"Food is an important part of a balanced diet"
Fran Lebowitz

Nutrition and the Evidence Conundrum

What we know (very little) and what we will likely never know (a lot) about nutrition

James McCormack, BSc(Pharm), Pharm D
Professor, Faculty of Pharmaceutical Sciences, UBC

"Few things are more prey to fad and fashion than alleged dietary influences on health"
Geoff Watts - BMJ

When do we have debate about health issues?

the answer may be impossible to know

the best available evidence is tenuous

the potential difference in outcome is “small”

there is a belief about “a mechanism”

the stakes are high - pharmaceutical and nutrition beliefs are very “marketable”

FOOD, especially with individual nutrients, HAS ALL OF THESE

Cause and Effect

How do we figure out whether “food” is healthy or unhealthy?

**BIG effects in nutrition have occurred
Vitamin deficiencies, Gross malnutrition etc**

How do we differentiate association from causality?

Then, how big is the effect?

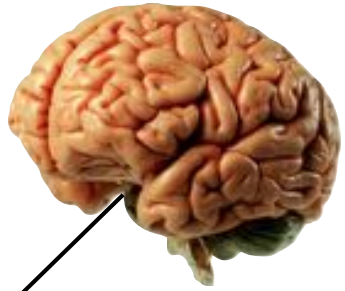
The Best Way - RCTs -10s

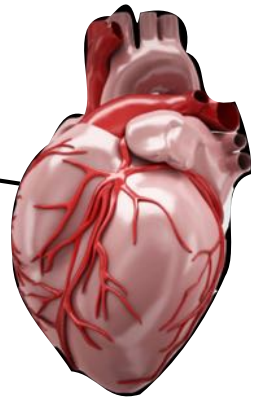
1000s
of people

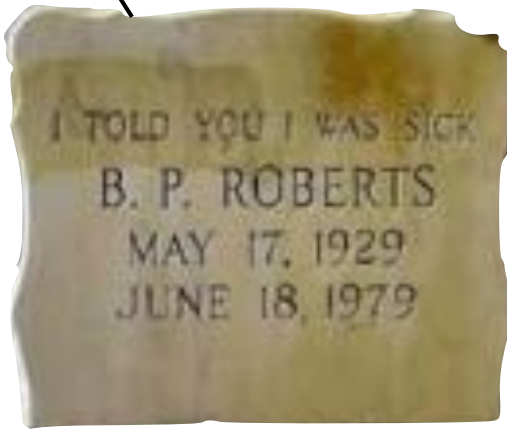
Randomized

+

Follow
them
for
3-10 years

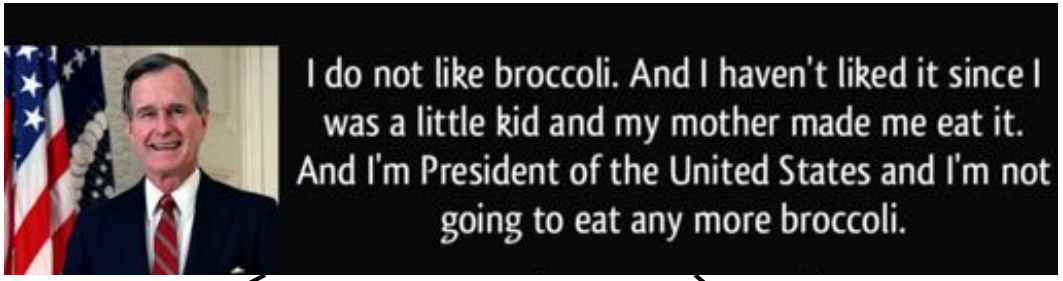


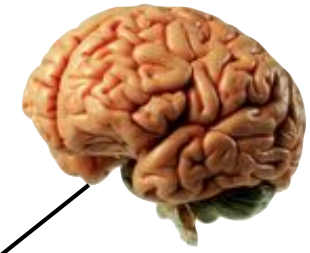




The OK way - Cohort Studies -100s

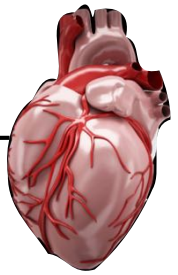
Prospective or retrospective





1000s of people

Follow them for 3-10 years



Quantiles

Tertiles

Quartiles

Quintiles

Can help prevent misclassification

Nutritional cohort studies

EXAMPLES OF BIASES

Recall bias

Everybody is unblinded

EXAMPLES OF CONFOUNDING

When we see real differences but, there is a “third” cause

Coffee - does it cause lung cancer - smoking is a confounder

Beer preference is associated with less healthy dietary behaviour, especially compared with wine preference

Eating “healthy” - may be more physically active

Alcohol intake - may be more social, less stress

Nutritional studies

ALL STUDIES

PUBLICATION BIAS

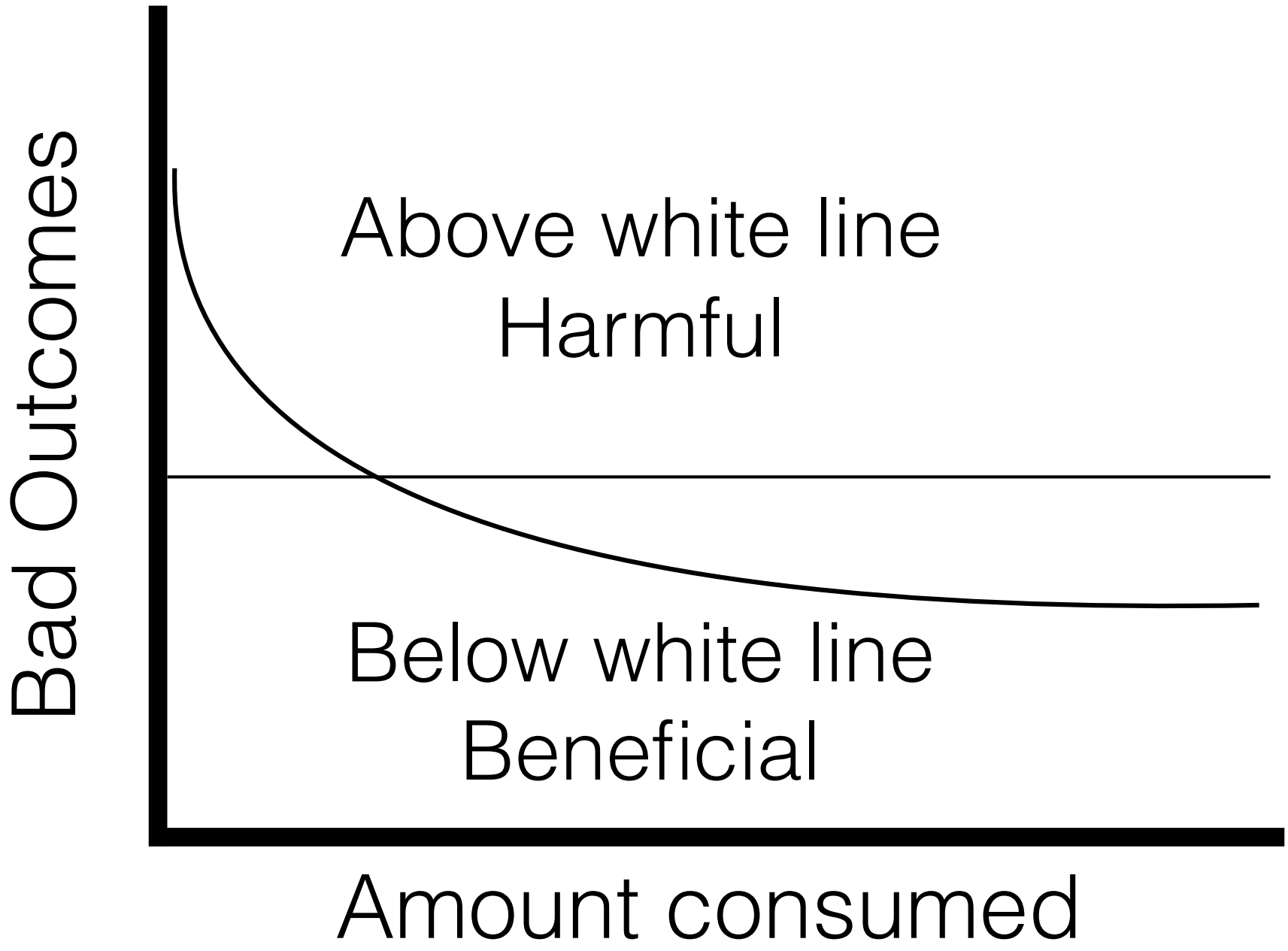
Publish findings that are found to show differences or are controversial

REPORTING BIAS

Media flip-flopping - more likely to report “NEW or DIFFERENT” findings

But despite all the limitations of observational studies, they will often be the best we have and will likely be the best we will ever have because RCTs may not be possible

Nutritional cohort studies



The Worst Way (to infer causality) -“Mechanisms”- 1000s

Assess the impact of nutrition on surrogate markers or get wedded to an hypothesis

- insulin
- glucose
- lipids
- weight
- ketones
- blood pressure
- hormone balance
- atherosclerosis
- endothelial function

Eat what people ate 10,000+ years ago

What can we study?

