Optimizing Macronutrient Composition for Health

Walter C. Willett, MD, DrPH

Department of Nutrition

Harvard School of Public Health

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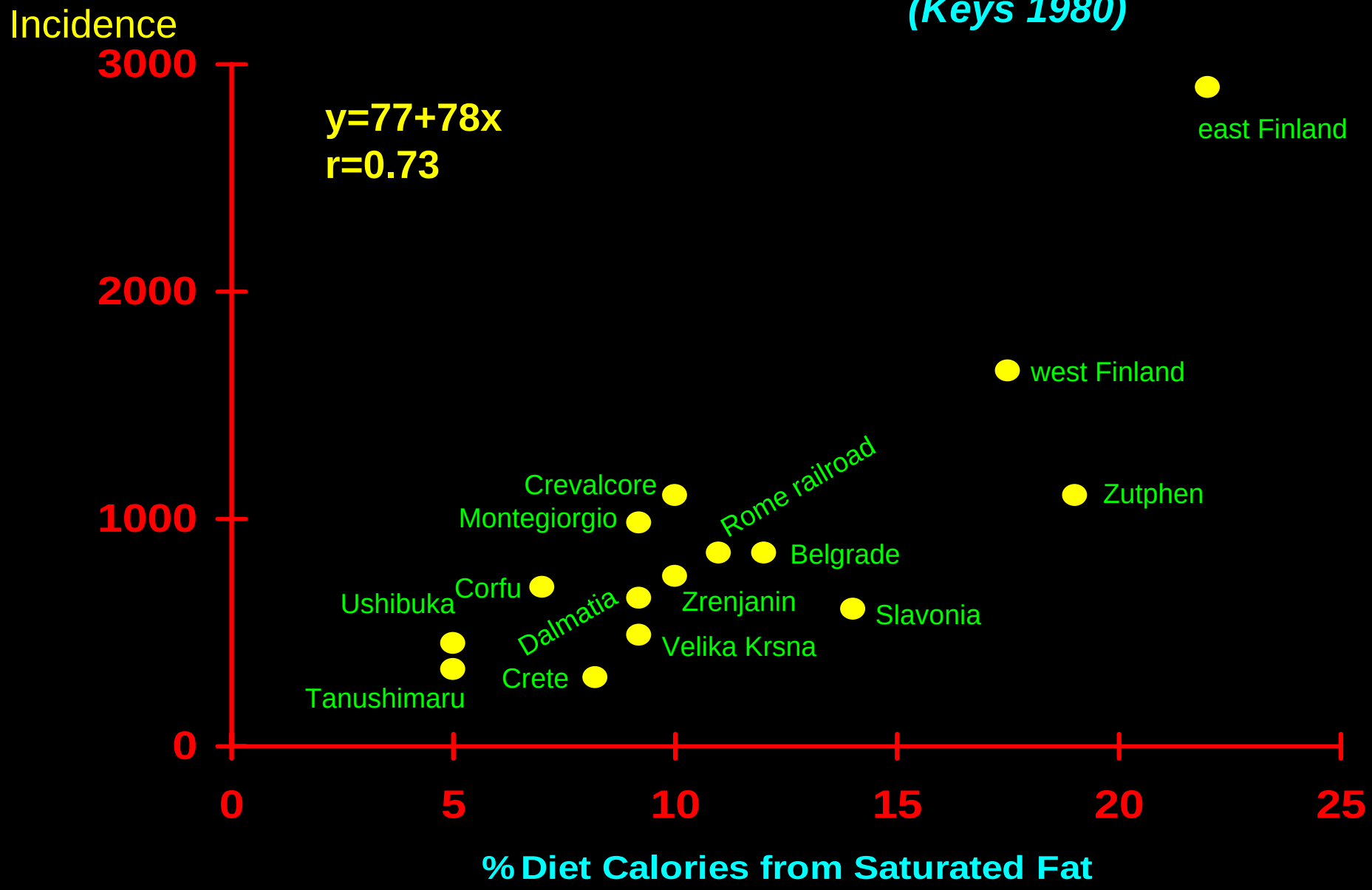
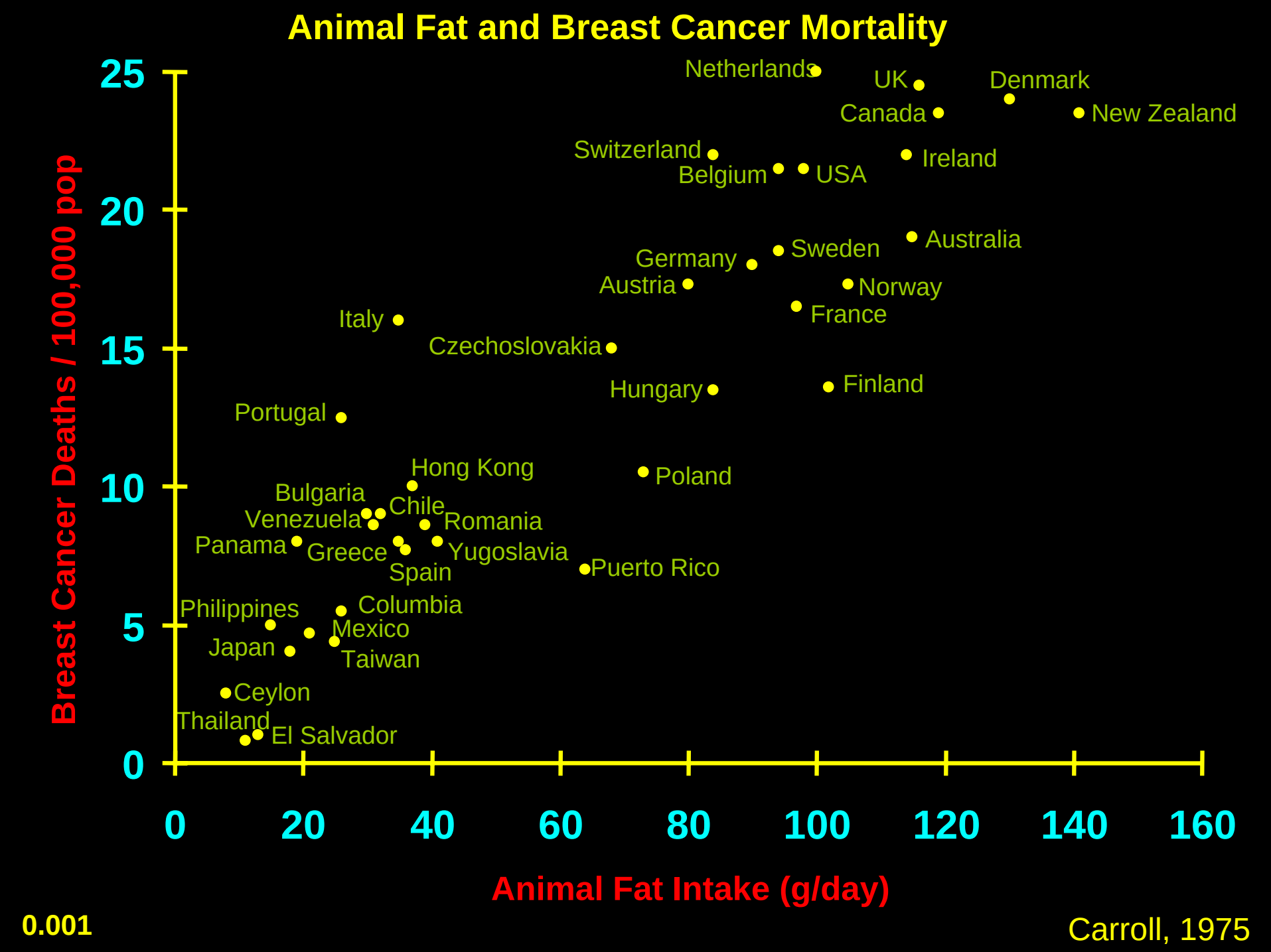
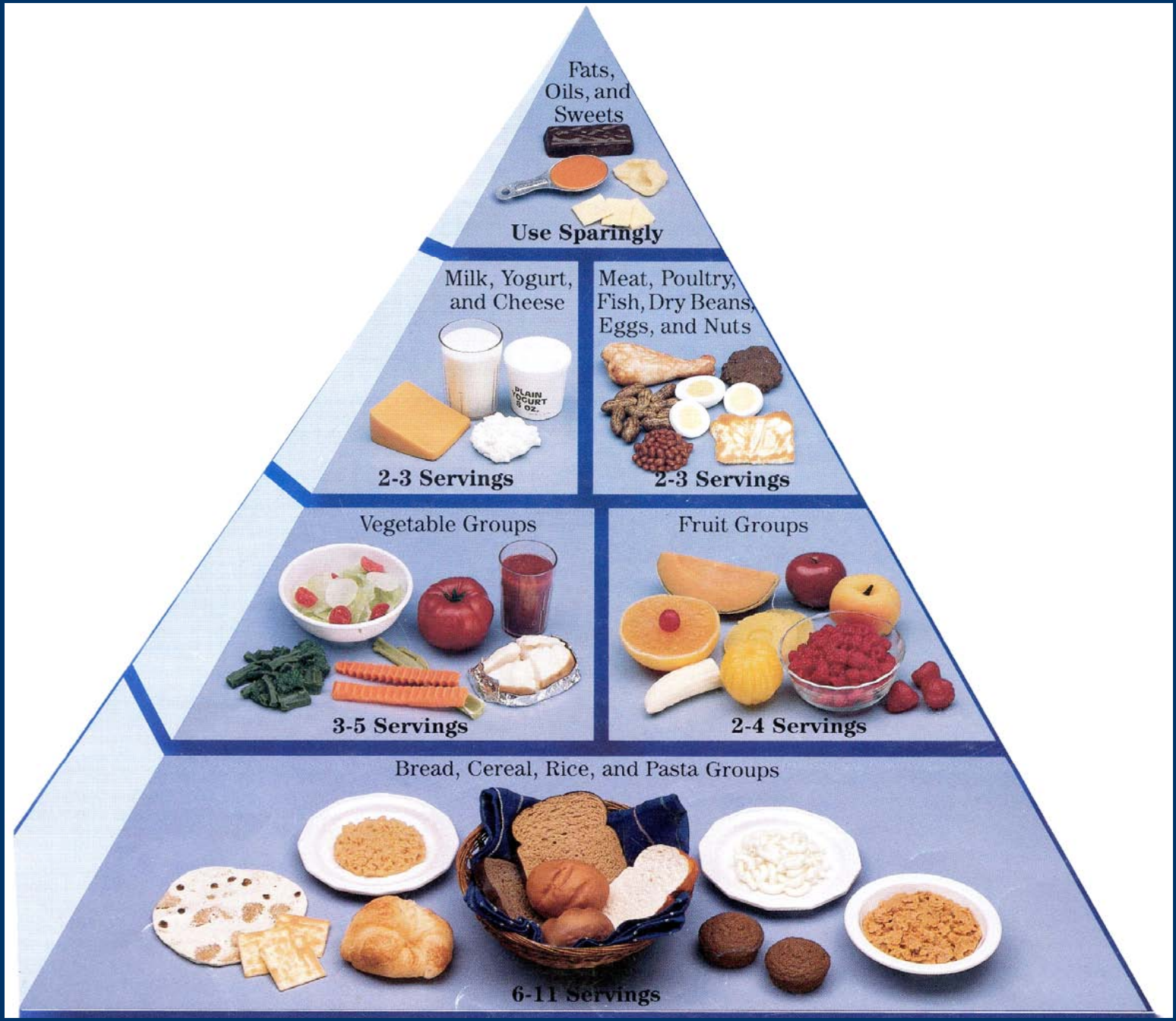
Walter Willett has nothing to disclose and no conflicts of interest. Dr. Willett will not be discussing the off-label or investigational use of any drugs, products or devices.

10-Year Coronary Incidence Per 10,000 Men

(Keys 1980)




Animal Fat and Breast Cancer Mortality
Breast Cancer Deaths / 100,000 pop
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
Animal Fat Intake (g/day)
Netherlands
UK
Denmark
Canada
New Zealand
Switzerland
Ireland
Belgium
USA
Australia
Germany
Sweden
Austria
Norway
France
Italy
Czechoslovakia
Hungary
Finland
Portugal
Hong Kong
Poland
Bulgaria
Chile
Venezuela
Romania
Panama
Greece
Yugoslavia
Spain
Puerto Rico
Philippines
Columbia
Mexico
Japan
Taiwan
Ceylon
Thailand
El Salvador
0.001
Carroll, 1975


Fats, Oils, and Sweets
Use Sparingly
Milk, Yogurt, and Cheese
2-3 Servings
Meat, Poultry, Fish, Dry Beans, Eggs, and Nuts
2-3 Servings
Vegetable Groups
3-5 Servings
Fruit Groups
2-4 Servings
Bread, Cereal, Rice, and Pasta Groups
6-11 Servings

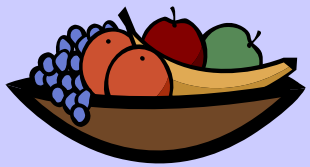
1: Use Nonfat Products

To reduce your fat intake:

Eat more fruits, vegetables, and their juices. Most are naturally low in fat…and high in vitamins and minerals.

Here are some other ways to reduce fat in your food.

TRY	INSTEAD OF
Butter-flavored granules	Butter or margarine
Nonfat yogurt	Regular yogurt
Nonfat salad dressings	Regular salad dressings
Angel food cake	Devil's food cake
Fat-free cookies and crackers	High-fat cookies and crackers



21.031

21.038

The New York Times
nytimes.com

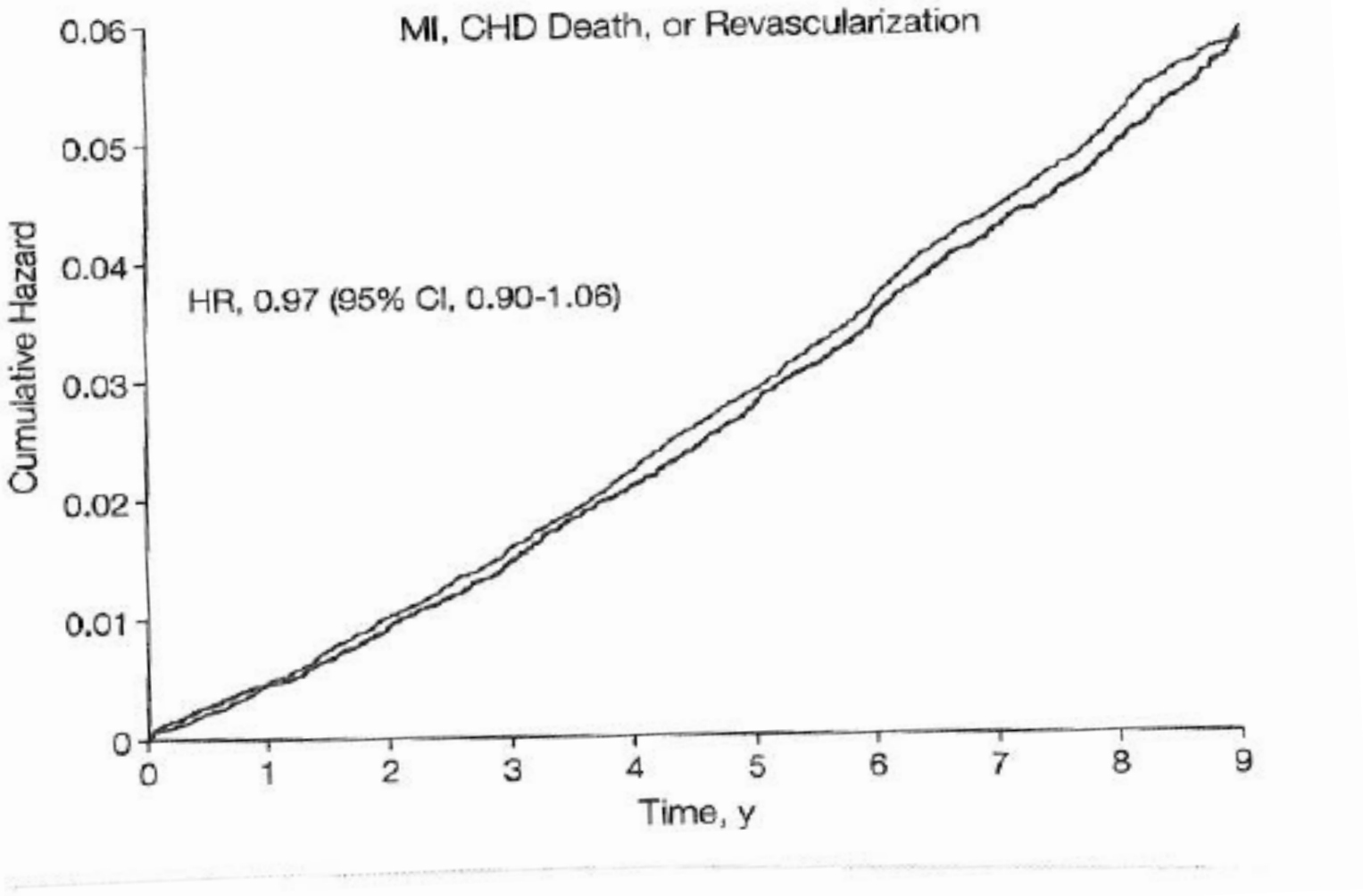
February 8, 2006

Low-Fat Diet Does Not Cut Health Risks, Study Finds

By GINA KOLATA

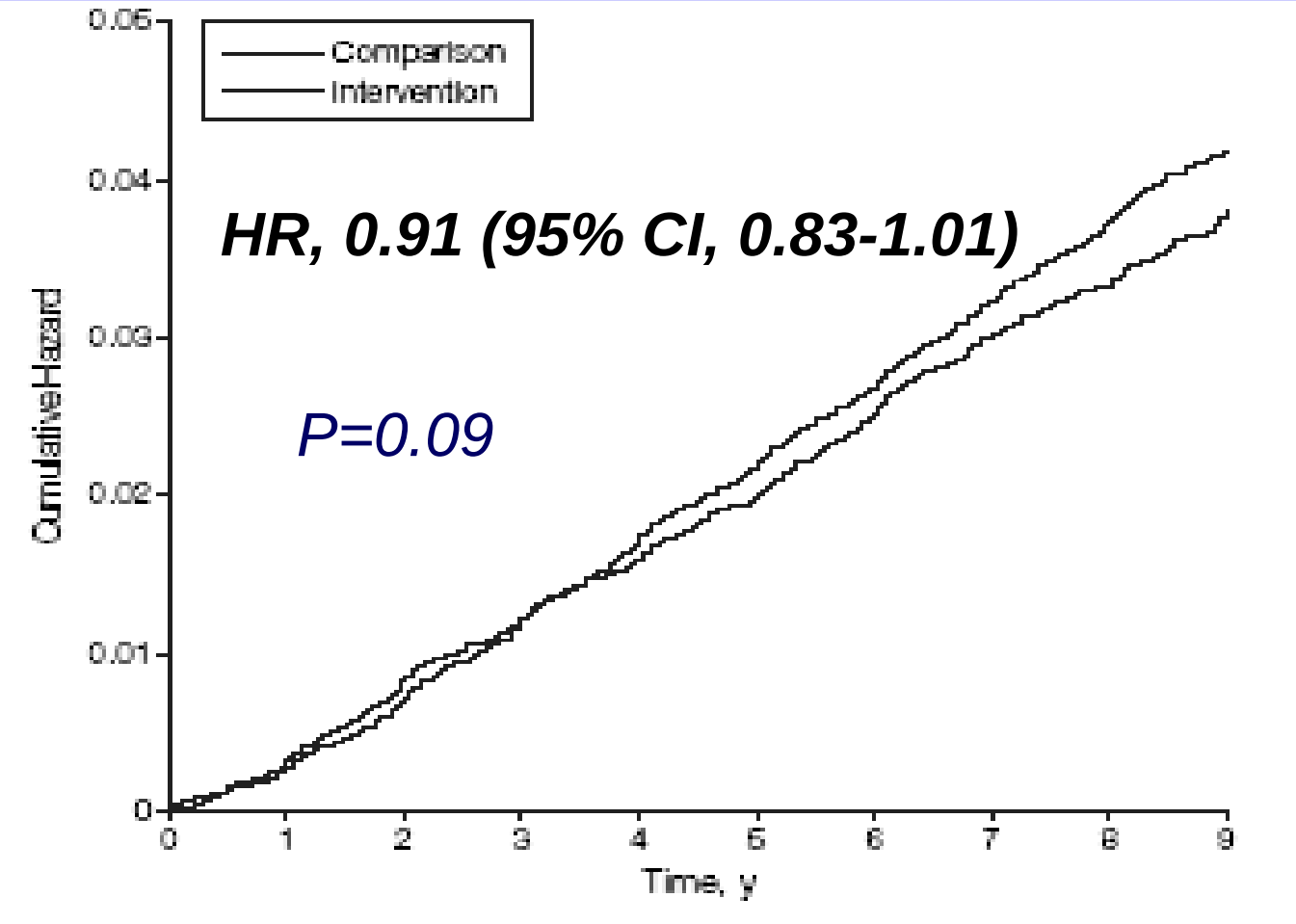
The largest study ever to ask whether a low-fat diet reduces the risk of getting cancer or heart disease has found that the diet has no effect.

