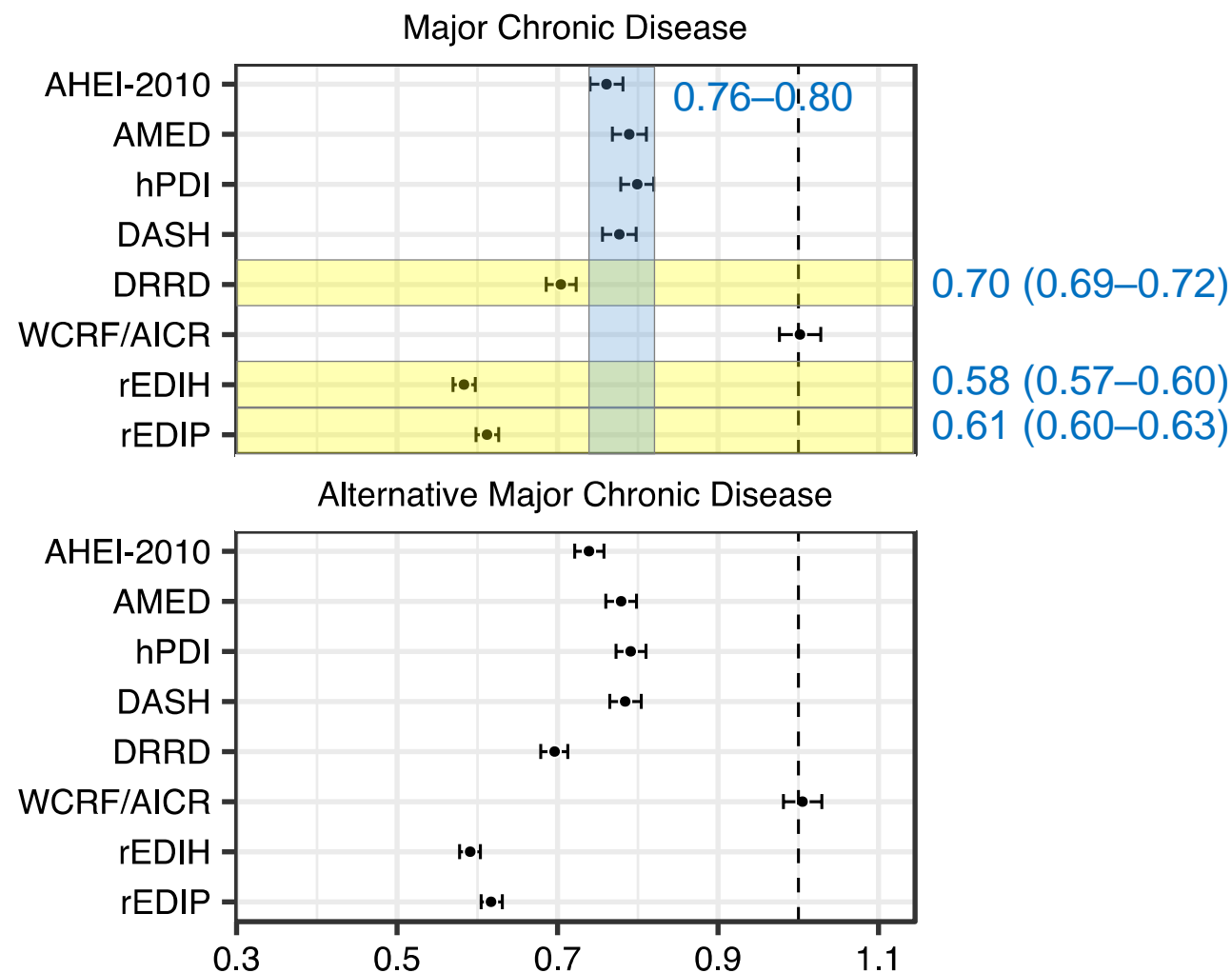
Hazards ratio for an increment from 10th to 90th percentile in score adjusted for physical activity, socioeconomic status, cigarette smoking, multivitamin use, family history of diabetes, cancer, and