
KING'S College LONDON
University of London

# Health and nutritional trends – obesity, nutritional profiling and the omega-3 and omega-6 fatty acid balance

Tom Sanders
Professor of Nutrition & Dietetics
Nutritional Sciences Research Division
King's College London

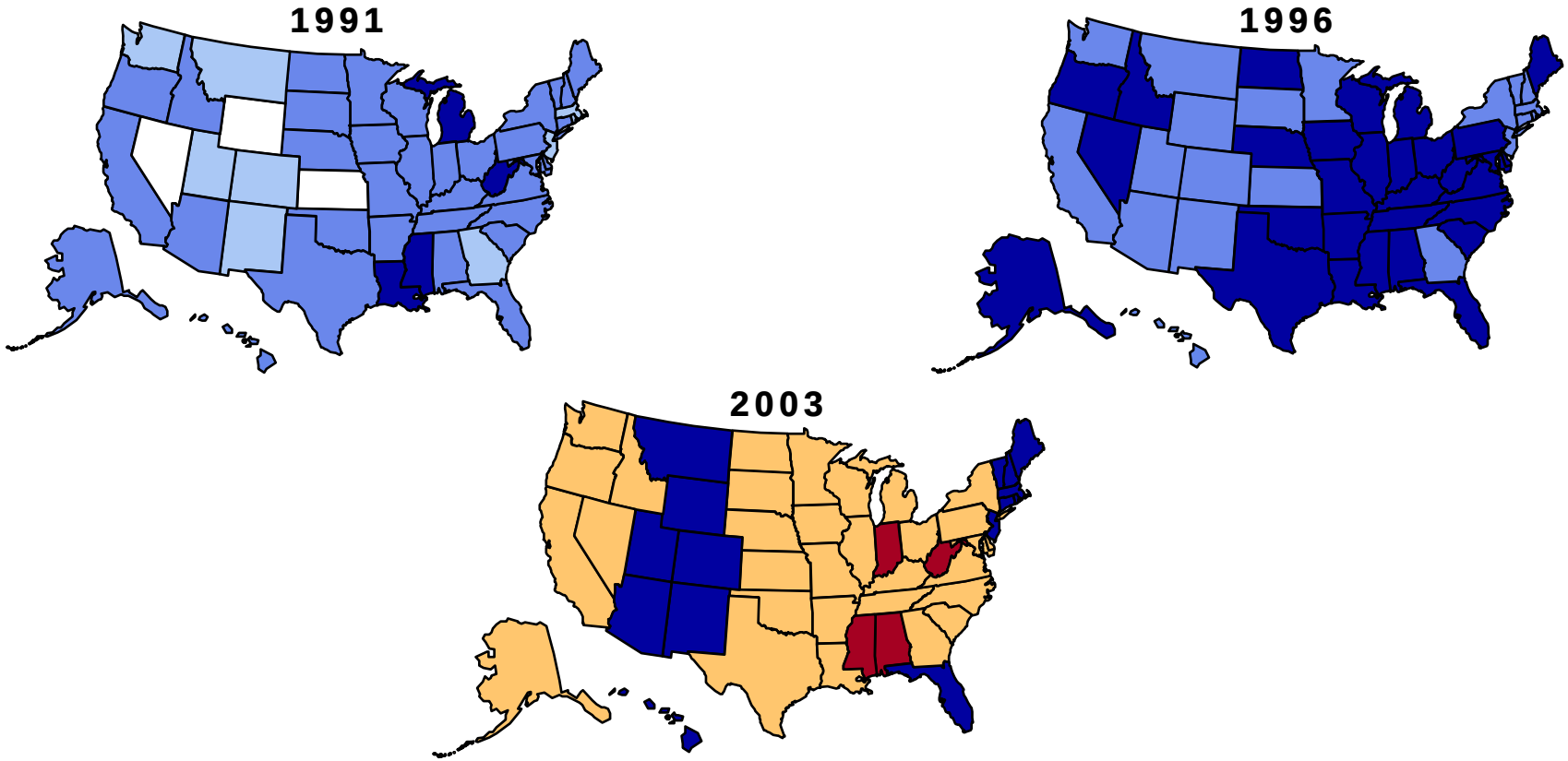
- Fat quantity – obesity

- Fat quality – cardiovascular disease

# Obesity Trends* Among U.S. Adults

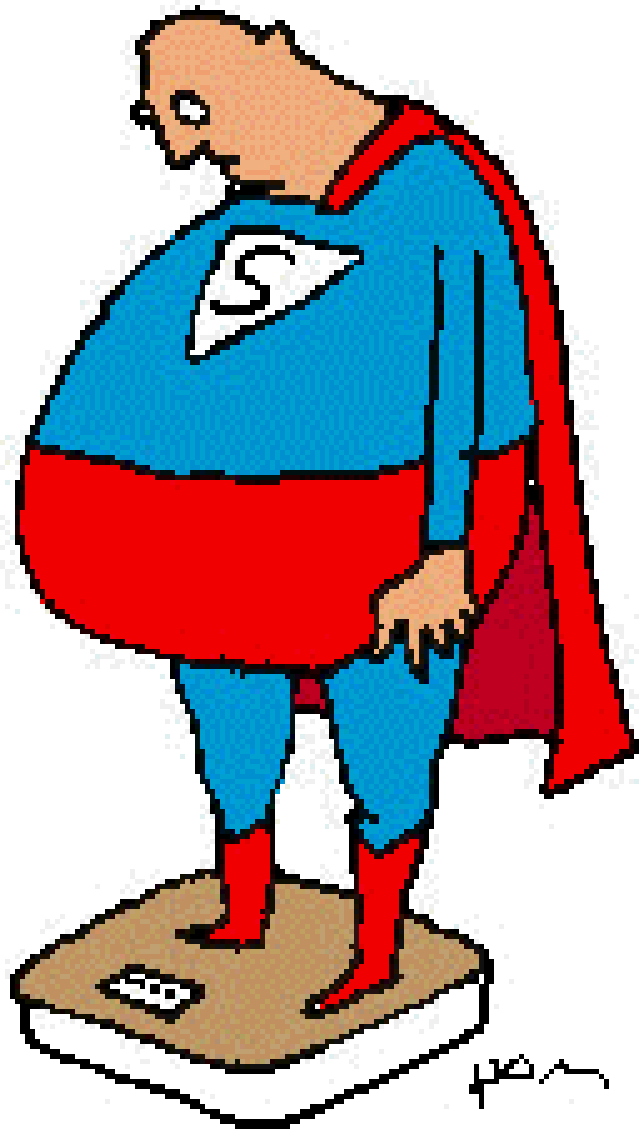
## BRFSS, 1991, 1996, 2003

**(*BMI ≥30, or about 30 lbs overweight for 5'4" person)**

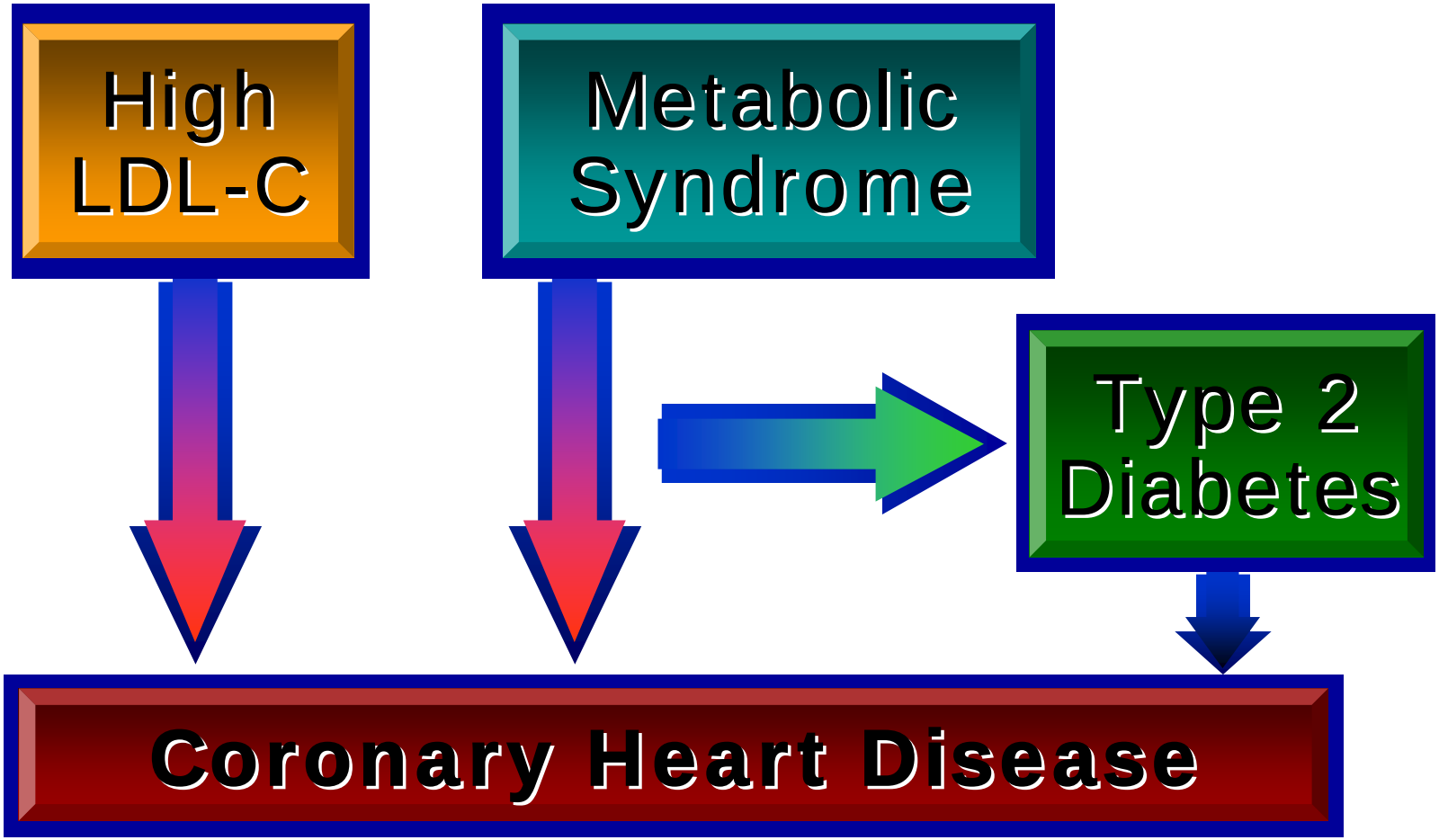



Source: Behavioral Risk Factor Surveillance System, CDC.

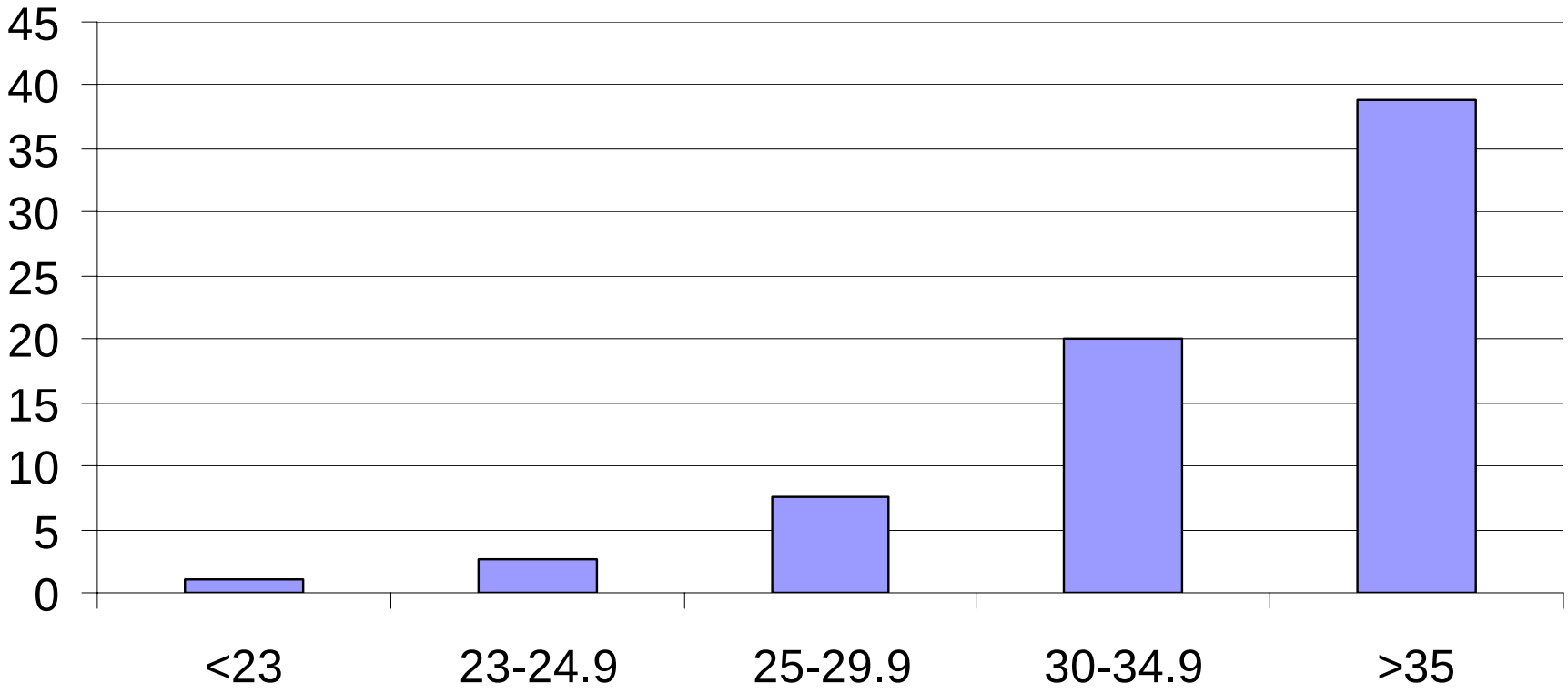
- Storing fat in the wrong place
- Metabolic syndrome



