6th Annual Nutrition and Health Conference

Diet and Cardiovascular Disease Prevention: An Update

5/12/09

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Sponsored by

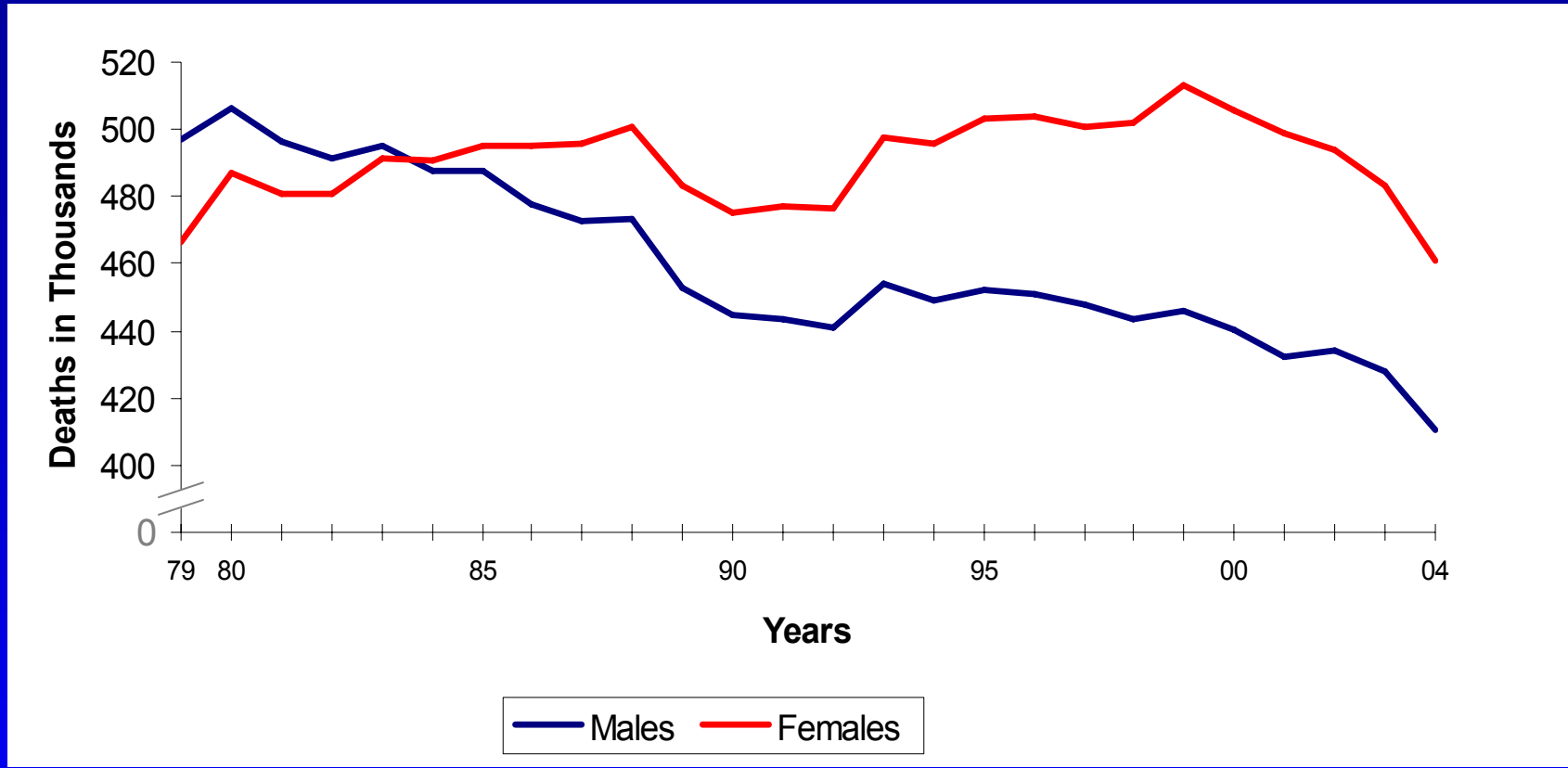
The University of Arizona
College of Medicine
at the Arizona Health Sciences Center

Disclosure

I have nothing to disclose

Objectives

- Review CVD statistics and current diet/lipid recommendations
- Consider emerging research
- Role of obesity/other risk factors
- Future directions



Cardiovascular Disease Mortality Trends for Males and Females (United States: 1979-2004)

Source: NCHS and NHLBI

Mean US Total Cholesterol Levels*: 1980-1982 vs. 2003-2006

	1980-1982		2003-2006	
Measure	**Men**	**Women**	**Men**	**Women**
Total cholesterol*				
mg/dL	**212**	**208**	**199.7**	**201.5**

*Age Adjusted

NHANES III, 2008

Statistical Fact Sheet – Miscellaneous 2007 Update*

Nutrition and Cardiovascular Diseases — Statistics

Mean Dietary Intake of Energy and 10 Key Nutrients for Public Health	Total Population	Males	Females
Energy (kcal)	2,146	2,475	1,833
Protein, percent of calories	14.7%	14.9%	14.6%
Carbohydrate, percent of calories	51.9%	50.9%	52.8%
Total fat, percent of calories	32.7%	32.7%	32.6%
Saturated fat, percent of calories	11.2%	11.2%	11.1%
Cholesterol (mg)	265	307	225
Calcium (mg)	863	966	765
Folate micrograms (mcg)	361	405	319
Iron (mg)	15.2	17.2	13.4
Zinc (mg)	11.4	13.3	9.7
Sodium (mg)	3,375	3,877	2,896

Source: NHANES (1999-2000), NCHS, 2003. Advance Data, Vital and Health Statistics, No. 334, April 17, 2003

Current NHANES Intake of Fats as Percent of Energy-All Persons

Dietary Component	NFCS 1977-78	CSFII 1989-91	CSFII 1994-96	NHANES 2001-02	NHANES 2003-04	NHANES 2005-06
	(n=~30,000)[1]	(n=15,128)[1]	(n=15,968)[2]	(n= 9,033)[3]	(n=8,273)[3]	(n= 8,549)[3]
	Mean (SE)[4]	*Mean*	*Mean (SE)*[4]	*Mean (SE)*[4]	*Mean (SE)*[4]	*Mean (SE)*[4]
Total fat, %	40.1 (0.16)	34.4	32.8 (0.1)	33 (0.3)	33.4 (0.25)	33.6 (0.19)
Sat'd fat (%)	NA[6]	12.3	11.3 (0.1)	NA[6]	11.2 (0.11)	11.4 (0.09)
Polyunsat'd fat (%)	NA[6]	6.6	6.4 (0.01)	NA[6]	7.0 (0.09)	7.0 (0.08)
Monounsat'd fat (%)	NA[6]	12.7	12.5 (0.1)	NA[6]	12.5 (0.09)	12.3 (0.07)
Energy (kcal)	1854 (12.9)	1839	2002 (16)	2178 (16.1)	2195 (15.6)	2157 (29.0)

Data sources: Published USDA, ARS reports from What We Eat In America-National Health and Nutrition Examination Surveys (NHANES), Continuing Surveys of Food Intakes by Individuals (CSFII), and Nationwide Food Consumption Survey (NFCS), 1 day data. [1]Includes all persons from birth. [2]Includes all persons from birth; excludes breast-fed children. [3]Includes persons 2 years and over; excludes breast-fed children. [4]SE= Standard error. [5]Unpublished data from Food Surveys Research Group, ARS, USDA. [6]NA = Not available.

Dietary Factors Influencing LDL-C

LDL Concentration Modifiers

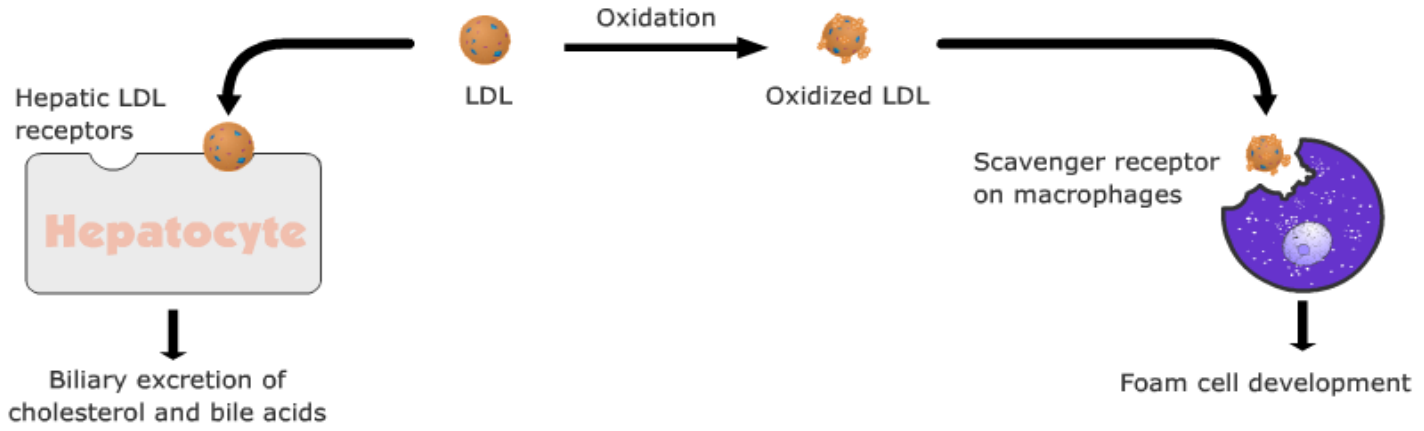
Factors influencing serum LDL concentration:

- Genetics
- Body weight and exercise
- LDL-raising dietary factors
  - saturated and *trans*-fatty acids
  - cholesterol
- LDL-lowering dietary factors
  - polyunsaturated fatty acids
  - *viscous dietary fiber* (pectin and ß-glucan)
    - in oats, barley, legumes, and fruits
  - soy protein
  - plant *stanols/sterols*
    - in nuts, seeds, vegetable oils
    - added to margarines and other foods
  - antioxidants
  - *flavonoids*
    - in fruits, vegetables, wine, and tea

The Bottom Line: Lifestyle changes can reduce excessive LDL concentrations by 20-40%.