cardiovascular disease, aspirin, non-steroidal anti-inflammatory drugs, postmenopausal hormone use and total energy intake (alcohol consumption was adjusted for DASH, hPDI, and DRRD).
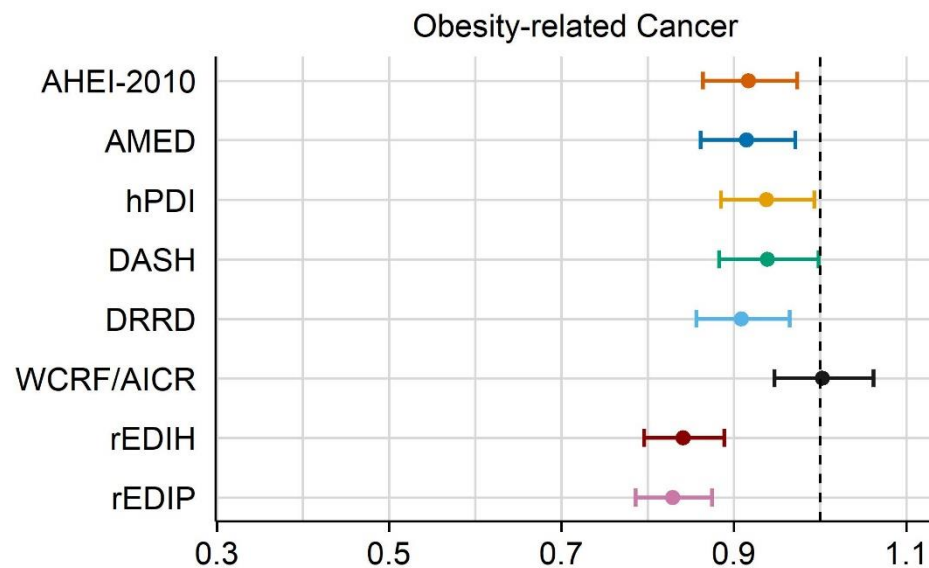