The $415 million federal study involved nearly 49,000 women ages 50 to 79 who were followed for eight years. In the end, those assigned to a low-fat diet had the same rates of breast cancer, colon cancer, heart attacks and strokes as those who ate whatever they pleased, researchers are reporting today.

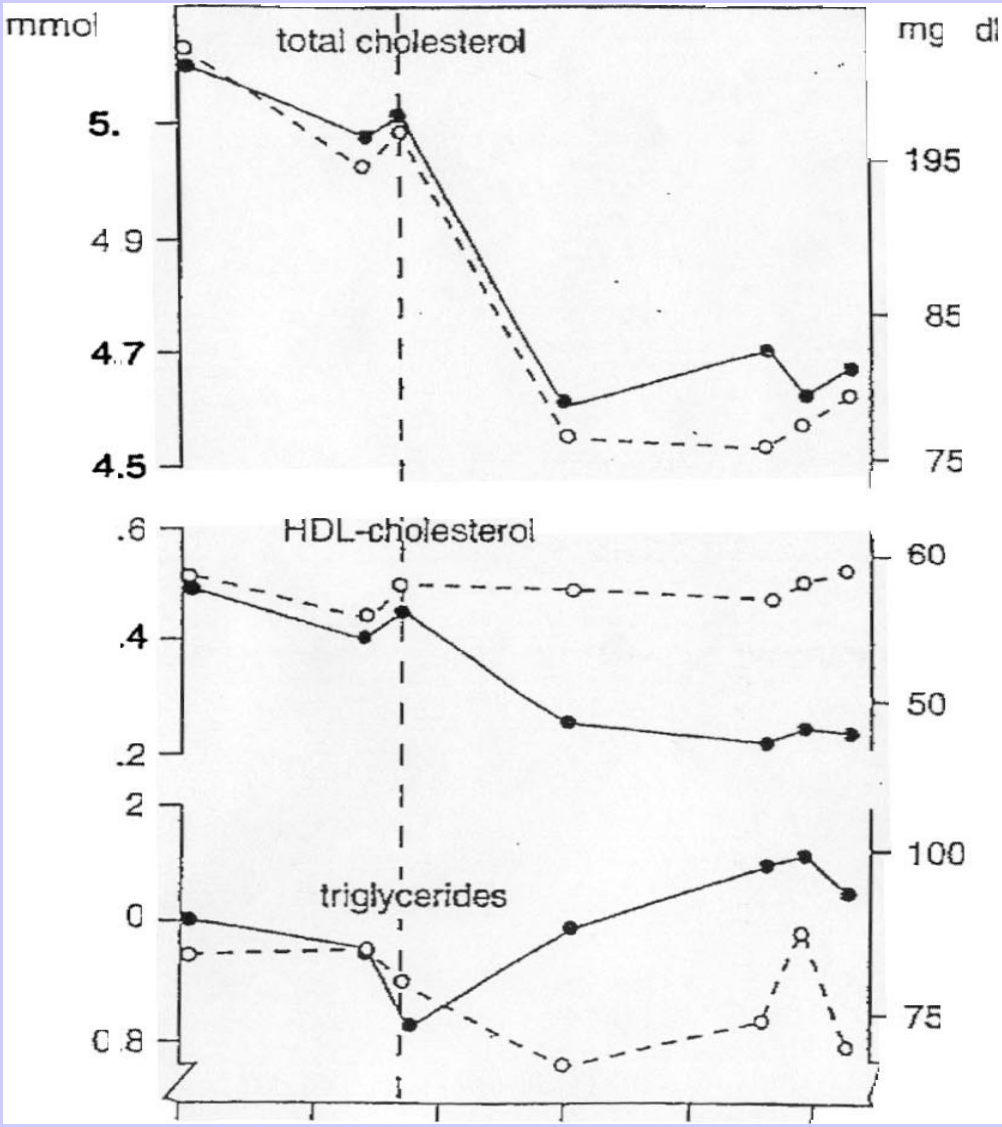


(Howard et al. 2006)

Breast Cancer Incidence in WHI



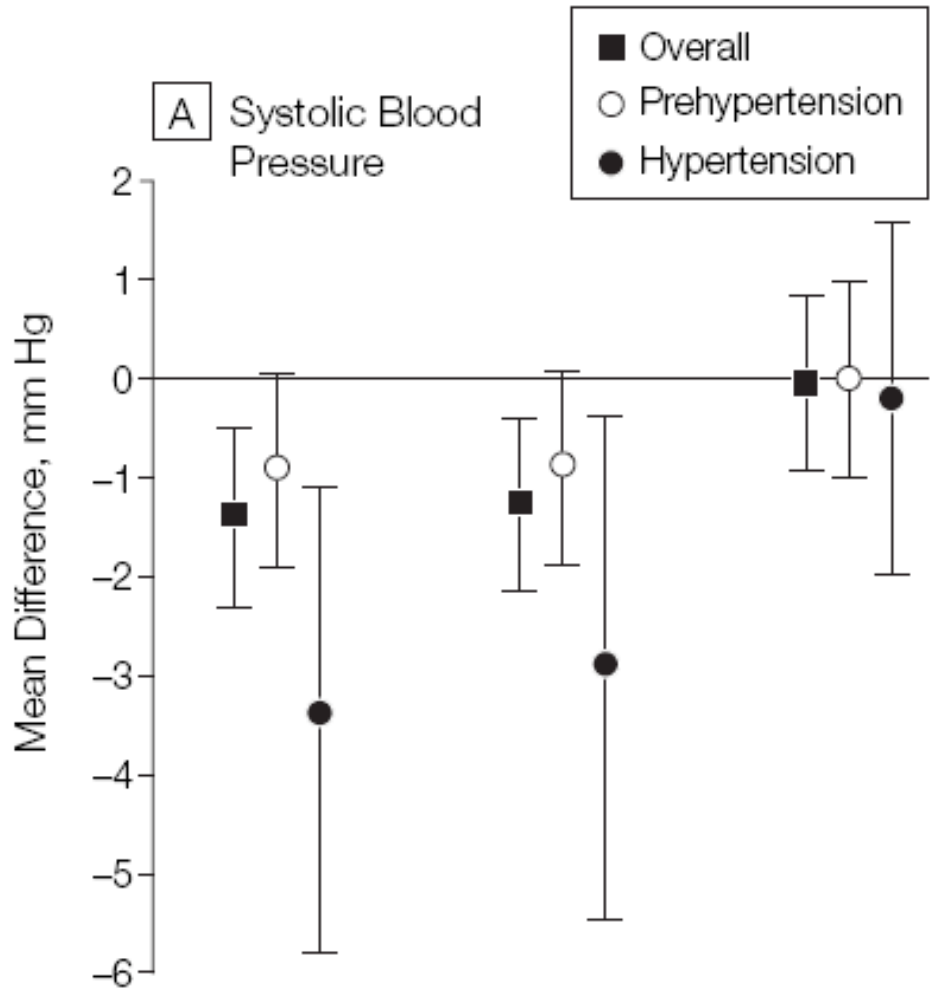
(Prentice et al. 2006)



Western	olive oil
	complex carb.

Mensink and Katan, 1987

Omni Heart Study: Effect on Blood Pressure

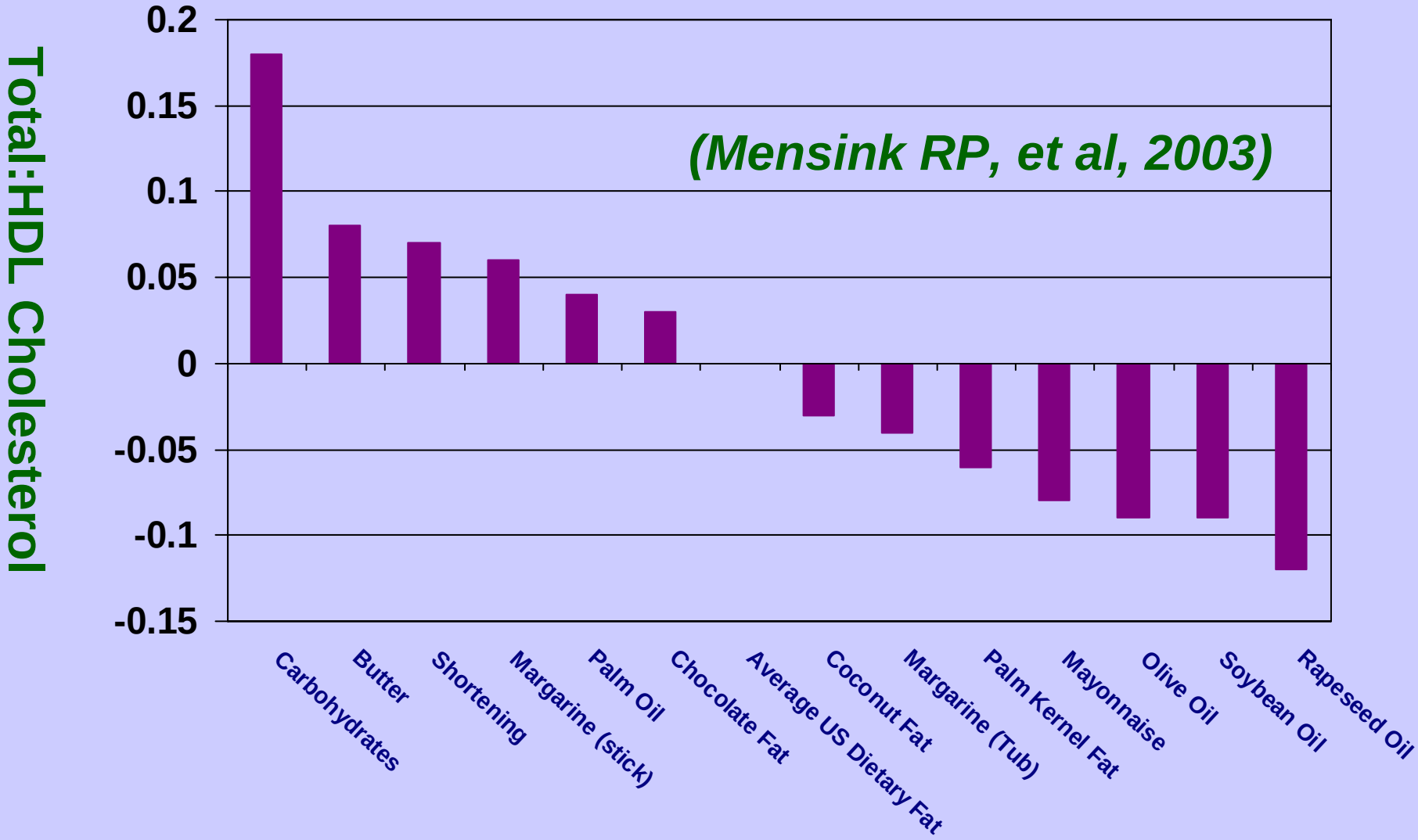


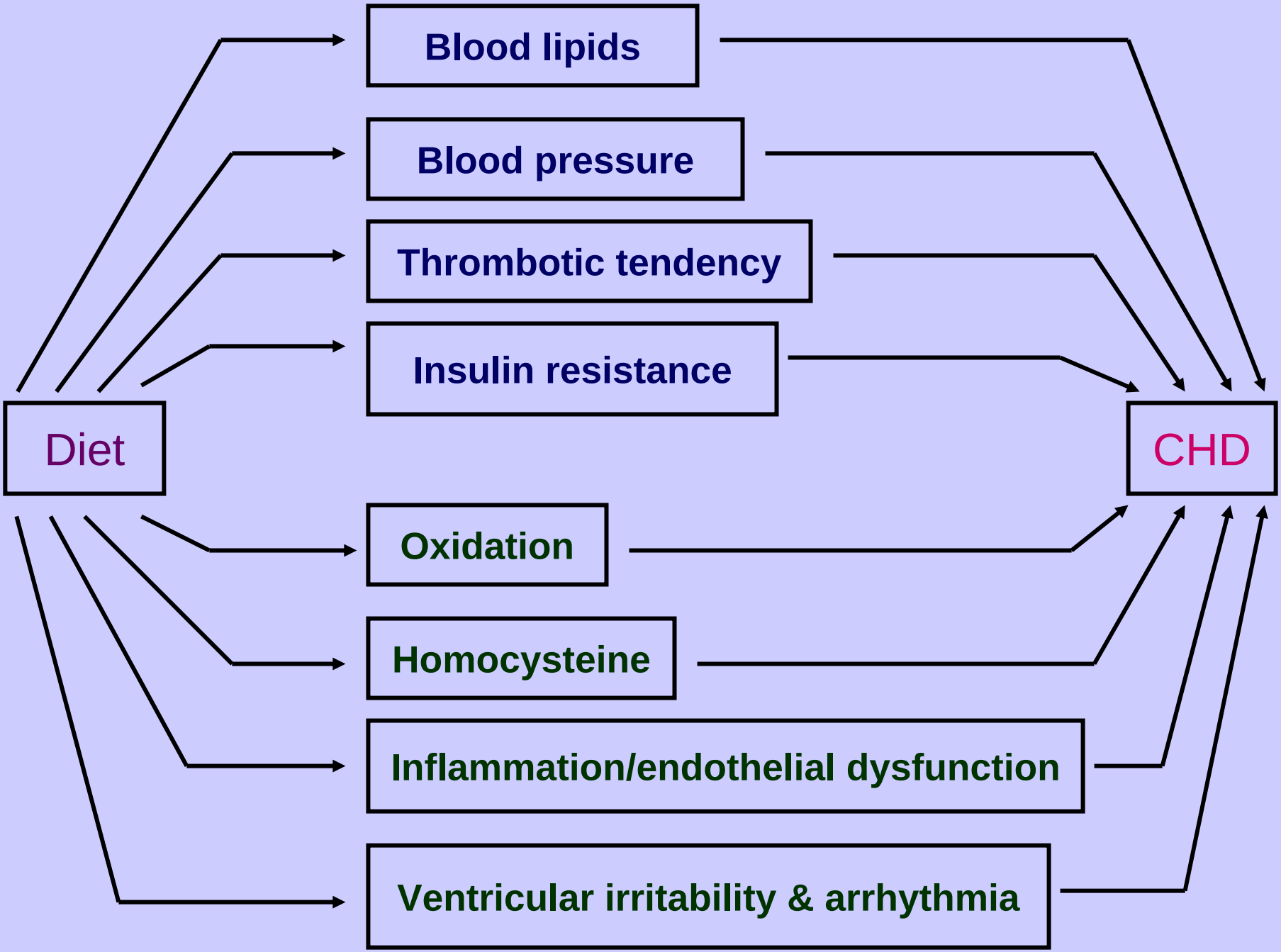
(Appel et al. 2005)

Change (%) in Estimated 10-year Risk of Coronary Heart Disease Using Framingham Score *(Omni Heart Study)*

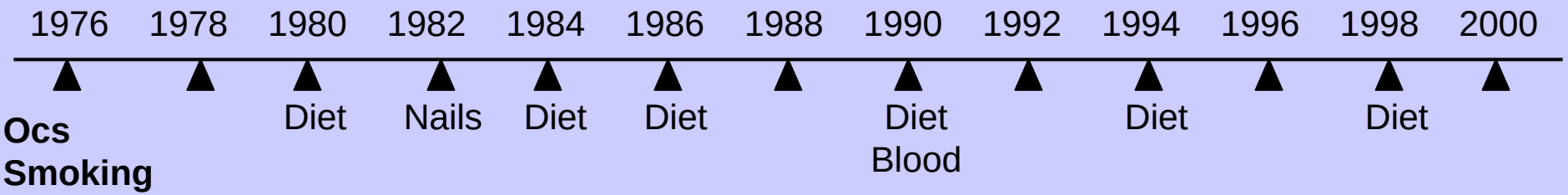
	Protein	*Unsaturated Fat*
Men		
Change from carbohydrate	**-5.6%**	**-3.9%**
Women		
Change from carbohydrate	**-11.1%**	**-12.9%**

(Appel et al. 2005)

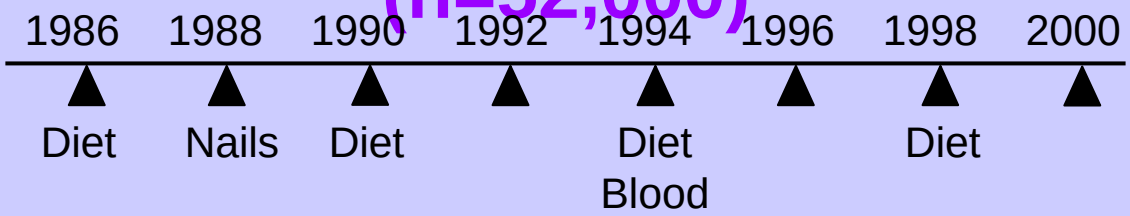

Total:HDL Cholesterol
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
(Mensink RP, et al, 2003)
Carbohydrates
Butter
Shortening
Margarine (stick)
Palm Oil
Chocolate Fat
Average US Dietary Fat
Coconut Fat
Margarine (Tub)
Palm Kernel Fat
Mayonnaise
Olive Oil
Soybean Oil
Rapeseed Oil