# Fat patterning associated with metabolic syndrome


High LDL-C
Metabolic Syndrome
Type 2 Diabetes
Coronary Heart Disease

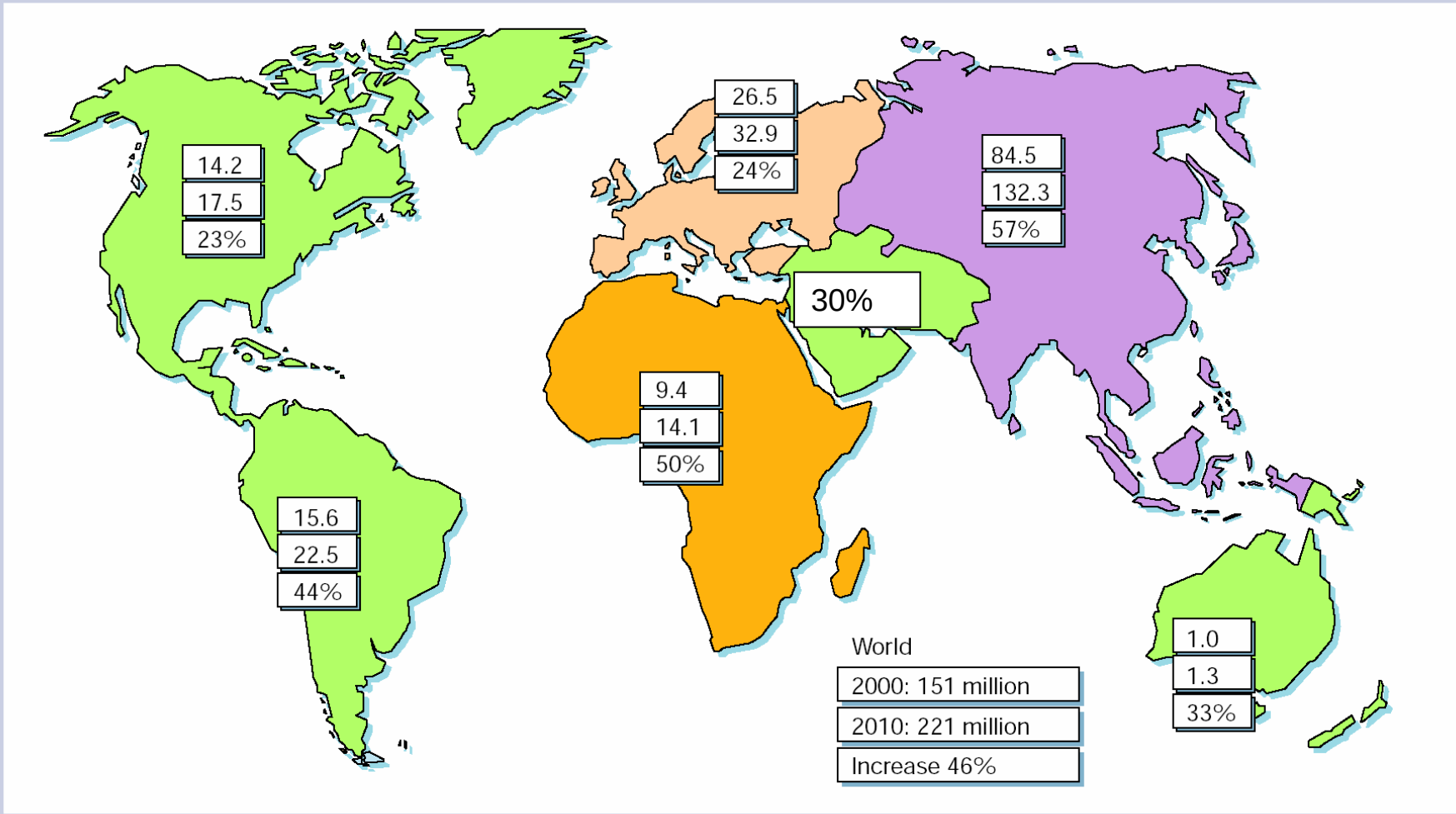
# Relative Risk of Diabetes with increasing BMI



# Obesity and metabolic syndrome

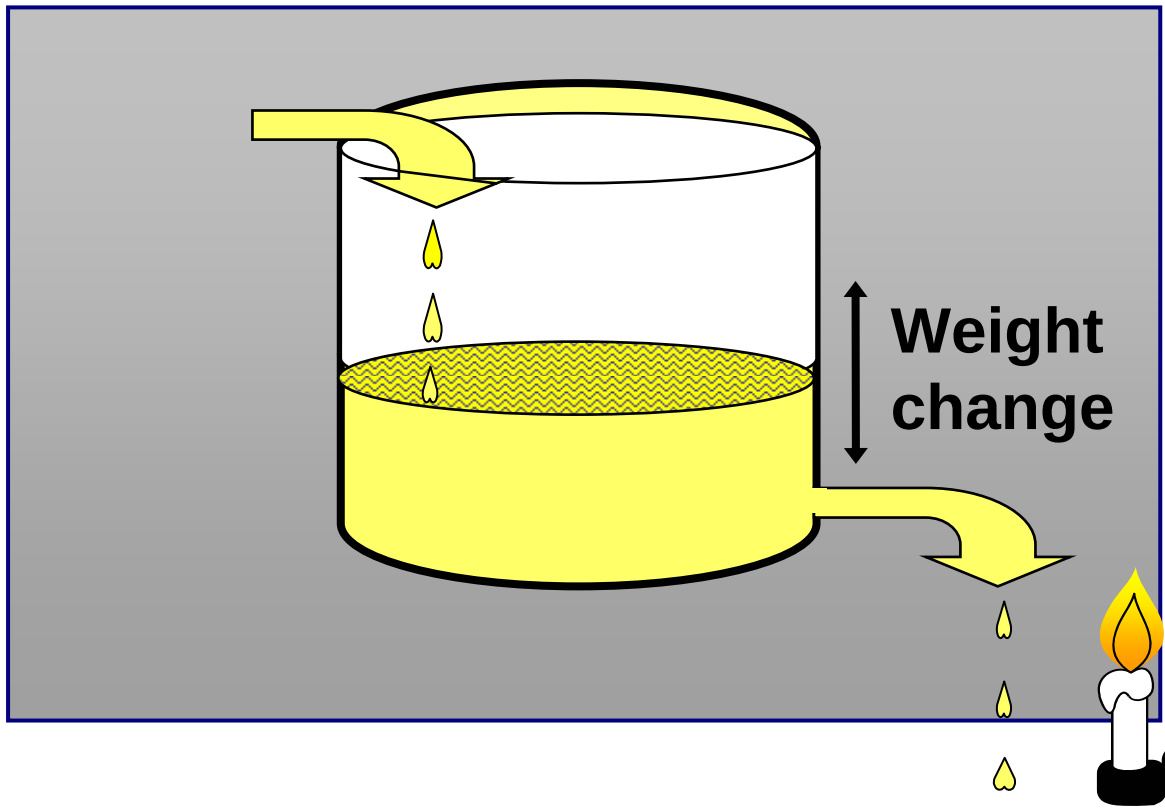
- Obesity contributes to causing metabolic syndrome
- Physical activity is protective
- A diet high in rapidly absorbed carbohydrate (both starch and sugar) makes metabolic syndrome worse

**Figure 1** Numbers of people with diabetes (in millions) for 2000 and 2010 (top and middle values, respectively), and the percentage increase. Data adapted from ref. 2.



# • Energy Balance = Intake - Expenditure

**Energy intake**
**(food)**




**Energy expenditure**
**(metabolism, activity)**

# Is obesity a genetic disorder?

- Precocious obesity under the age of 5 usually has a genetic cause

- Common obesity in teenagers and adults is life-style acquired

# Leptin Therapy: From mice to humans


**Left: Ob mouse 6 weeks post leptin therapy**
**Right: Ob mouse 6 weeks post saline injections**

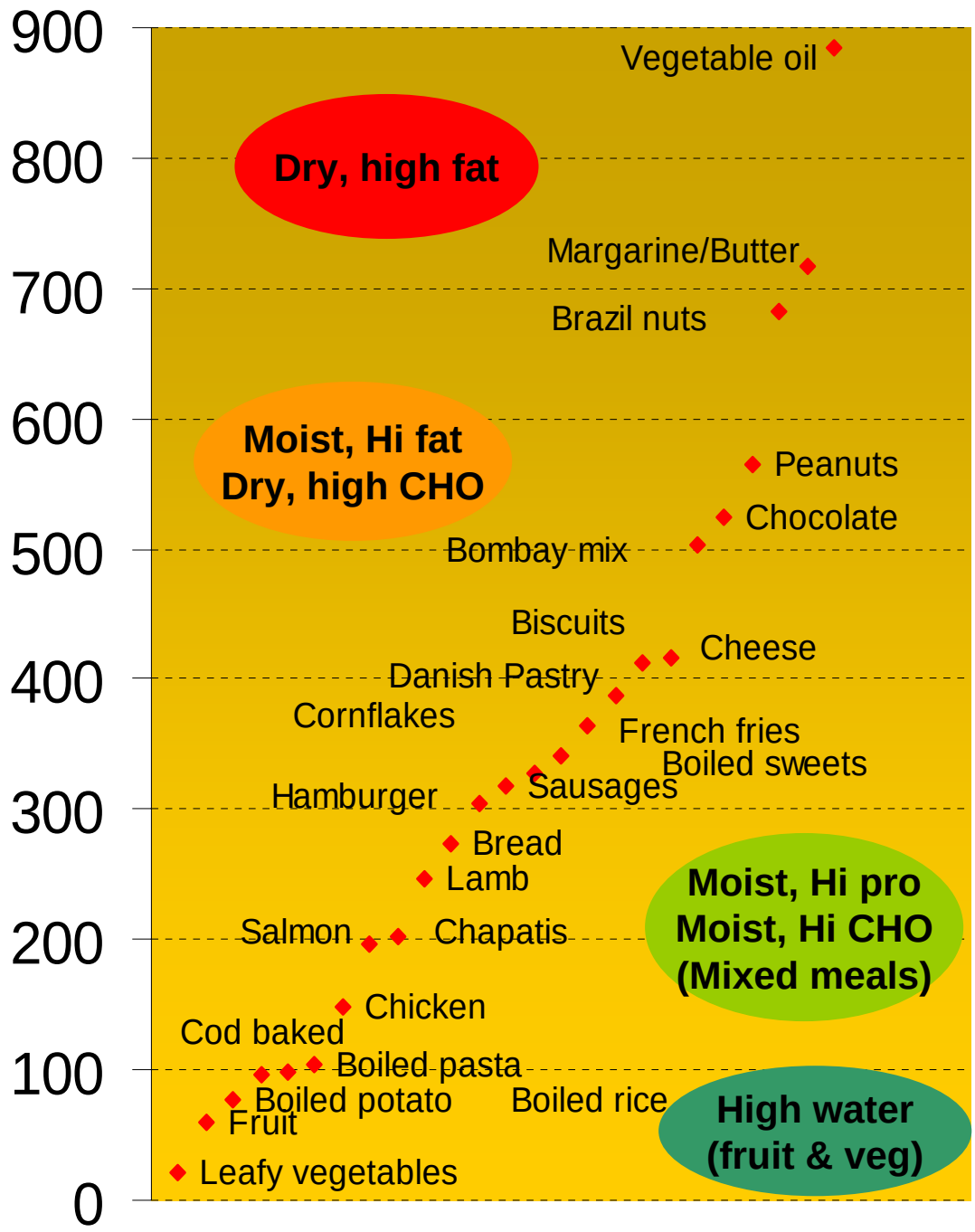
Murphy, J. E. et al. (1997). Proc Natl Acad Sci U S A **94**(25): 13921-6.

**A child with a mutation in the leptin gene before and after leptin therapy**

Farooqi, I. S. and S. O'Rahilly (2004). Recent Prog Horm Res **59**: 409-24.