Source: Nutrition in Medicine *CVD: Lipoproteins* Web Course, 2006

LDL Oxidation



Oxidized LDL

When free radicals attack LDL, its protein moiety, *apoB*, may be fragmented or otherwise modified and the unsaturated fatty acids become oxidized. In this state, modified LDL is no longer recognized by its normal receptor, but can bind to one of several alternative receptors. Most important for the binding of modified LDL is the *scavenger receptor*, which allows its uptake by macrophages and other extrahepatic cells and promotes the progression of atherogenesis.

Source: Nutrition in Medicine *CVD: Lipoproteins* Web Course, 2006

Saturated Fat: Effect on Blood Lipids

- **Mechanism:** **Raises LDL-C** by suppressing hepatic LDL-receptor expression and activity

- **Dietary Sources:** red meats, regular-fat dairy foods, baked goods, fried foods

- **ATP III Recommendations:**

  < 7% of total calories

  (or 16 grams/day for a 2,000 calorie diet)

Saturated Fat Content of Selected Foods

Saturated Fat Content of Common Foods					
Food	**Serving**	**Sat. Fat (grams)**	**Food**	**Serving**	**Sat. Fat (grams)**
Butter, stick	1 Tbl	7.2	Ice cream, gourmet	1 cup	15.0
Lard	1 Tbl	5.0	Ice cream, light	1 cup	6.2
Margarine, stick	1 Tbl	2.0	Ground beef, 80% lean	3 oz cooked	6.8
Peanut butter	1Tbl	1.5	Ground beef, 93% lean	3 oz cooked	2.7
Margarine, light tub	1 Tbl	1.0	Chocolate chip cookie	3-inch diameter	4.2
Cheese, regular fat	1 oz	6.0	Chocolate candy bar	1.45 oz	7.3
Cheese, light	1 oz	1.2	Danish w/cheese filling	1 medium	13.0

Dietary Cholesterol: Effect on Blood Lipids

- **Mechanism:** **Raises LDL-C** by down regulating hepatic cholesterol receptors.

- **Dietary sources:** animal protein esp. red meat, egg yolks, dairy foods, some baked goods & fried foods.

- **ATP III Recommendations:**
  < 200 mg/day

Different Fats Impact Blood Cholesterol Differently

Keys Formula: Metabolic Ward "Feeding Study"

$1.35\ (2SFA - PFA) + 1.5\ \sqrt{C}$

SFA ↑

PUFA ↓

Dietary Cholesterol ↑

SFA = % Kcal Sat. Fat

PFA = % Kcal Poly. Fat

C = Diet Chol. in mg/4184 KJ

Blood Cholesterol: Diet–CHD Connection

Evidence Based on:

- Studies in laboratory animals
- Epidemiological studies
  - Between populations
  - Within populations
- Genetic hypercholesterolemias
- Clinical Trials

Monounsaturated Fat: Effect on Blood Lipids

- **Mechanism:** Lowers LDL-C
  Neutral effect on HDL-C

- **Dietary Sources:** Olives, olive oil, peanuts, peanut oil, avocadoes, canola oil

- **ATP III Recommendations:**
  Up to 20% of total calories

Monounsaturated Fat (MUFA) Content of Selected Foods

MUFA Content of Common Foods					
Food	**Serving**	**MUFA (grams)**	**Food**	**Serving**	**MUFA (grams)**
Olive Oil	**1 Tbl**	**10**	**Almonds**	**¼ cup**	**11**
Canola Oil	**1 Tbl**	**8**	**Peanuts**	**¼ cup**	**9**
Peanut Oil	**1 Tbl**	**6**	**Peanut butter**	**2 Tbl**	**4**
Grapeseed Oil	**1 Tbl**	**2**	**Hazelnuts**	**¼ cup**	**17**
Avocado	**1 med**	**17**	**Olives**	**5 med**	**2**

Polyunsaturated Fats: Effect on Blood Lipids

- **Effects:**

  Omega-6: lowers LDL-C; may lower HDL-C

  Omega-3: lowers triglycerides; slightly raises HDL-C

  Also decreases platelet adhesion, improves endothelial dysfunction, decreases vasoconstriction, reduces inflammation and reduces risk of coronary thrombosis

- **Dietary Sources:**

  Omega-6: Soybean oil, safflower oil, corn oil

  Omega-3: Salmon, herring, flax seeds, walnuts, canola oil

- **ATP III Recommendations:**

  Up to 10% of total calories; emphasis on eating two or more 4 oz servings of fatty fish per week and walnuts, canola oils and other plant fats rich in omega 3 fats

Polyunsaturated Fats

Omega 6 Fats

C18:2 ω-6 Linoleic

Corn, Safflower & Sunflower Oils

C20:4 ω-6 Arachidonic

- *Platelet aggregation*
- *Vasoconstriction*
- *Pro-inflammatory*

Omega 3 Fats

C18:3 ω-3 α-Linolenic

- *Anti-arrhythmic*
- *Anti-inflammatory*

Flaxseed, Canola & Soybean Oils

C20:5 ω-3 Eicosapentaenoic (EPA)

C22:6 ω-3 Docosahexaenoic (DHA)

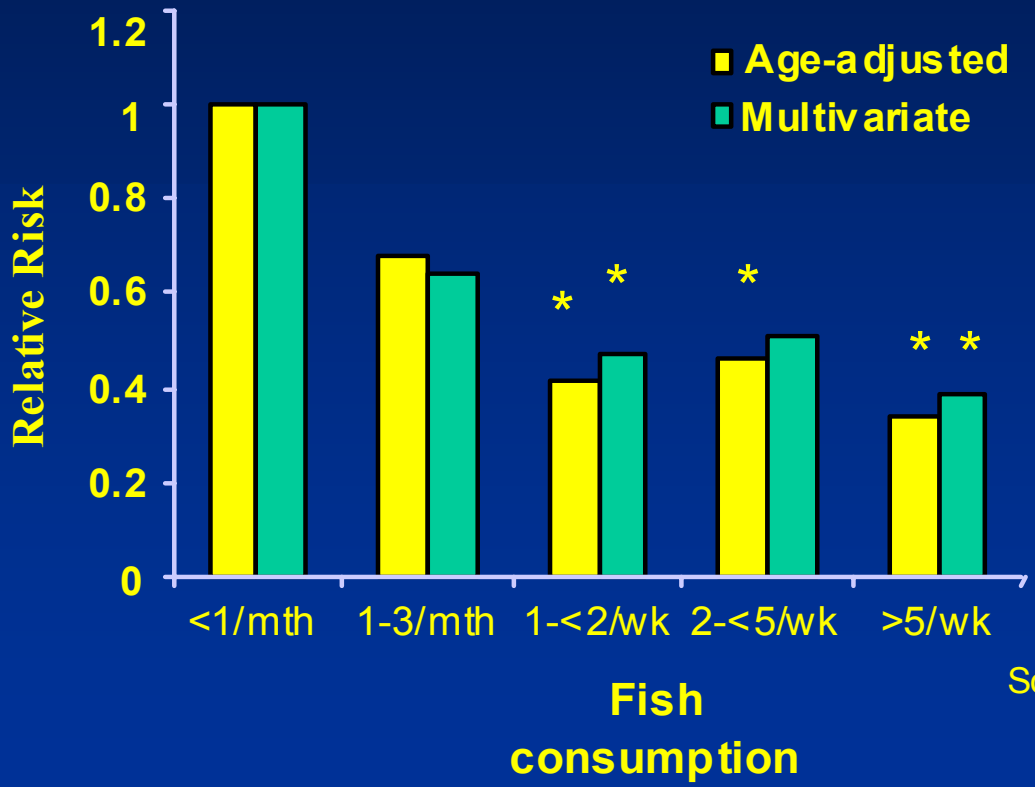
- *TG- lowering*
- *Anti-arrthymic*
- *Anti-inflammatory*