Blood lipids
Blood pressure
Thrombotic tendency
Insulin resistance
Diet
CHD
Oxidation
Homocysteine
Inflammation/endothelial dysfunction
Ventricular irritability & arrhythmia

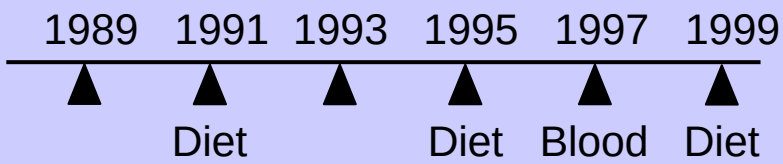
Nurses' Health Study (n=121,700)



Health Professionals Follow-up Study (n=52,000)



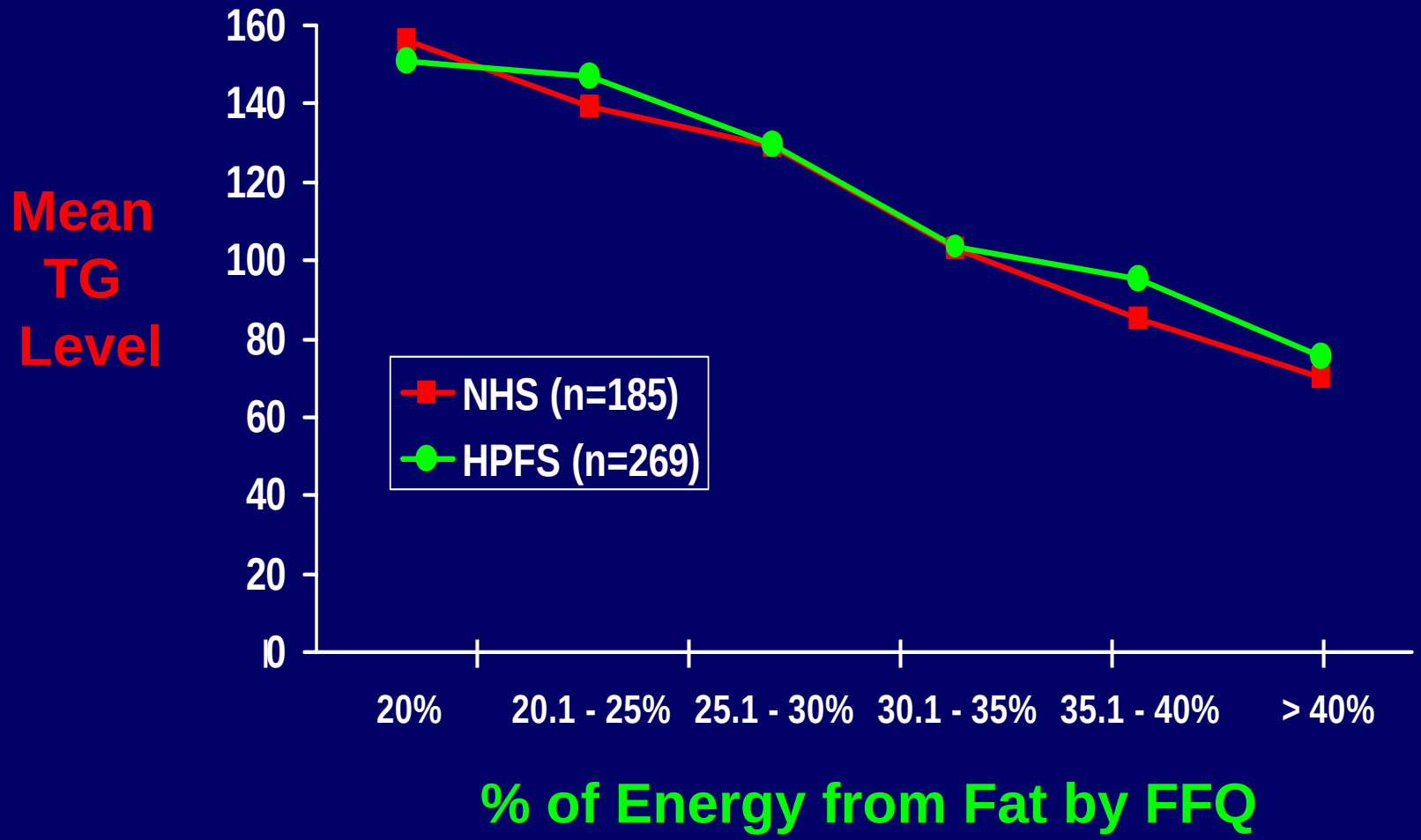
Nurses' Health Study II (n=116,000)

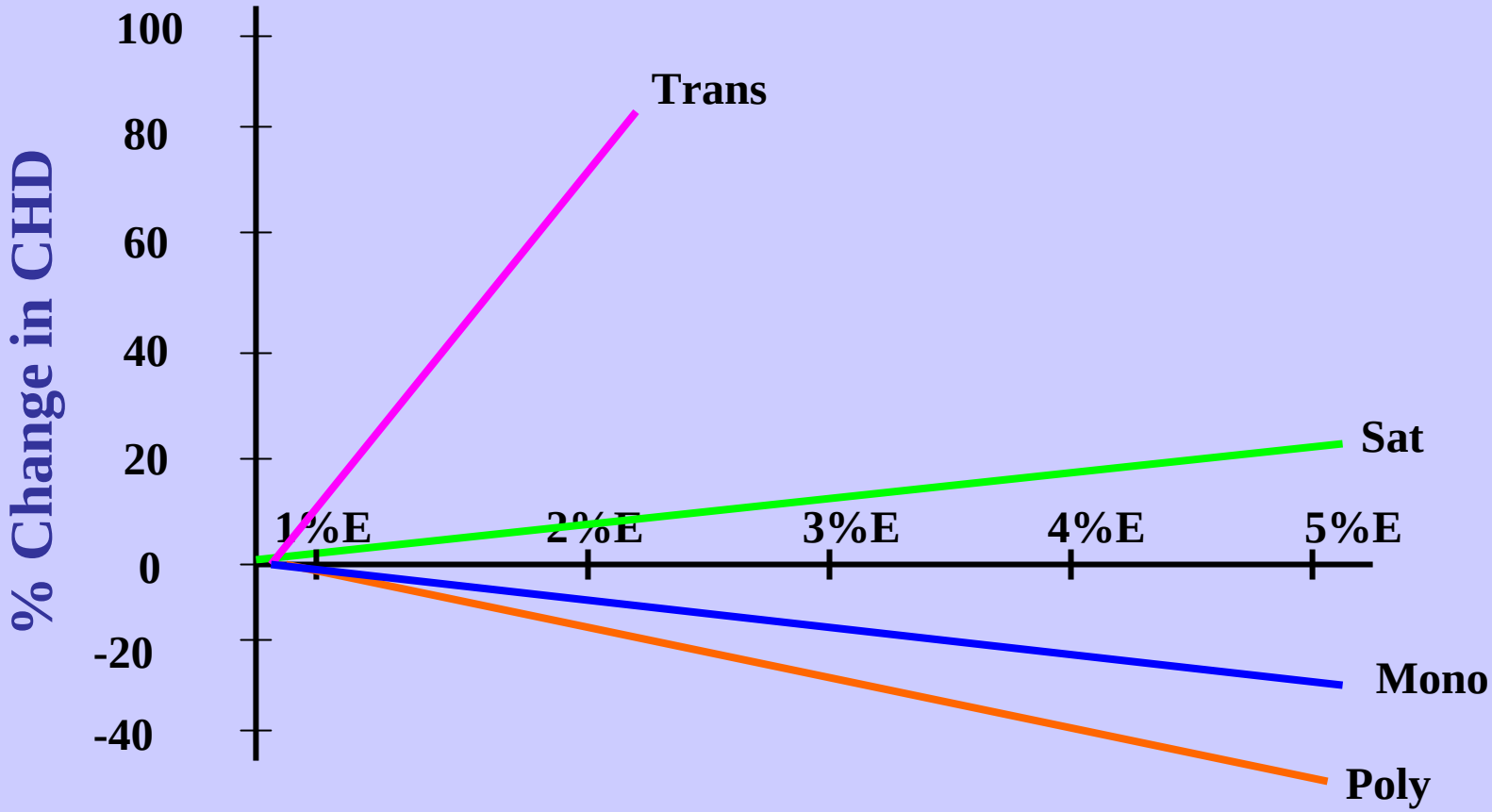


Investigators: ***Frank Speizer, Bernie Rosner, Meir Stampfer, Graham Colditz, David Hunter, JoAnn Manson, Sue Hankinson, Eric Rimm, Edward Giovannucci, Alberto Ascherio, Gary Curhan, Charlie Fuchs, Fran Grodstein, Michelle Holmes, Frank Hu***

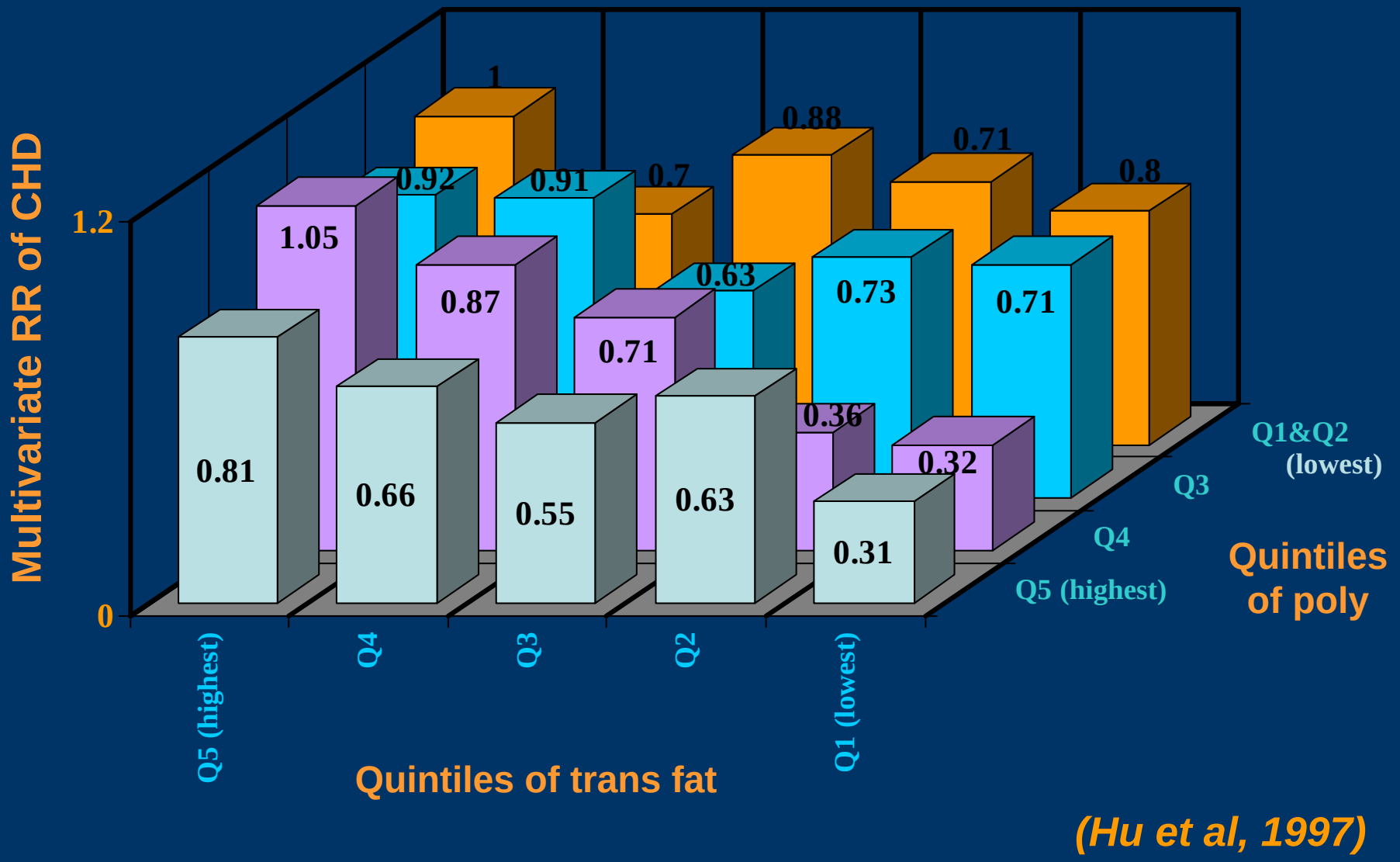
0.198R

Percent of Energy from Fat and Plasma Triglyceride Level




% Change in CHD
100
80
60
40
20
0
-20
-40
1%E
2%E
3%E
4%E
5%E
Trans
Sat
Mono
Poly

(Hu et al. 1997)

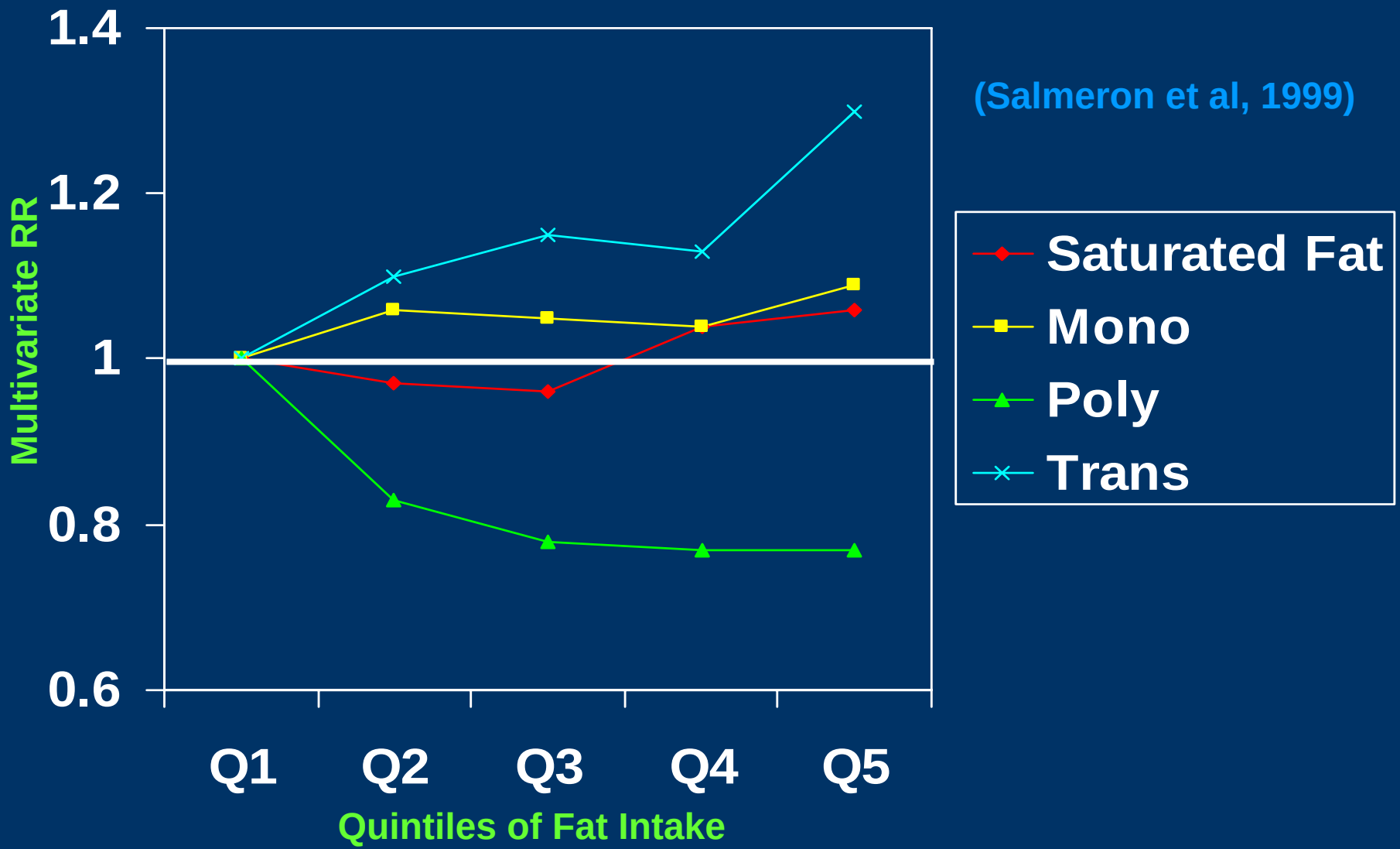

Multivariate RR of CHD
1.2
0
1
0.92
0.91
0.7
0.88
0.71
0.8
1.05
0.87
0.63
0.73
0.71
0.71
0.36
0.32
0.81
0.66
0.55
0.63
0.31
Q5 (highest)
Q4
Q3
Q2
Q1 (lowest)
Quintiles of trans fat
Q1&Q2 (lowest)
Q3
Q4
Q5 (highest)
Quintiles of poly

(Hu et al, 1997)

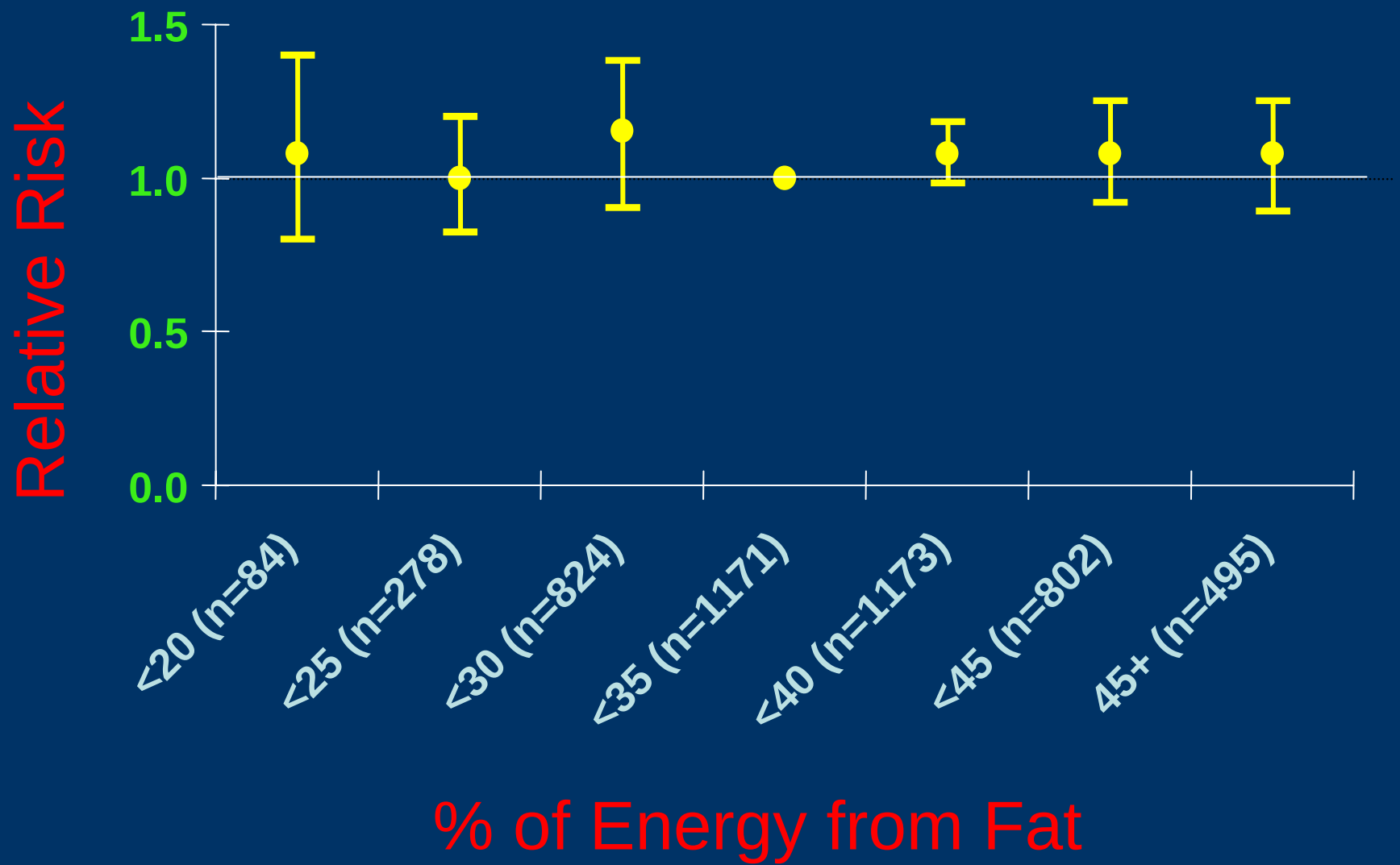
“Intake of total fat *per se*, independent of the relative content of different types of fatty acids, is not associated with high blood cholesterol levels and coronary heart disease”.