# Causes of common obesity

- Access to high energy density food
- Low levels of physical activity



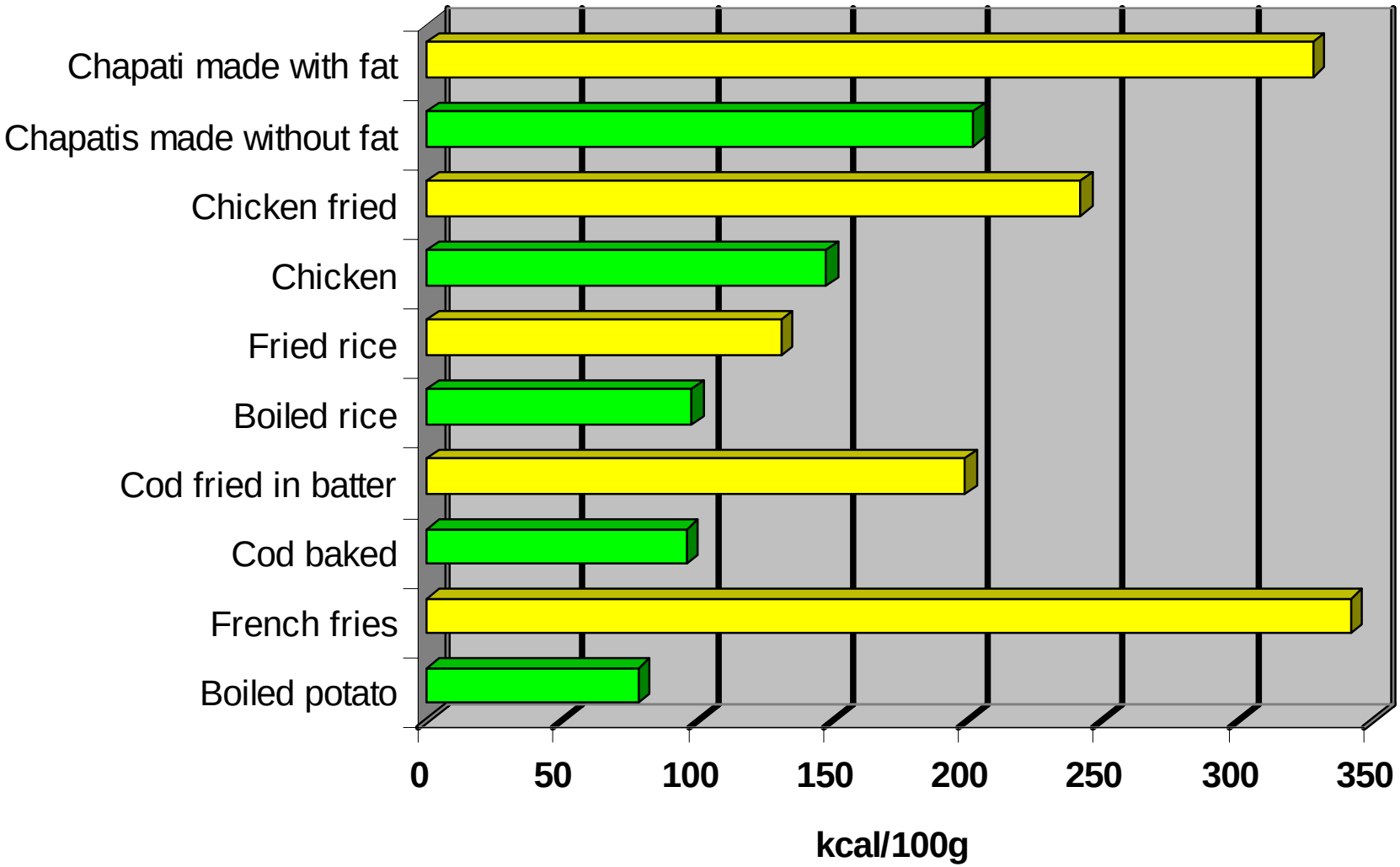

**Energy density (ED) = kcal/100g**

**•a major factor in appetite control**

**•diets based on lower ED foods -> less weight gain risk**

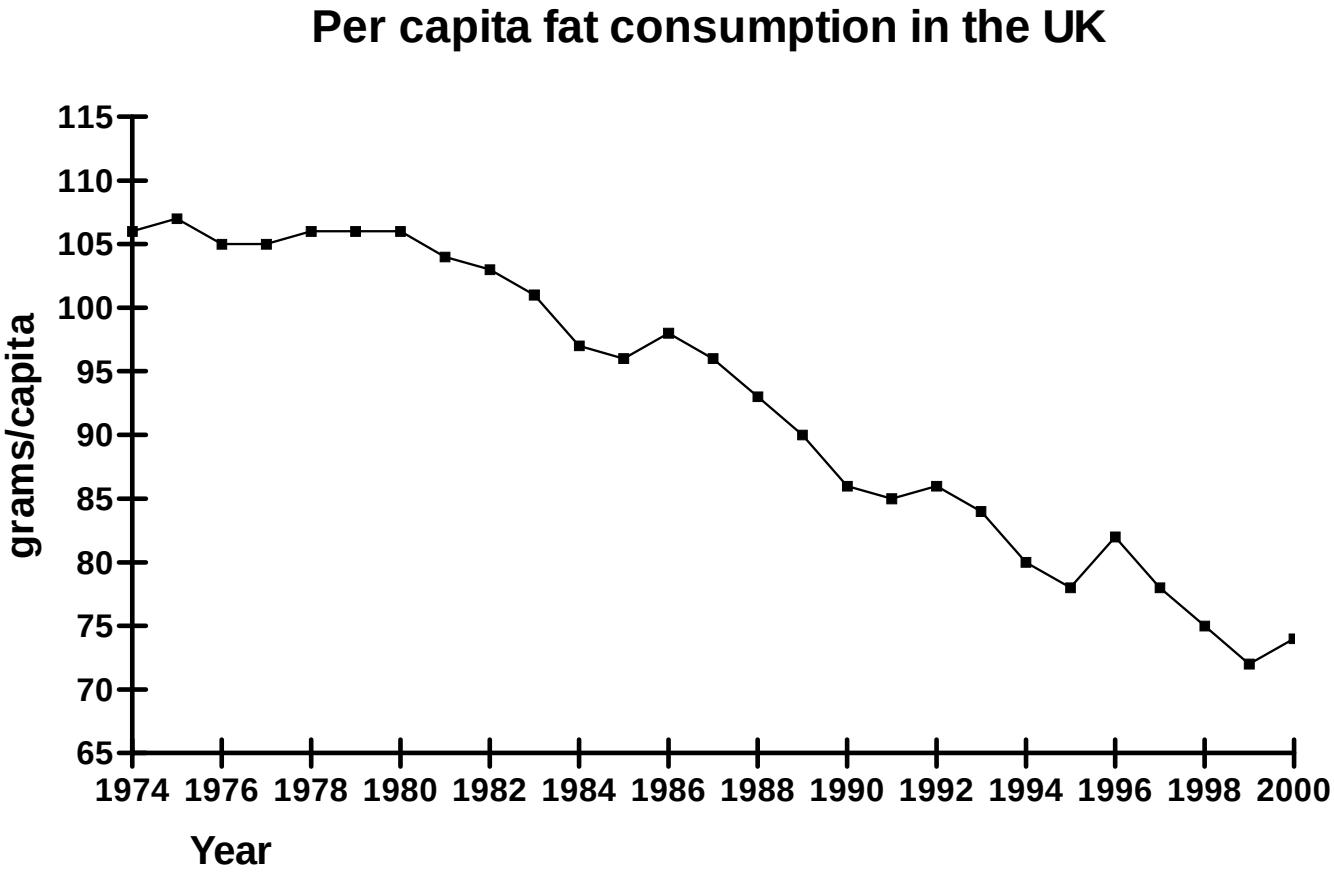
**<u>Diet</u> ED <150 kcal/100g appears desirable for weight control**

# Effect of fat additions on energy density




COOKING
OIL
What goes into crisps
goes into you.
Some crisps contain 33% cooking oil. bhf.org.uk
British Heart
Foundation

# Total fat consumption has not increased during the obesity epidemic



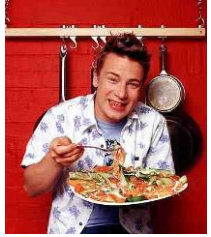

**Source: UK Nation Food Survey**

# National Dietary and Nutritional Survey

| | Men | | Women | |
|---|---|---|---|---|
| | **1986/87** | **2000/2001** | **1986/87** | **2000/2001** |
| Energy (MJ) | 10.3 | 9.72 | 7.05 | 6.87 |
| Fat % food energy | 40.4 | 35.8 | 40.3 | 34.9 |
| SFA | 16.5 | 13.4 | 17 | 13.2 |
| Trans | 2.2 | 1.2 | 2.2 | 1.2 |
| PUFA | 6.2 | 6.4 | 6.1 | 6.3 |

# The fat gap

- Obesity is rapidly increasing globally
- No evidence from N America or Europe to show fat intakes are increasing (the opposite is true)
- But vegetable oil production has increased markedly



**Slow Food** → ***Fast Food***

**High skill base, time consuming, "food" focused**

**Convenient social**

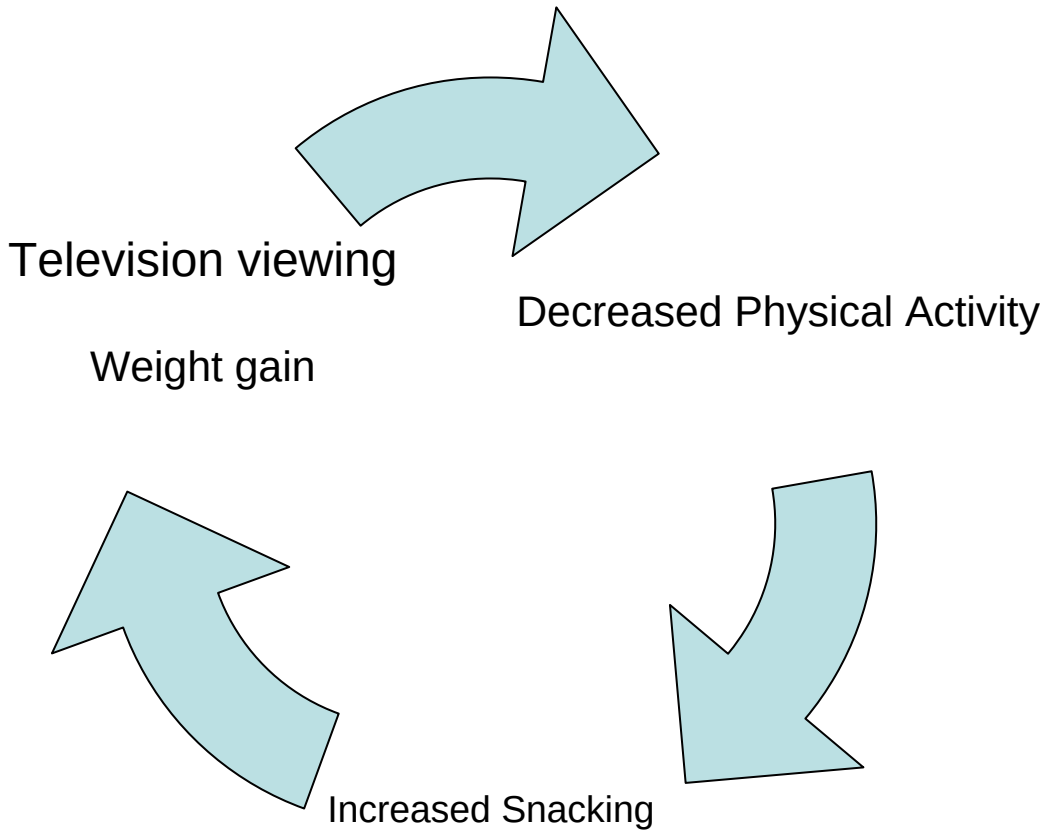
| SCRATCH COOKING | COMPONENT COOKING | READY MEALS | TAKE-AWAYS | SNACKING 'ON THE HOOF' | DELIVERY | QSR | RESTAURANT |
|---|---|---|---|---|---|---|---|
| e.g. primary products, traditional grocery | e.g. prepared vegetables, prepared meat/fish, sauces, pizza | | | e.g. Sandwiches, Sushi | | | |

Physical activity →

Physical inactivity



Photo: Avi Gerver


Television viewing
Decreased Physical Activity
Increased Snacking
Weight gain


Pringles
SOUR CREAM & ONION
Salted
MIXED NUTS
مكسرات مملحة
Pringles
ORIGINAL
After Eight
THIN CHOCOLATE MINTS
Lindt
SWISS CLASSIC
MILK
EXTRA FINE
chocolate
Spearmint
ROLLUP
Galaxy
Duetto
Galaxy
Fruit & Nut
mentos
mint
SNICKERS
TOBLERONE
ROASTED NUTS EX
الوزن الصافي
٥٠ جرام
Net weight