Implausible results in human nutrition research

Definitive solutions won't come from another million observational papers or small randomized trials

John P A Ioannidis *professor of medicine, health research and policy, and statistics*

Stanford Prevention Research Center, Stanford, CA 94305, USA

BMJ 2013;347:f6698

Objectively speaking, we can't get definitive answers from more studies because they all have important biases, there are numerous confounders and evaluating surrogate markers is fraught with problems

Single Nutrients

"on the basis of dozens of randomized trials, single nutrients are unlikely to have relative risks less than 0.90 for major clinical outcomes …"

"… most are greater than 0.95"

In other words,if differences exist they are

<10% and may be <5%

"Observational studies and even randomized trials of single nutrients

seem hopeless,

with rare exceptions"

BMJ 2013;347:f6698

Multiple Nutrients and Behaviours

"Larger effect sizes [ie. >10%] are more plausible for complex dietary patterns that sum the effects of multiple nutrients and behaviors"
PREDIMED, Lyon Diet Heart Study

Now, it is possible to *"identify nutrition related interventions that produce a 5-10% relative risk reduction in overall mortality in the general population"*

However, this would require
>10 times the sample size of PREDIMED
(n = 80,000 and 4,000 endpoints)

BMJ 2013;347:f6698

Risk of Smoking

The negative impact of smoking on CVD, cancer, lungs etc may be an order of magnitude larger than the effect of any single nutrient and possibly as big as, if not more, than overall nutrition

No RCTs because they are unethical

Decades to get to the “truth”

Dozens of cohort studies and mechanistic studies

Companies were able to convince people that smoking can’t be concluded as a problem because of the confounders!!!

Sheer weight of evidence prevailed

The Process

Present the best available evidence I could find - MA or SR

Not doing a detailed critical appraisal - all RCTs and cohorts have design and implementation issues

If these “studies” I present have serious limitations then we are basically stuck with opinion that is not informed by evidence

Single Nutrients

and some little behaviours

Salt, breakfast, eggs, fiber,
coffee, daily servings, chocolate, alcohol

Does salt increase blood pressure and increase risk of cardiovascular disease?

The problem of the surrogate marker

Salt

Average Canadian daily intake ~3000 mg/day

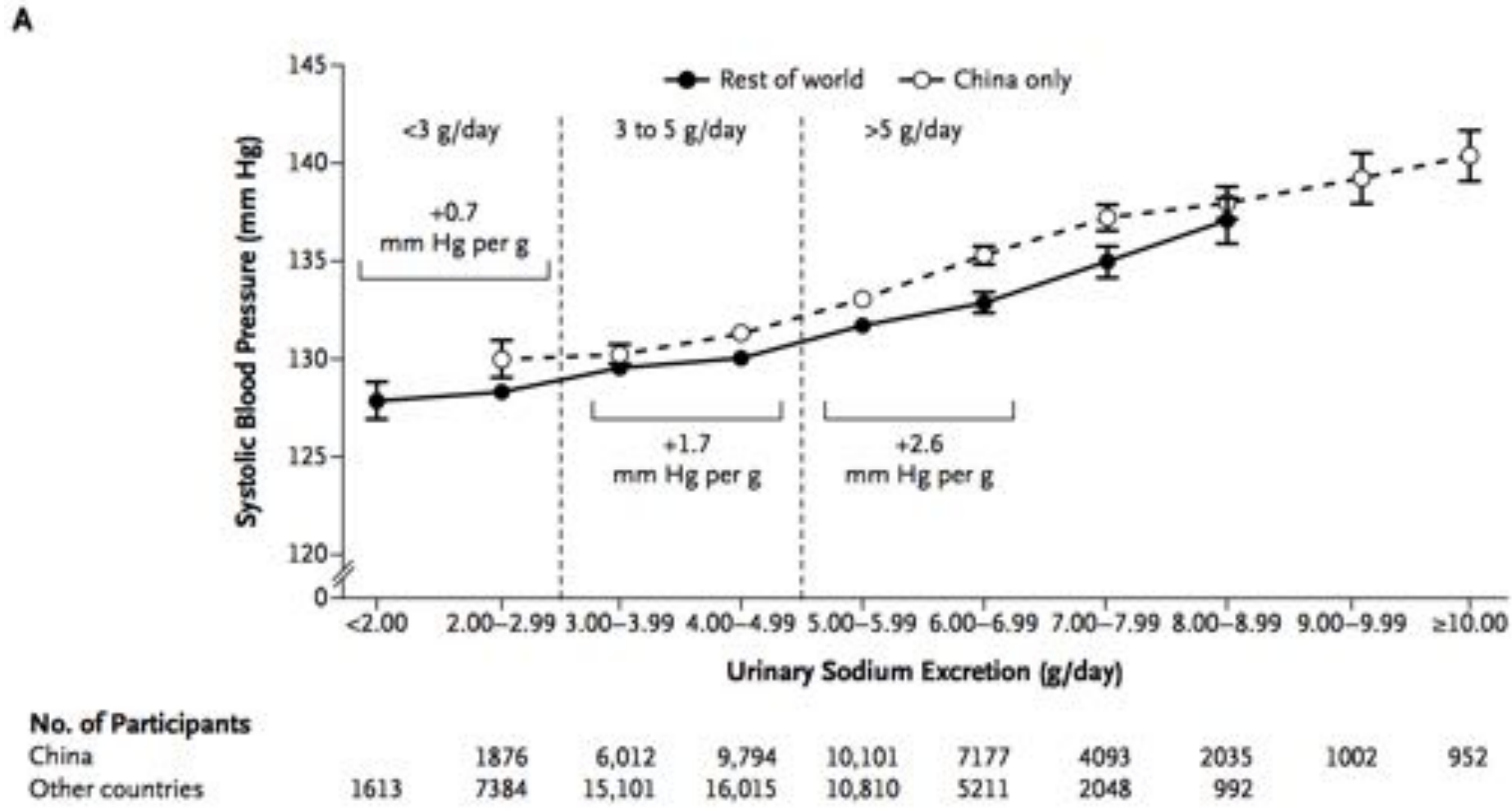
Health Canada

"This is more than double the amount we need"

Aim for 1500 mg/day and don't go over 2300 mg/day

BUT

Salt does (on average) increase BP



No. of Participants										
China		1876	6,012	9,794	10,101	7177	4093	2035	1002	952
Other countries	1613	7384	15,101	16,015	10,810	5211	2048	992		

N Engl J Med 2014;371:601-11

Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials

"A modest reduction in salt intake for four or more weeks causes significant and, from a population viewpoint, important falls in blood pressure"

BMJ 2013;346:f1325 doi: 10.1136/bmj.f1325

Sodium Intake in Populations
Assessment of Evidence

Committee on the Consequences of Sodium Reduction in Populations
Food and Nutrition Board
Board on Population Health and Health Practice

Brian L. Strom, Ann L. Yaktine, and Maria Oria, *Editors*

Institute of Medicine - May 2013

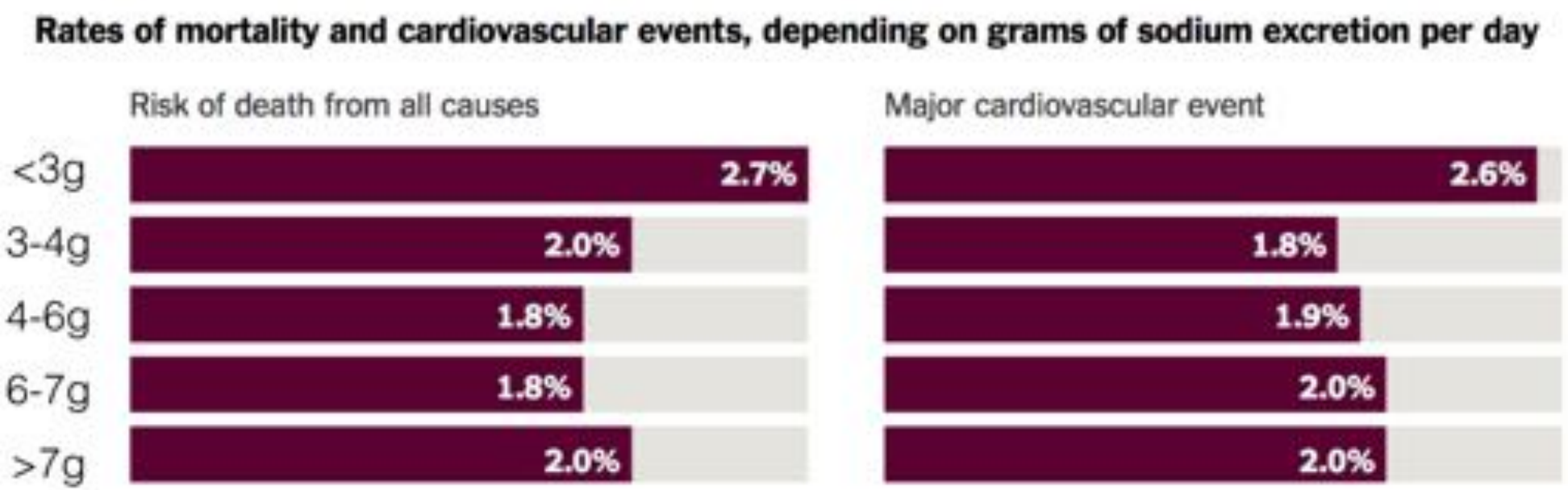
"evidence from studies on direct health outcomes is inconsistent and insufficient to conclude that lowering sodium intakes below 2,300 mg per day either increases or decreases risk of CVD outcomes"

"the available evidence suggests that low sodium intakes may lead to higher risk of adverse events in mid- to late-stage CHF patients with reduced ejection fraction and who are receiving aggressive therapeutic regimens"

PURE study

Cohort - 101,945 people in 17 countries - 3.7 years

Association between CVD and sodium **excretion**



ABSOLUTE RISKS

N Engl J Med 2014;371:612-23

Do eggs increase the risk of coronary heart disease?