Diet and Health, 1989, page 7

Multivariate RRs of type 2 diabetes according to quintiles of specific types of dietary fat (mutually adjusted)

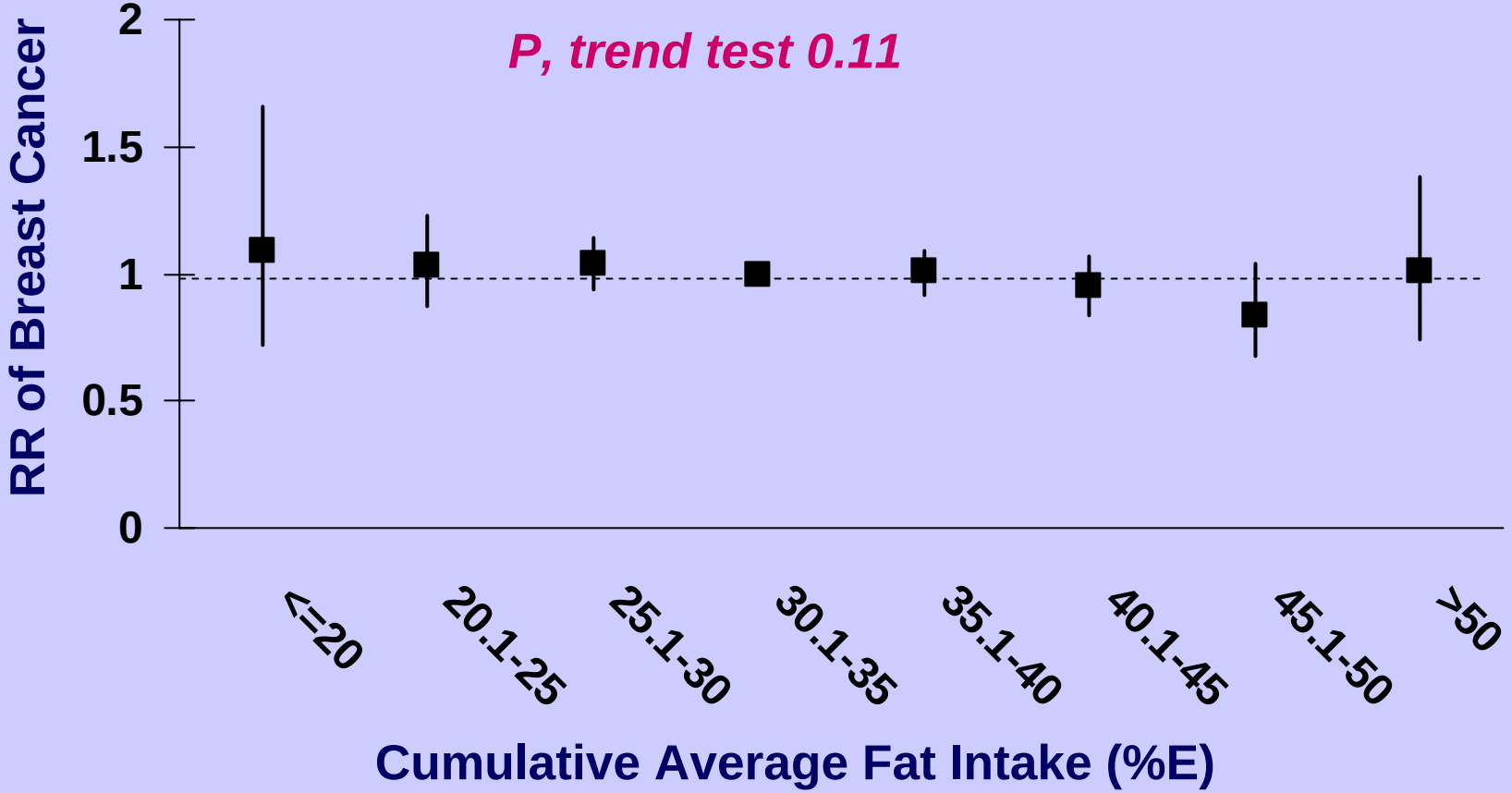


(Salmeron et al, 1999)



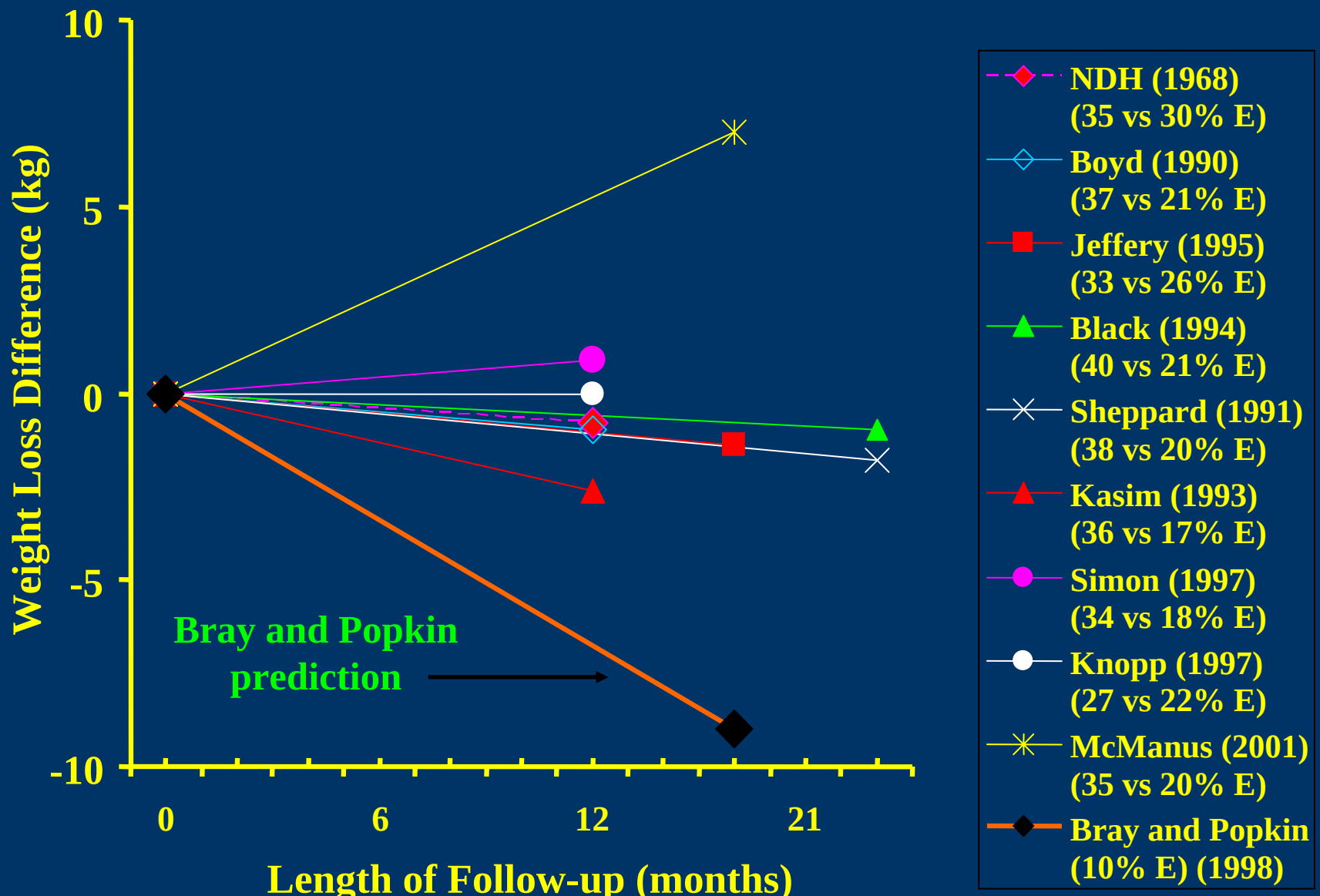
(Hunter et al. 1996)

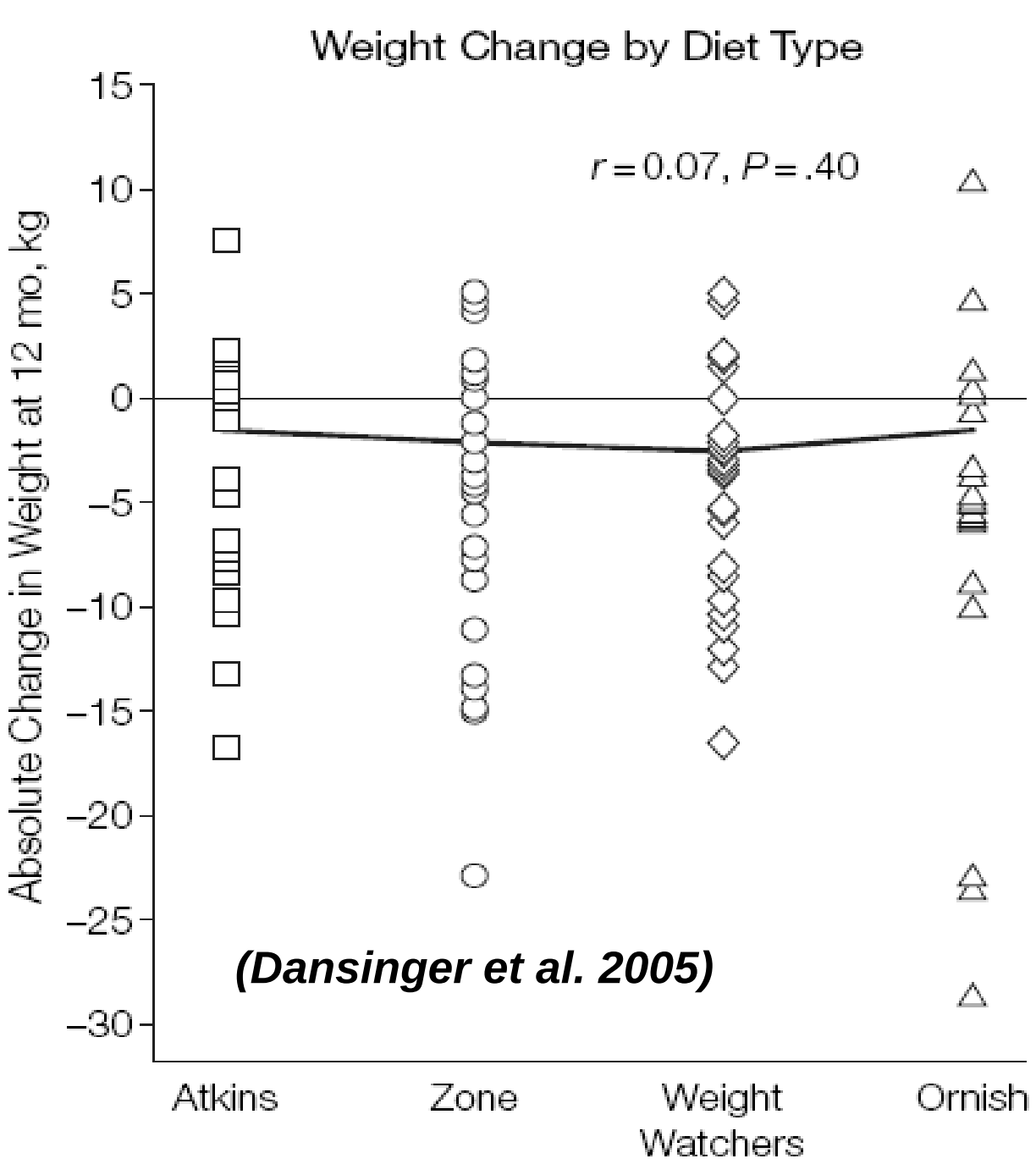
Fat & Postmenopausal Breast Cancer in NHS, 1980-2000 (3537 cases)



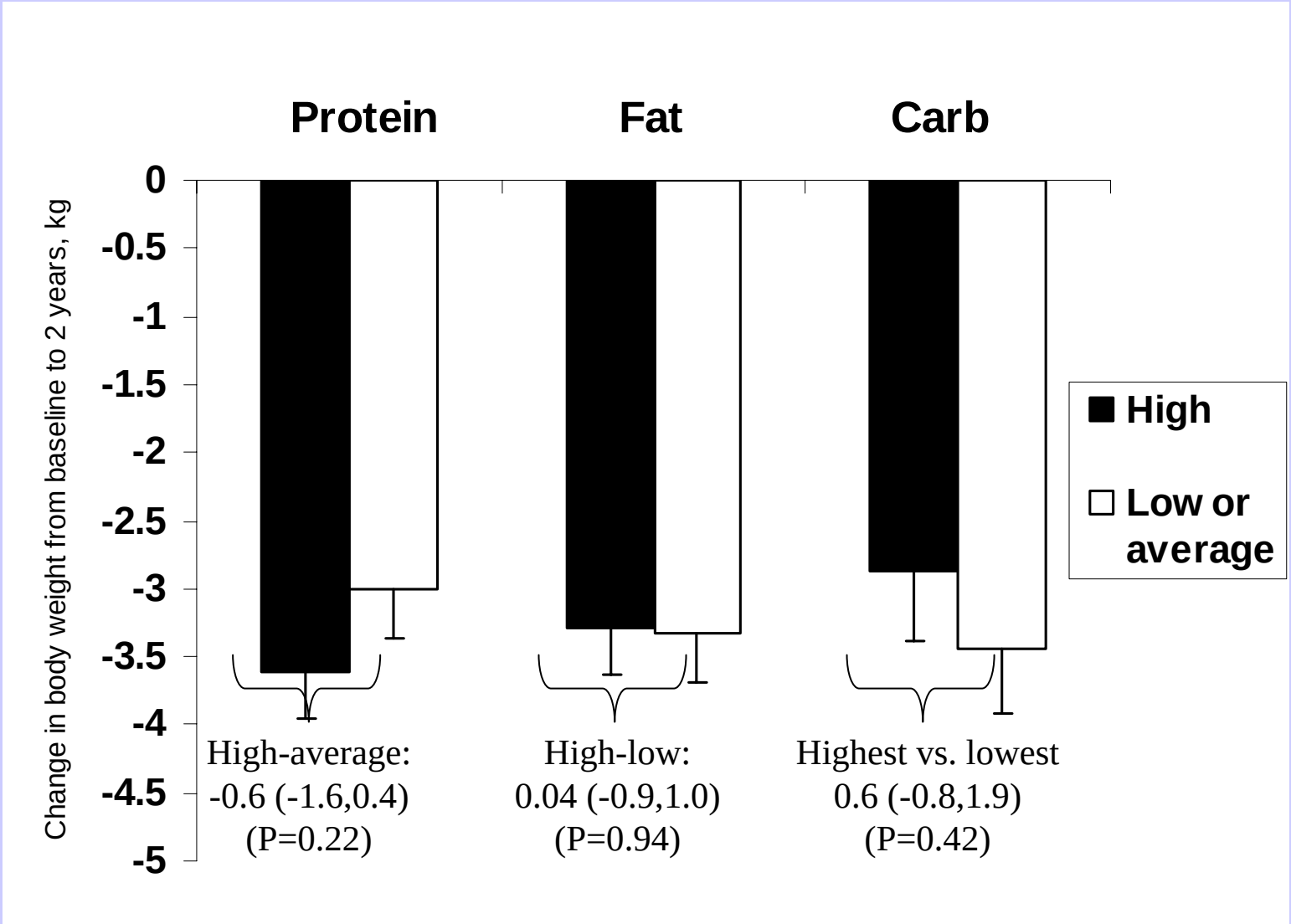
(Kim et al. 2006)