# Quality of fat

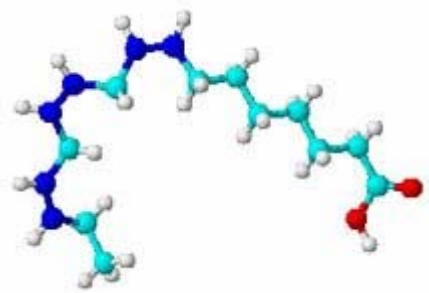

All-*cis* unsaturated fatty acids

Saturated fatty acids lauric, myristic and palmitic

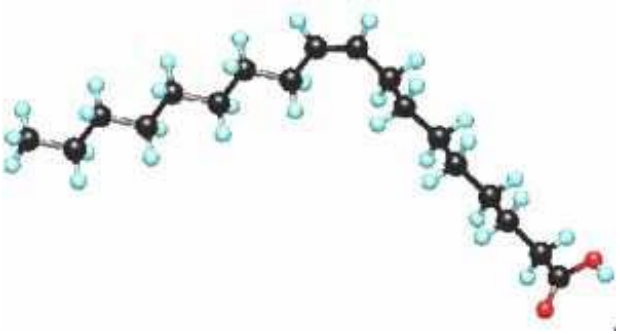
*Trans* fatty acids

# Types of Fatty Acid

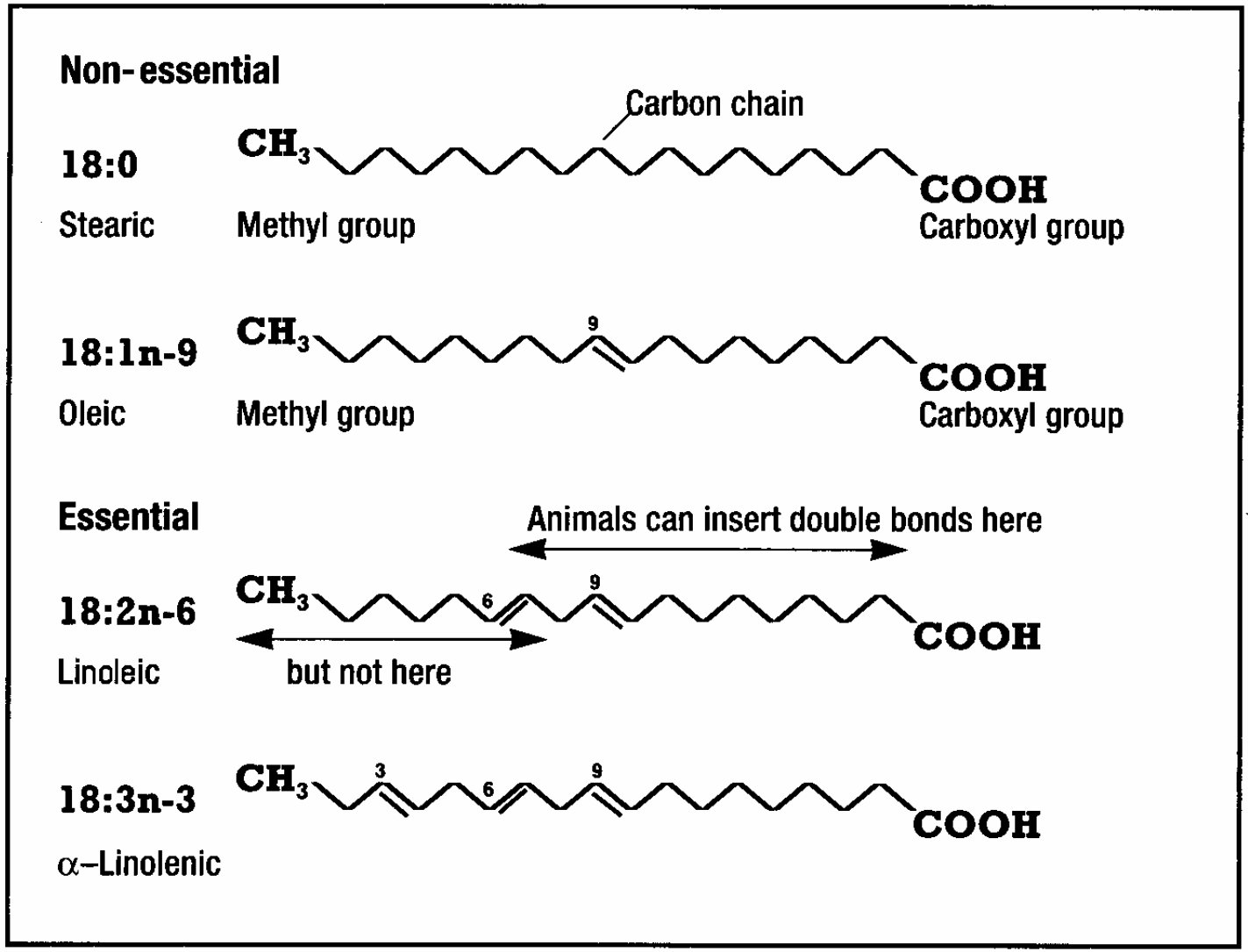
Saturated

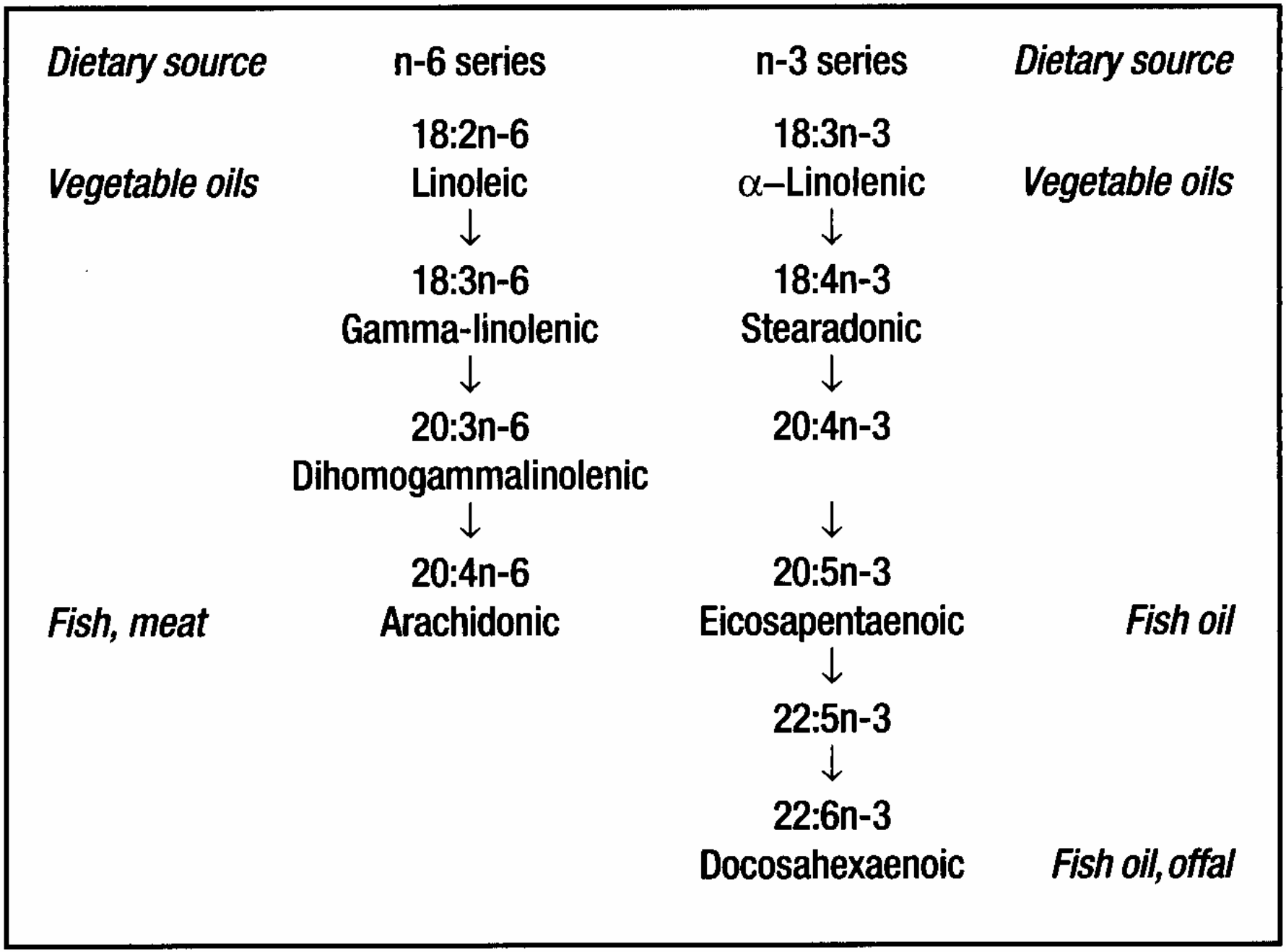


Polyunsaturated

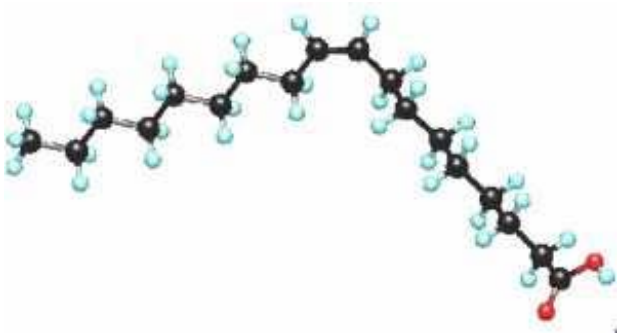


Monounsaturated

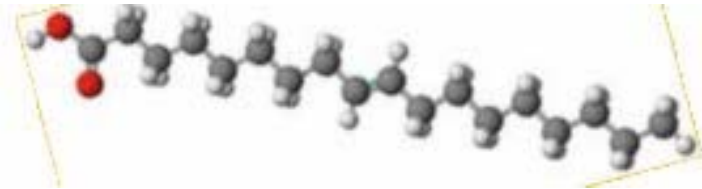

Non-essential
Carbon chain
18:0
CH3
COOH
Stearic
Methyl group
Carboxyl group
18:1n-9
9
CH3
COOH
Oleic
Methyl group
Carboxyl group
Essential
Animals can insert double bonds here
18:2n-6
6
9
CH3
COOH
Linoleic
but not here
18:3n-3
3
6
9
CH3
COOH
α–Linolenic


Dietary source
n-6 series
n-3 series
Dietary source
18:2n-6
Linoleic
18:3n-3
α–Linolenic
Vegetable oils
Vegetable oils
18:3n-6
Gamma-linolenic
18:4n-3
Stearadonic
20:3n-6
Dihomogammalinolenic
20:4n-3
20:4n-6
Arachidonic
20:5n-3
Eicosapentaenoic
Fish, meat
Fish oil
22:5n-3
22:6n-3
Docosahexaenoic
Fish oil, offal