Fatty Fish and Fish Oil Capsules

Omega-3 PUFA Content of Selected Foods

Omega-3 (N-3) Fat Content of Common Foods					
Animal Food	**Serving**	**N-3 (grams)**	**Plant Food**	**Serving**	**N-3 (grams)**
Salmon, Atlantic, wild	3 oz	2.3	Flax seed oil	1 Tbl	7
Salmon, Atlantic, farm raised	3 oz	1.9	Flax seeds, ground	1 Tbl	1.3
Rainbow Trout, fresh	3 oz	1.2	Walnuts	5 halves	0.9
Herring, pickled	3 oz	1.2	Canola oil	1 Tbl	1.3
Sardines	3 oz	1.4	Soybean oil	1 Tbl	0.9

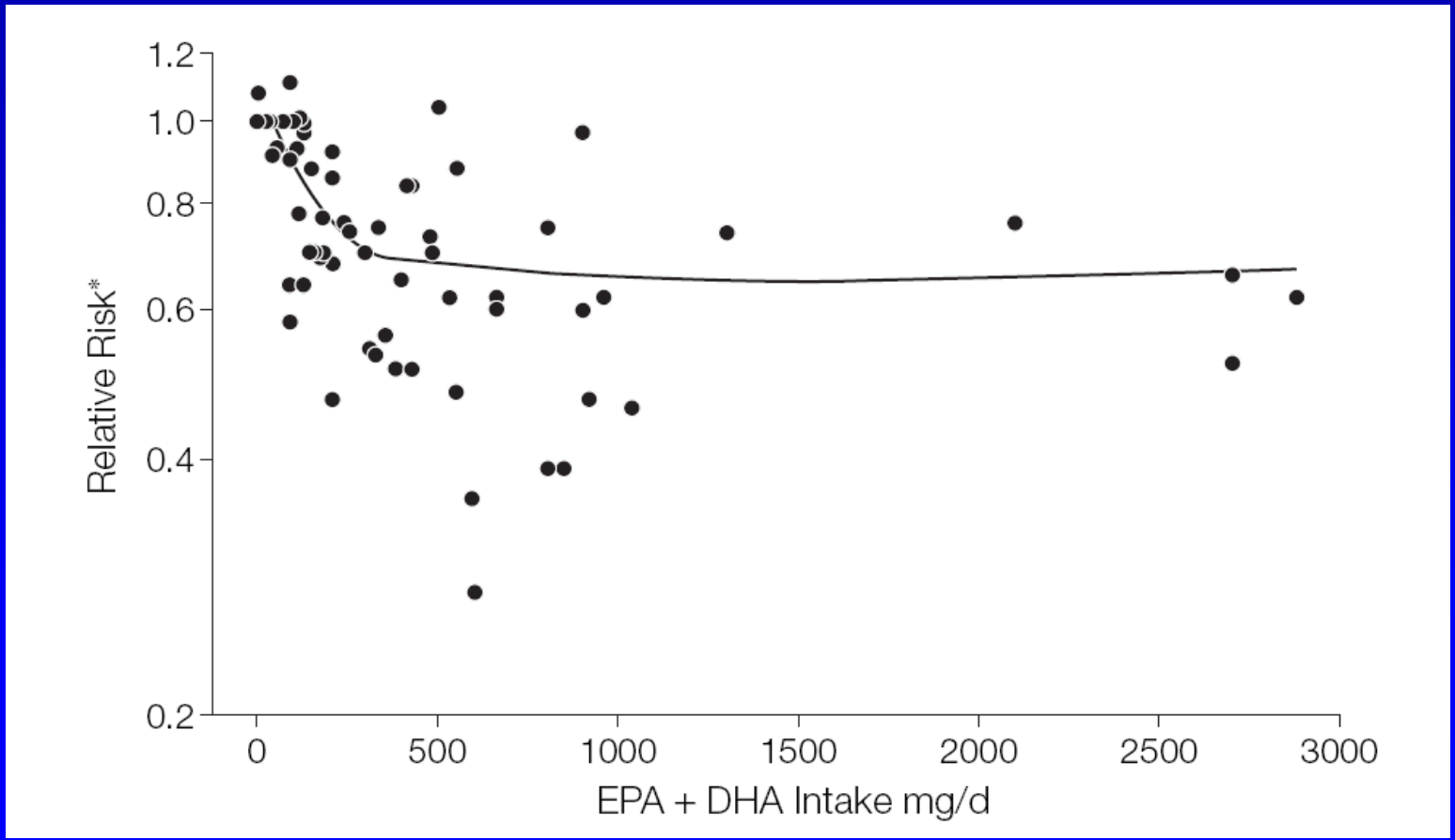
Risk of Sudden Death According to Dietary Fish Intake in 20,551 Male Physicians Followed for 11 Years



* significant, 95% CI does not contain 1.0

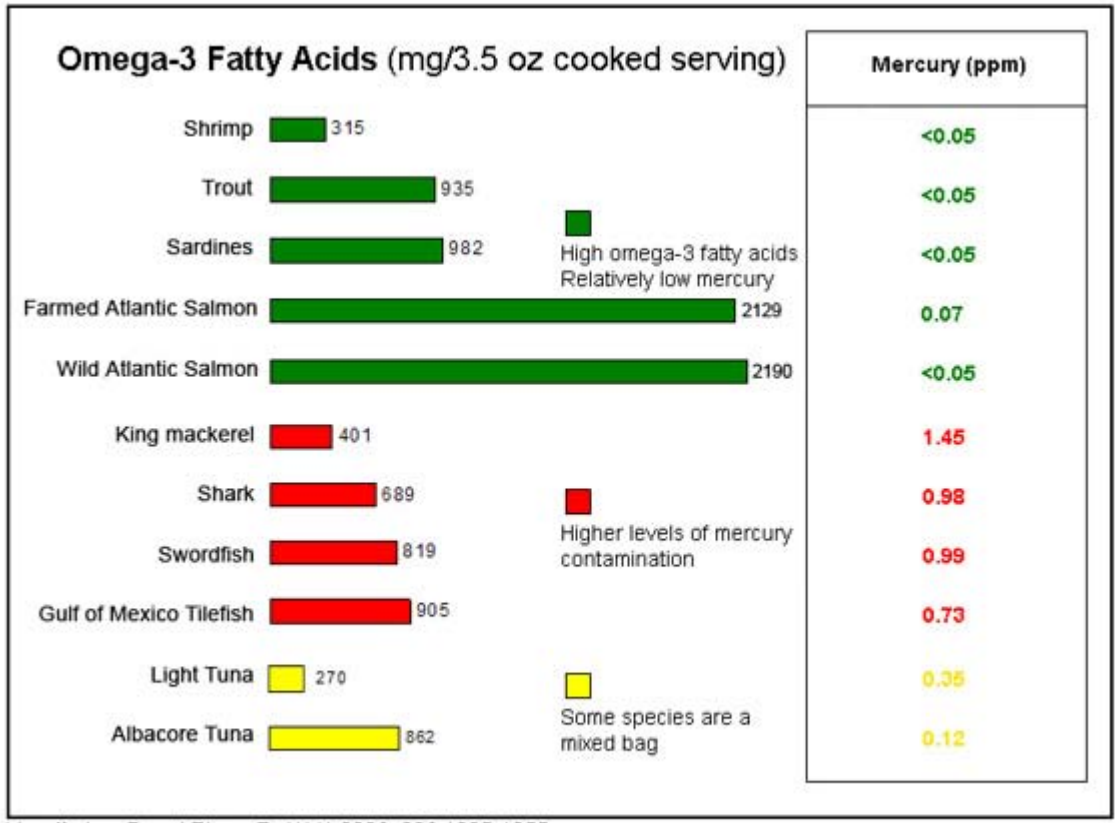
Source: Albert et al., 1998
JAMA 279:23-28

Intake of Fish or Fish Oil and Relative Risk of CHD Death



Mozaffarian D, Rimm EB. JAMA. 2006;296:1885-1899

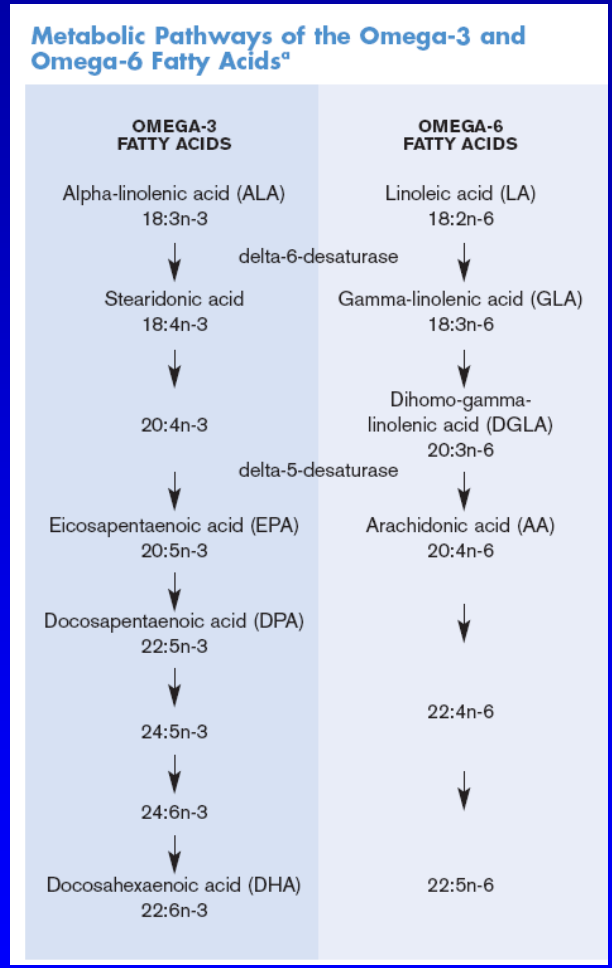
Omega-3 PUFA and Mercury Content of Selected Fish



Moraffarian, D and Rimm, E. JAMA 2006; 296:1885-1855.