Low-Fat Weight Loss Trials

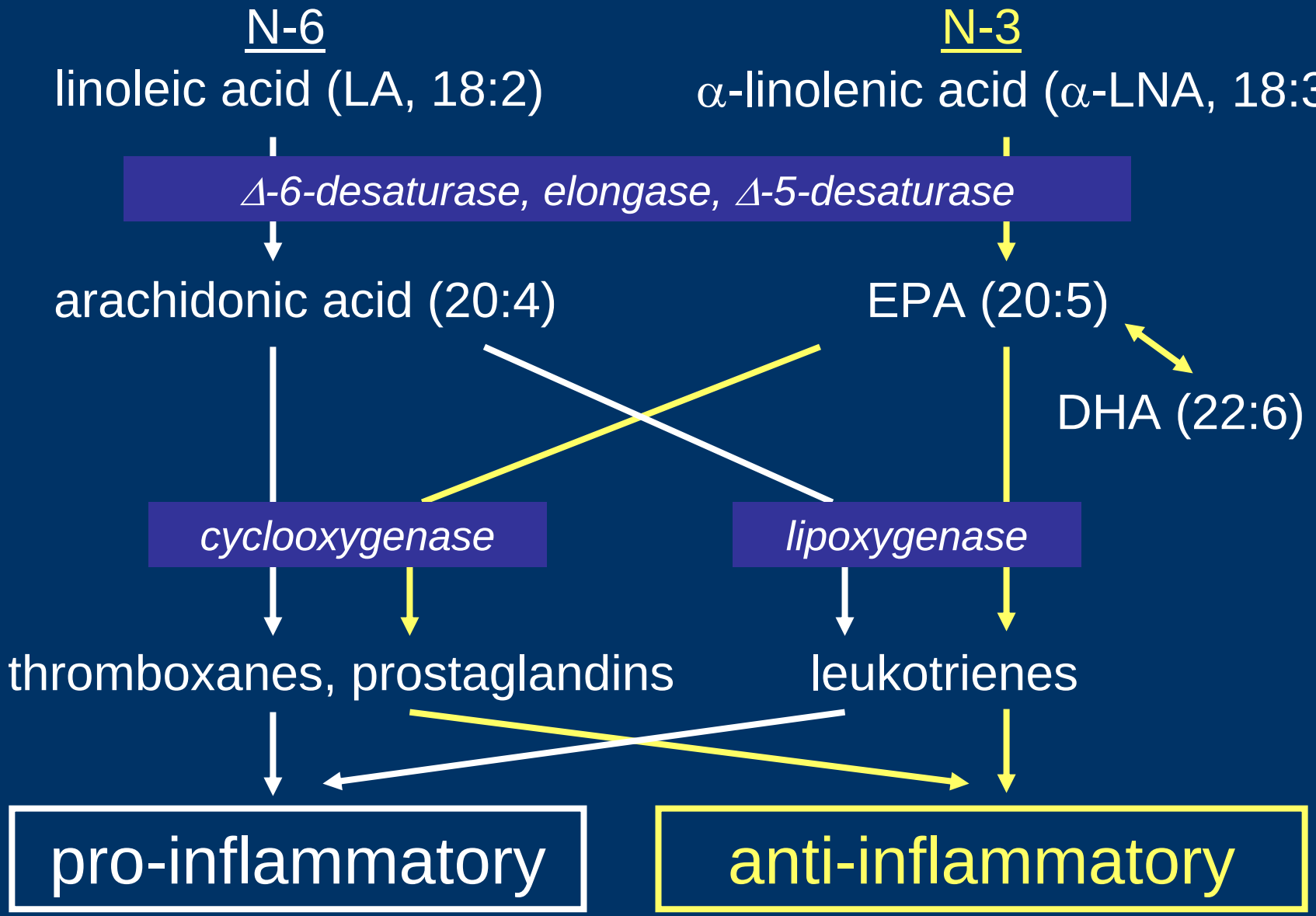



Weight Change by Diet Type
r = 0.07, P = .40
Absolute Change in Weight at 12 mo, kg
15
10
5
0
−5
−10
−15
−20
−25
−30
Atkins
Zone
Weight Watchers
Ornish
(Dansinger et al. 2005)

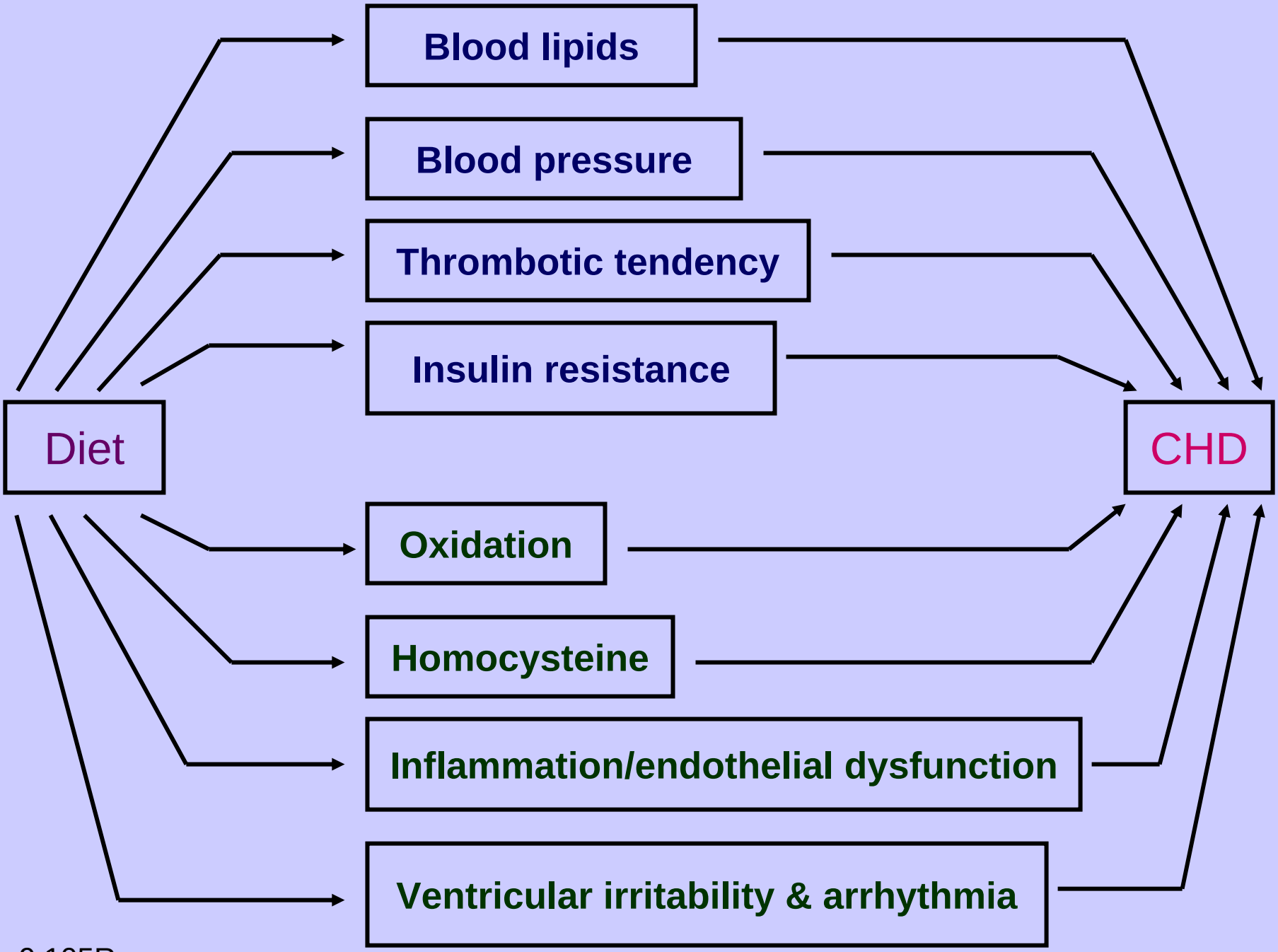
PoundsLost: Primary Trial Outcome, 2 years
Body Weight Change: All randomized participants



Human eicosanoid synthesis



(Pischon et al. 2003)


Blood lipids
Blood pressure
Thrombotic tendency
Insulin resistance
Diet
CHD
Oxidation
Homocysteine
Inflammation/endothelial dysfunction
Ventricular irritability & arrhythmia

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Keys

$$\triangle \text{Serum chol} = 1.35\,(2\triangle S - \triangle P) + 1.5\triangle C^{0.5}$$

Hegsted

$$\triangle \text{Serum chol} = 2.16\triangle S - 1.65\triangle P + 0.176\triangle C$$

Total cholesterol = 1.51 (carb → sat) – 0.12 (carb → mono) – 0.60 (carb → poly)

LDL-C = 1.28 (carb → sat) – 0.24 (carb → mono) – 0.55 (carb → poly)

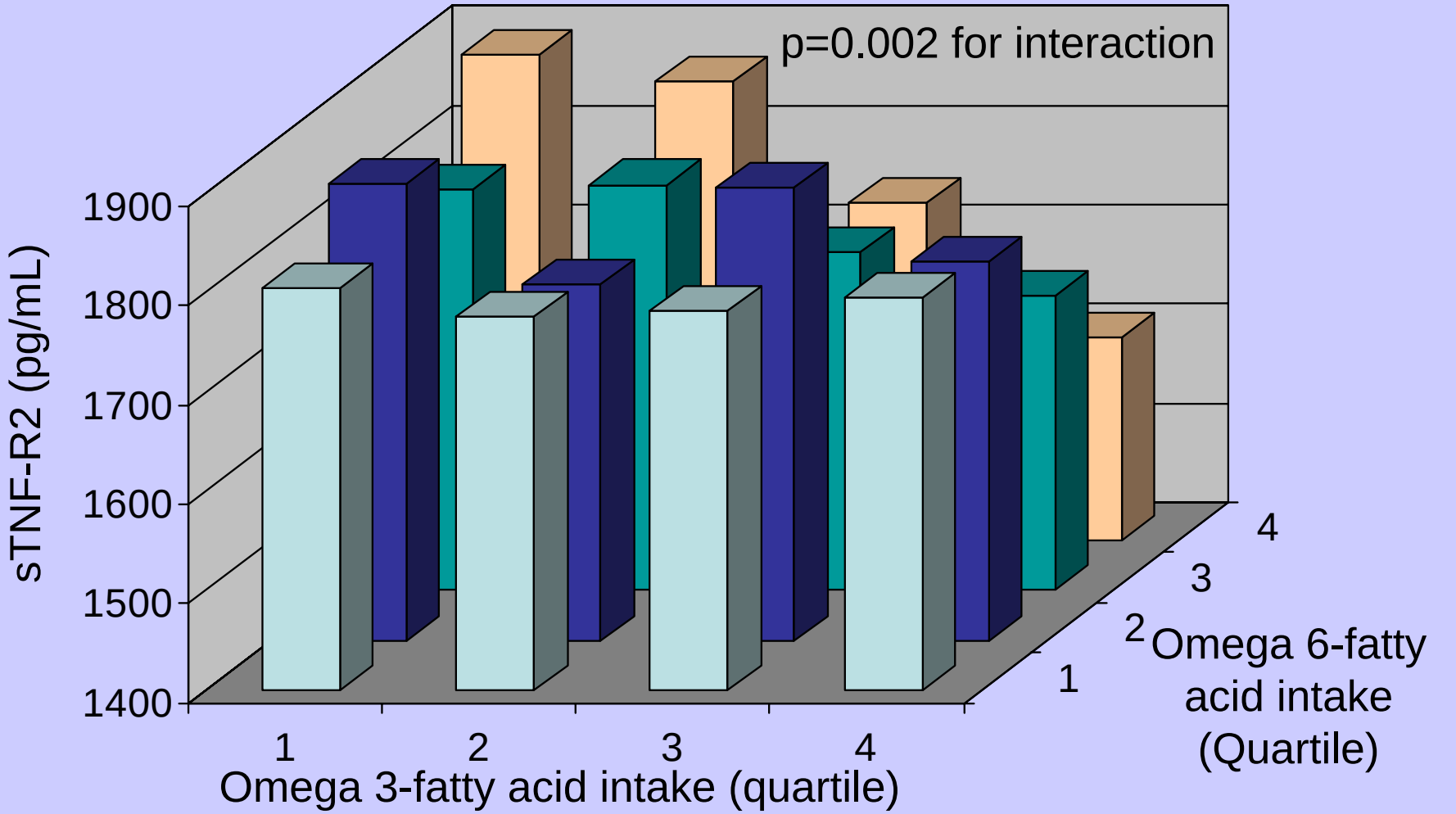
HDL-C = 0.47 (carb → sat) + 0.34 (carb → mono) + 0.28 (carb → poly)

Triglycerides = -2.22 (carb → sat) – 1.99 (carb → mono) – 2.47 (carb → poly)

All equations predict change expected as a result of 1% daily dietary energy intake as carbohydrate replaced by a particular fatty acid. Changes in lipids are in mg/dl.

(Mensink & Katan, 1992)

Association between omega-3 and omega-6 fatty acid intake and inflammation (HPFS+NHS2, n=859)*



*adjusted for age, gender, smoking status, physical activity, alcohol consumption, NSAID, BMI, energy intake, intake of protein, saturated fats, monounsaturated fats, and cholesterol; n=859

Pischon et al, Circulation 2003; 108: 155

Trial of LA (N-6) on Inflammatory Factors

	High LA (N-6)	*Low LA (N-6)*
Percent of Energy	**10.5% E**	**3.8% E**
N-6/N-3	**10:1**	**4:1**
CRP (ng/L)	**0.56 (± 0.15)**	**0.60 (± 0.21)**
IL-6 (ng/L)	**0.96 (± 0.33)**	**0.93 (± 0.30)**
Platelet aggregation	**85 (± 2.51)**	**81 (± 1.63)**

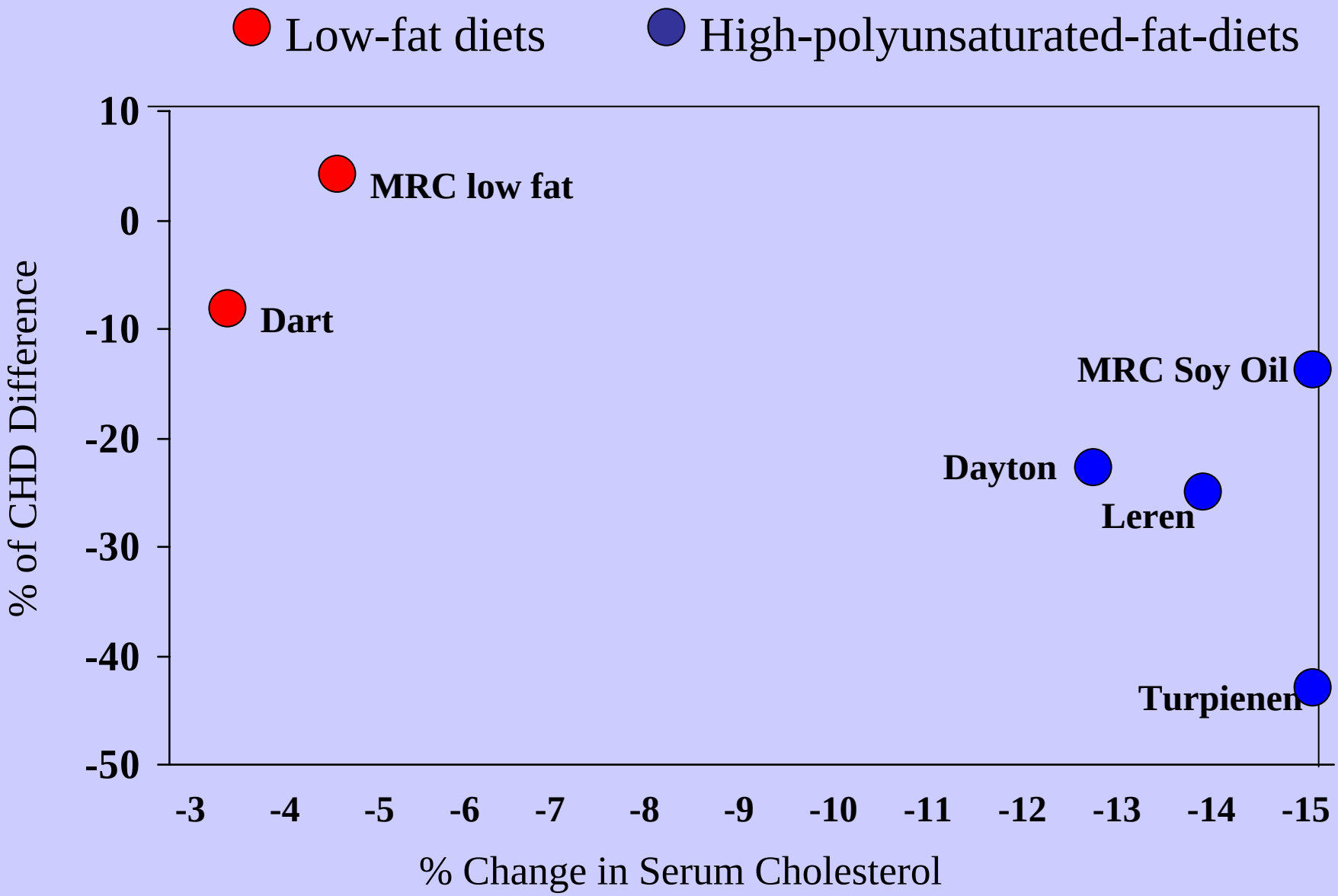
(***Liou YA, J Nutrition 2006***)

The Effect of Dietary Intervention with 5-week Periods of SFA or PUFA Diet in 17 Subjects ± SD

(Summers et al. 2002)

	PUFA Diet	SFA Diet
Body weight (kg)	80.8 ± 3.6	81.2 ± 3.7
BMI (kg/m^2)	29.6 ± 1.6	29.7 ± 1.6
Total cholesterol (mmol/l)	5.0 ± 1.2	5.5 ± 1.4*
HDL-Cholesterol (mmol/l)	1.1 ± 0.27	1.1 ± 0.32
LDL-Cholesterol (mmol/l)	3.1 ± 1.1	3.6 ± 1.2**
Insulin sensitivity ($\mu mol \cdot 1 \cdot mU^{-1} \cdot kg^{-1} \cdot min^{-1}$)	0.64 ± 0.43	0.51 ± 0.35***

*p = 0.001 **p = 0.002 ***p = 0.02

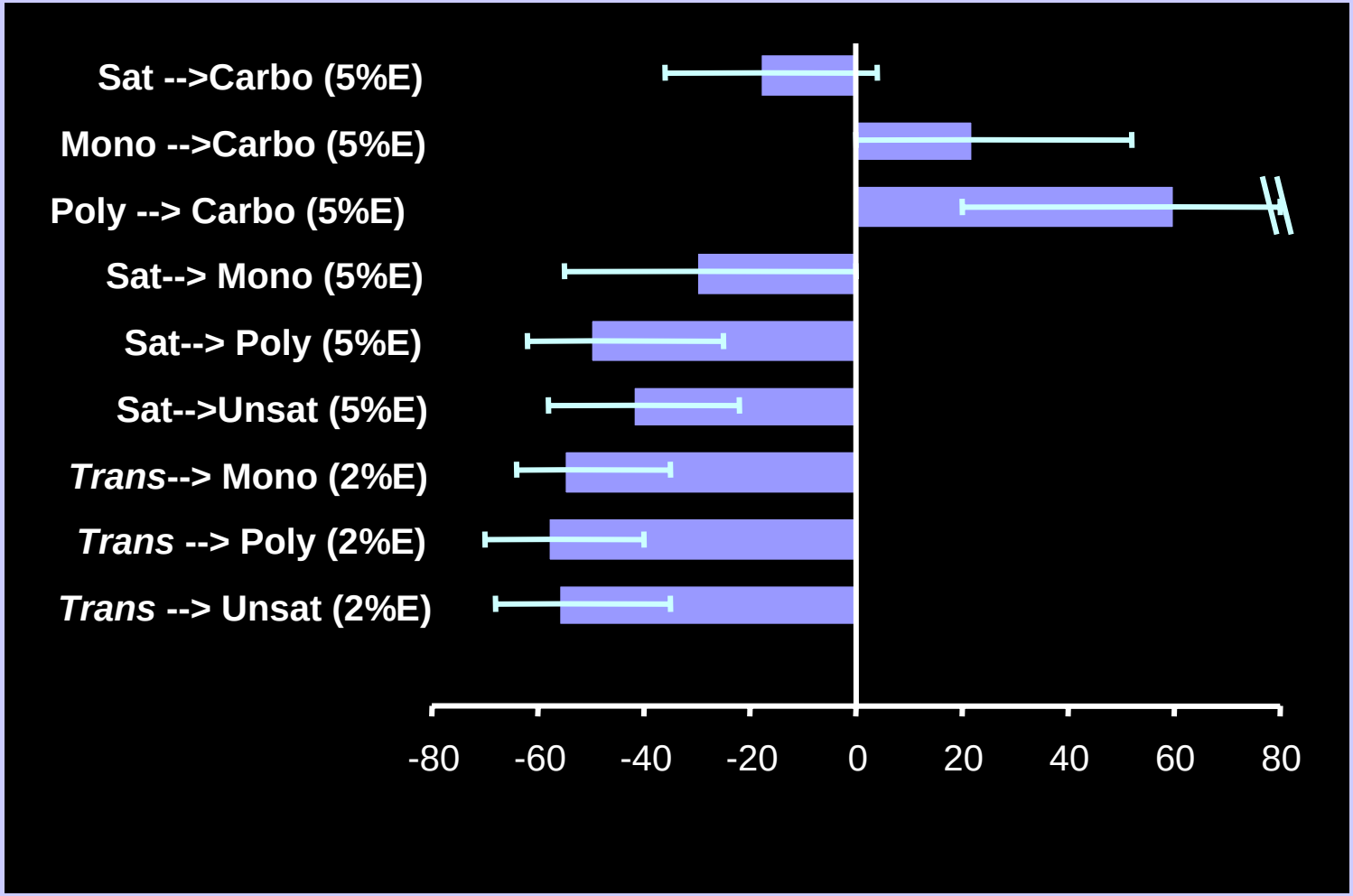

Low-fat diets
High-polyunsaturated-fat-diets
10
0
-10
-20
-30
-40
-50
% of CHD Difference
MRC low fat
Dart
MRC Soy Oil
Dayton
Leren
Turpienen
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
-15
% Change in Serum Cholesterol