# Effect of partial hydrogenation



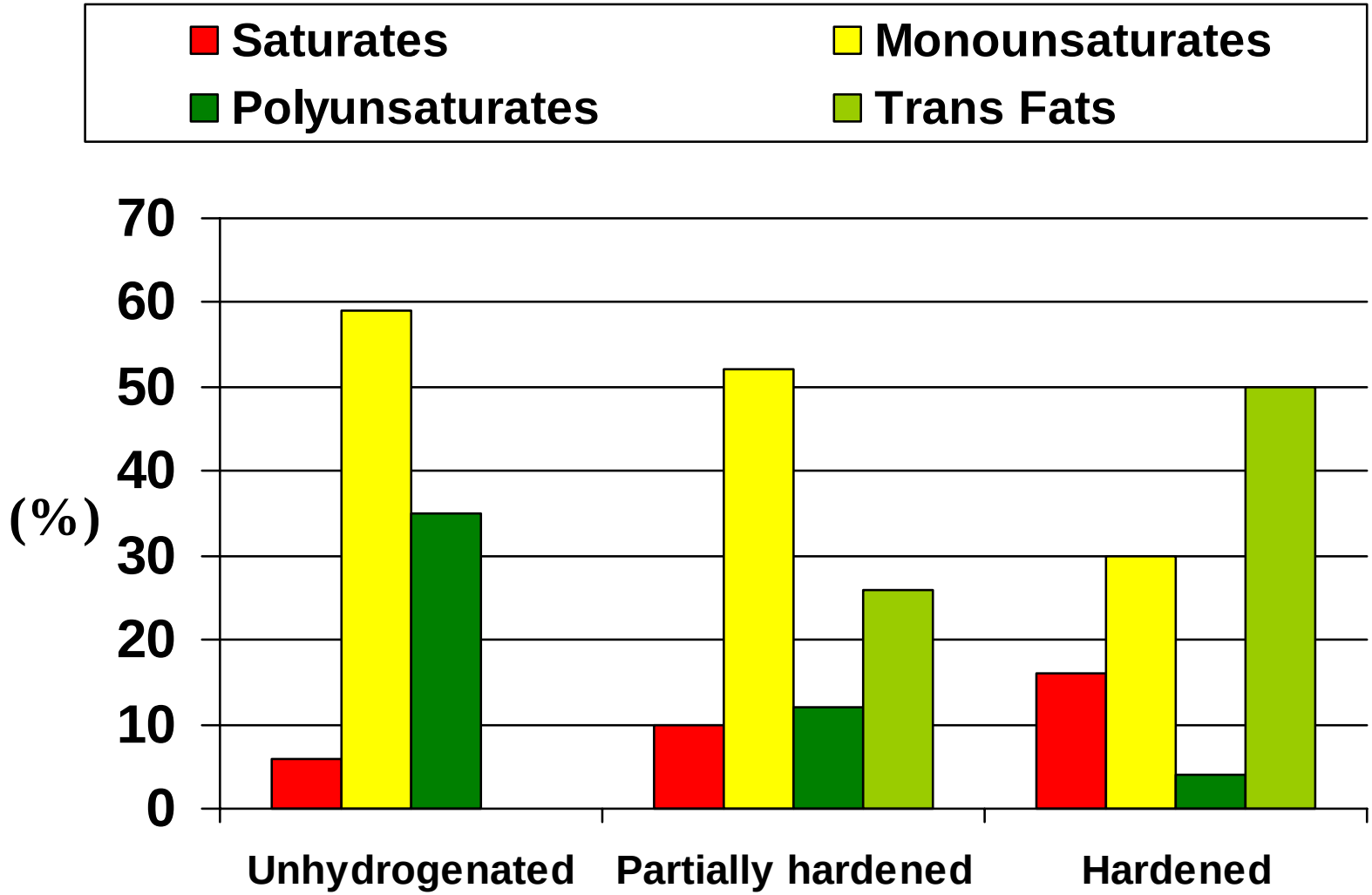
Cis monounsaturated



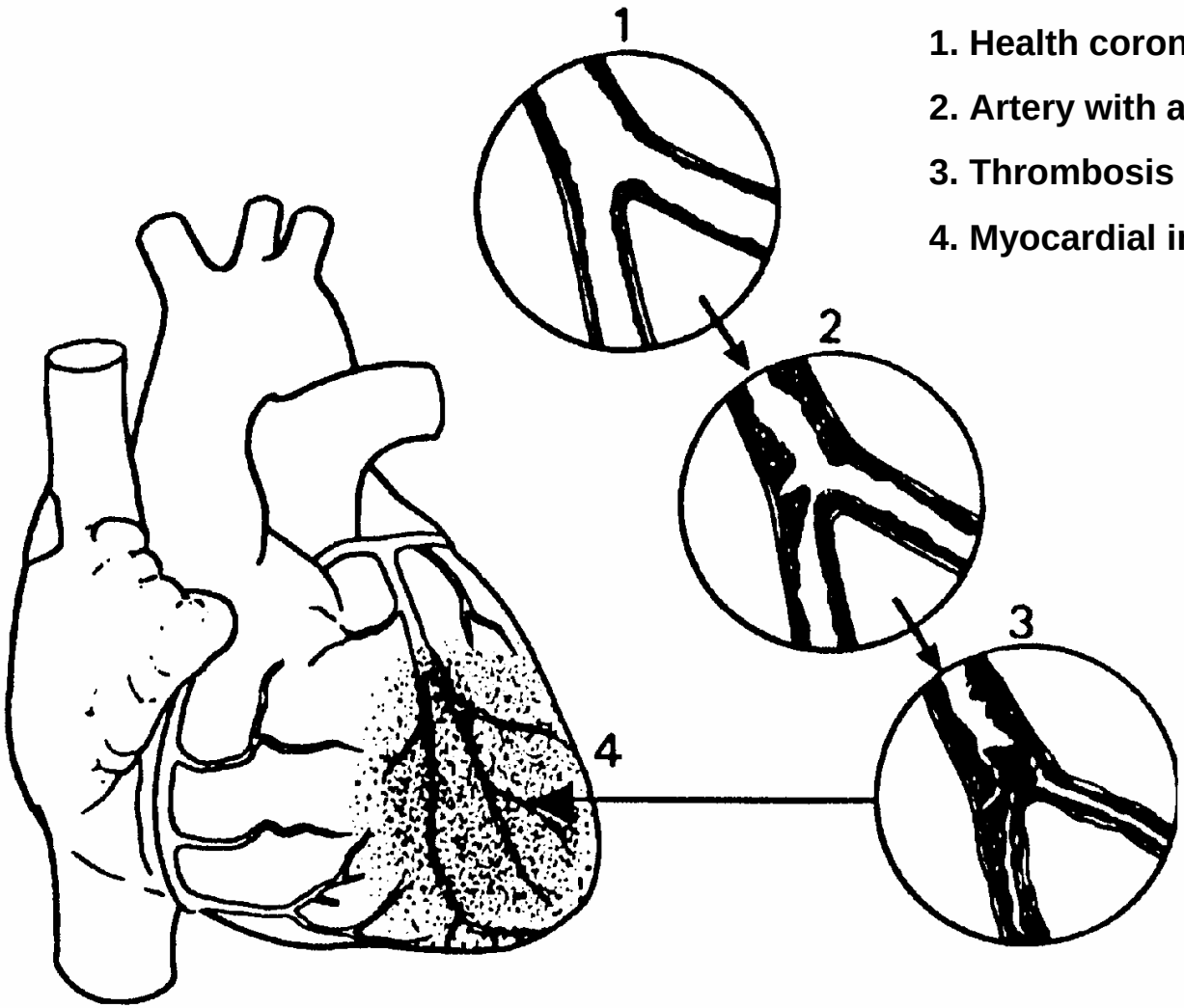
Trans Fatty Acid

**Raises melting point and improves organoleptic properties**

# Effect of hydrogenation on rapeseed oil



# The Heart Attack

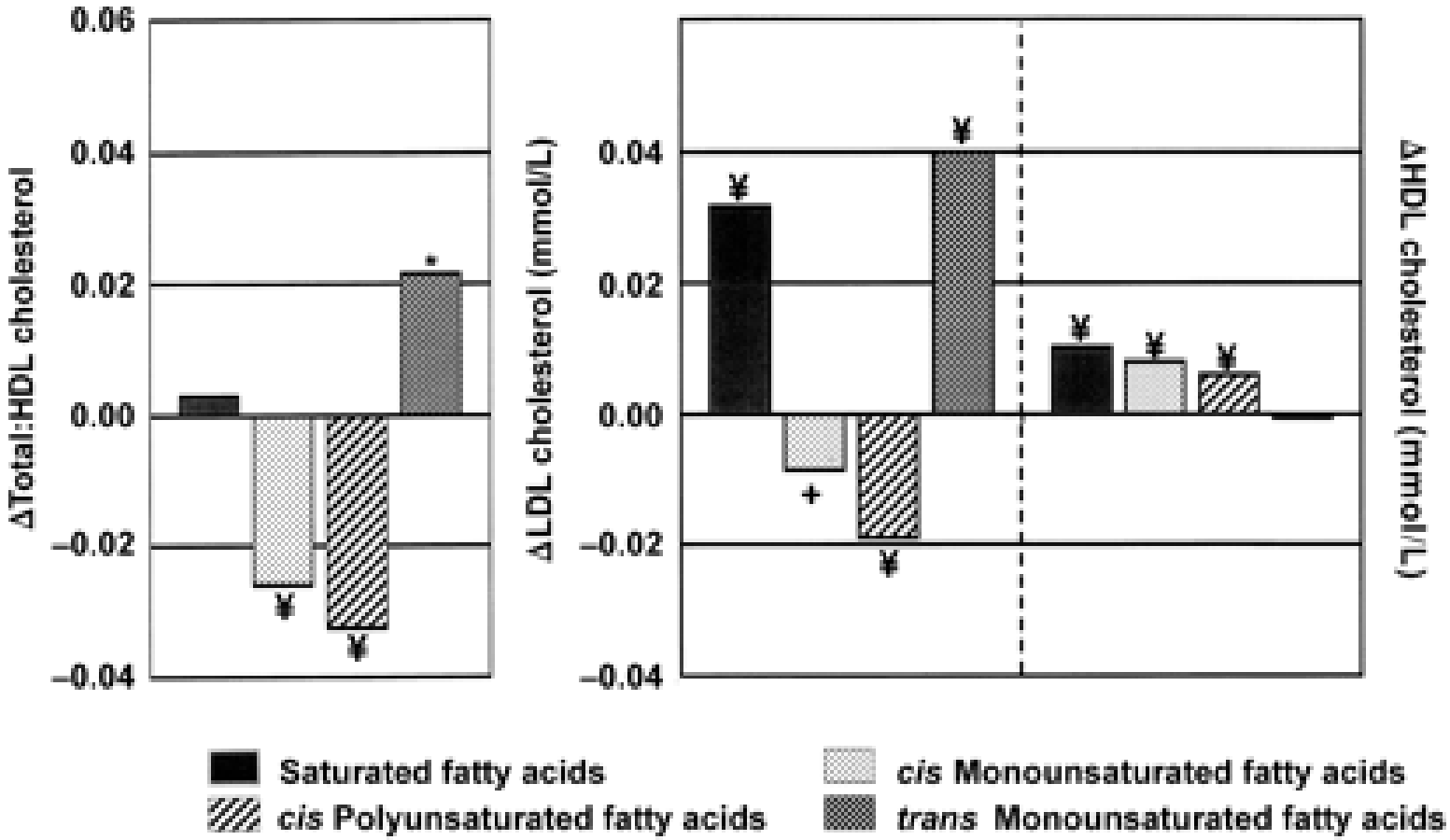



1. Health coronary artery
2. Artery with atherosclerosis
3. Thrombosis
4. Myocardial infarction

# Blood cholesterol as a risk factor for CHD

- Elevated LDL and low HDL cholesterol are involved in the atherogenic process
- Differences in saturated fatty acid intake explain 2/3rds of the variation in plasma LDL cholesterol between populations
- Intervention trials using drugs have shown
  - 1) that lowering LDL cholesterol decreases risk
  - 2) that increasing HDL decreases risk

Predicted changes in the ratio of serum total to HDL cholesterol and in LDL- and HDL-cholesterol concentrations when carbohydrates constituting 1% of energy are replaced by different fatty acids