The problem of mechanisms and surrogate markers

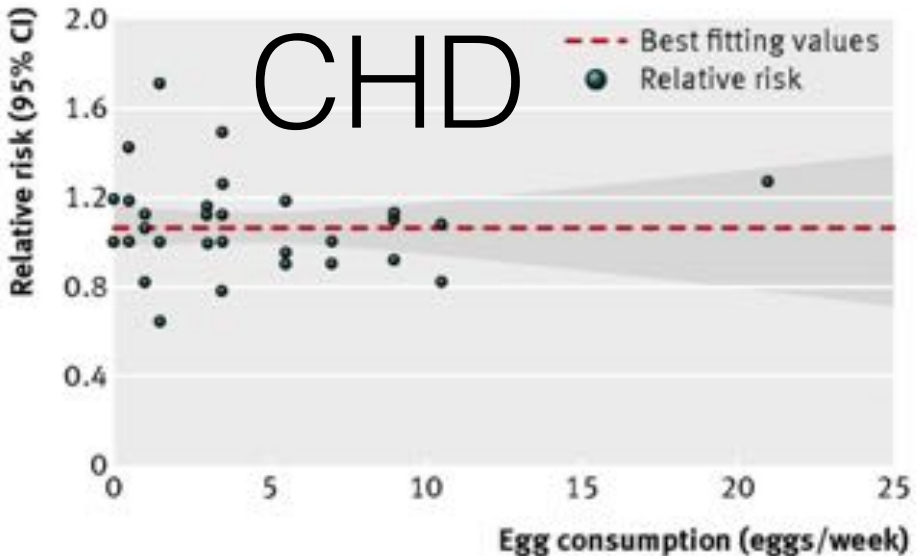
Egg consumption and risk of coronary heart disease and stroke: dose-response meta-analysis of prospective cohort studies

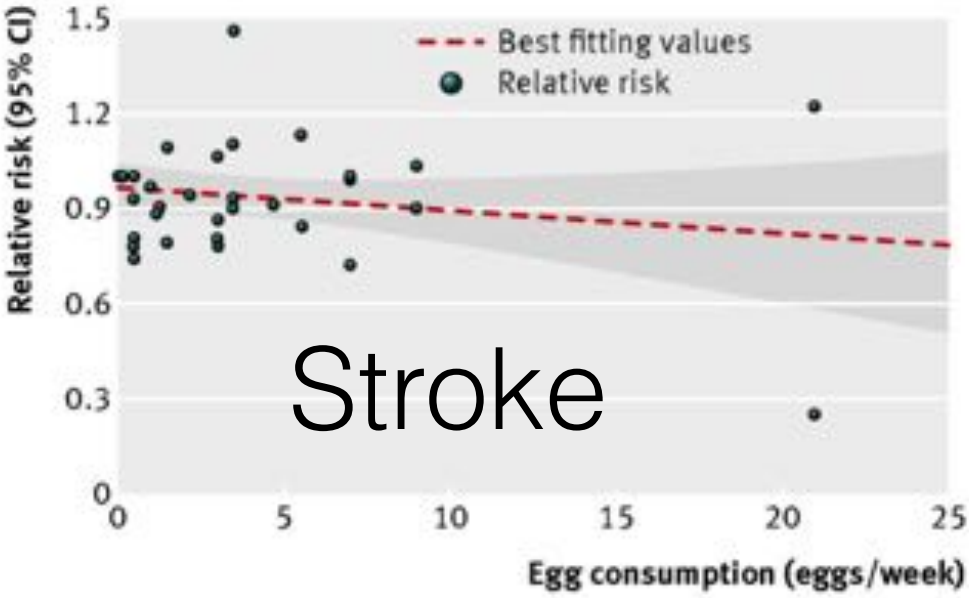
8 articles - 17 reports - 9 for CHD, 8 for stroke

3,081,269 person years and 5847 incident cases for CHD; 4,148,095 person years and 7579 incident cases for stroke

Risk for every additional egg eaten/day
CHD 0.99 (0.85-1.15), Stroke 0.91 (0.81-1.02)

BMJ 2013;346:e8539 doi: 10.1136/bmj.e8539





Another systematic review and meta-analysis supports these data

overall CVD 0.97 (0.86, 1.09)

Am J Clin Nutr doi: 10.3945/ajcn.112.051318

BMJ 2013;346:e8539 doi: 10.1136/bmj.e8539

Does increasing fiber decrease the risk of cardiovascular disease?

The problem of the size of the difference

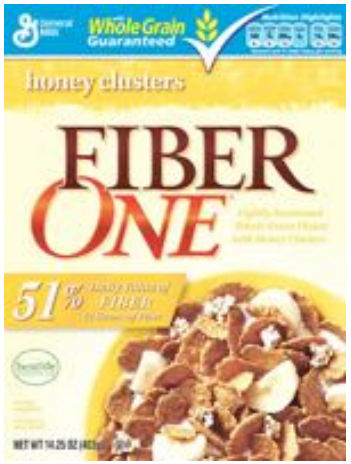
ORIGINAL INVESTIGATION

Dietary Fiber and Risk of Coronary Heart Disease

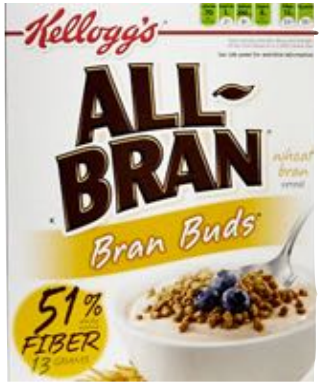
A Pooled Analysis of Cohort Studies

Mark A. Pereira, PhD; Eilis O'Reilly, MSc; Katarina Augustsson, PhD; Gary E. Fraser, MBChB, PhD; Uri Goldbourt, PhD; Berit L. Heitmann, PhD; Goran Hallmans, MD, PhD; Paul Knekt, PhD; Simin Liu, MD, ScD; Pirjo Pietinen, DSc; Donna Spiegelman, ScD; June Stevens, MS, PhD; Jarmo Virtamo, MD; Walter C. Willett, MD; Alberto Ascherio, MD