(Sacks, 1994)

Prospective Studies of PUFA & CHD
(Summarized in Nutritional Epidemiology, 1998)

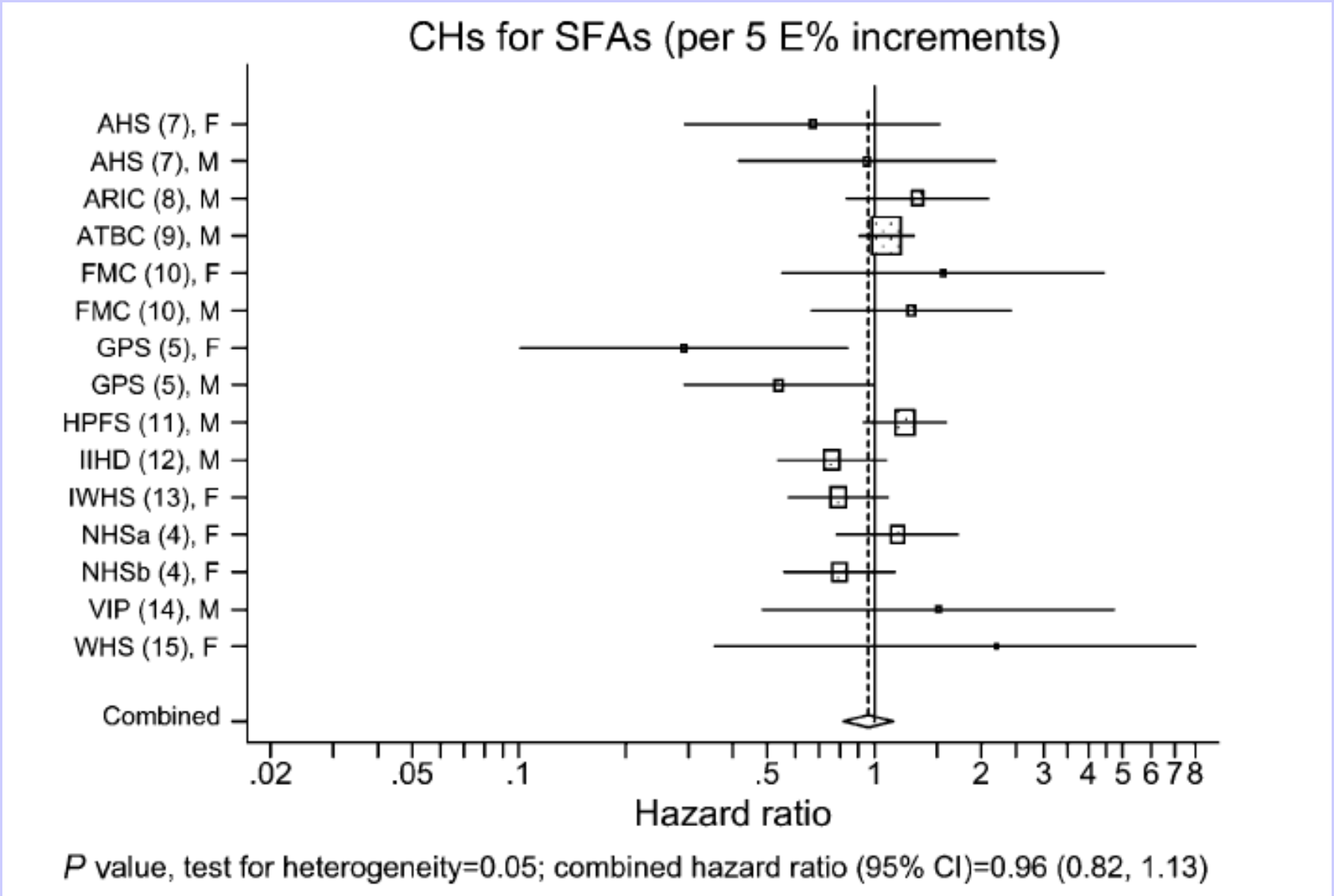
- A significant inverse association was seen in 5 of 13 studies (Shekelle 1981; McGee 1984; Goldbourt 1993; Dolecek 1992; Hu 1997)
- In no study was a positive association observed

Nurses' Health Study
Dietary Fats and Risk of CHD



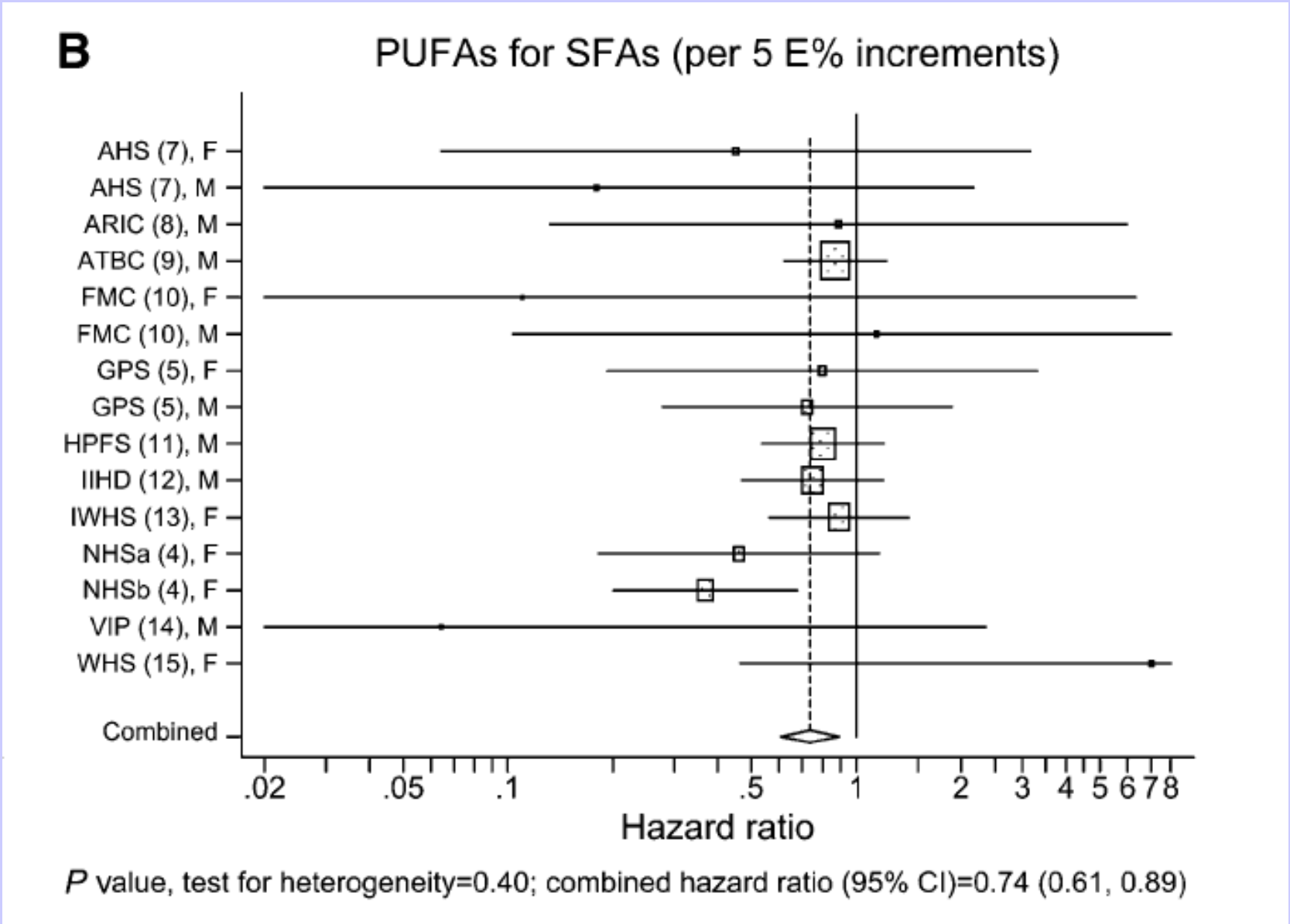
Hu et al, 1997

CHD Mortality



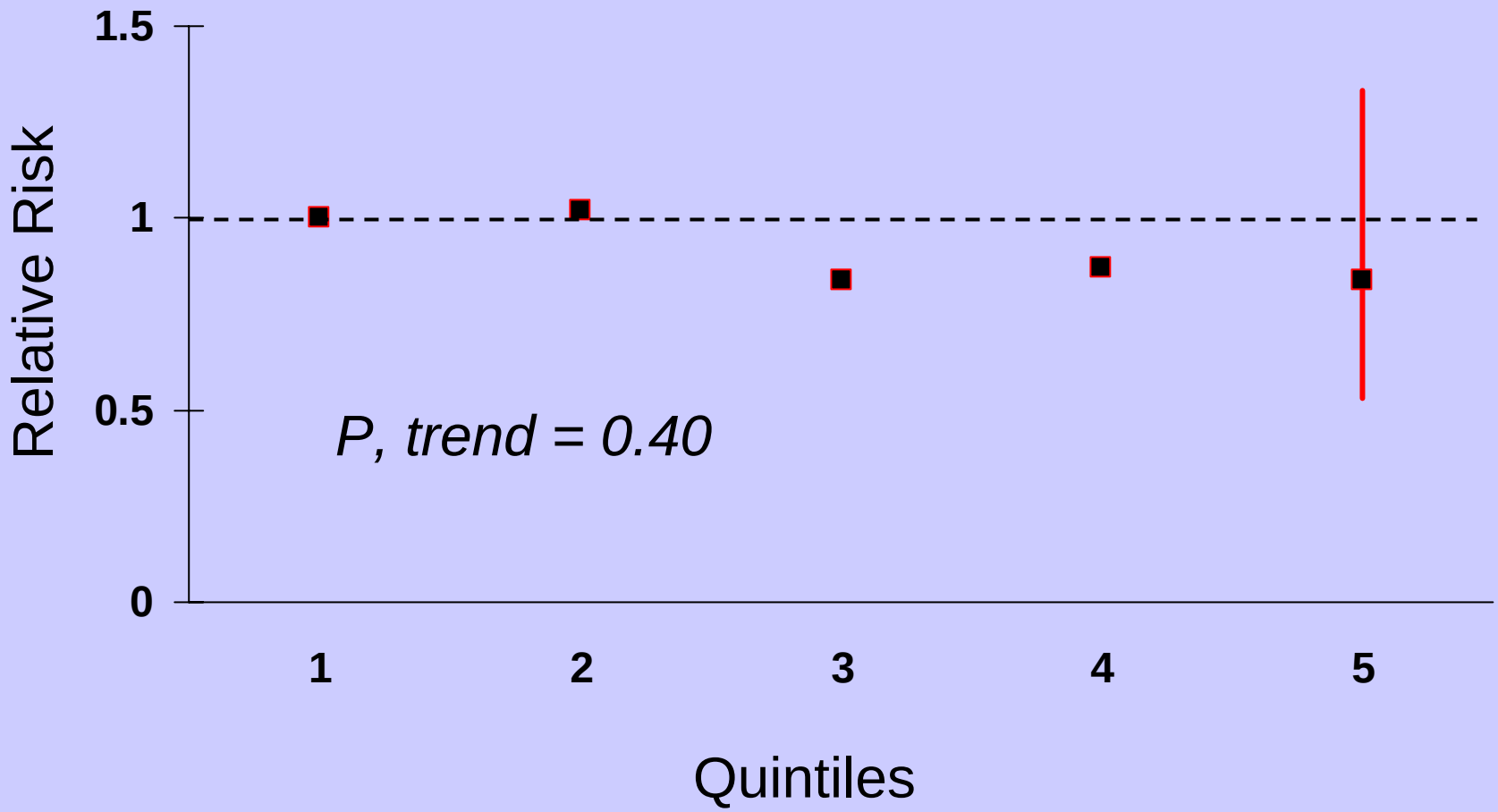
(Jakobsen et al. 2009)

CHD Mortality

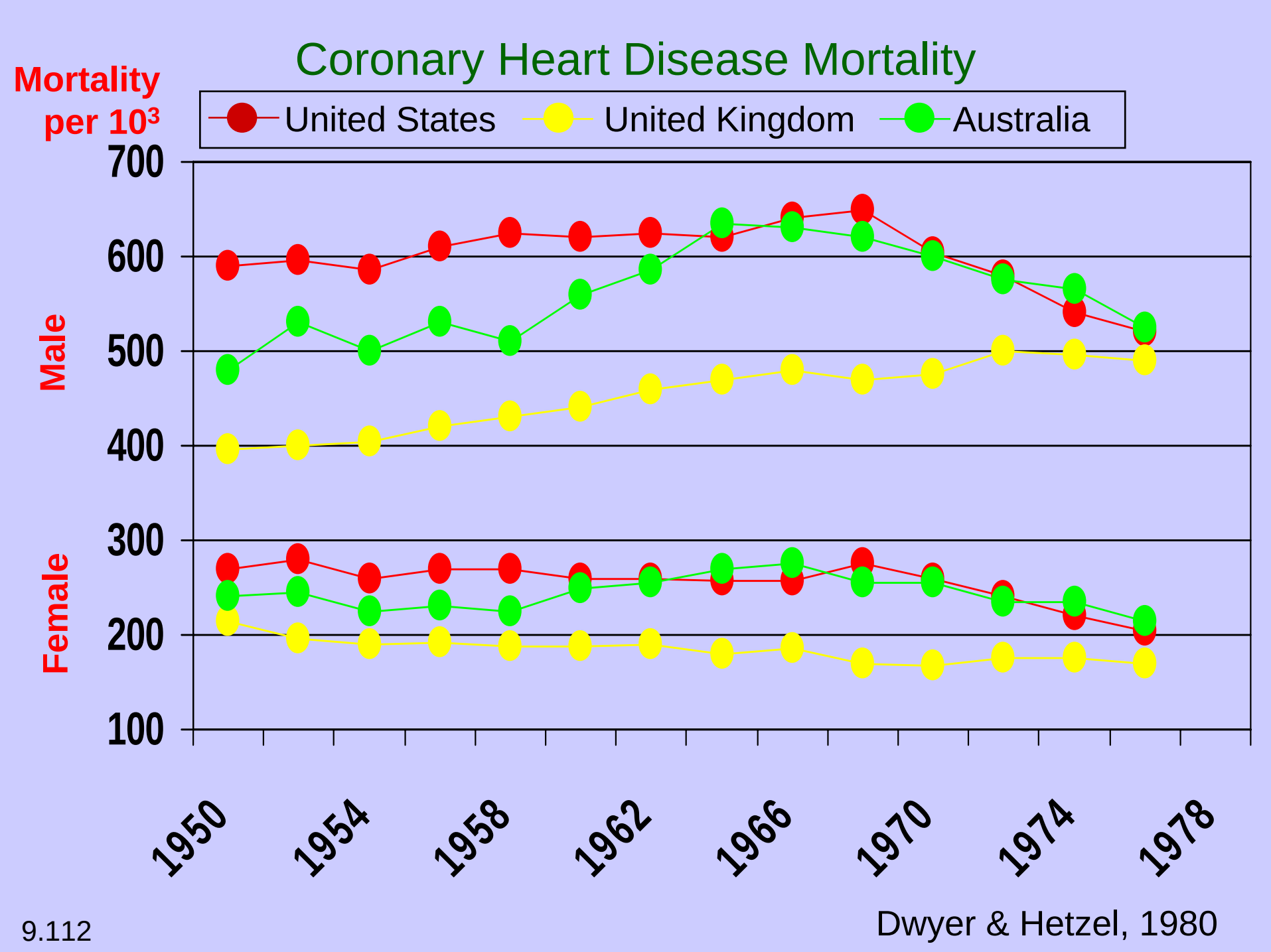


(Jakobsen et al. 2009)

Ratio of ALA to LA & Risk of Fatal CHD in NHS (Hu, F. et al. AJCN 1999)