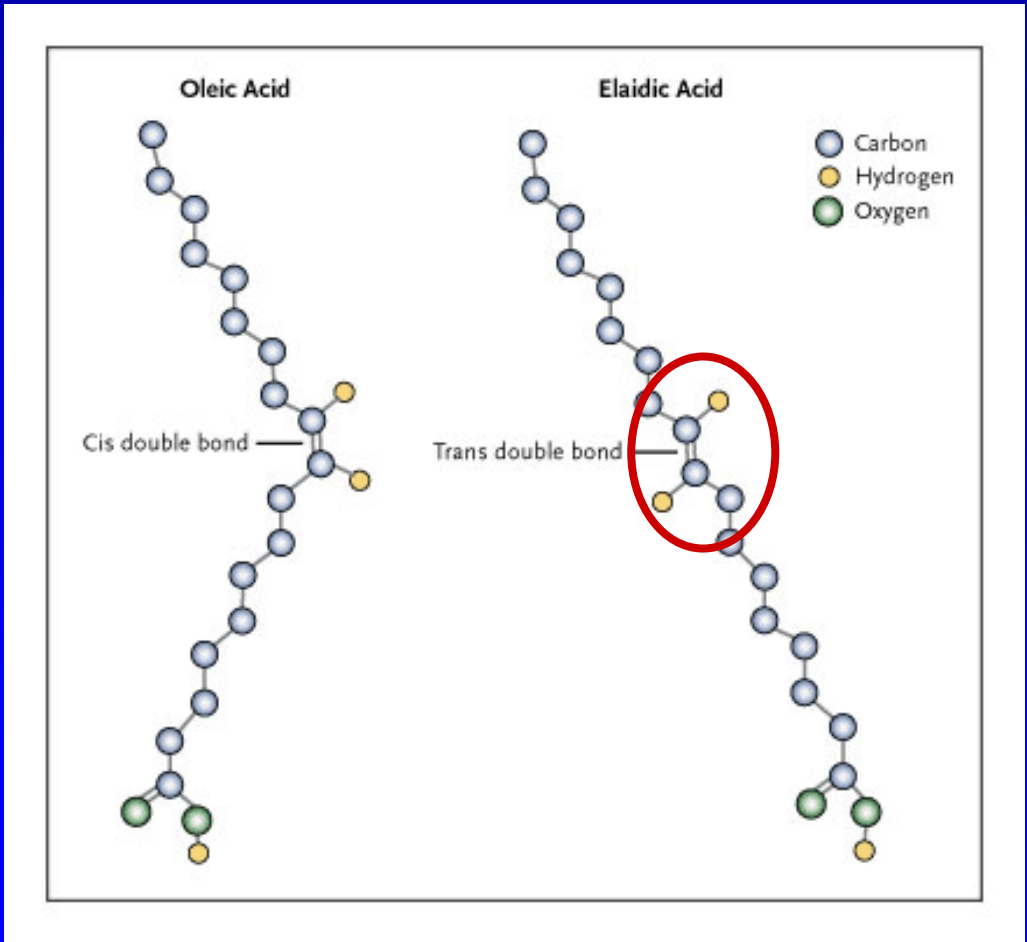
Factors Influencing ALA Metabolism

- Diet rich in n-6 fatty acids decrease ALA conversion to EPA/DPA by ~ 40-50%
- Rate of ALA conversion to **EPA** < 10%
- Rate of ALA conversion to **DHA** is 0-9%



Br J Nutr. 2002;88(4):411-420; Am J Clin Nutr. 2004;80(5):1167-1174

Trans Fat: Chemical Structure



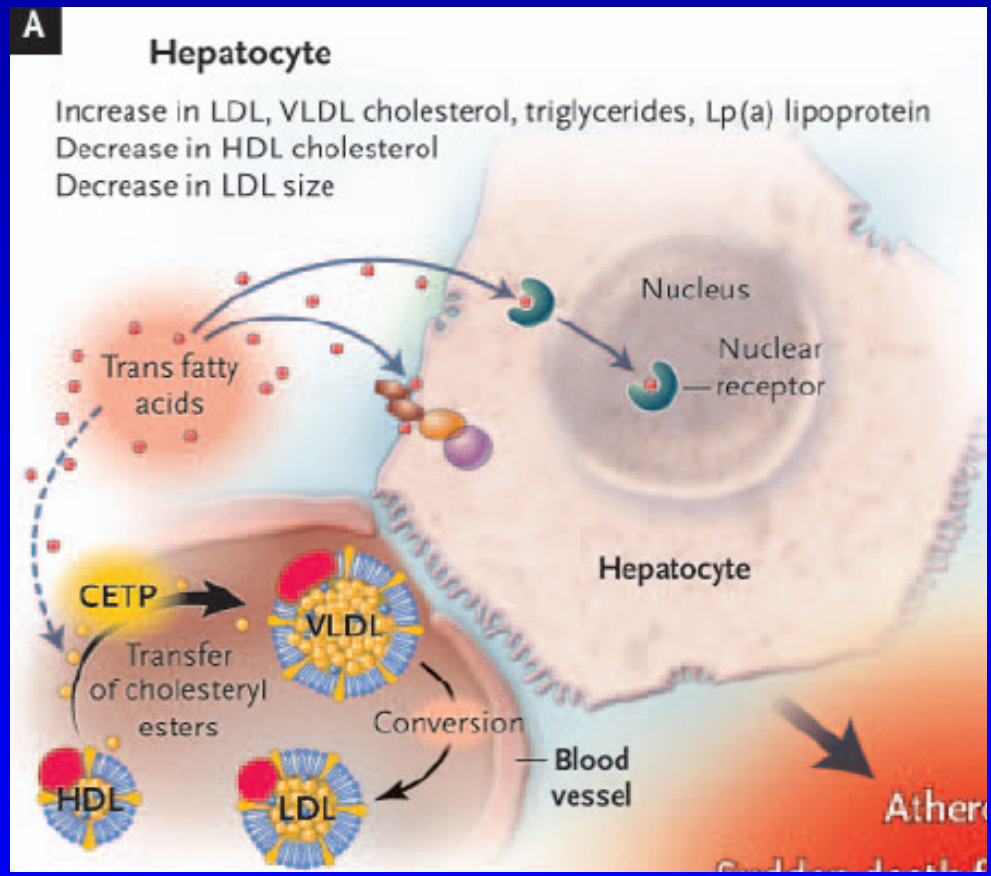
Mozaffarian, D. et al. N Eng J Med 2006: 354:1601-13.

Trans Fat: Effect on Blood Lipids

- **Mechanism:**
  - **Raises LDL-C , VLDL-C, triglycerides and Lipoprotein a**
  - **Lowers HDL-C**
- **Other Physiological Effects:**
  - Increases inflammatory response
  - Triggers endothelial dysfunction
  - Increases levels of circulating adhesion molecules
- **Dietary Sources:** Fried foods, baked goods, snack items
- **ATP III Recommendations:**