Arch Intern Med 2004;164:370-6

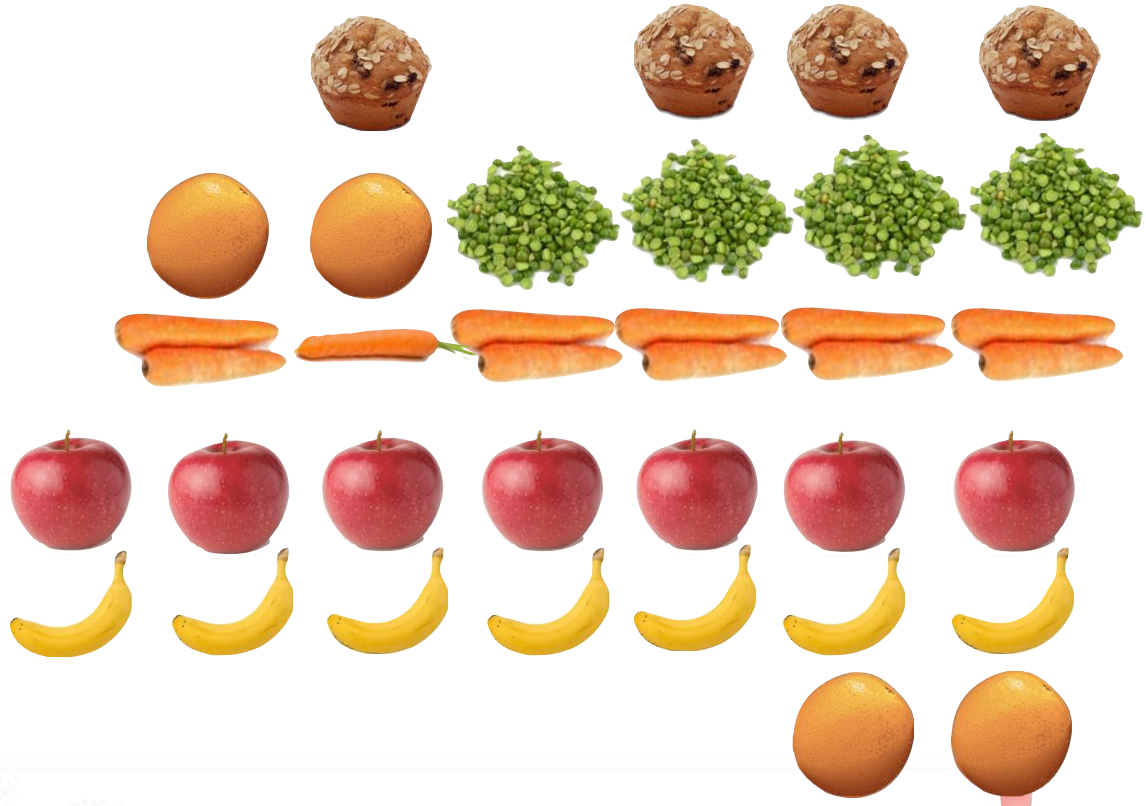


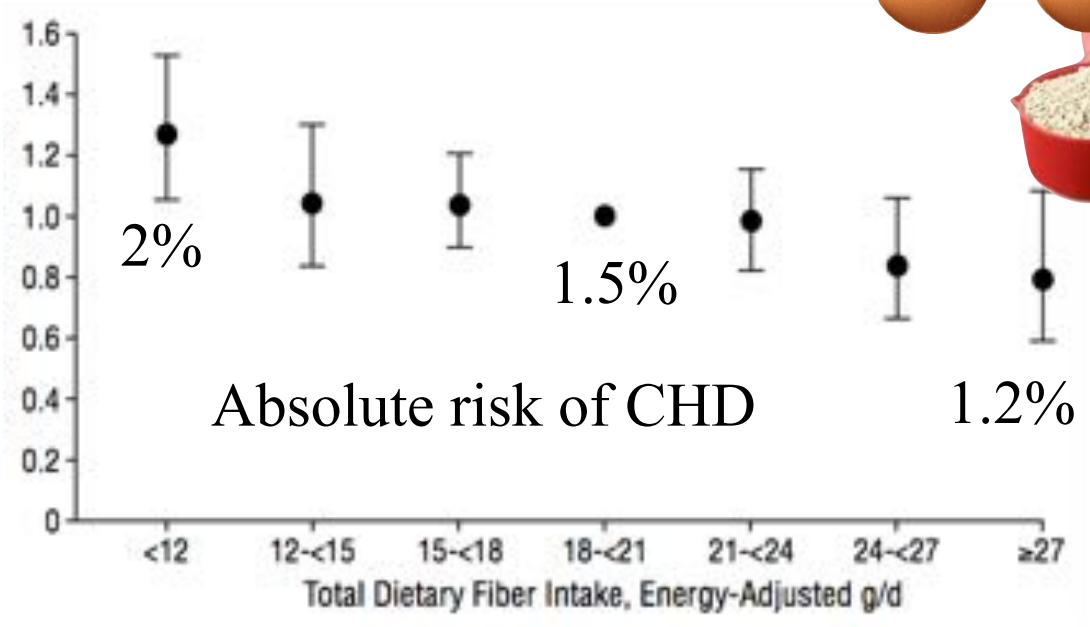
10 prospective cohorts - 6-10 years
336,244 - avg age ~ 50-55
5,249 events



for each 10g/day increment of dietary fiber
CHD was reduced by 14% CI (4-22)

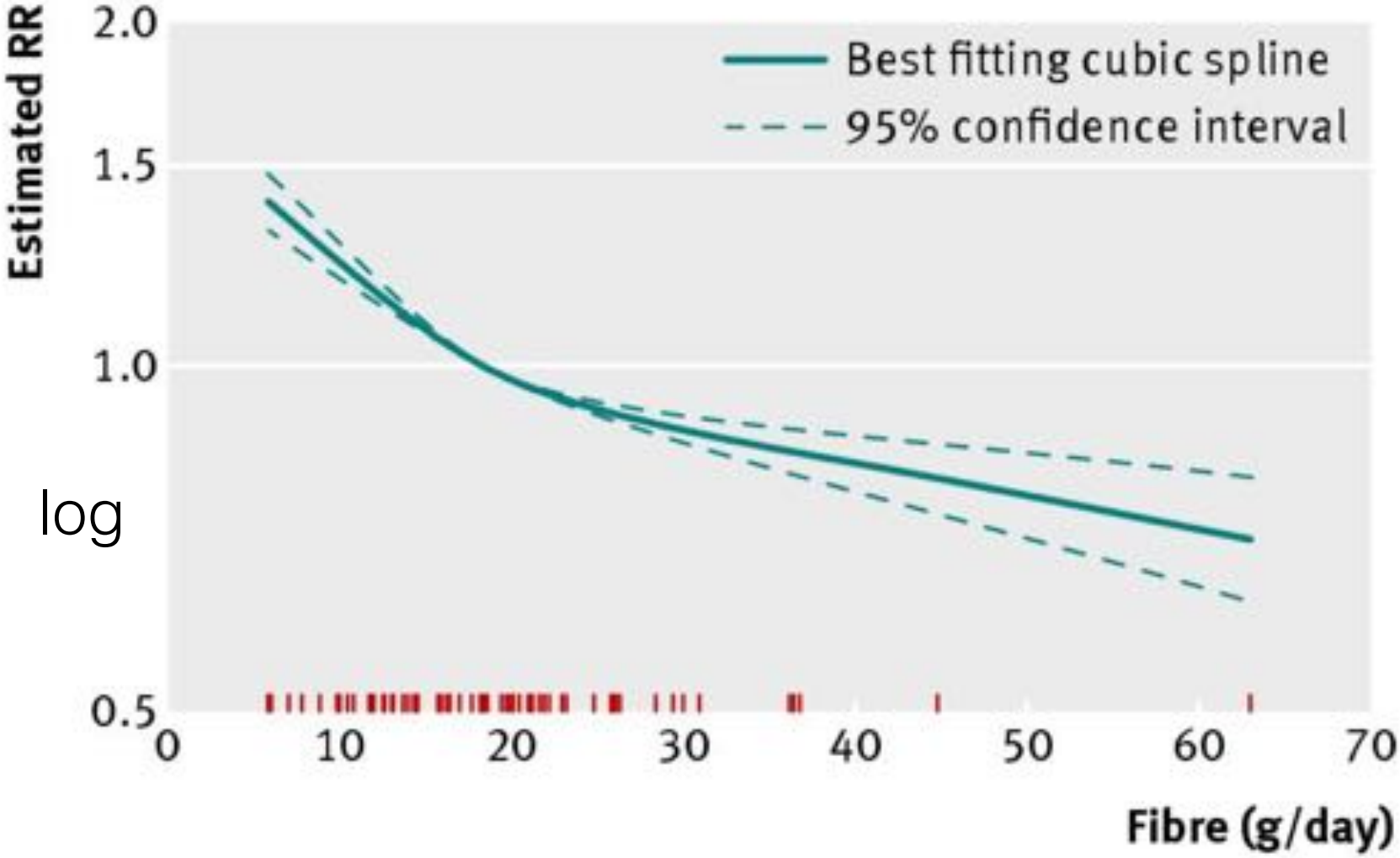
55 y/o
increase fiber
from
none to a lot
for 5-10 years
1 in 125 would
not die from
CHD





Relative risk of death from coronary heart disease

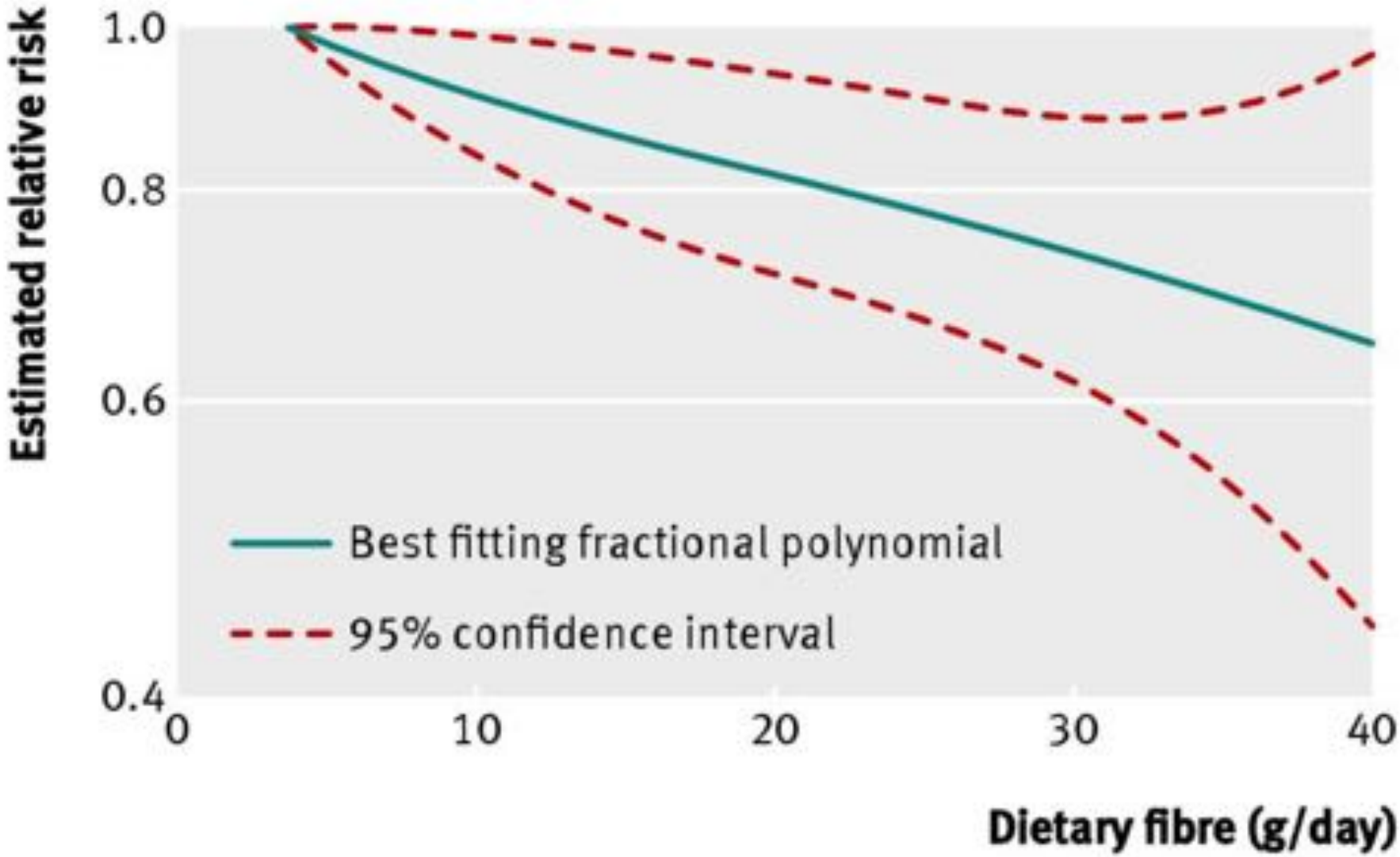
Fibre and risk of cardiovascular disease