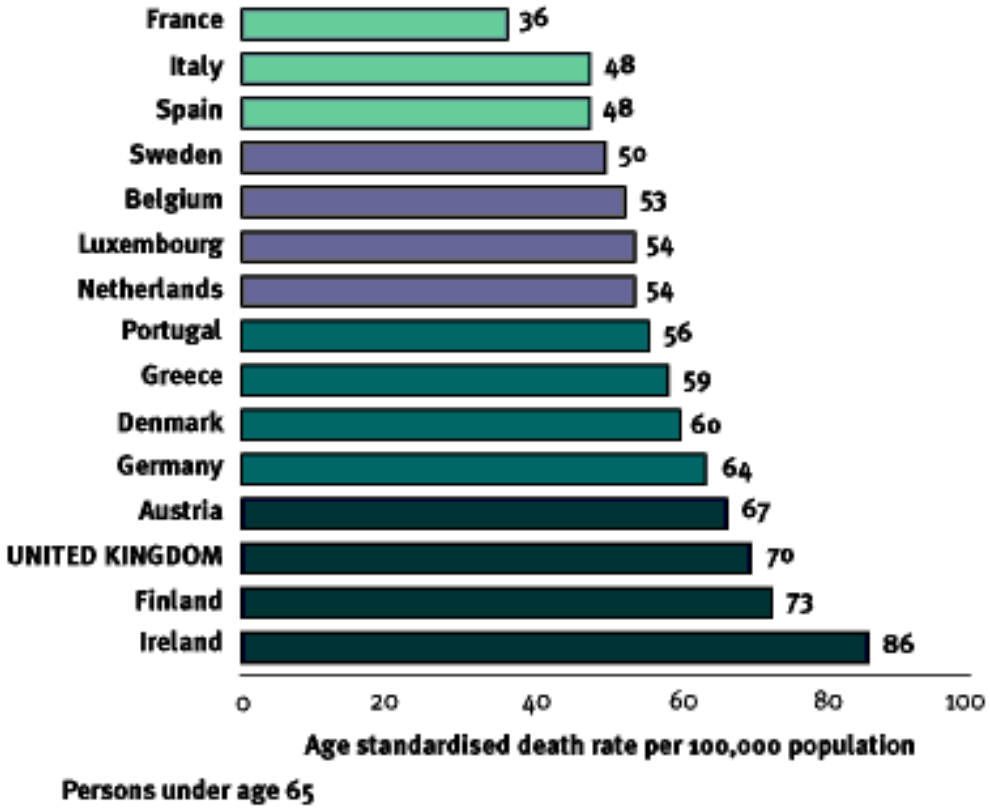


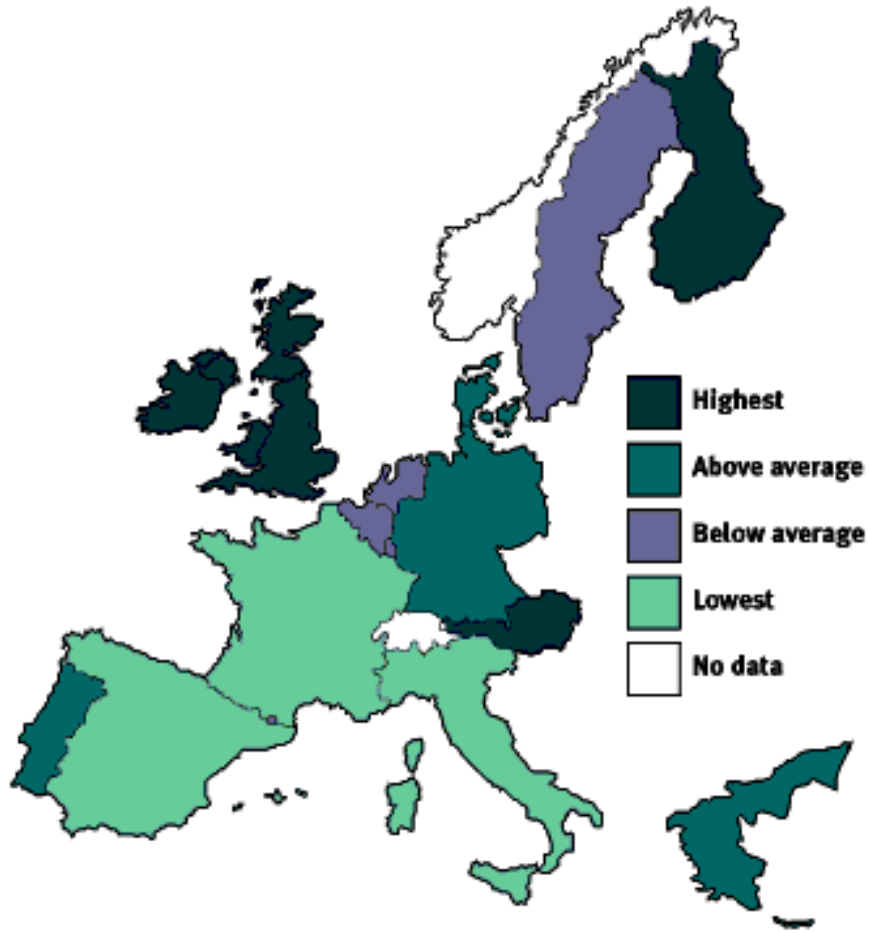

Mensinck et al. Am J Clin Nutr 2003; 77: 1146-1155

# Comparative effect of different plant derived fatty acids on LDL and HDL cholesterol

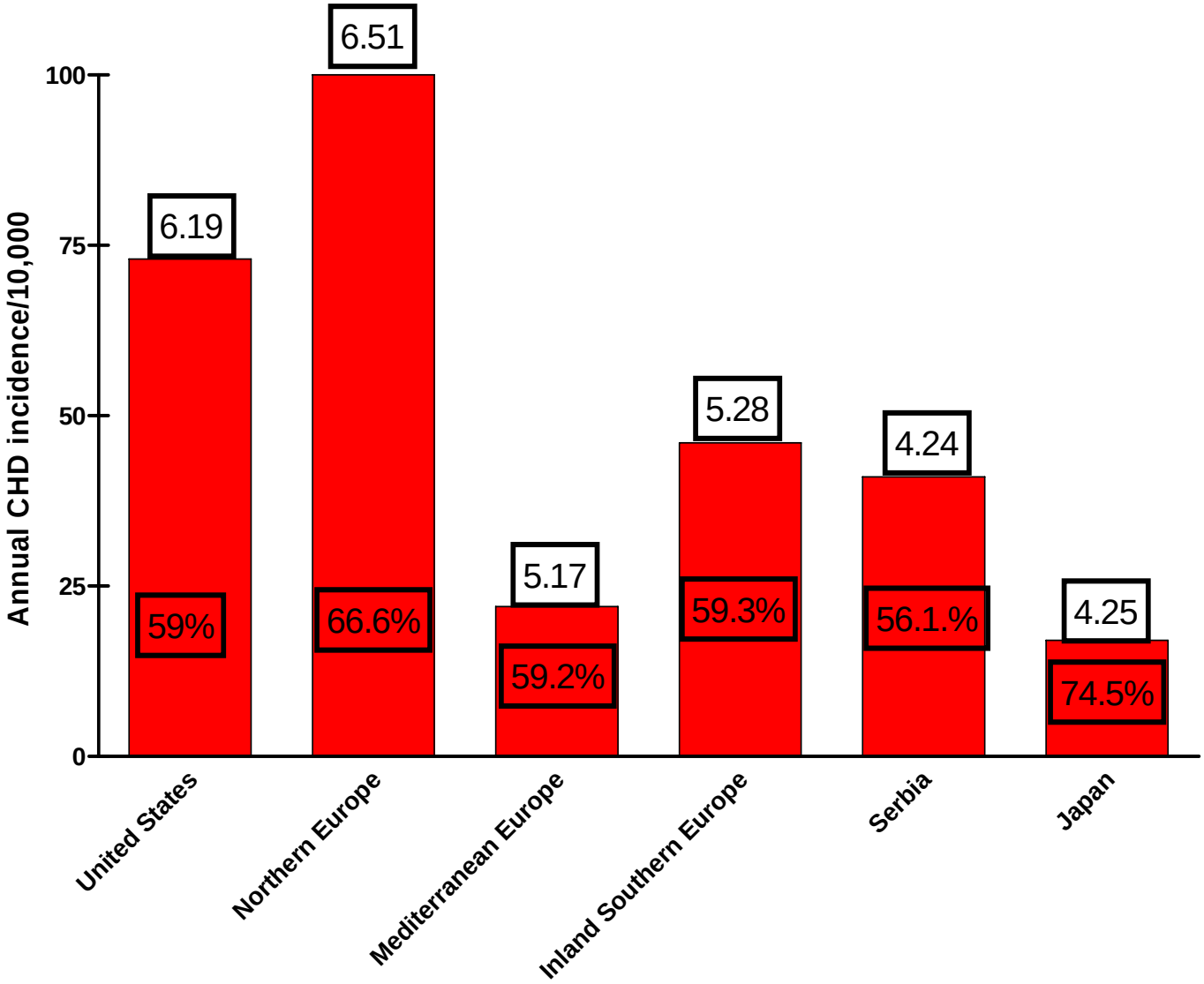
- Saturated fatty acids – (lauric, myristic and palmitic) raise LDL cholesterol
- Oleic acid – is neutral
- Linoleic acid and linolenic acids slightly lower LDL cholesterol
- Trans unsaturated fatty acids raise LDL cholesterol and lower HDL cholesterol

# CARDIOVASCULAR MORTALITY IN EUROPE
## (WHO, 1995)

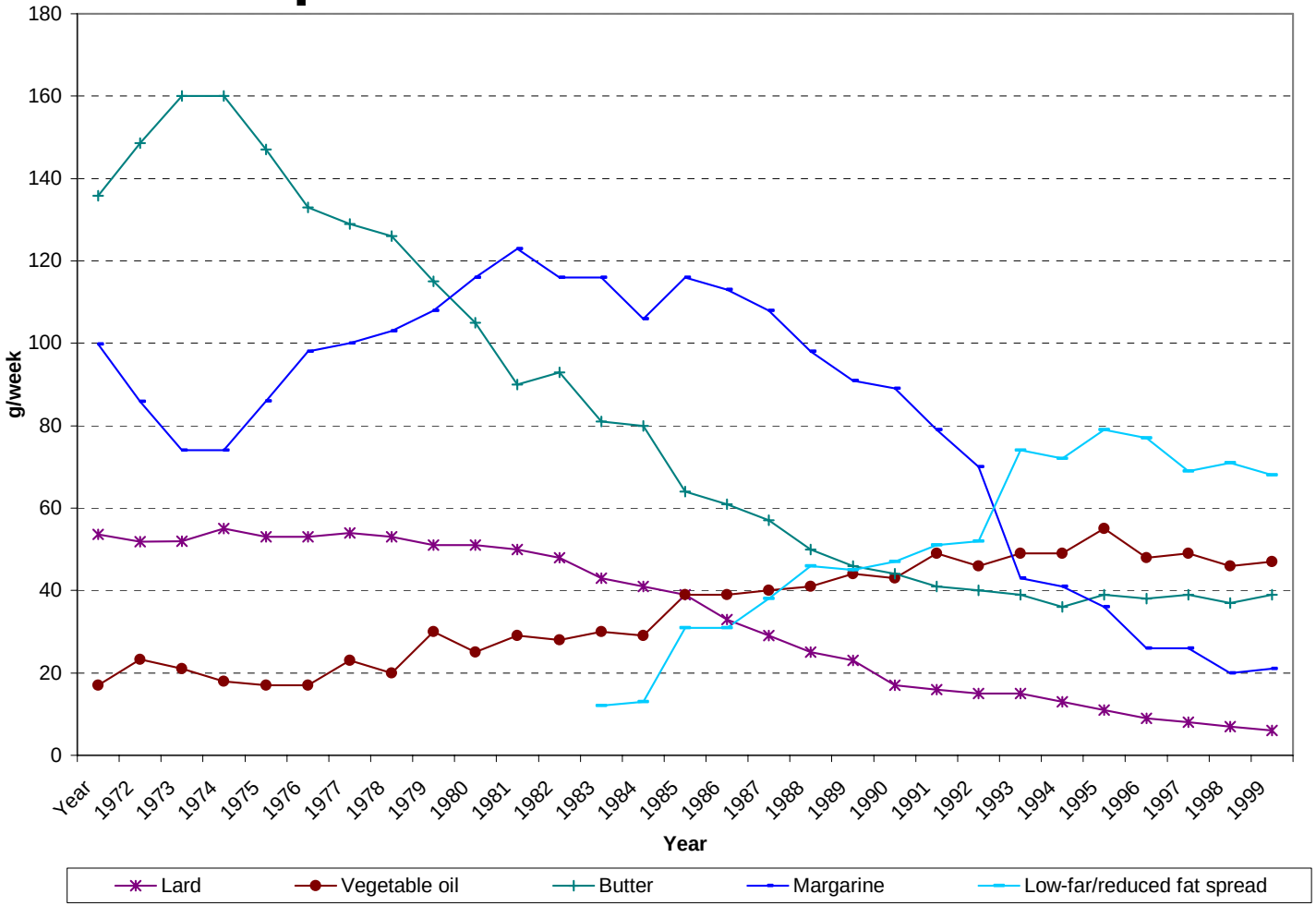


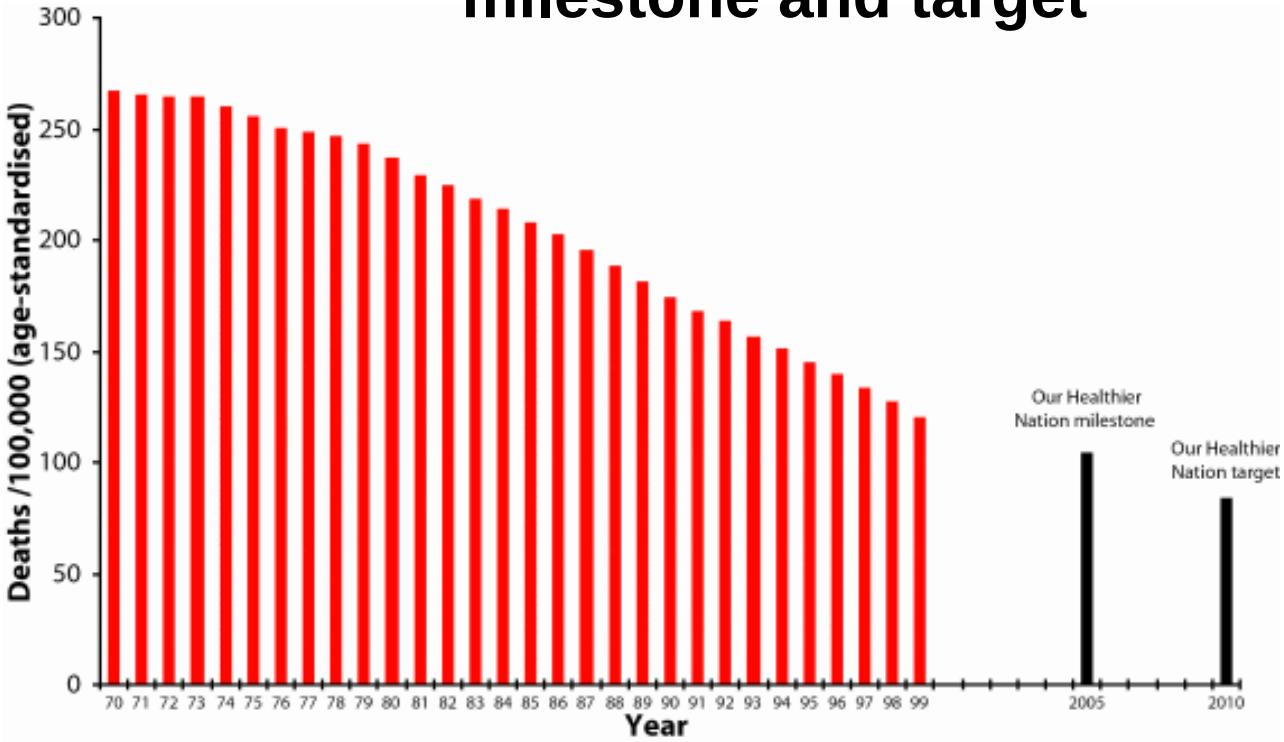
# Relationship between serum cholesterol and CHD incidence in the Seven Countries Study and smoking (%)



# Changes in weekly oil and fats consumption in the UK 1992-2000

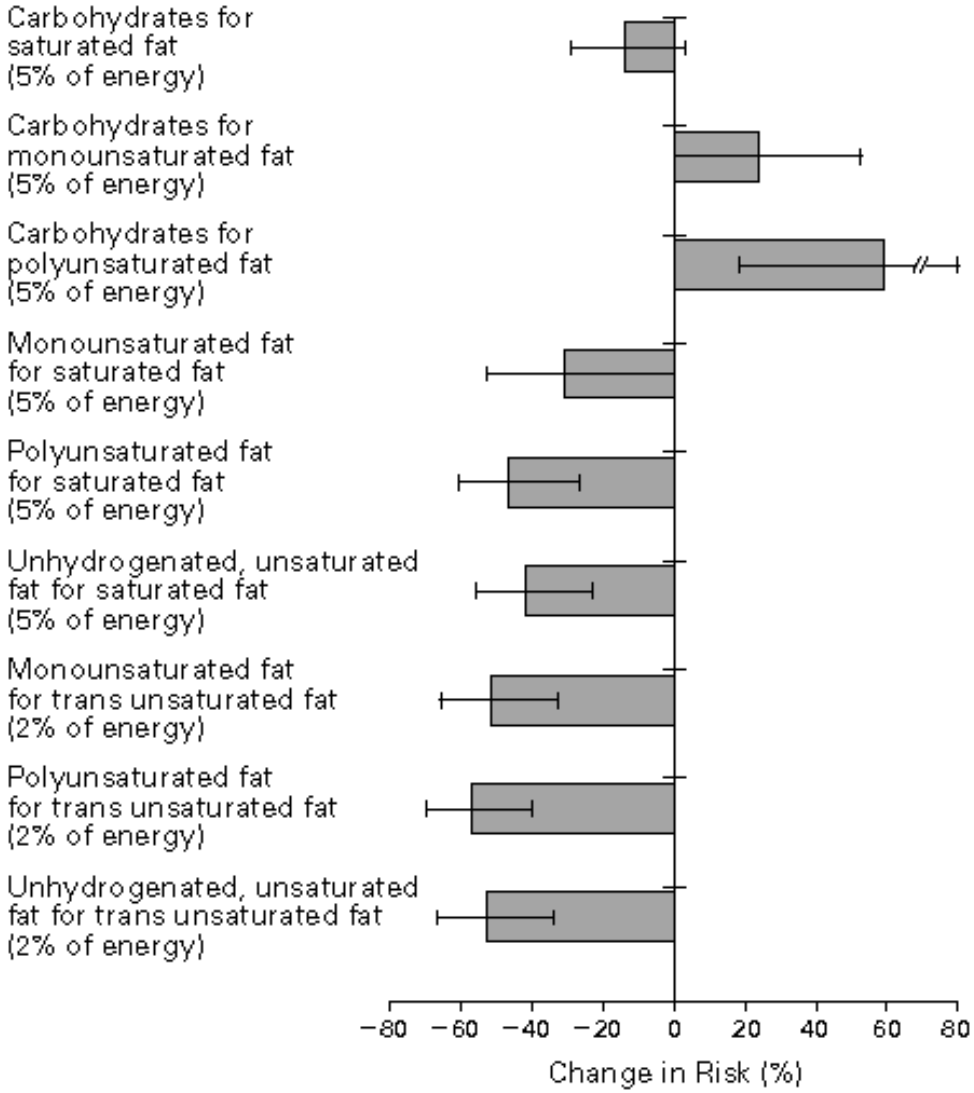


# Death rates from CHD, stroke and all other diseases of the circulatory system, people aged under 75, 1970-1999, England, with Our Healthier Nation milestone and target