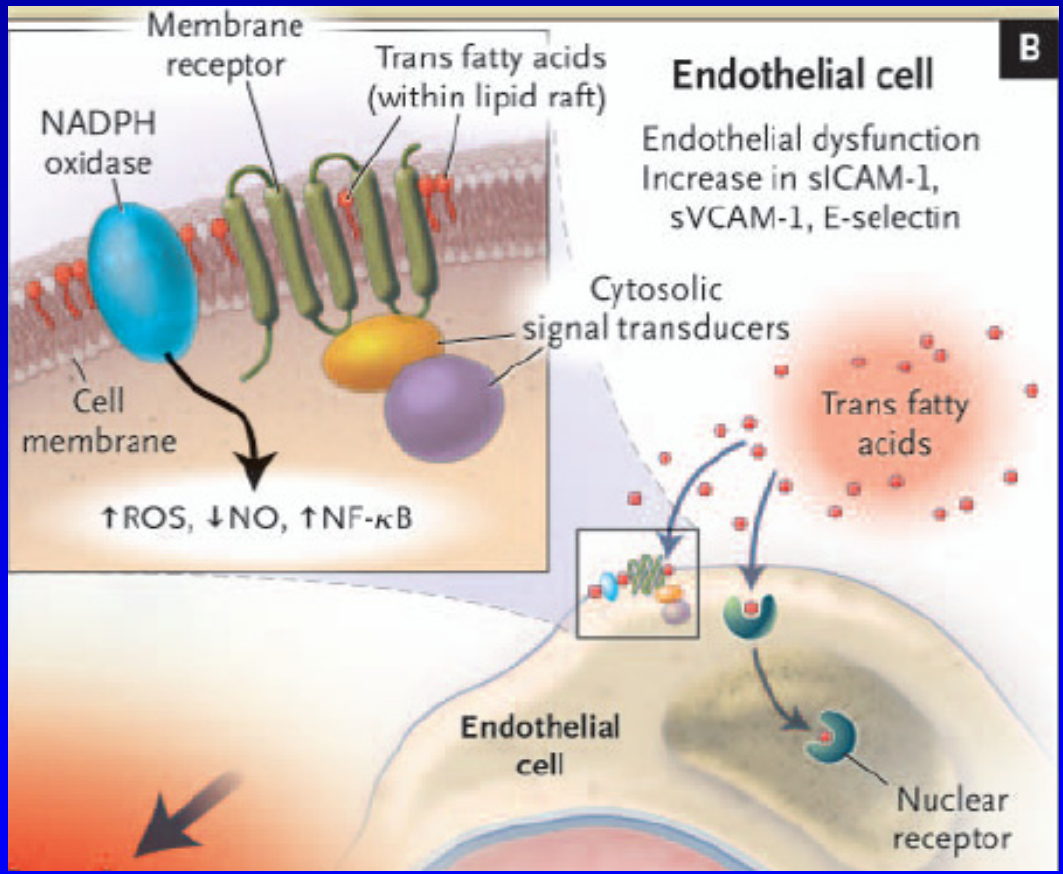
  < 7% of total calories (saturated *AND* trans fat)

Trans Fat: Effects on Lipids



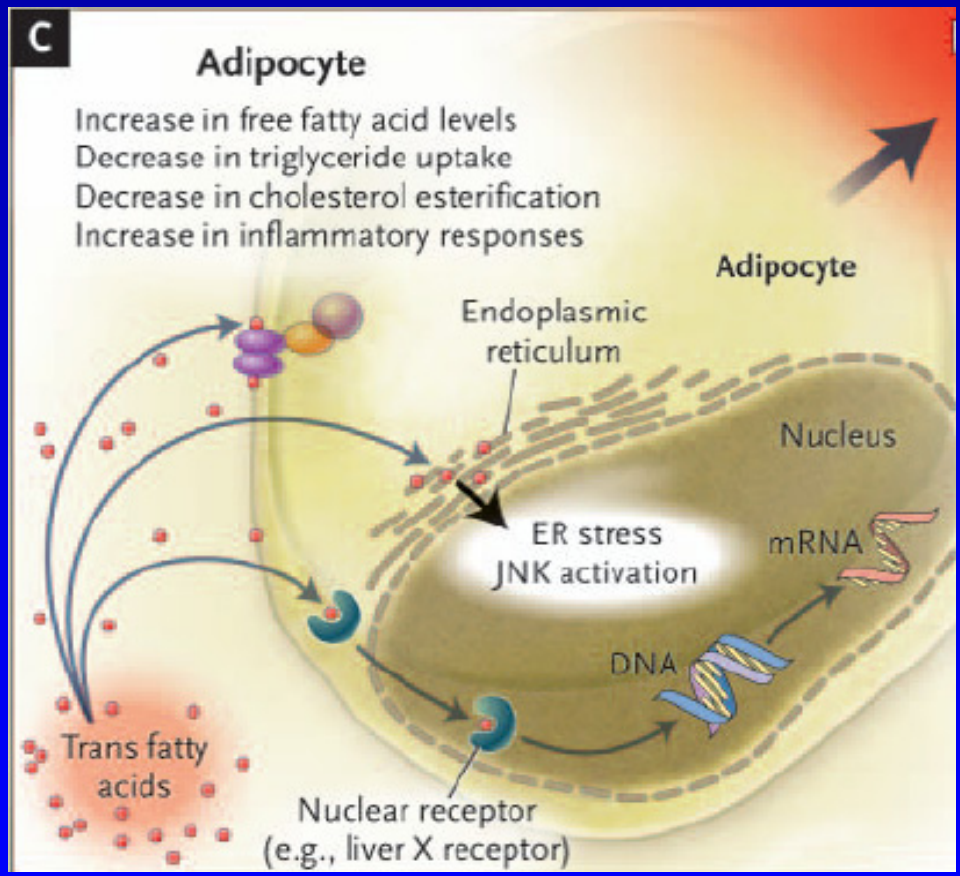
Mozaffarian, D. et al. N Eng J Med 2006: 354:1601-13

Trans Fat: Effects on Endothelial Cells



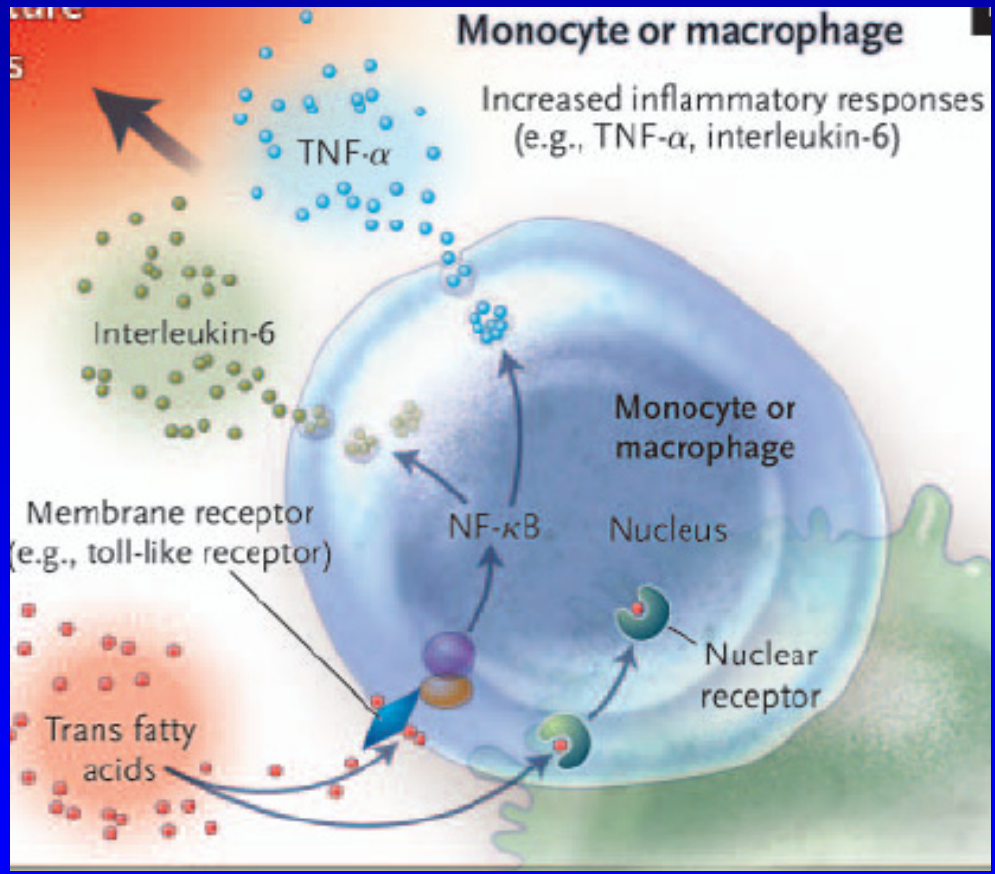
Mozaffarian, D. et al. N Eng J Med 2006: 354:1601-13

Trans Fat: Effects on Adipocytes



Mozaffarian, D. et al. N Eng J Med 2006: 354:1601-13

Trans Fat:
Effects on Monocyte & Macrophage Activity

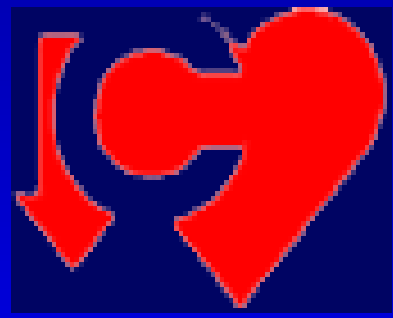


Mozaffarian, D. et al. N Eng J Med 2006: 354:1601-13

Trans Fat Content of Selected Foods

Trans Fat Content of Commercial Foods					
Food	**Serving**	**Trans Fat (grams)**	**Food**	**Serving**	**Trans Fat (grams)**
Potato chips	1 oz	0	Fried chicken	3 oz	3.1
Margarine, stick	1 Tbl	0.7	Chocolate doughnut	4.25" Dia.	3.3
Banana nut muffin	3.25" Dia.	0.7	Hash browns, frozen	1 cup	3.7
Cheese Danish	1 medium	1.9	Apple pie, frozen type	1/8 pie	4.0
Chocolate chip cookie	3.5" Dia.	2.0	Onion rings	1 order	4.1
Shortening	1 Tbl	2.2	French Fries, regular	1 order	4.8
Crackers, flavored	1 oz	2.3	Popcorn, commercially prep.	6 cups	4.9