log

BMJ 2013;347:f6879

Fibre and risk of colorectal cancer



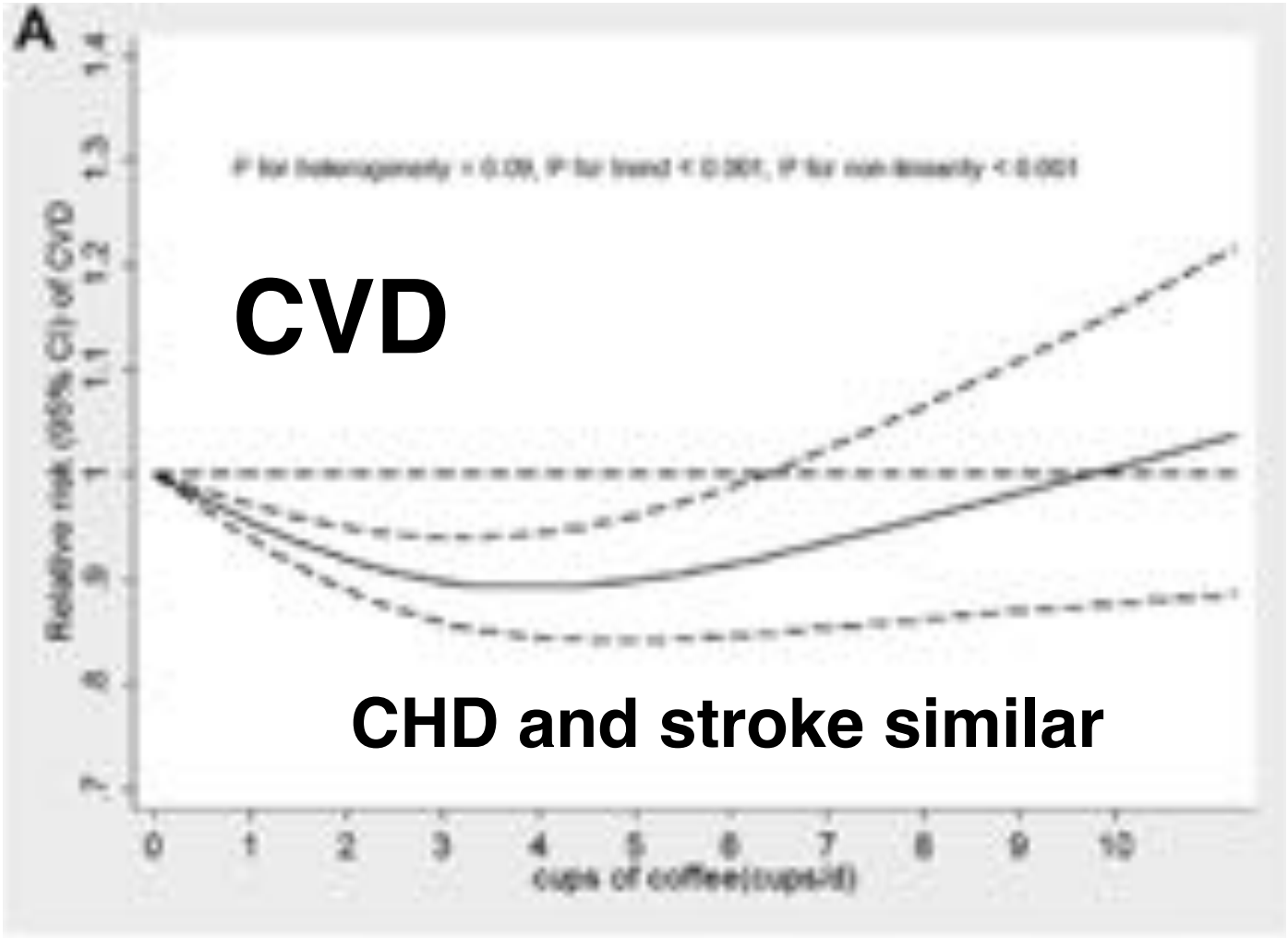
BMJ 2011;343:d6617 doi: 10.1136/bmj.d6617

Coffee

Does coffee increase cardiovascular risk?

The problem of “I like coffee”

Thirty-six prospective cohort studies 1,279,804 participants, 36,352 CVD cases



"the lowest CVD risk at 3 to 5 cups per day of coffee consumption, and heavy coffee consumption was not associated with CVD risk"

Circulation 2014;129:643–59

"coffee intake is inversely related to all cause and, probably, CVD mortality"

Eur J Epidemiol 2013;28:527–39

Does alcohol or red wine decrease the risk of cardiovascular disease

The problem of “I like wine”

The cardioprotective association of average alcohol consumption and ischaemic heart disease: a systematic review and meta-analysis

44 observational studies
38,627 IHD events (mortality or morbidity) among 957,684 participants

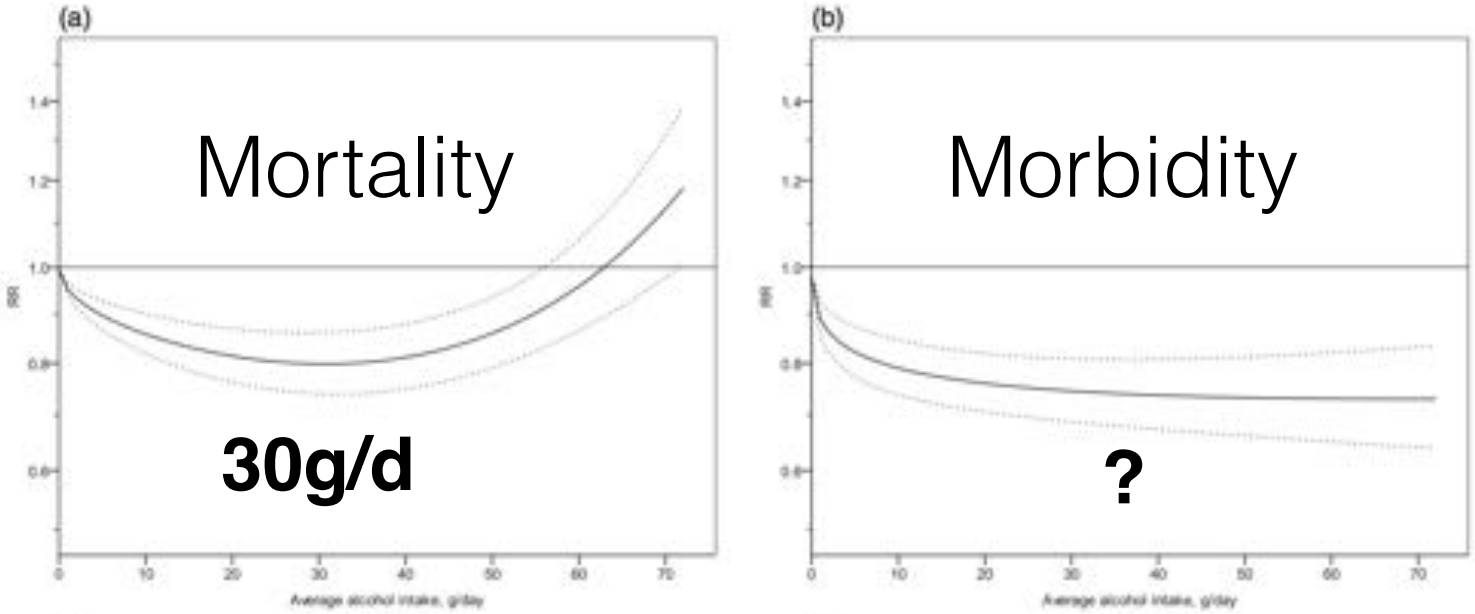
20 grams
~ Pint (550 mL) of beer/cider
~1/4 (200 mL) bottle of wine
~ Double (70 mL) spirits (vodka, whisky, rum, gin)

Addiction 2012;107:1246–60

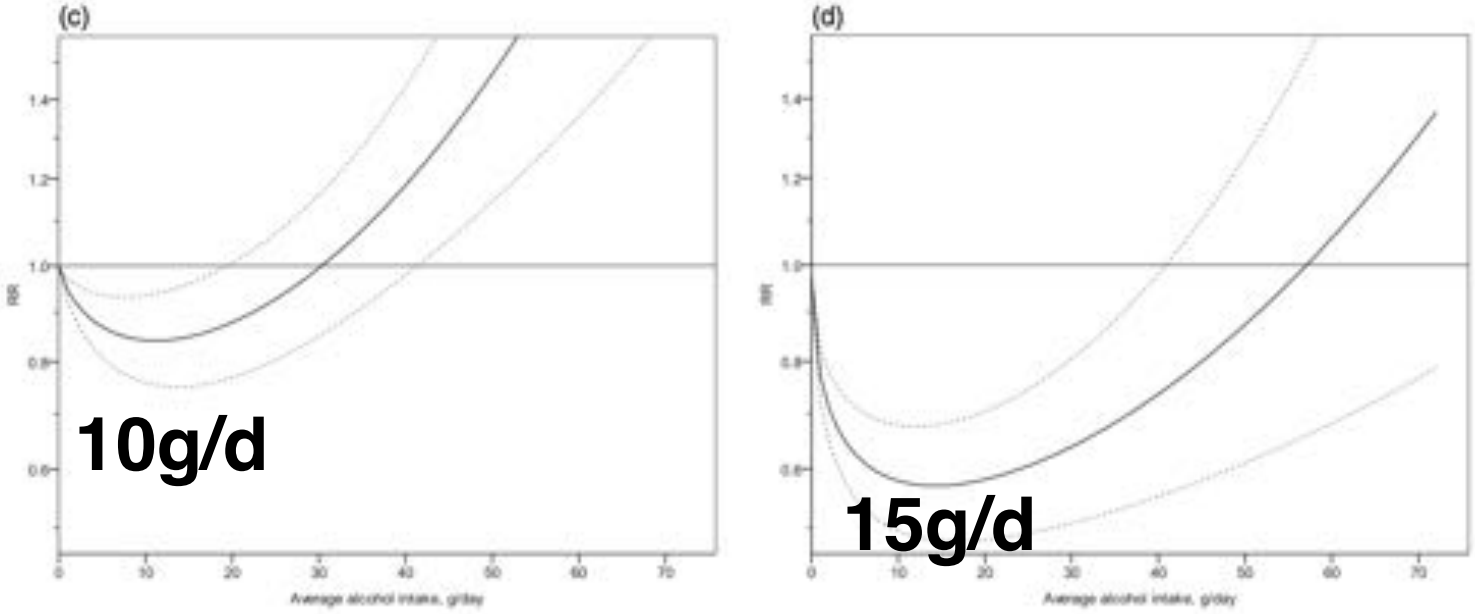
Ischemic heart disease

20 grams
~ Pint (550 mL) of beer/cider
~1/4 (200 mL) bottle of wine
~ Double (70 mL) spirits