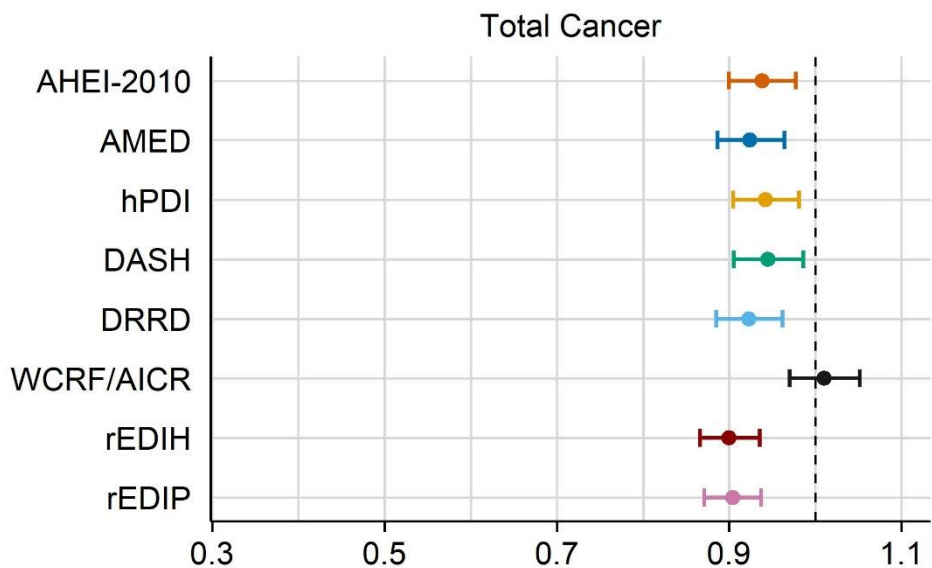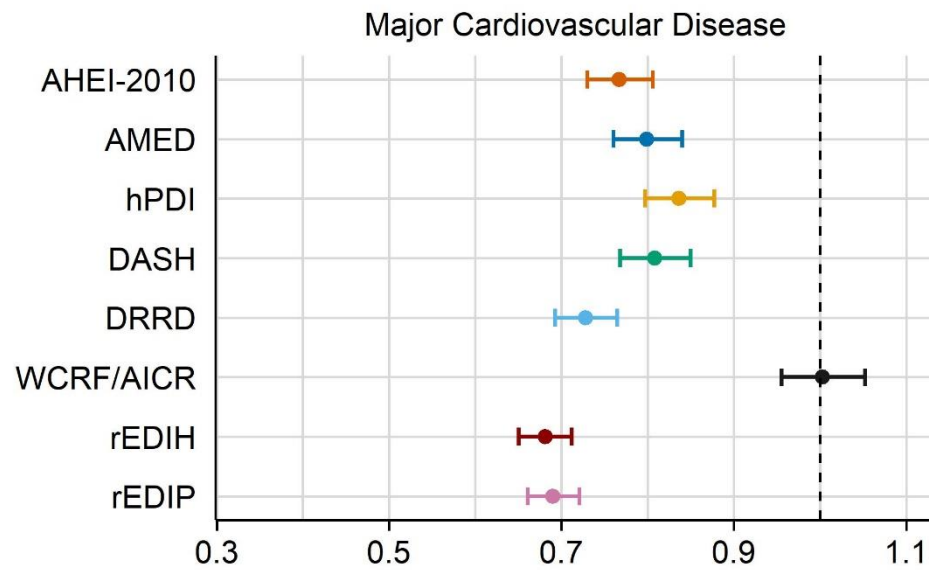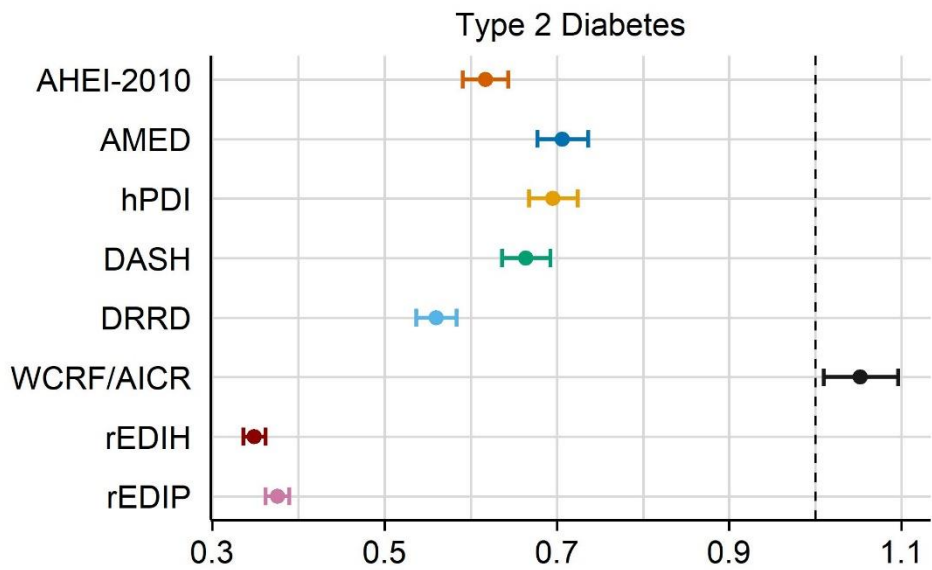
Multivariable-adjusted associations of cumulative average dietary patterns (90th to 10th%ile) (n = 205,852).