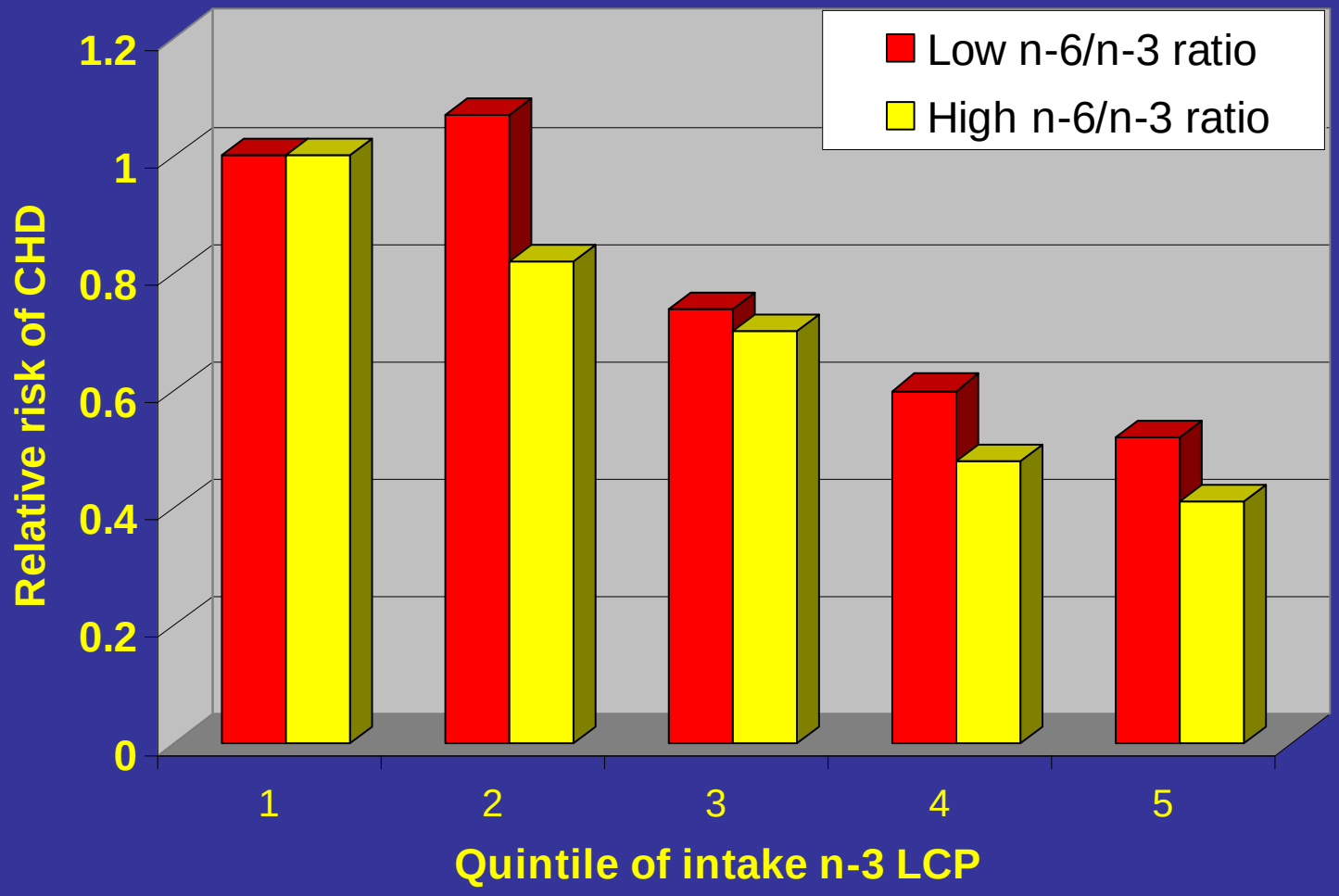


# Risk of CHD according to changes in the intakes of different fatty acids

## Nurses Health Study

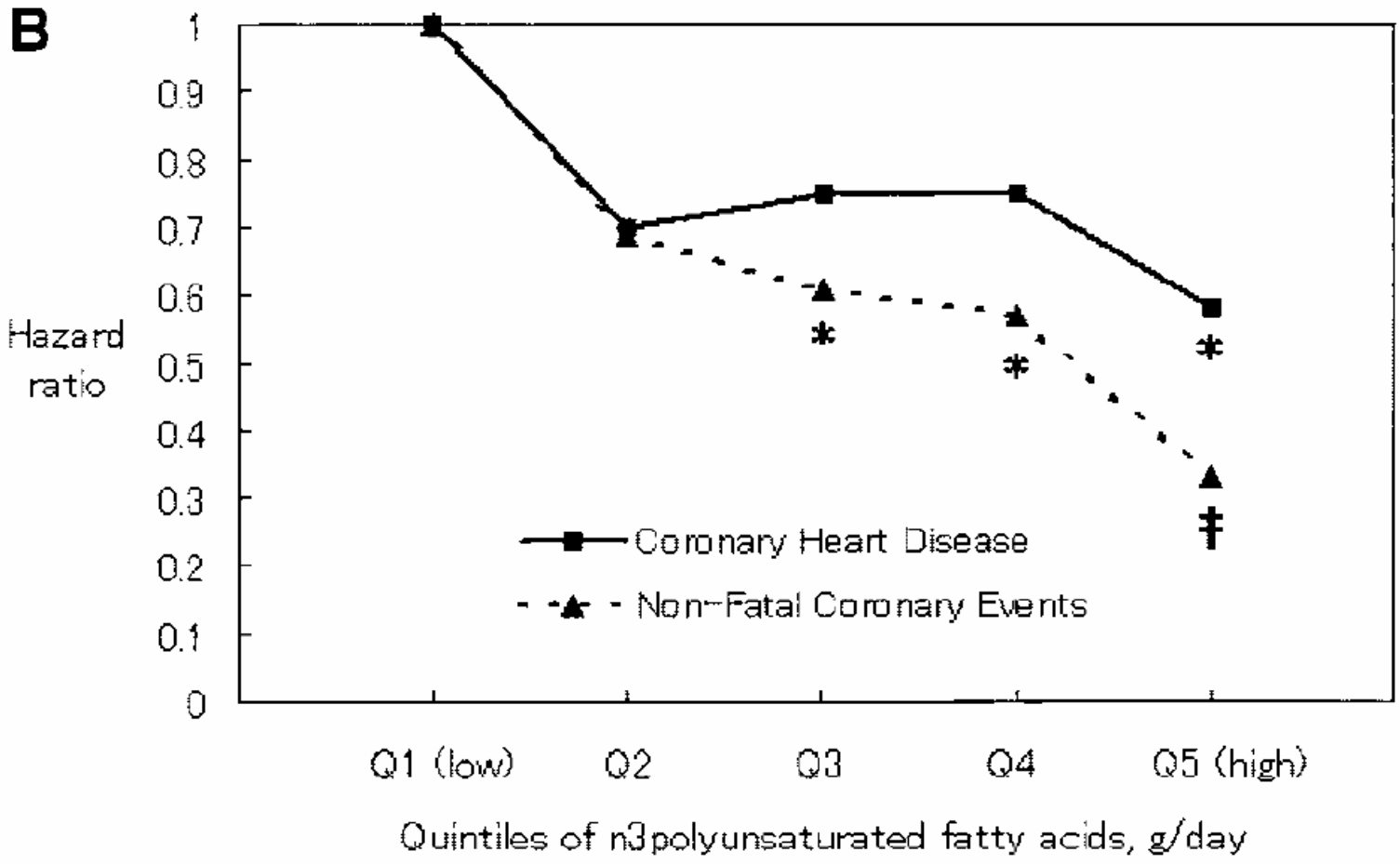


# Risk of fatal CHD is decreased the intake long chain n-3 fatty acids and not affected by the ratio



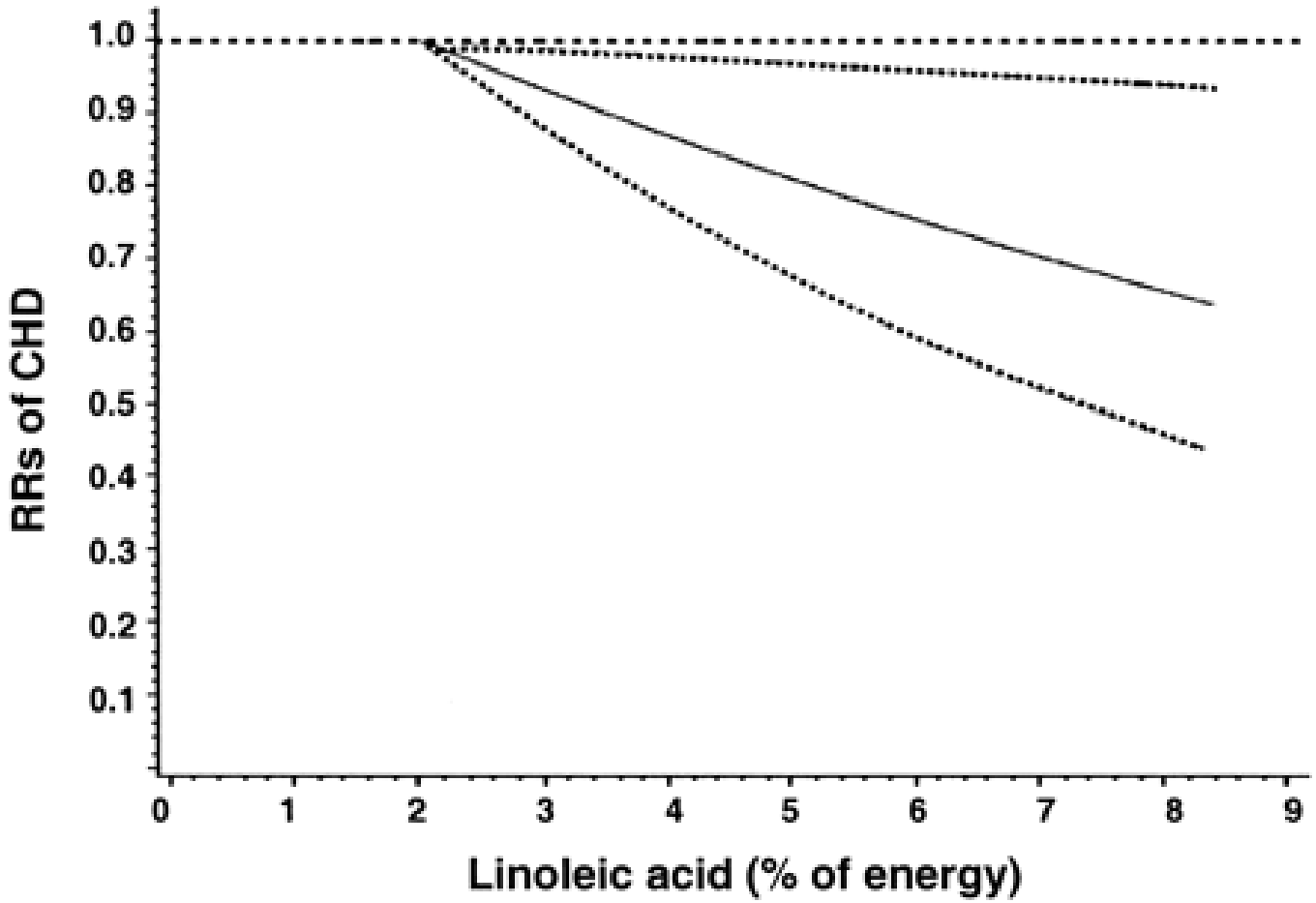

Hu et al. JAMA 2002

# Intake of long chain n-3 fatty acids in 41,578 Japanese men and women and risk of CHD over 10 years

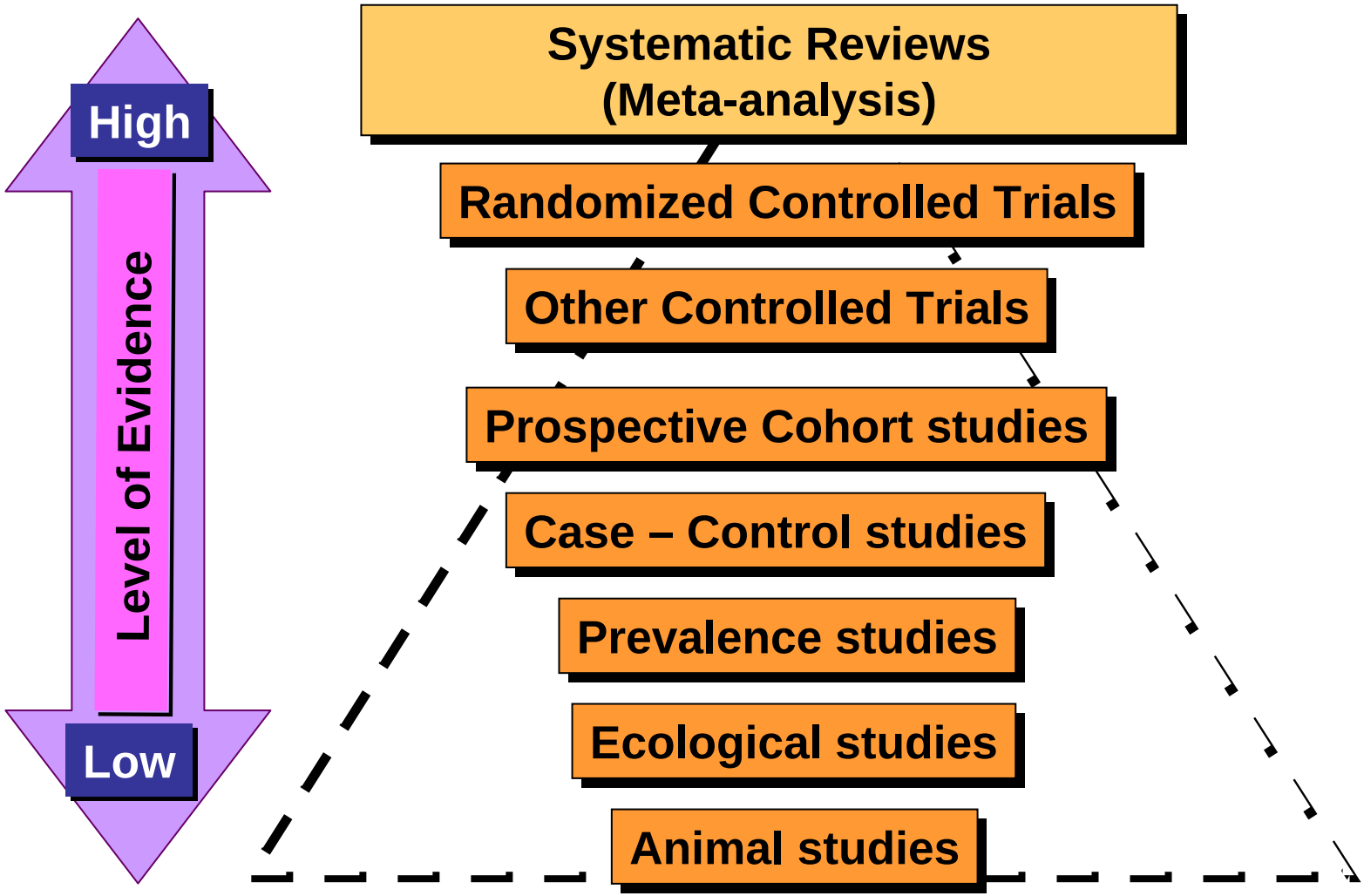



**Iso et al. *Circulation* 2006;113:195-202.**

# Data from the Nurses Health Study suggests linoleic acid decreases risk of CHD



# Hierarchy in Scientific Evidence



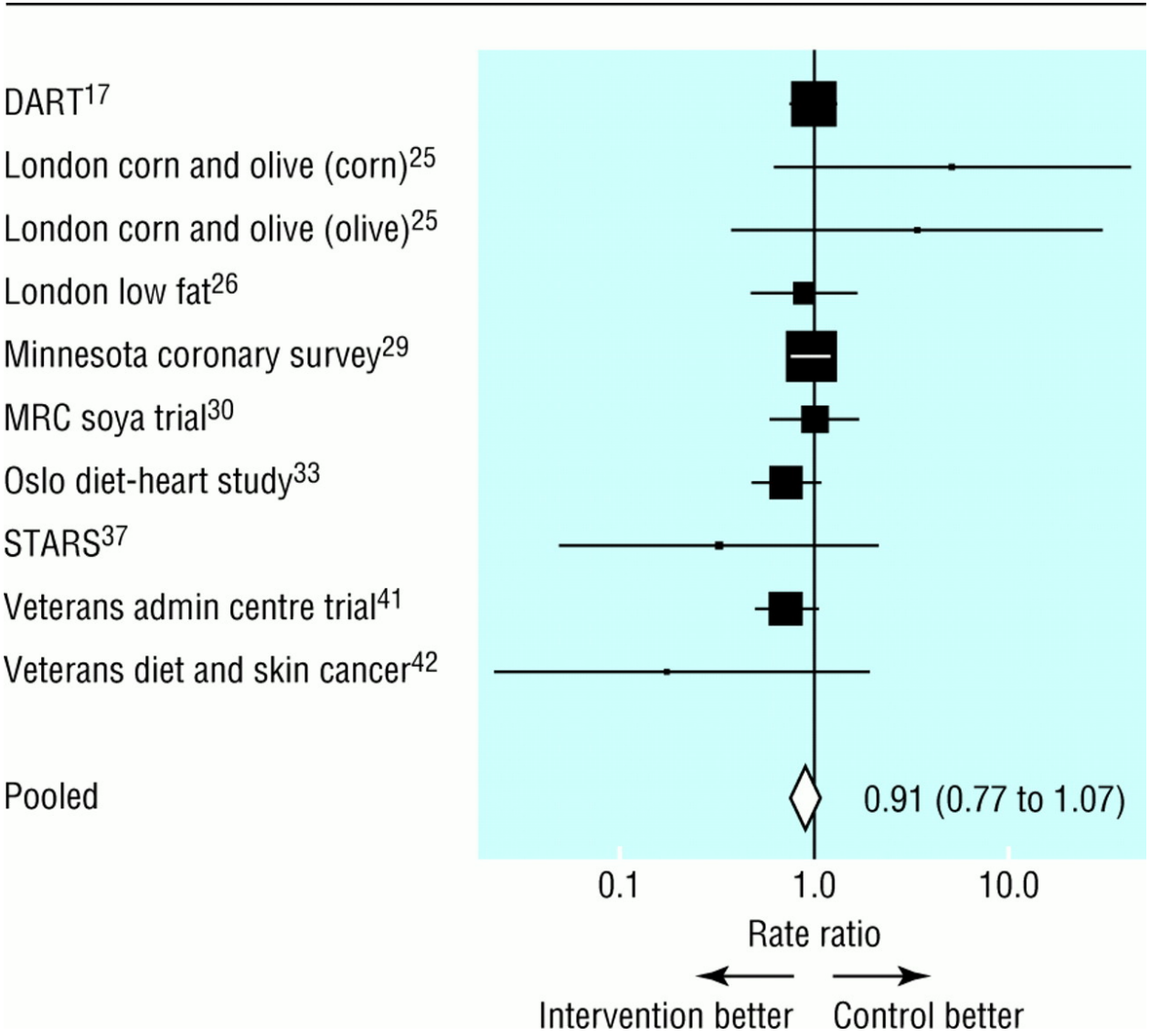
# The Women's Health Initiative

- 48,835 postmenopausal women were randomized to dietary modification (40% or a comparison group (60%)
- Dietary fat intake was 8.1 % energy lower at year 6
- The difference in weight between the control and intervention group after 8 years was only1.3 kg
- The intervention had no significant effect on incidence of  cancer, heart disease or diabetes

**Howard, B. V. et al. JAMA 2006;295:655-666**

**Influence of decreasing fat or exchanging saturated fatty acids for polyunsaturated fatty acids on cardiovascular mortality**

Hooper et al. *BMJ* 2001;322:757-763 ( 31 March )



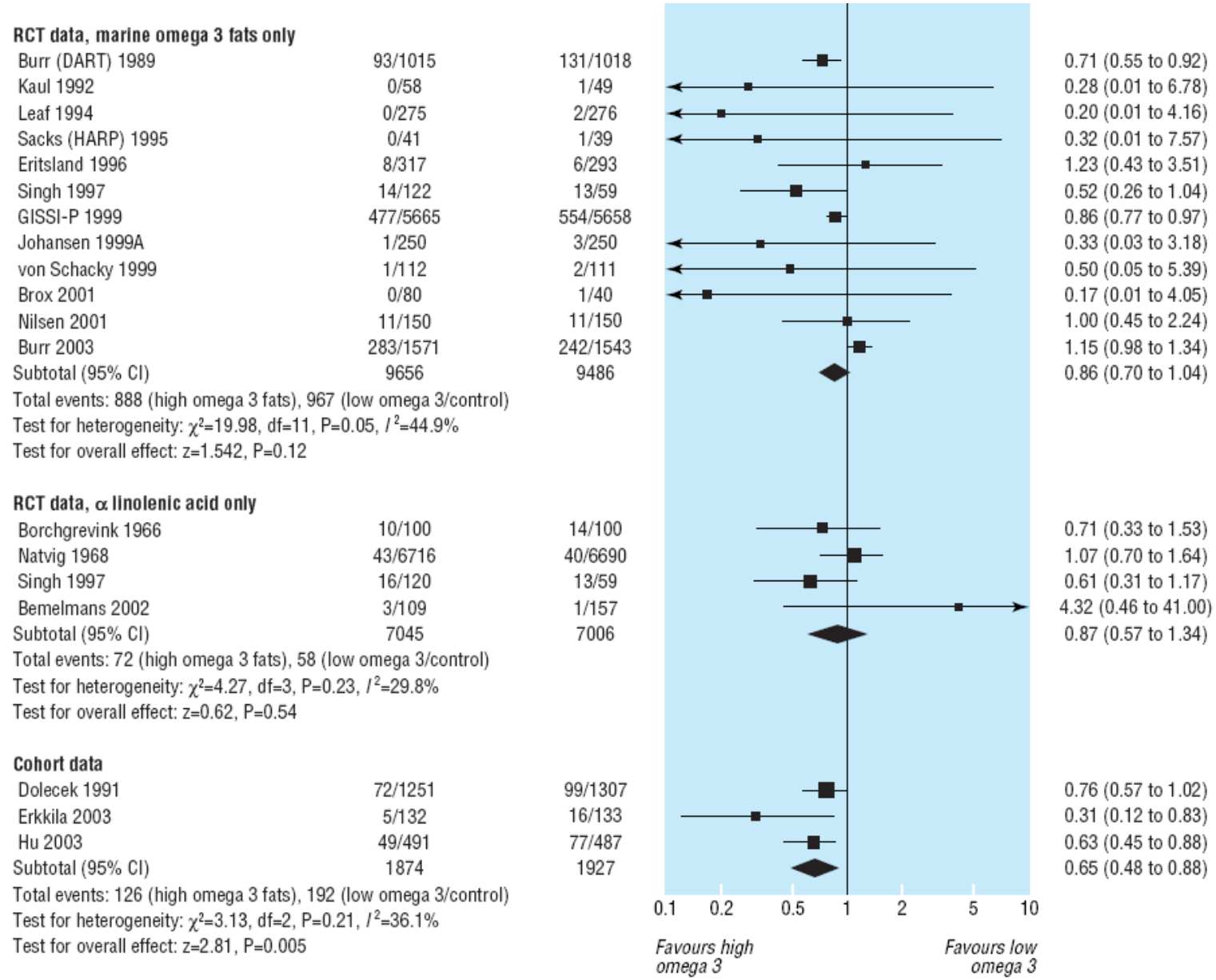
**Risks and benefits of omega 3 fats for mortality, cardiovascular disease, and cancer: systematic review**

Review of studies published up to 2002

- **Results** The pooled estimate showed no strong evidence of reduced risk of total mortality (relative risk 0.87, 95% confidence interval 0.73 to 1.03) or combined cardiovascular events (0.95, 0.82 to 1.12) in participants taking additional omega 3 fats.

- **Conclusion** Long chain and shorter chain omega 3 fats do not have a clear effect on total mortality, combined cardiovascular events, or cancer.

Hooper et al. BMJ 2006 epub 24 March 2006


RCT data, marine omega 3 fats only
Burr (DART) 1989 93/1015 131/1018 0.71 (0.55 to 0.92)
Kaul 1992 0/58 1/49 0.28 (0.01 to 6.78)
Leaf 1994 0/275 2/276 0.20 (0.01 to 4.16)
Sacks (HARP) 1995 0/41 1/39 0.32 (0.01 to 7.57)
Eritsland 1996 8/317 6/293 1.23 (0.43 to 3.51)
Singh 1997 14/122 13/59 0.52 (0.26 to 1.04)
GISSI-P 1999 477/5665 554/5658 0.86 (0.77 to 0.97)
Johansen 1999A 1/250 3/250 0.33 (0.03 to 3.18)
von Schacky 1999 1/112 2/111 0.50 (0.05 to 5.39)