Men



Women



Does chocolate decrease the risk of cardiovascular disease

The problem of “I like chocolate”

Chocolate consumption and cardiometabolic disorders: systematic review and meta-analysis

7 observational studies

114,009 participants

“highest levels of chocolate consumption were associated with a 37% reduction in cardiovascular disease and a 29% reduction in stroke compared with the lowest levels”

definition of “highest level” varied

BMJ 2011;343:d4488 doi: 10.1136/bmj.d4488

Multiple Nutrients and Behaviours

The Journal of Nutrition
Nutrient Requirements and Optimal Nutrition

Americans Do Not Meet Federal Dietary Recommendations[1]

"nearly the entire U.S. population consumes a diet that is not on par with recommendations"

Is this a problem with the population, the guidelines or both?

J Nutr 2010;140:1832–38

The Traditional Healthy Mediterranean Diet Pyramid

“currently there is insufficient material to give a proper definition of what the Mediterranean diet is or was in terms of well defined chemical compounds or even in terms of foods.... The all embracing term 'Mediterranean diet' should not be used in scientific literature....”

Eur J Clin Nutr 1989;43:13–29

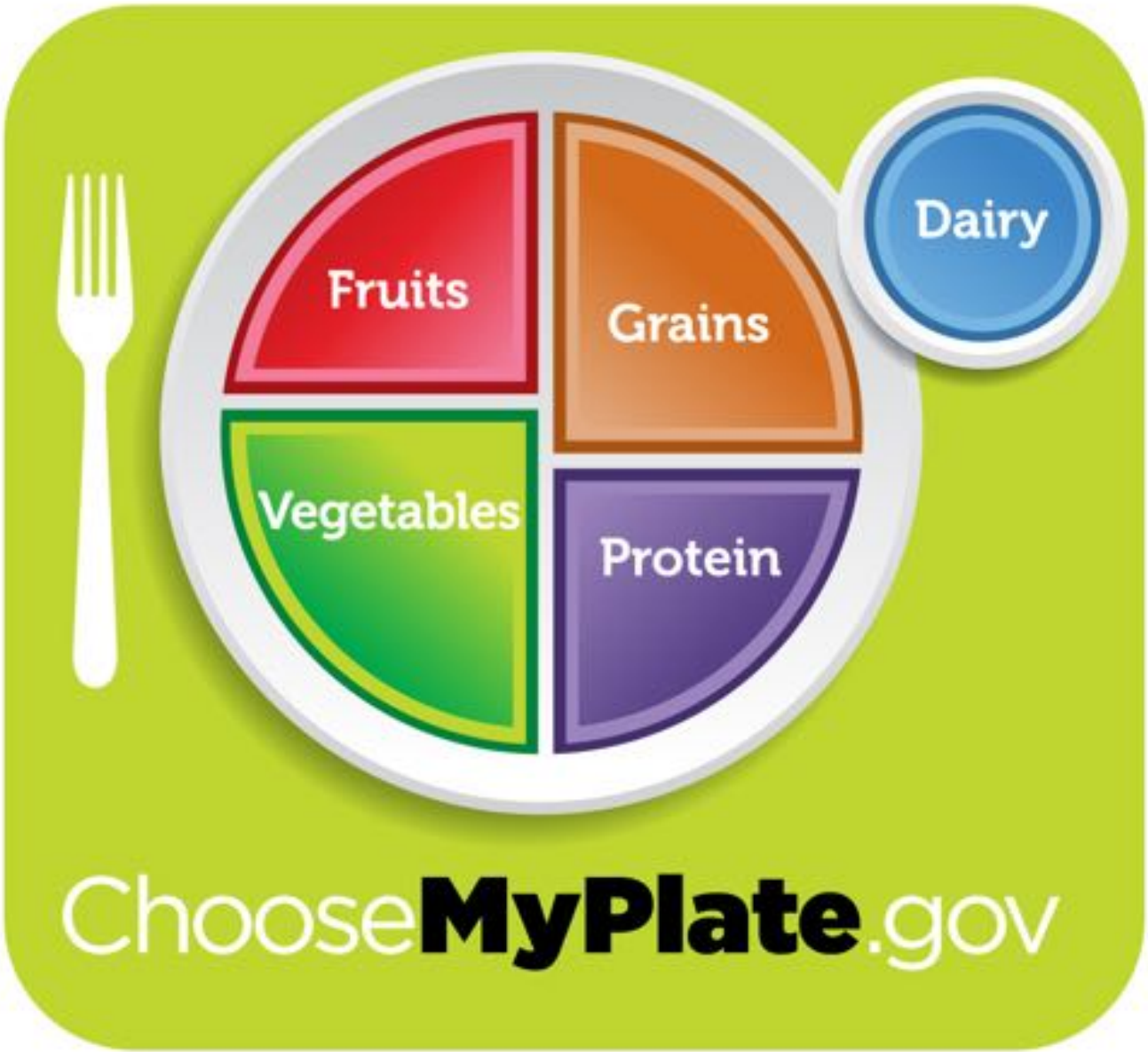
Original Article

There are many Mediterranean diets

Ann Noah MSc and Arthur Stewart Truswell MD, DSc

Canada's Food Guide

USDA


Fruits
Grains
Dairy
Vegetables
Protein
ChooseMyPlate.gov

Diets: Different but equal?

RCT (2 yrs, 3 arms)

322 pts - Age 52, 86% male, BMI 31 (mean)

Weight CHANGE (kg)	Low fat	Medit	Low carb
24 months	-2.9	*-4.4	*-4.7

N Engl J Med 2008;359:229-41

Systematic Review - "The results suggested that the proportion of macronutrients in the diet was not important in predicting changes in weight"

Food & Nutrition Research 2012,56:19103

OPEN ACCESS Freely available online

PLOS ONE

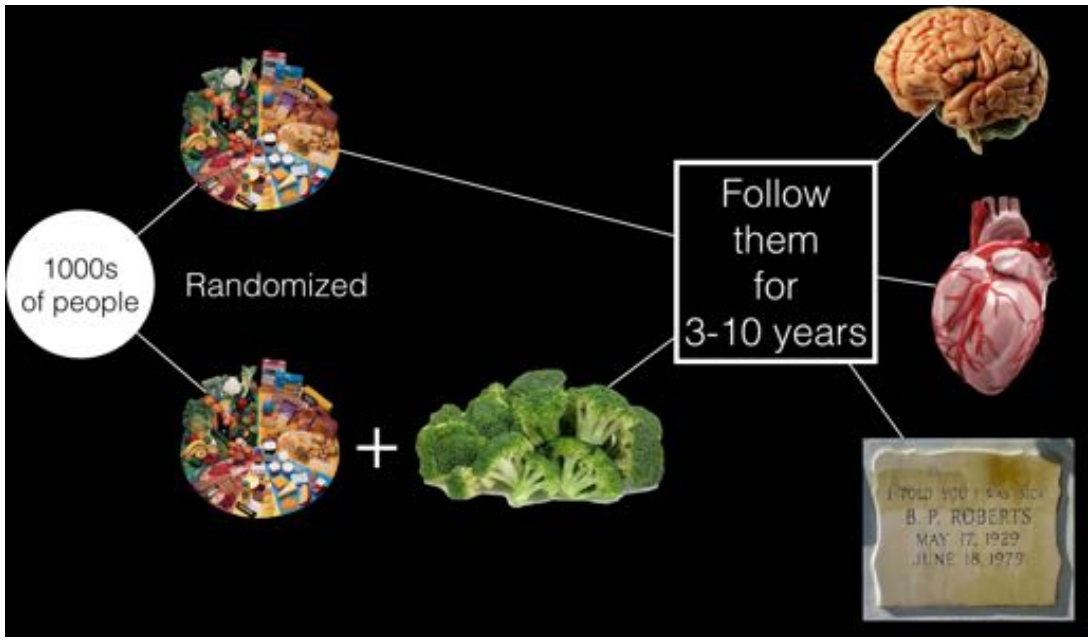
Low Carbohydrate versus Isoenergetic Balanced Diets for Reducing Weight and Cardiovascular Risk: A Systematic Review and Meta-Analysis

"This review, including 19 RCTs with 3,209 participants showed there is probably little or no difference in changes in weight and cardiovascular and diabetes risk factors with low CHO (high fat or protein) weight loss diets compared to isoenergetic balanced weight loss diets."

No stat differences but "seemed" to favour low CHO but even if real - 1 kg difference

PLOS ONE 2014;9:e100652

Are there differences in cardiovascular outcomes in people randomized to different diets?