P. Wang et al. Nature Med 2023

AHEI-2010, Alternative Healthy Eating Index-2010; AMED, Alternate Mediterranean Diet score; DASH, Dietary Approaches to Stop Hypertension score; DRRD, Diabetes Risk Reduction Diet; hPDI, Healthful plant-based diet index; rEDIH, reversed Empirical dietary index for hyperinsulinemia; rEDIP, reversed Empirical dietary inflammation pattern; WCRF/AICR, dietary score.

Associations for most dietary patterns consistent in:

- **Men**
- **Women ***
- **Whites**
- **Blacks**
- **Asians**
- **Hispanics**
- **Age < 65 y ***
- **Age > 65 y**
- **BMI <25**
- **BMI >25 ***
- **Never smokers ***
- **Past smokers**
- **Current smokers**
- **Alcohol < 1 drink/day ***
- **Alcohol > 1 drink/day**
- **Neighborhood SES > median**
- **Neighborhood SES < median**

*stronger association

37 food or food group items in relation to total chronic disease from most protective (blue) to most adverse (red)
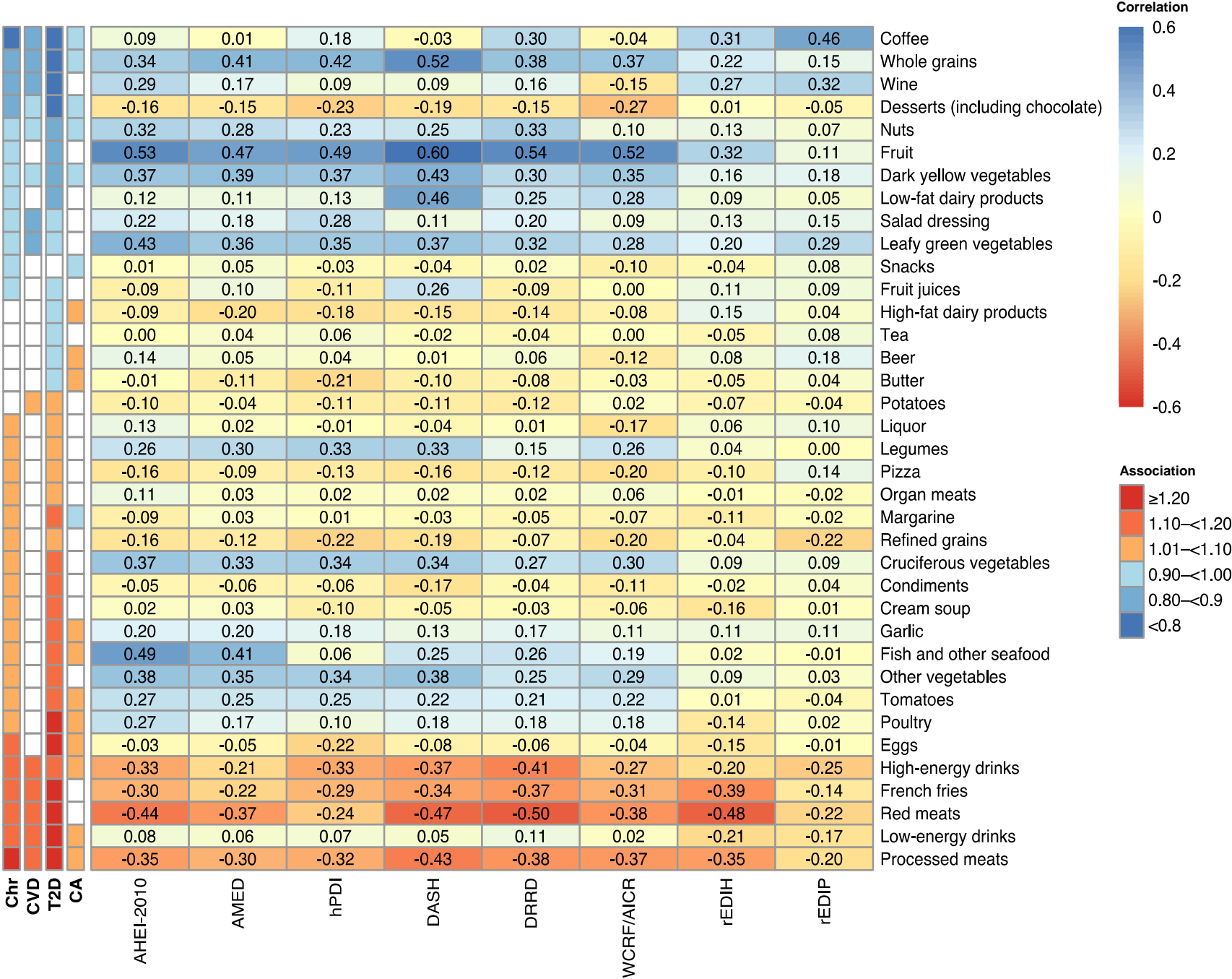
Most beneficial for chronic disease
1. Coffee
2. Whole grains
3. Wine
4. Desserts (incl. chocolate)
5. Nuts
6. Fruits
7. Dark, yellow vegetables
8. Low-fat dairy
9. Salad dressing
10. Leafy, green vegetables