Brox 2001 0/80 1/40 0.17 (0.01 to 4.05)
Nilsen 2001 11/150 11/150 1.00 (0.45 to 2.24)
Burr 2003 283/1571 242/1543 1.15 (0.98 to 1.34)
Subtotal (95% CI) 9656 9486 0.86 (0.70 to 1.04)
Total events: 888 (high omega 3 fats), 967 (low omega 3/control)
Test for heterogeneity: χ²=19.98, df=11, P=0.05, I²=44.9%
Test for overall effect: z=1.542, P=0.12
RCT data, α linolenic acid only
Borchgrevink 1966 10/100 14/100 0.71 (0.33 to 1.53)
Natvig 1968 43/6716 40/6690 1.07 (0.70 to 1.64)
Singh 1997 16/120 13/59 0.61 (0.31 to 1.17)
Bemelmans 2002 3/109 1/157 4.32 (0.46 to 41.00)
Subtotal (95% CI) 7045 7006 0.87 (0.57 to 1.34)
Total events: 72 (high omega 3 fats), 58 (low omega 3/control)
Test for heterogeneity: χ²=4.27, df=3, P=0.23, I²=29.8%
Test for overall effect: z=0.62, P=0.54
Cohort data
Dolecek 1991 72/1251 99/1307 0.76 (0.57 to 1.02)
Erkkila 2003 5/132 16/133 0.31 (0.12 to 0.83)
Hu 2003 49/491 77/487 0.63 (0.45 to 0.88)
Subtotal (95% CI) 1874 1927 0.65 (0.48 to 0.88)
Total events: 126 (high omega 3 fats), 192 (low omega 3/control)
Test for heterogeneity: χ²=3.13, df=2, P=0.21, I²=36.1%
Test for overall effect: z=2.81, P=0.005
0.1
0.2
0.5
1
2
5
10
Favours high omega 3
Favours low omega 3

# Fat and heart disease

- Decreasing the intake of fat has not been shown to reduce risk of heart disease

- But changing the type of fat consumed probably reduces risk of heart disease.
  - Replacing saturated and trans fatty acids with unsaturated fatty acids
  - Increasing the intake of n-3 fatty acids
  - Increasing the intake of linoleic acid

# Conclusion

- Fat needs to be consumed in moderation to avoid obesity
- Attention needs to be paid to the fatty acid profile in order to prevent cardiovascular disease

# Nutrient Profiling

- A scheme developed by the UK Food Standards Agency to classify foods into “good” and “bad” categories is now spreading to other countries
- To be used as a management tool
  - To provide front of pack labelling
  - To regulate TV advertising of food targeted at children
  - To control the types of food that can be used to make up school meals
  - To regulate health claims

UK Food Standards Agency Multiple Traffic Light


# High Fat is >20g/100g
# High Sat Fat >5g/100g

Using this definition all oils would fall into the high category

# Ideal fatty acid profile of vegetable oil

- <15% saturated fatty acids
- 15% polyunsaturated fatty acids
    - n-6/n-3 ratio <10:1
- 70% monounsaturated
- Trans <1%