National Cholesterol Education Program



Adult Treatment Panel IV
(ATP IV) Guidelines expected in 2010

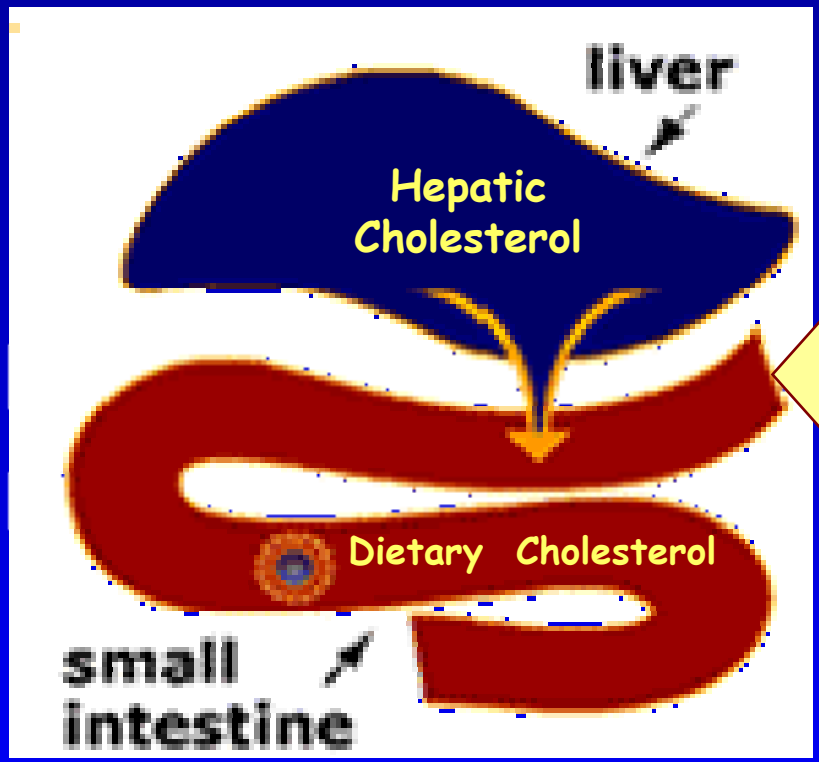
Source: NHLBI, National Cholesterol Education Program, available at http://hp2010.nhlbihin.net/ncep_slds/menu.htm#2

ATP III Therapeutic Lifestyle Changes Nutrient Composition of TLC Diet

Nutrient	Recommended Intake
• Saturated fat	Less than 7% of total calories
• Polyunsaturated fat	Up to 10% of total calories
• Monounsaturated fat	Up to 20% of total calories
• Total fat	25–35% of total calories
• Carbohydrate	50–60% of total calories
• Fiber	20–30 grams per day
• Protein	Approximately 15% of total calories
• Cholesterol	Less than 200 mg/day
• Total calories (energy) expenditure	Balance energy intake and to maintain desirable body weight/ prevent weight gain

Source: NHLBI, National Cholesterol Education Program, available at http://hp2010.nhlbihin.net/ncep_slds/menu.htm#2

ATP III Dietary Adjuncts:
Soluble (Viscous) Fiber



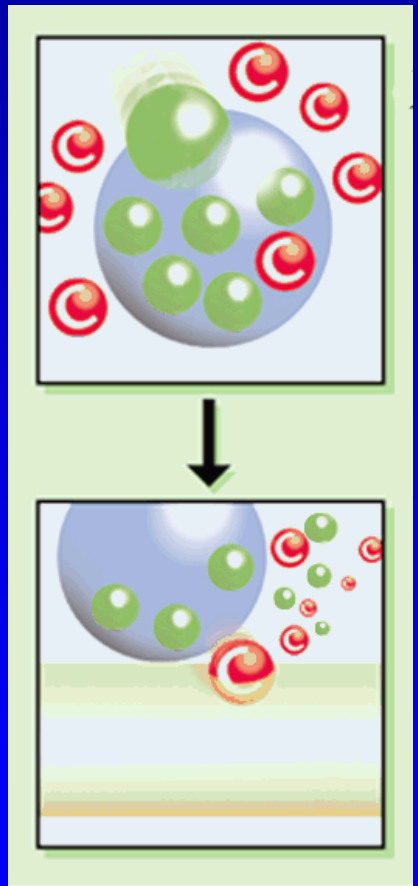
Soluble fiber
binds with both:
1. Hepatic cholesterol
2. Dietary cholesterol in the **small intestine**, both which are eventually eliminated out of the body.

♥ 3-5% LDL-C lowering expected.

- Soluble fiber has greater LDL-lowering potential than insoluble fiber.
- A high fiber diet (both soluble and insoluble fiber) is inversely associated with CHD.

ATP III Dietary Adjuncts: Plant Stanols

- Plant stanol esters block entry of most cholesterol into micelle
  - Dietary Cholesterol
  - Biliary Cholesterol
- Cholesterol absorption is reduced by 50%.
- Blocked cholesterol and plant stanol are eliminated from body.
- Commercial stanols: *Take Control* and *Benecol* nonhydrogenated tub margarines.



Sterols & Stanols: Clinical Considerations

- 1-3 grams/day of plant sterols & stanols esters are effective in lowering LDL-C by 6-15%.
- No effect on HDL-C and TG.
- Because enriched foods are calorie dense, they must be substituted for other fatty foods as part of a diet low in cholesterol and saturated fat.
- Plant stanol esters are safe and effective in combination with statins and should be considered, along with a low fat diet and/or in combination with lipid-lowering medications, for patients with hypercholesterolemia.

Thompson,GR and Grundy, SM. Am J Cardiol 2005; 96(suppl): 3D-9D).

Cumulative Benefit of Dietary Factors on LDL-C Reduction

Dietary Component	Meets Dietary Goal	Approximate LDL Reduction
Major Component		
Saturated & trans fats	<7% of calories	8-10%
Dietary cholesterol	<200 mg/day	3-5%
Weight reduction	Lose 10 lbs	5-8%
Other LDL-lowering options		
Viscous fiber	5-10 g/day	3-5%
Plant sterol/stanol esters	2 g/day	11-14%
Cumulative estimate		30- 40%

ATPIII Final Report in Circulation 2002; 106: 3143-421;
Guigliano, D et al. J Am College of Cardio 2006; 48: 677-85.

Cardiovascular Nutrition

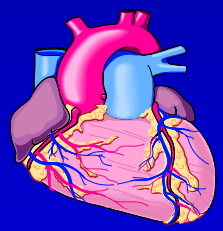
20th Century

Fat-Cholesterol Focused

Single Nutrient

Reduce/Omit Approach

- Total Fat
- Saturated Fat
  - Trans fat
- Cholesterol
- Salt



21st Century

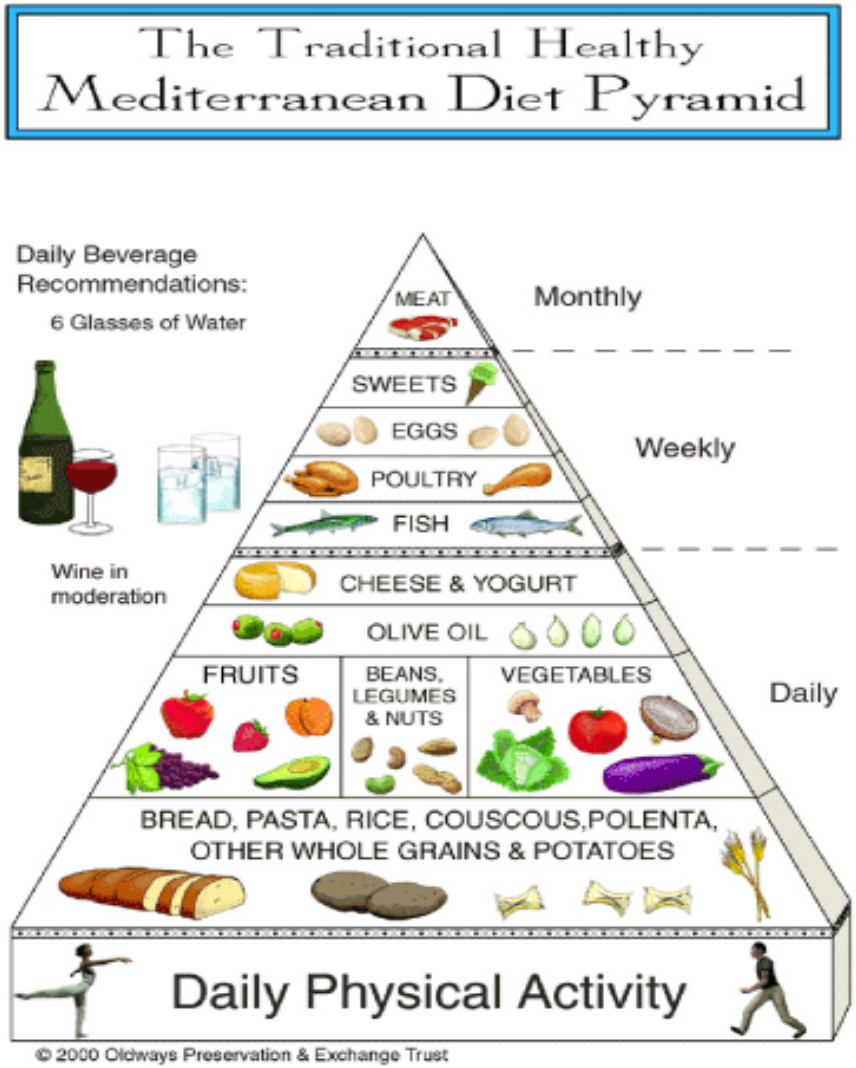
Benefit Focused:

Dietary Pattern Approach

-Lyon Diet
-Mediterranean Diet
-Fish: omega-3 fats
-Fiber/whole grains
-Nuts
-Fruits & Vegetables
-Low fat dairy
-Olive oil

Adapted from McCulloch, 2004

Mediterranean Diet



Selected Nutrition Studies Showing Reduced Risk of CVD

- **OSLO:** Lowered Fat and Cholesterol (1960-1970)
- **Multiple Risk Factor Intervention Trial (MRFIT):** Lower Fat and Cholesterol (1970-1980)
- **Dietary Approaches to Stopping Hypertension (DASH):** Increase Fruits and Vegetables, Low Fat Dairy, Lower Sodium (1990-2000)
- **PREMIER:** Free living version of DASH (1990-2000)
- **OmniHeart:** CHO vs PRO vs MUFA

Hu, F. *ADAJ*, 2005;105:111.

OmniHeart Randomized Trial

- **Objective:** To compare effects of 3 healthful diets each with reduced SFA on BP and serum lipids.
- **Design:** Randomized 3 Period Crossover Feeding Study; Baltimore and Boston
  n=164 prehypertensive and hypertensive patients
  6 week feeding cycle
- **Interventions:** Three Diets
  - High CHO
  - High PRO (1/2 veg pro)
  - High MUFA

Appel, LJ et al. *JAMA*. 2005;294:2455-2464.

OmniHeart Randomized Trial
(continued)

Results

All three diets associated with reduced BP vs. Baseline

- **PRO vs. CHO Diet:**
  - -Further reduced SBP 1.4mm Hg (P=.002) and 3.5mm Hg (P=.006) for those with HTN
  - -LDL-C ↓ 3.3mg/dL (P=.01) and TG ↓ 15.7 mg/dL (p<.001)
- **MUFA vs CHO Diet:**
  - -Reduced SBP by 1.3 mm Hg (p=.005) and 2.9 mm Hg (p=.02) in HTN
  - -No effect on LDL and ↑ HDL by 1.1 mg/dL (p=.03) and ↓ TG by 9.6 mg/dL (P=.02)

Appel, LJ et al. *JAMA*. 2005;294:2455-2464.

OmniHeart Randomized Trial
(continued)

Conclusion

Diet can effectively lower BP, LDL-C, TG and increase HDL-C via changes in food patterns and adherence to dietary recommendations.

Appel, LJ et al. *JAMA*. 2005;294:2455-2464.

Other Dietary Considerations in the Prevention & Treatment of CVD

- Quality and Quantity of Carbohydrate
- Glycemic Index/Glycemic Load
- Antioxidants
- Sugar and High Fructose Corn Syrup
- Vitamin D

Hu, F. *ADAJ*, 2005;105:111.

Glycemic Index

- Definition: an estimate of the relative postprandial blood sugar response of a given food.
- Influenced by amounts and types of carbohydrates, cooking method, food processing, and other foods eaten at a meal.
- Total carbohydrate more important than type.
- Low glycemic meals are associated with **greater satiety**, **lower caloric intake** and reduction in **total cholesterol and possibly LDL-C levels.**

Glycemic Index v. Glycemic Load

Glycemic Index	Glycemic Load
Represents the blood sugar response to ingestion of a ***50g carbohydrate portion*** of a given food tested expressed as a percent of the response to the same amount of carbohydrate from white bread or pure glucose consumed by the same subject.	Represents the quality and quantity of carbohydrates consumed OR the glycemic index of a food multiplied by the amount of carbohydrates per serving.
Types of carbohydrate consumed, food preparation/cooking method and meal composition all influence blood sugar response.	**Calculatiing Glycemic LOAD:** $\frac{\text{Glycemic Index} \times \text{Amt Carbs (grams)}}{100}$
Glycemic **INDEX** Ranking: 0-55= Low 56-70= Medium 71+ = High	Glycemic **LOAD** Ranking: 0-10= Low 11-19= Medium 20+ = High

Antioxidants: Proposed Mechanism

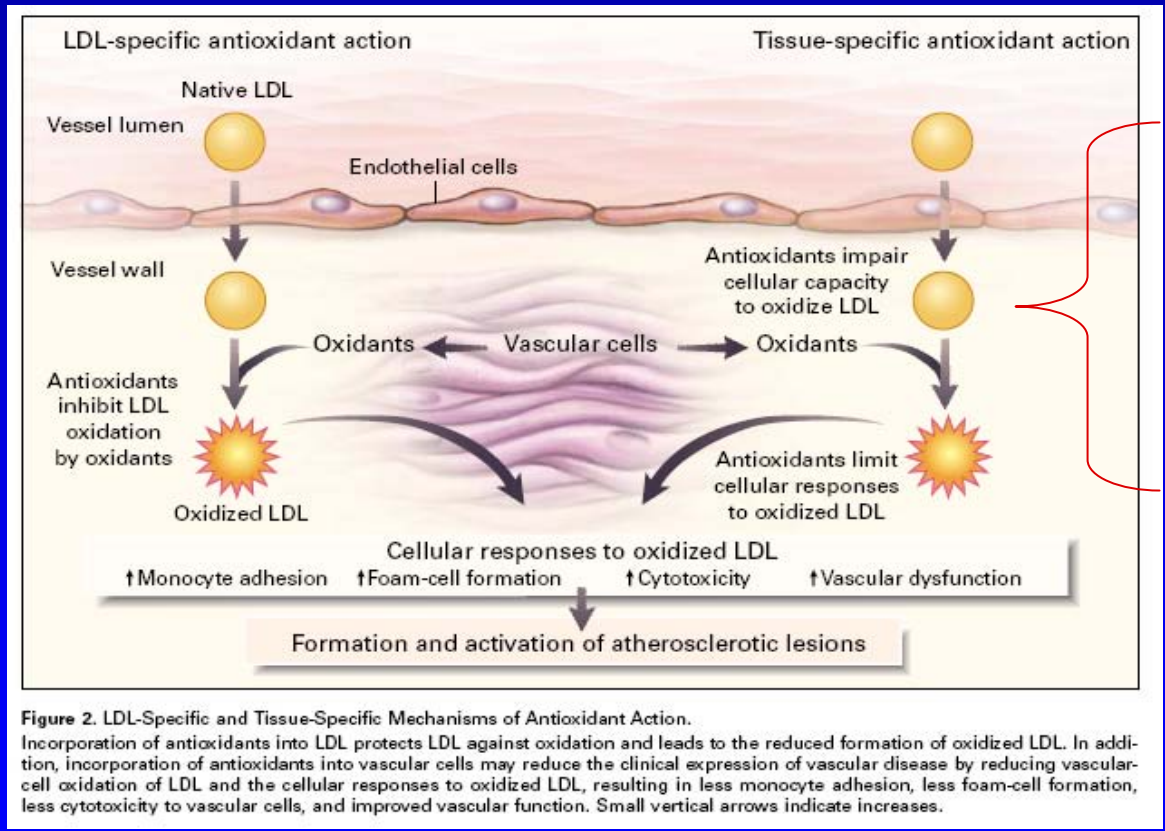


Figure 2. LDL-Specific and Tissue-Specific Mechanisms of Antioxidant Action.
Incorporation of antioxidants into LDL protects LDL against oxidation and leads to the reduced formation of oxidized LDL. In addition, incorporation of antioxidants into vascular cells may reduce the clinical expression of vascular disease by reducing vascular-cell oxidation of LDL and the cellular responses to oxidized LDL, resulting in less monocyte adhesion, less foam-cell formation, less cytotoxicity to vascular cells, and improved vascular function. Small vertical arrows indicate increases.

Dietary Antioxidants:

- **Vitamins C & E**
- **Phytochemicals**

Diaz MN, N Engl J Med 1997; 337:408-416.