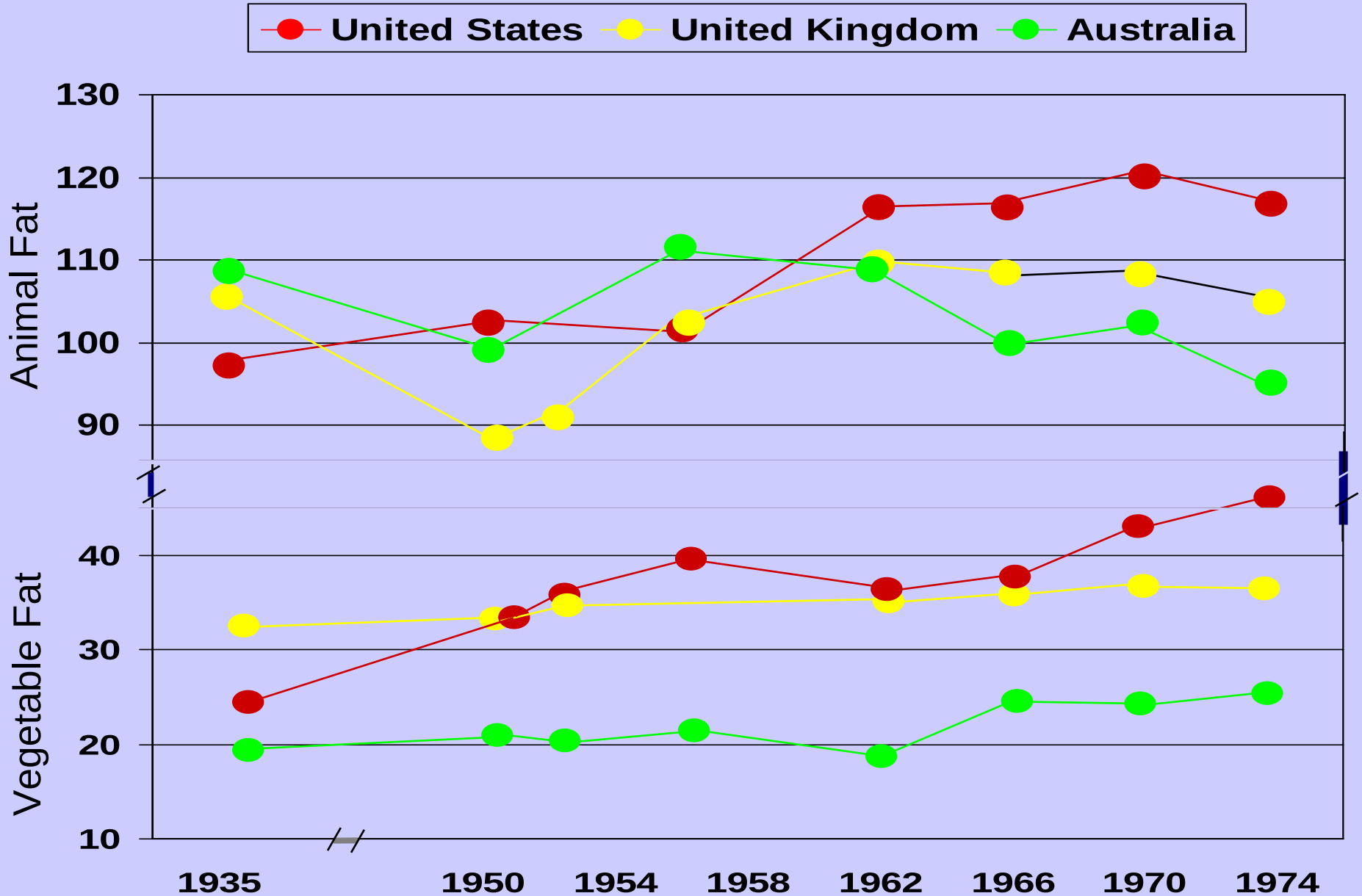


Coronary Heart Disease Mortality



Dwyer & Hetzel, 1980

Consumption of Animal and Vegetable Fat (g/day)



9.113

Dwyer & Hetzel, 1980

Conclusions

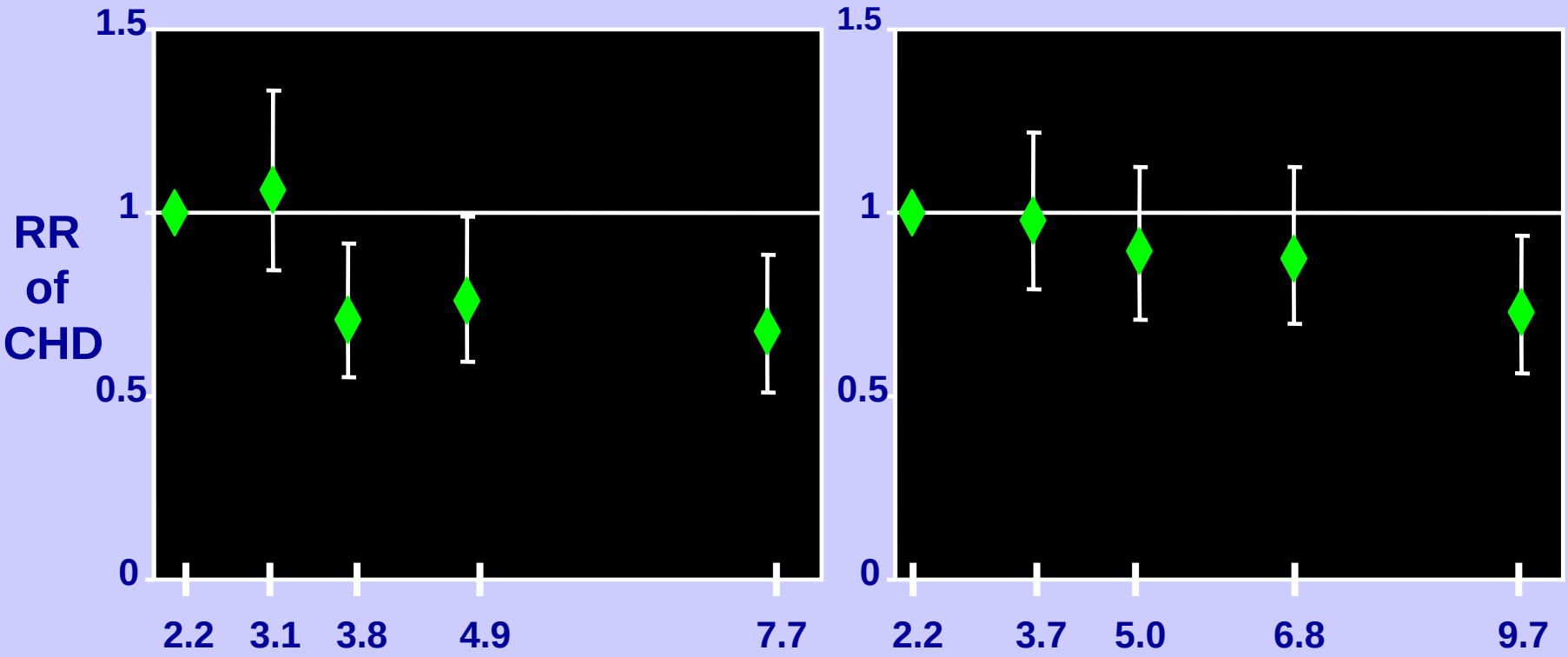
- Both N-3 & N-6 fatty acids are essential
- Ratio of N-6 to N-3 is not helpful
- Many diets are more deficient in N-3 than N-6
- Reducing N-6 to “improve” the ratio is likely to increase the risk of CHD & diabetes
- The upper limit for N-6 is not clear, but up to roughly 10% of total energy intake appears to be increasingly beneficial

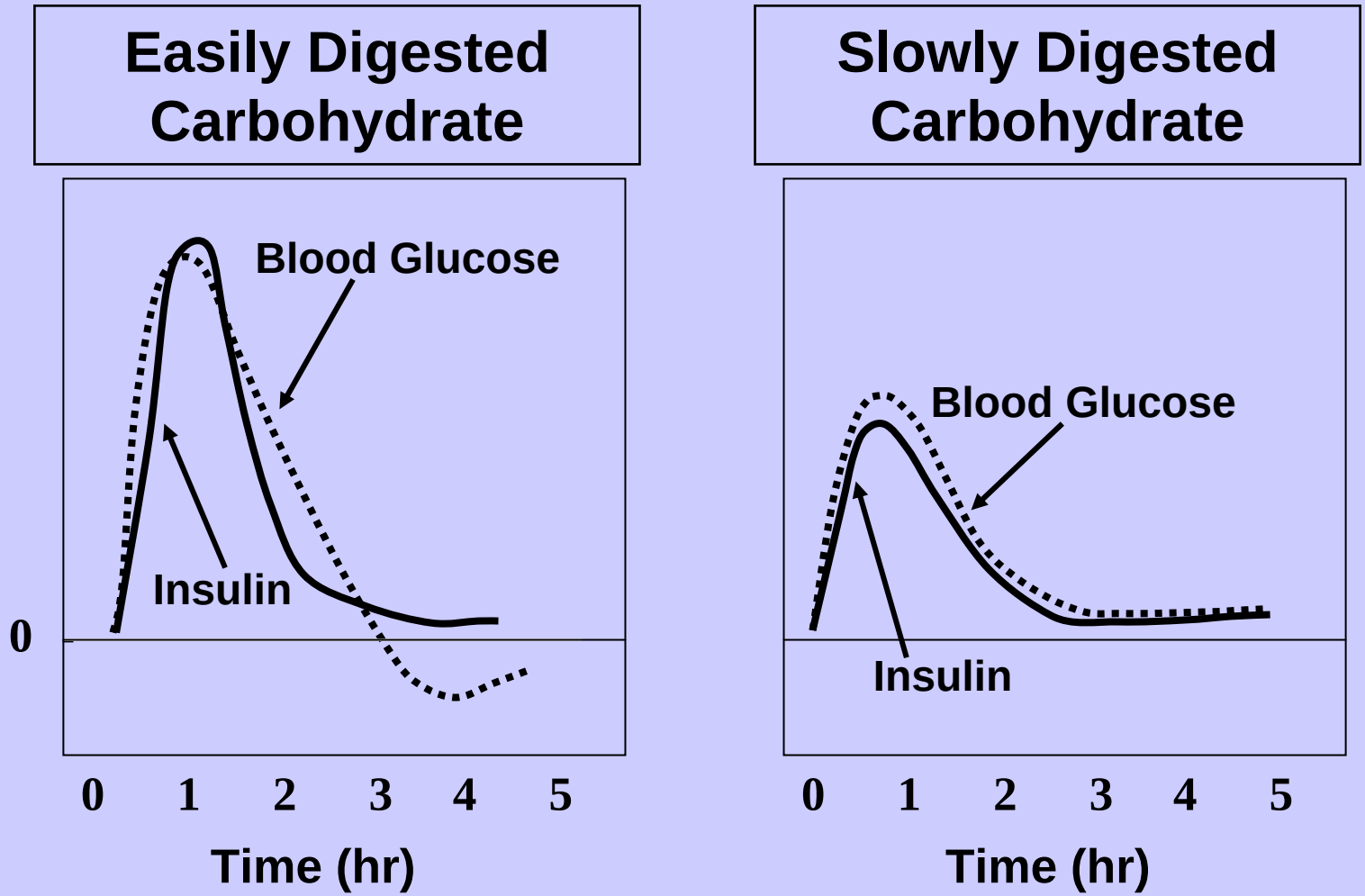
Women (591cases)

Wolk et al. 1999

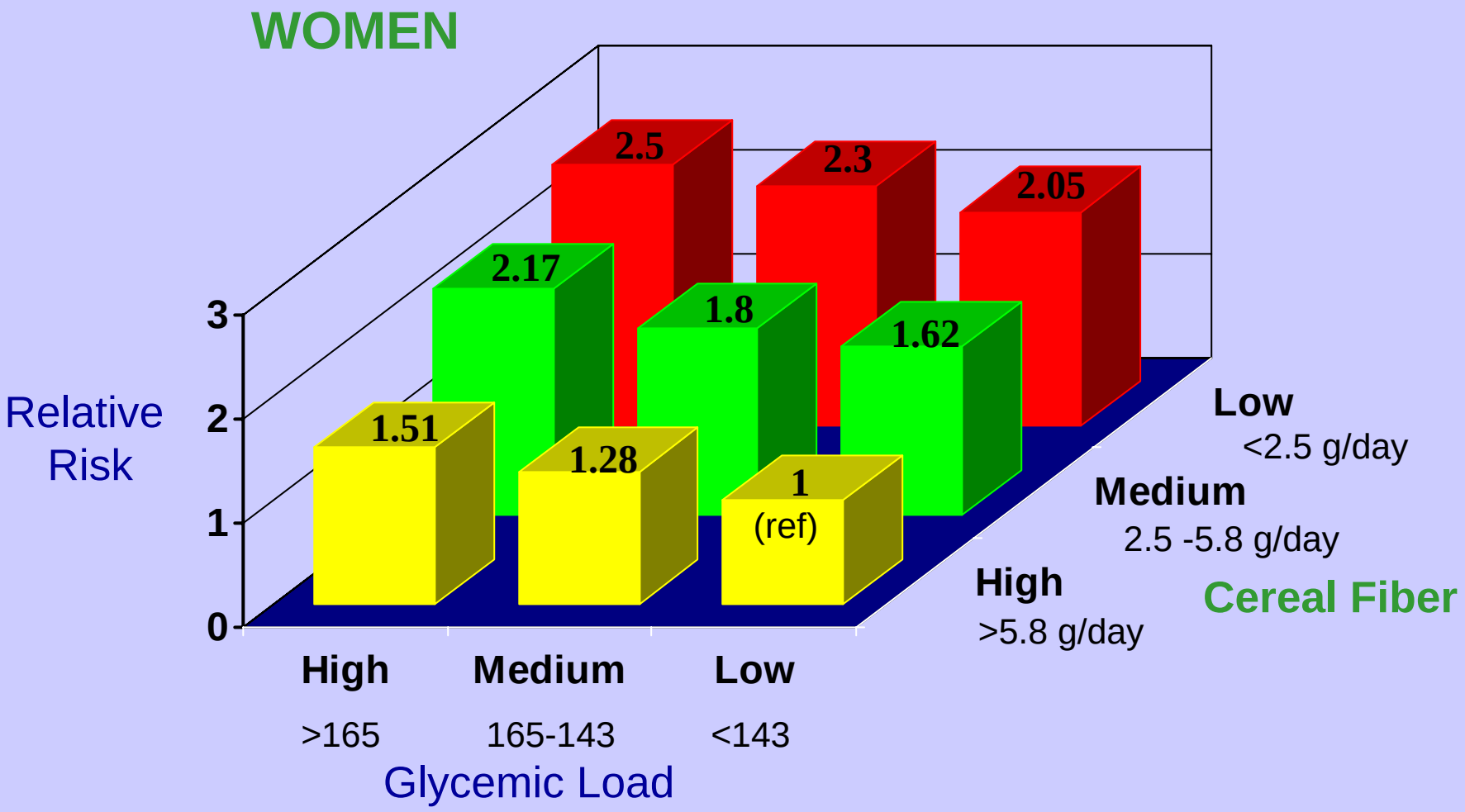
Men (734 cases)

Rimm et al. 1996



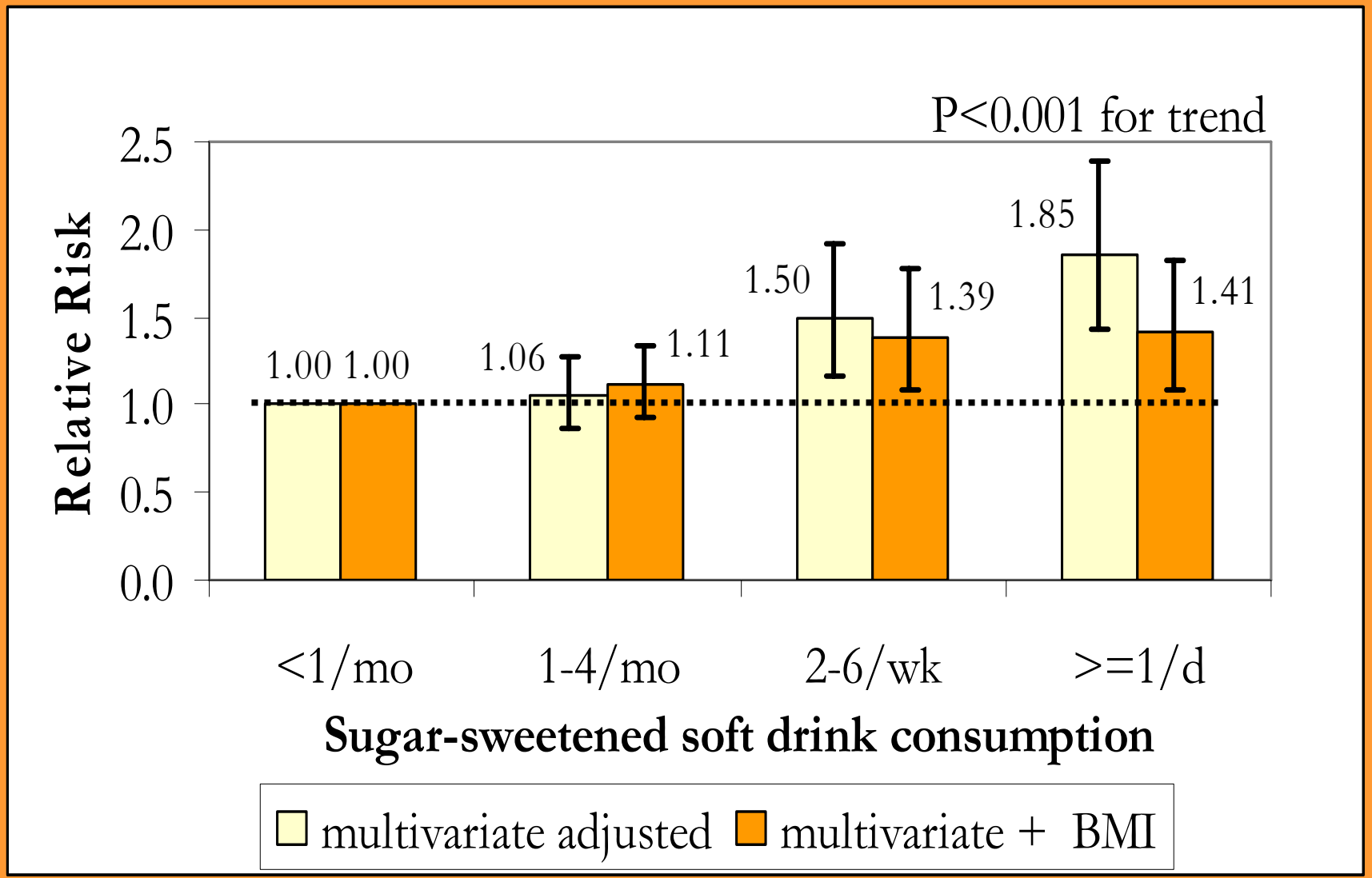

Easily Digested Carbohydrate
Blood Glucose
Insulin
0
0 1 2 3 4 5
Time (hr)
Slowly Digested Carbohydrate
Blood Glucose
Insulin
0 1 2 3 4 5
Time (hr)

Relative Risk of Type 2 Diabetes by Different Levels of Cereal Fiber and Glycemic Load



(Salmeron et al,1997)

Regular Soft Drinks and Type 2 Diabetes, NHS2



(Schulze et al. 2004 JAMA)