Mediterranean diet in secondary prevention of coronary heart disease - Lyon Diet Heart Study

27 months - 605 patients <age 60 with a previous MI in the last 6 months - 90% male

one group advised in a one-hour session (with a couple of follow ups) to adopt a diet of more bread, more root vegetables, more fish, less beef, lamb and pork (replaced with poultry), no day without fruit; and butter and cream replaced with margarine - also used rapeseed, and olive oils in salad

Results

Weight, cholesterol, lipoproteins and blood pressure were not statistically different between groups

Lancet 1994;343:1454-9

Mediterranean diet in secondary prevention of coronary heart disease

	Total mortality (%)	Cardiovascular deaths (%)	Non-fatal MI's (%)	Total primary endpoints (%)
Dietary intervention	3.5	1.0	1.7	2.6
No dietary intervention	6.6	5.3	5.6	10.9
Relative risk reduction	47	81	NSS	76
Absolute risk reduction	3.1	4.3		8.3
Number needed to treat	32	23		12

Lancet 1994;343:1454-9

Women's Health Initiative Randomized Controlled Dietary Modification Trial - “low fat”

48,835 postmenopausal women (62 y/o) - 4% prev CVD - 8.1 years

1) lower fat intake to 20% of their total calories, and to eat five or more fruit/vegetable servings and six or more grain servings a day

2) asked not to make any dietary changes

led to ~10% reduction in energy from fat and one more serving a day of vegetables/fruit

no statistical difference in CHD, CVD, stroke, breast cancer, colorectal cancer

JAMA 2006;295:629-642, 643-54, 655-66

Primary Prevention of Cardiovascular Disease with a Mediterranean Diet PREDIMED - 4 years, 67 y/o, 58% male, 48% T2DM

	Total mortality (%)	Myocardial infarction, stroke, and death from cardiovascular causes (%)	MI (%)	Stroke (%)
Control "Low fat"	4.7	4.4	1.6	2.4
Mediterranean diet - EVOO - 1 liter/week**	4.6	3.8*	1.5	1.9*
Mediterranean diet - NUTS (30 gm of mixed nuts per day)**	4.7	3.4*	1.3	1.3*

**increased weekly servings of fish (by 0.3 servings) and legumes (by 0.4 servings)

* statistical different from control

N Engl J Med 2013; 368:1279-90

Reduced or modified dietary fat for preventing cardiovascular disease (Review)

36 hard (non-surrogate) outcomes were reported

1 outcome showed a statistically significant difference in combined cardiovascular events 0.86 (0.77-0.96)

If true - 1% absolute reduction in risk

CD002137

2015 DGAC: MEETING 7 December 15, 2014

Science Base Chapter:

Food and Nutrient Intakes, and Health: Current Status and Trends

Subcommittee 1

health.gov

- Cholesterol is not considered a nutrient of concern for overconsumption.

Do saturated fats increase the risk of cardiovascular disease

The problem of a theory gone completely haywire

Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease[1–5]

Requested RR for extreme quantiles of saturated fat intake
1.07 (0.96-1.19) for CHD
0.81 (0.62-1.05) for stroke
1.00 (0.89-1.11) for CVD

"A meta-analysis of prospective epidemiologic studies showed that there is no significant evidence for concluding that dietary saturated fat is associated with an increased risk of CHD or CVD."

Am J Clin Nutr 2010;91:535–46

Association of Dietary, Circulating, and Supplement Fatty Acids With Coronary Risk

A Systematic Review and Meta-analysis

32 observational studies (512,420 participants) of fatty acids from dietary intake
17 observational studies (25,721 participants) of fatty acid biomarkers
27 randomized controlled trials (105,085 participants) of fatty acid supplementation

Compared tertiles

Ann Intern Med 2014;160:398-406

Monounsaturated fat

- Olive oil
- Canola oil
- Sunflower oil
- Peanut oil
- Sesame oil
- Avocados
- Olives
- Nuts (almonds, peanuts, macadamia nuts, hazelnuts, pecans, cashews)
- Peanut butter

COHORT
9 studies - CHD
1.00 (0.91-1.10)

Polyunsaturated fat

- Soybean oil ω-6 FA
- Corn oil ω-6 FA
- Safflower oil ω-6 FA
- Walnuts ω-3 FA
- Sunflower, sesame, and pumpkin seeds ω-6 FA
- Flaxseed ω-3 FA
- Fatty fish (salmon, tuna, mackerel, herring, trout, sardines) ω-3 FA
- Soymilk ω-6 FA
- Tofu ω-3 FA

COHORT
ω-6
8 studies - CHD
0.98 (0.90-1.06)

COHORT
ω-3 short chain
Plant oils
7 studies - CHD
0.99 (0.86-1.14)

COHORT
ω-3 long chain
Marine Oils
16 studies - CHD
0.87 (0.78-0.97)

Saturated fat

- High-fat cuts of meat (beef, lamb, pork)
- Chicken with the skin
- Whole-fat dairy products (milk and cream)
- Butter
- Cheese
- Ice cream
- Palm and coconut oil
- Lard

COHORT
20 studies - CHD
1.03 (0.98-1.07)

Trans fat

- Commercially-baked pastries, cookies, doughnuts, muffins, cakes, pizza dough
- Packaged snack foods (crackers, microwave popcorn, chips)
- Stick margarine
- Vegetable shortening
- Fried foods (French fries, fried chicken, chicken nuggets, breaded fish)
- Candy bars

COHORT
5 studies - CHD
1.16 (1.06-1.27)

“Current evidence does not clearly support cardiovascular guidelines that encourage high consumption of polyunsaturated fatty acids and low consumption of total saturated fats”

Ann Intern Med 2014;160:398-406

“The present systematic review [secondary prevention] provides no evidence (moderate quality evidence) for the beneficial effects of reduced/modified fat diets in the secondary prevention of coronary heart disease”

BMJ Open 2014;4:e004487 doi:10.1136/bmjopen-2013-004487

Does red meat consumption increase the risk of cardiovascular disease?

The problem of different types of meat

Red and Processed Meat Consumption and Risk of Incident Coronary Heart Disease, Stroke, and Diabetes Mellitus

A Systematic Review and Meta-Analysis

20 studies - 1,218,380 individuals and 23,889 CHD, 2,280 stroke, and 10,797 diabetes mellitus cases

Red meat - unprocessed meat from beef, hamburgers, lamb, pork, or game and excluding poultry, fish, or eggs

Processed meat - meat preserved by smoking, curing, or salting or addition of chemical preservatives, such as bacon, salami, sausages, hot dogs, or processed deli or luncheon meats, and excluding fish or eggs

Circulation 2010;121:2271-83

Relative risk	Red meat (per 100g serving/day)	Processed meat (per 50g serving/day)
CHD	1.00 (0.81-1.23)	1.42 (1.07-1.89)
Stroke	1.17 (0.40-3.43)	1.14 (0.94-1.39)

Circulation 2010;121:2271-83

Does added sugar consumption increase the risk of obesity or cardiovascular disease?

The potential problem of a new theory and the size of the differences

Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies

Adults

Reduced intake of dietary sugars was associated with a decrease in body weight - 0.80 kg (0.39-1.21)

Increased sugars intake was associated with a weight increase - 0.75 kg (0.30 -1.19)

Isoenergetic exchange of dietary sugars with other carbohydrates showed no change in body weight - 0.04 kg (–0.04 to 0.13)

Children

Sugar sweetened beverages - one year follow-up in prospective studies - odds ratio for being overweight or obese was 1.55 (1.32 to 1.82) - highest intake compared with the lowest intake

BMJ 2012;345:e7492 doi: 10.1136/bmj.e7492

Sweetened Beverage Consumption, Incident Coronary Heart Disease, and Biomarkers of Risk in Men