Least beneficial for chronic disease
28. Fish & other seafood
29. Other vegetables
30. Tomatoes
31. Poultry
32. Eggs
33. Sugar-sweetened beverages
34. French fries
35. Red meats
36. Artificially sweetened beverages
37. Processed meats

Key items treated differently among dietary patterns – *more research!*

Components	AHEI-2010	AMED	hPDI	DASH	DRRD	WCRF	rEDIH	rEDIP
Range	11	9	18	8	9	6	18	18
	0 - 110	0 - 9	18 - 90	8 - 40	9 - 45	0-5	NA	NA
Fruit and vegetables						G		
Fruit	G	G	G	G	G		G	
Vegetables	G	G	G	G				
Leafy green vegetables							G	G
Dark yellow vegetables								G
Other vegetables							R	R
Tomatoes							R	R
Potatoes			R					
Total fiber								
Whole grains	G	G	G	G				
Cereal fiber					G			
Refined grains			R					R
Nuts and legumes	G			G				
Nuts		G	G		G			
Legumes		G	G		G			
Total meats			R					
Red and Processed meats	R	R	R	R		R		
Red meats					R		R	R
Processed meats							R	R
Poultry							R	
Eggs			R				R	
Fish and seafood		G	R					
Other fish							R	R
Organ meats								R
Miscellaneous animal-based foods			R					
Percent of total calorie from ultra-processed foods						R		
Sweets and desserts			R					
French fries							R	
Snacks								G
Pizza								G
Animal fat			R					
Butter							R	
Vegetable oils			G					
Creamy soups							R	
Margarine							R	
Sugar-sweetened beverages and fruit juices	R							
Sugar-sweetened beverages			R	R	R	R		
Low-energy beverages							R	R
High-energy beverages							R	R
Fruit juices			R					G
Total alcohol	B	B				R		
Wine							G	G
Beer							G	G
Tea and coffee			G					
Tea								G
Coffee					G			G
Total dairy			R					
High-fat dairy							G	
Low-fat dairy				G			R	
trans fat	R				R			
Long chain omega-3 fatty acids	G							
Polyunsaturated fatty acids	G							
Ratio of monounsaturated to saturated fatty acids		G						
Ratio of polyunsaturated to saturated fatty acids					G			
Sodium	R			R				
Glycemic index					R			