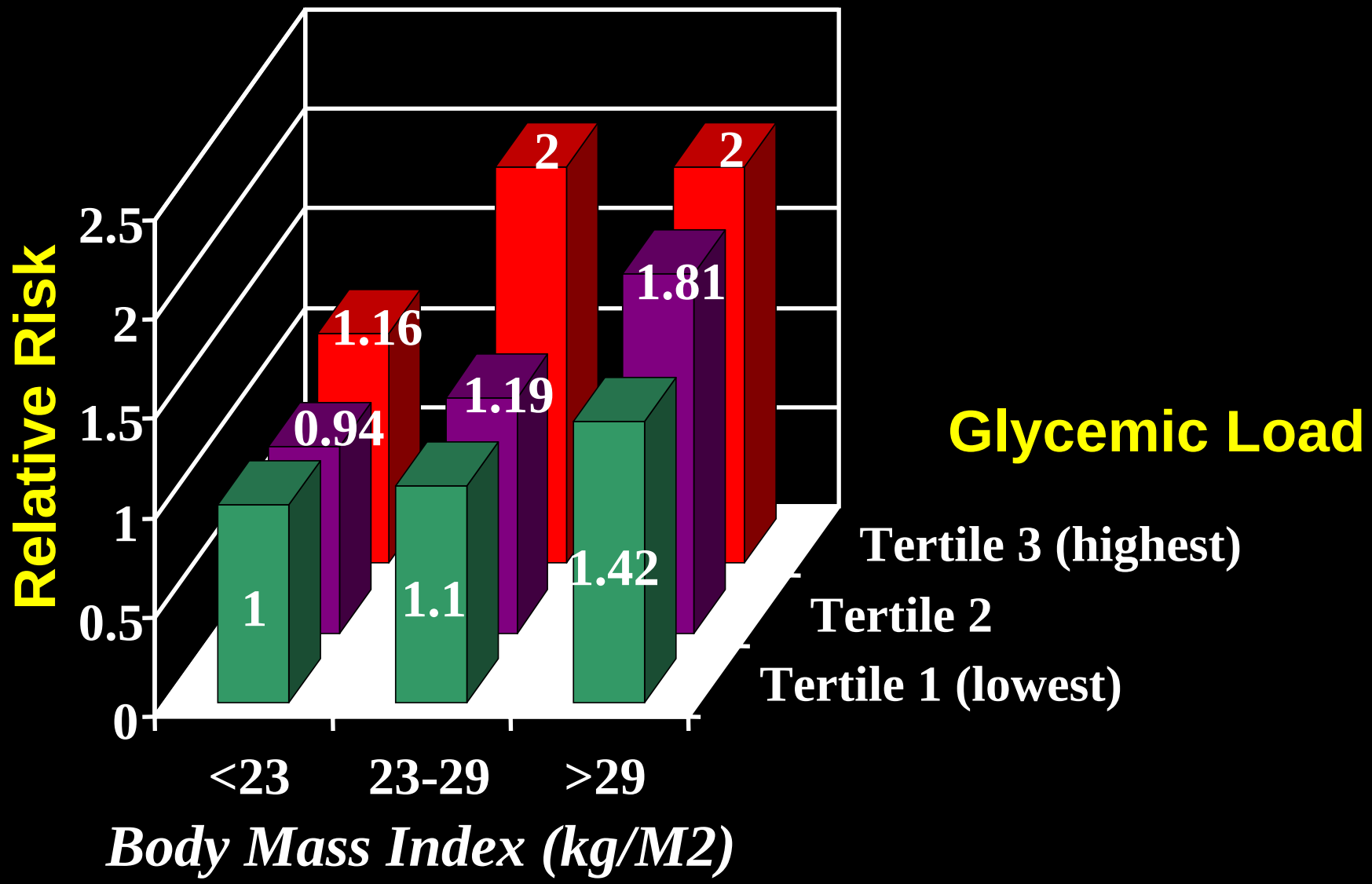
Correlation between baseline insulin resistance and increase in postprandial glucose, insulin, and triacylglycerol after increasing dietary carbohydrate from 40-60% of energy

(n = 10 postmenopausal women)

Variables	***r***	***P***
Glucose	0.68	0.06
Insulin	0.82	< 0.02
Plasma triacylglycerol	0.77	< 0.05

(Jeppesen et al. 1997)

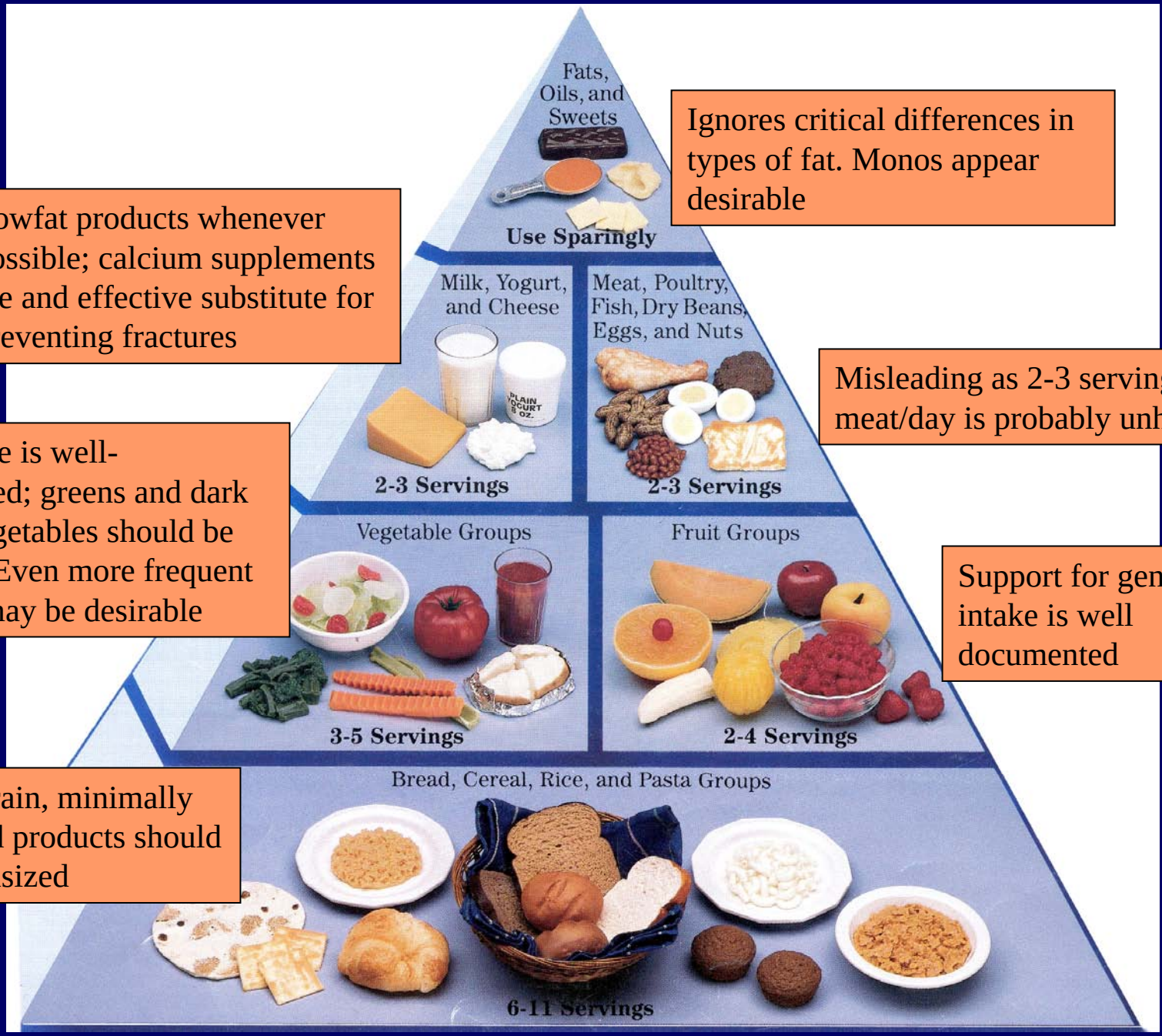
Relative Risk of Coronary Heart Disease



Liu et al., 2000

Optimal macronutrients: Considerations

- Whole grains: CHO: fiber = about 6:1
- for 30 gm of fiber/day, 180 gm CHO = 720 kcal
- For 2500 kcal/day this is about 30% E
- Fruits/vegetables add 10 to 15% carbohydrate, or 40 to 45% E from CHO
- Add 35 to 45% E from fat and 15 to 20% E from protein



Ignores critical differences in types of fat. Monos appear desirable

Lowfat products whenever possible; calcium supplements are and effective substitute for preventing fractures

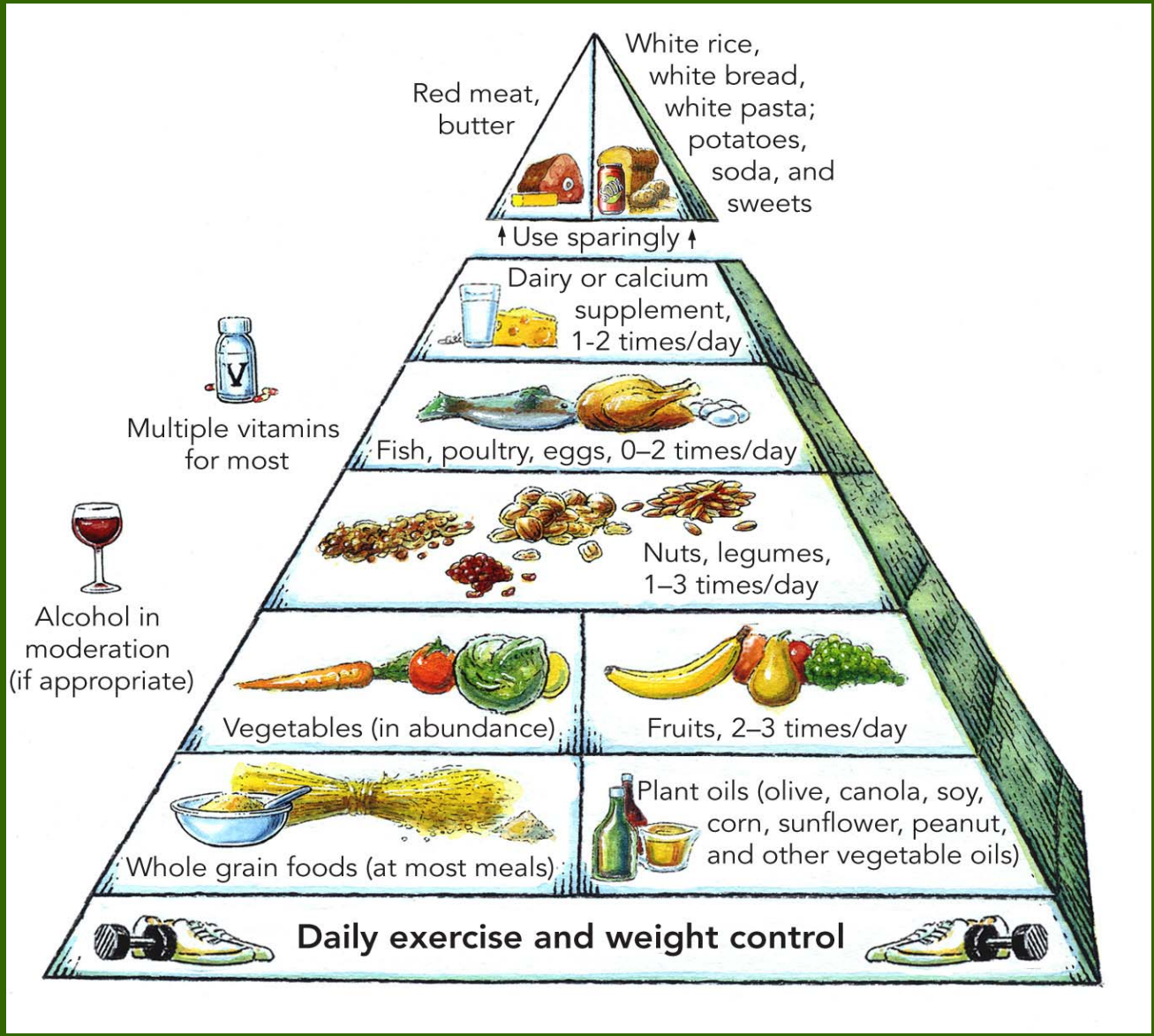
Misleading as 2-3 servings of meat/day is probably unhealthy

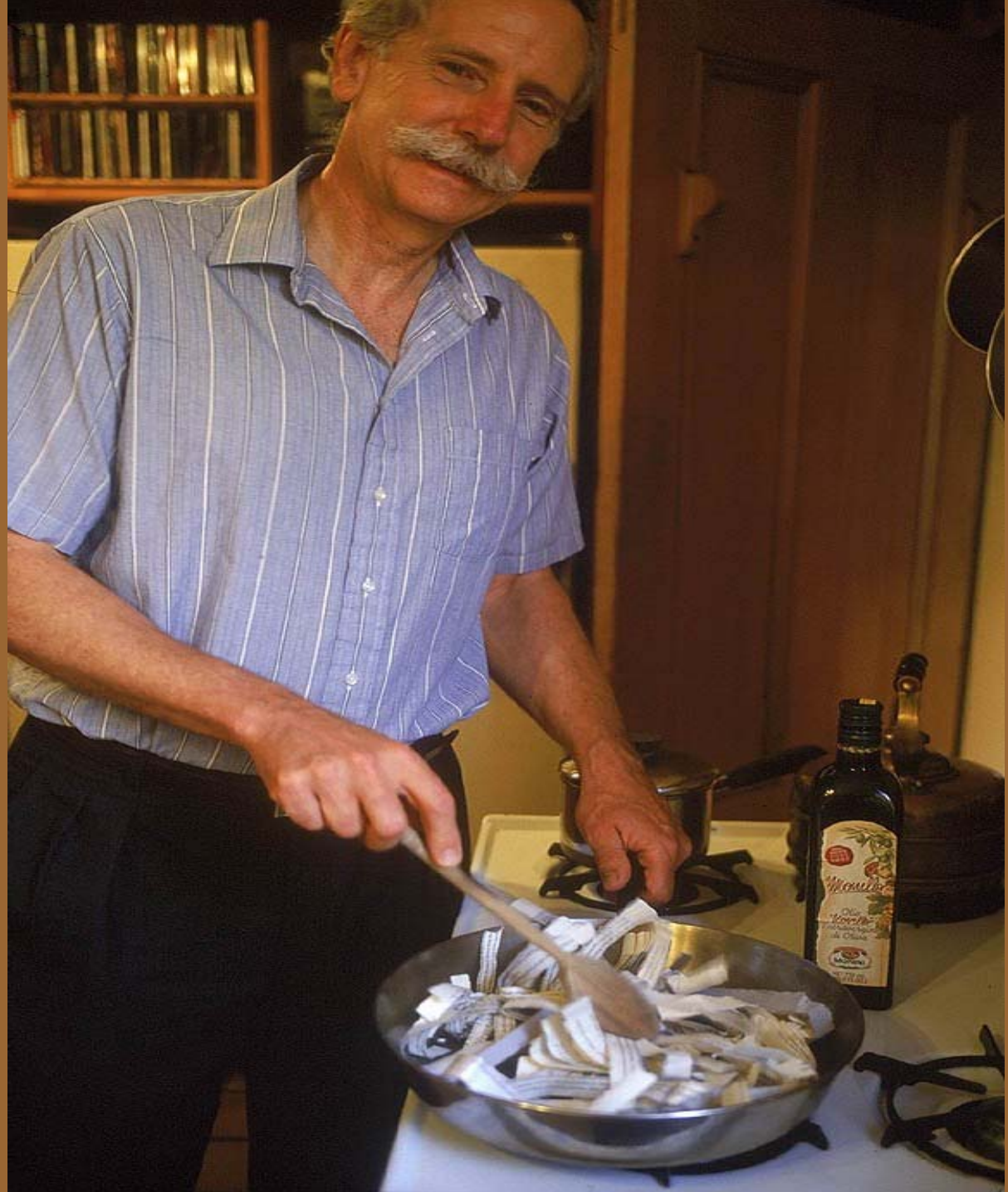
Importance is well-documented; greens and dark orange vegetables should be included. Even more frequent servings may be desirable

Support for generous intake is well documented

Whole-grain, minimally processed products should be emphasized

Healthy Eating Pyramid





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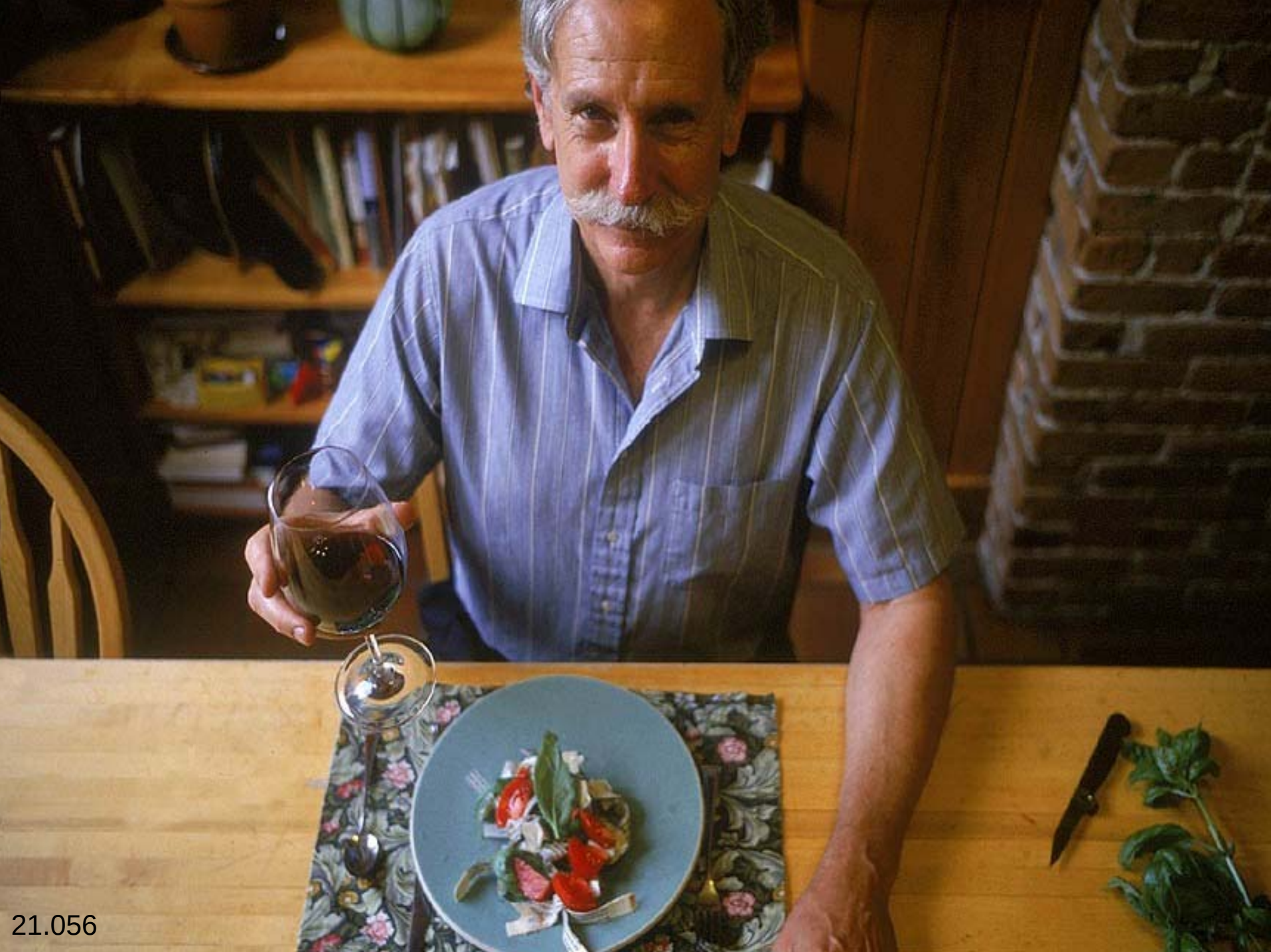

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