Compared never drink vs 2 servings (12oz)/month vs 2/week vs 7/week

Only 7 servings/week showed a difference in CHD - roughly 20%

Circulation 2012;125:1735-41

Only 7 servings/week showed a difference in CVD mortality - roughly 30%

JAMA Intern Med 2014;174:516-24

Original Investigation

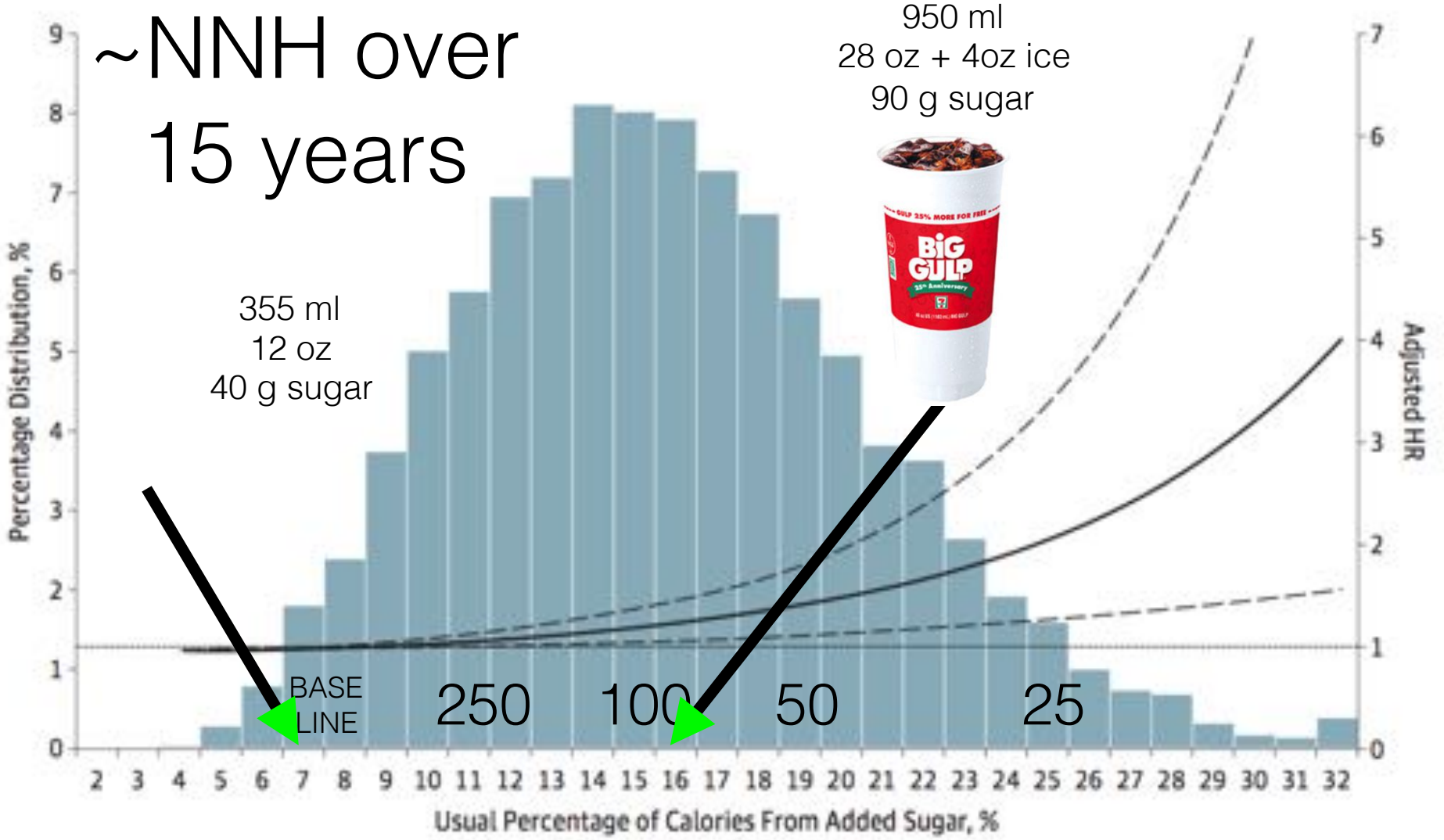
Added Sugar Intake and Cardiovascular Diseases Mortality Among US Adults

DEFINITION OF ADDED SUGARS
all sugars used in processed or prepared foods, such as sugar-sweetened beverages, grain-based desserts, fruit drinks, dairy desserts, candy, ready-to-eat cereals, and yeast breads, BUT NOT naturally occurring sugar, such as in fruits and fruit juices

FREE SUGARS = ADDED SUGARS + honey, syrups, or fruit juice

JAMA Intern Med 2014;174:516-24

Figure 1. Adjusted Hazard Ratio (HR) of the Usual Percentage of Calories From Added Sugar for Cardiovascular Disease Mortality Among US Adults 20 Years or Older: National Health and Nutrition Examination Survey Linked Mortality Files, 1988-2006



JAMA Intern Med 2014;174:516-24

Can We Say What Diet Is Best for Health?

"There have been no rigorous, long-term studies comparing contenders for best diet laurels using methodology that precludes bias and confounding, and for many reasons such studies are unlikely"

Annu Rev Public Health 2014; 35:83–103

What is the answer?

Teasing out the benefits and harms of things we eat is EXTREMELY complicated

SINGLE NUTRIENTS

Not enough robust data to ascribe causality

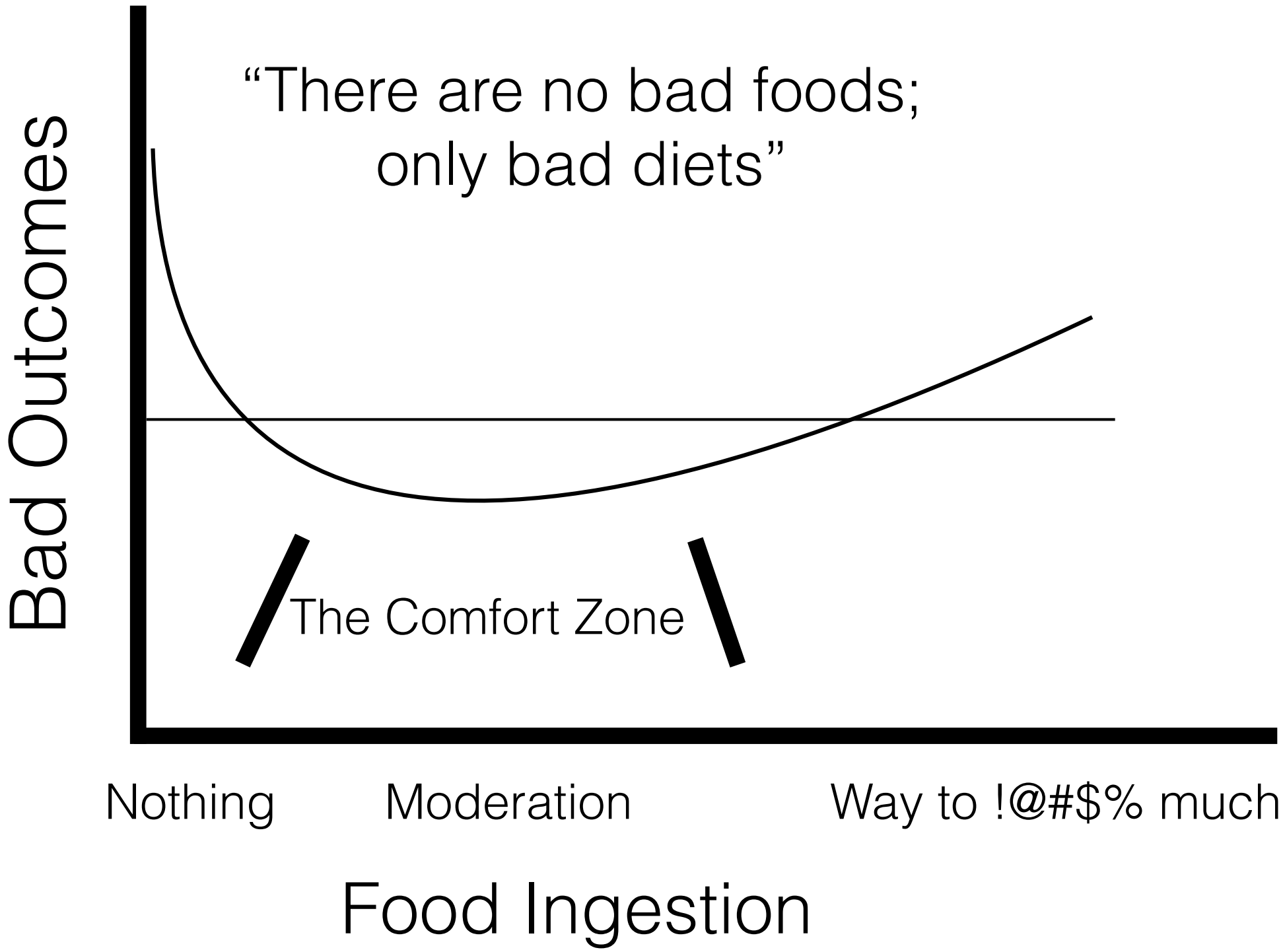
Some interesting associations - eggs, salt, coffee, alcohol

MULTIPLE NUTRIENTS AND BEHAVIOURS

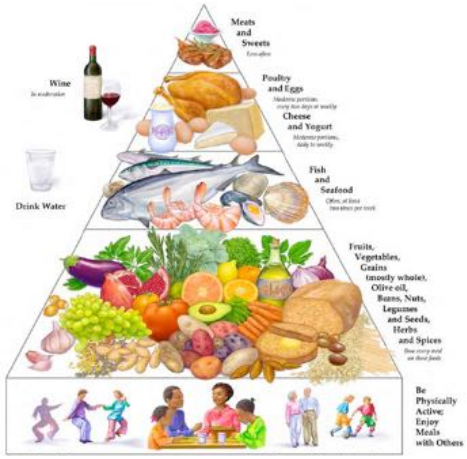
Issues of RCTs and Cohorts - bias and confounding - answer may be unknowable

How to best lose weight is very individual - low carb/higher fat/protein maybe somewhat better? - is the difference important?

Overall nutrition is hugely personal and emotional


"There are no bad foods;
only bad diets"
Bad Outcomes
The Comfort Zone
Nothing
Moderation
Way to !@#$% much
Food Ingestion

1. ENJOY EATING



Differences in outcomes are typically found from "extremes" and are "small"

The Mediterranean diet (whatever it is) seems reasonable - also CFG/USDA ~DASH

Eat in moderation/moderation/moderation

Avoid "highly" processed food - within reason

You can easily justify some red meat, butter etc

Eggs, coffee, salt, and alcohol in moderation seem fine if not even healthy

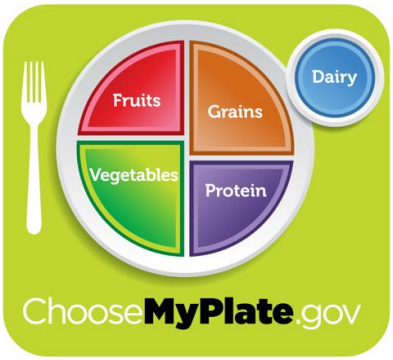
8. Saturated fats - OK - trans-fat?

Added sugars at the high end seem to increase risk

"Big Gulps"- really what is the point of them?

It is VERY unlikely a single "nutrient" would have an important effect

Animal rights/environmental issues are a whole other topic



The M&M's Diet

Mediterranean **Moderation**

"The secret of life is to eat what you like and let the food fight it out inside"
Mark Twain