← Total fruits & vegetables vs specific groups

← Non red meat animal products
← Specific types of fish

← Ultra-processed foods

← Artificially sweetened beverages
← Fruit juices

← Alcohol vs alcoholic beverages
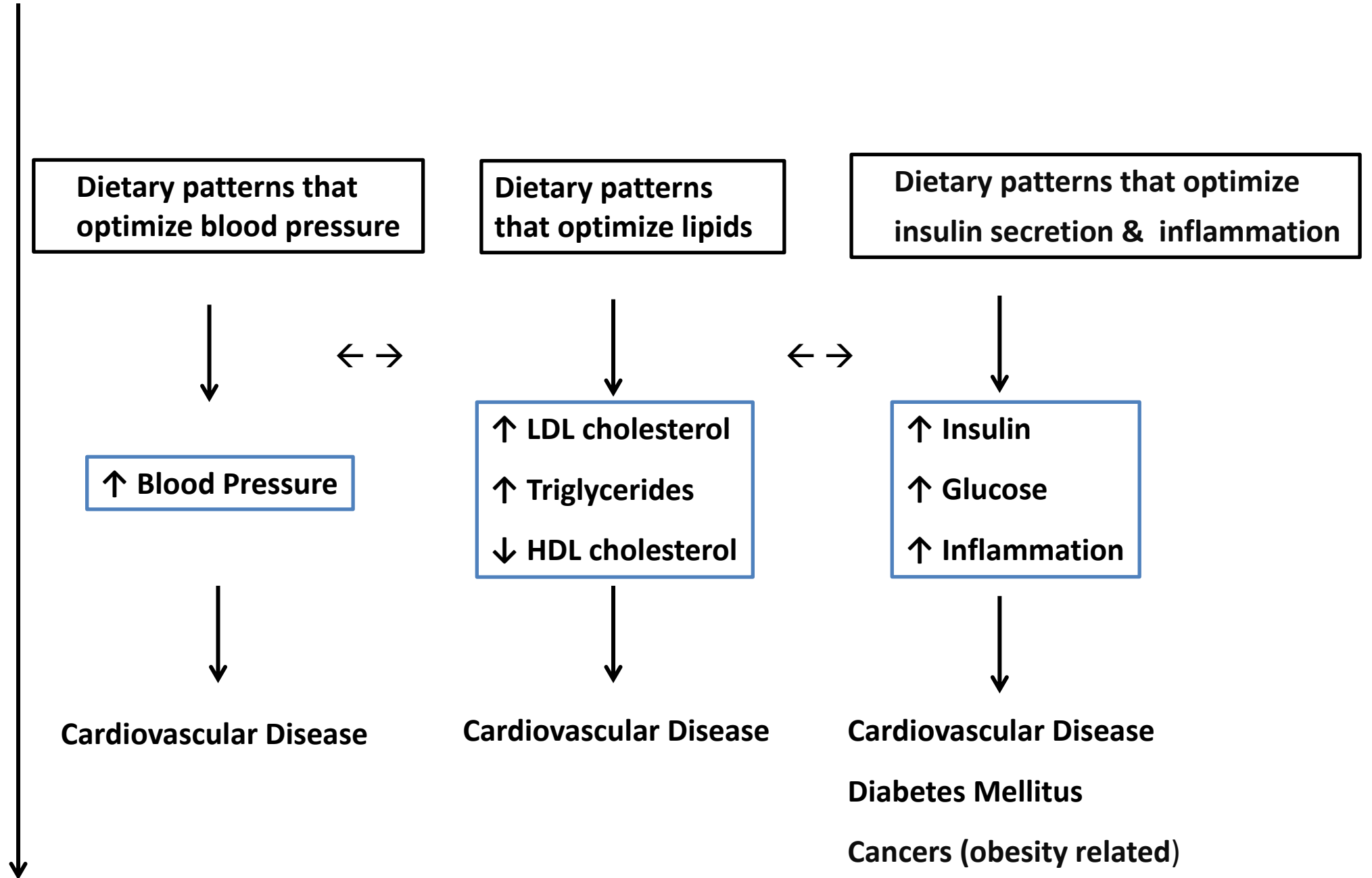
← Tea/coffee

← Low fat dairy
← Fatty foods vs total polyunsaturated/saturated fat ratio

← Sodium

Critical factors that determine the "optimal" diet pattern

Strength of dietary association with intermediates

Strength of association between intermediate and specific disease(s)

Relative importance of the disease

Diet/Lifestyle

Mediator

Disease

Dietary patterns that optimize blood pressure

Dietary patterns that optimize lipids

Dietary patterns that optimize insulin secretion & inflammation

← →

← →

↑ Blood Pressure

↑ LDL cholesterol

↑ Triglycerides

↓ HDL cholesterol

↑ Insulin

↑ Glucose

↑ Inflammation

Cardiovascular Disease

Cardiovascular Disease

Cardiovascular Disease

Diabetes Mellitus

Cancers (obesity related)

Many Americans do not have an "optimal" diet…

... In particular, plant-based items are underconsumed

The core elements of US Dietary Guidelines that make up a healthy dietary pattern:

Figure 1-6

Dietary Intakes Compared to Recommendations: Percent of the U.S. Population Ages 1 and Older Who Are Below and At or Above Each Dietary Goal

Intake At/Above Recommendation   Intake Below Recommendation

The center (0) line is the goal or limit. For most, those represented by the **dark blue** section of the bars can improve their dietary pattern by shifting toward the center line.

*NOTE: Recommended daily intake of whole grains is to be at least half of total grain consumption, and the limit for refined grains is to be no more than half of total grain consumption.

Data Source: Analysis of What We Eat in America, NHANES 2013-2016, ages 1 and older, 2 days dietary intake data, weighted. *Recommended Intake Ranges*: Healthy U.S.-Style Dietary Patterns (see *Appendix 3*).

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Key take-home messages

- Dietary patterns represent a useful approach for research and public health messaging.

- Multiple approaches to assess dietary patterns converge on reasonably consistent dietary factors that we should emphasize or limit in our diets.

- While some refinements are required, our current knowledge is sufficient to make a large impact on the major chronic diseases.

- The use of intermediate biomarkers is a useful approach to help determine optimal dietary patterns.

Thank you!