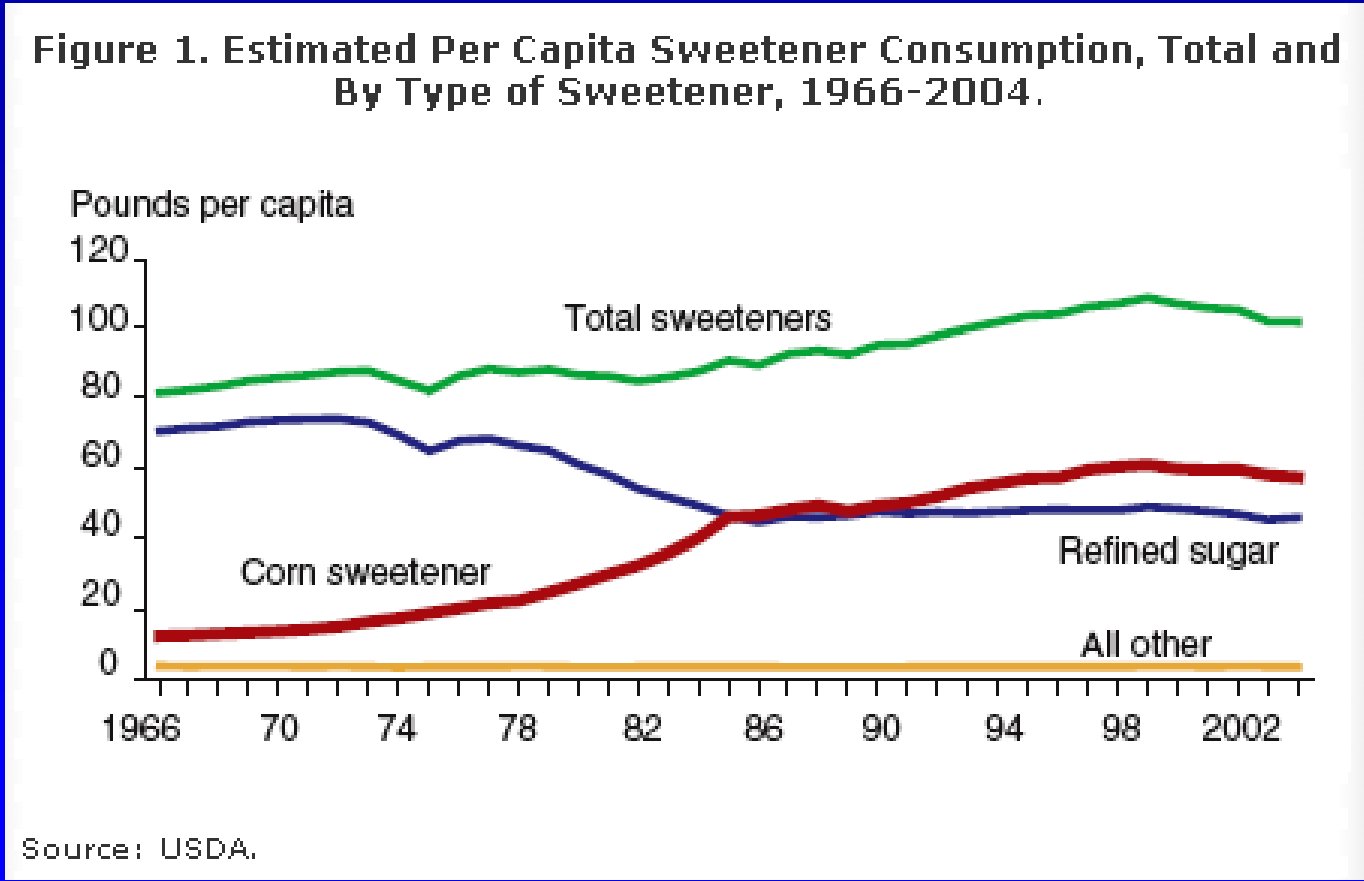
Vitamin Supplements and CVD Risk

Women's Antioxidant and Folic Acid Cardiovascular Study:

- Randomized clinical trial studying female health professionals 40 years or older who had a history of CVD or those with at least 3 CVD risk factors.
- 5422 women took either a placebo or combination of **folic acid, vitamin B_6 and vitamin B_{12}** for 7.3 years.
- 8171 females took either a placebo or vitamin C, **vitamin E** or **beta-carotene** for 9.4 years.
- Results: **NO CVD benefit** from taking **ANY** of the vitamin supplements.

Source: American Heart Association Meeting Report 11/13/2006

US Trends in High Fructose Corn Syrup Consumption

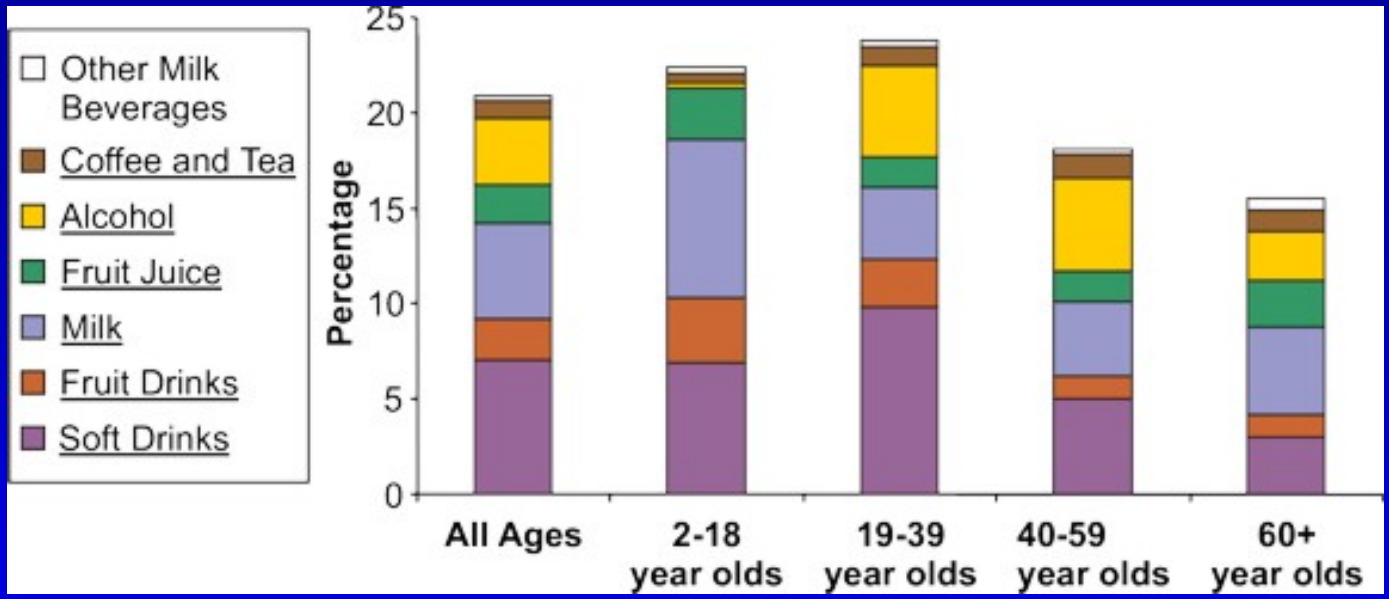


High Fructose Corn Syrup: Health Implications

- Fructose metabolism may promote lipogenesis by increasing postprandial TG levels and decreasing satiety hormone leptin.

- Individuals who drink sugary beverages do not compensate for their calories in other ways and may actually increase their desire to consume more sugary foods/beverages.

% Daily Caloric Intake from Beverages

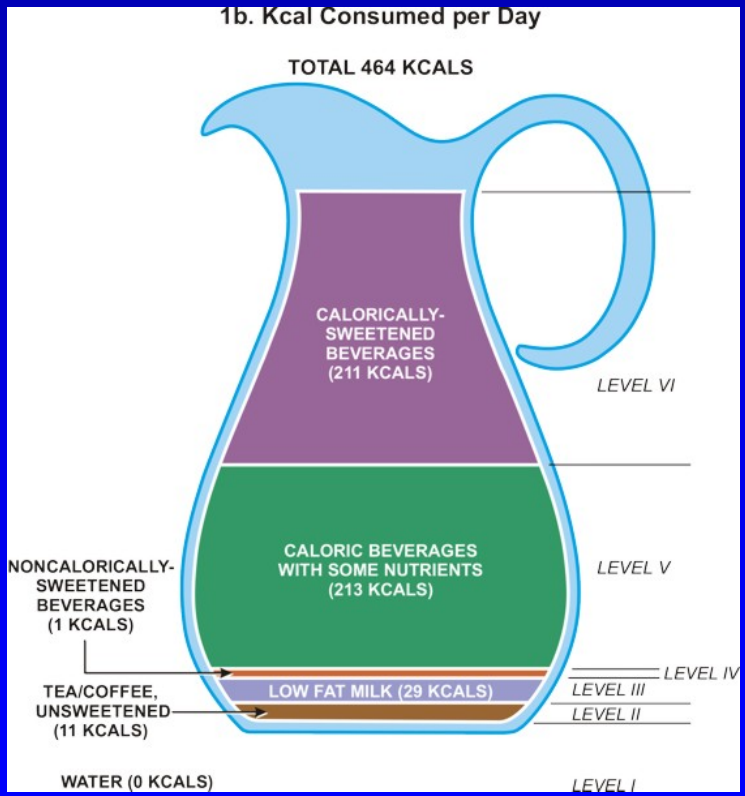


- Beverage intake pattern in the U.S. from the 1999–2002 NHANES surveys.
- Water, tea and coffee intake (unsweetened beverages) comprise 70% of the total volume but contribute only 2% of the calories.
- **Sugary soft drinks** and **fruit drinks** provide 46% of the calories consumed from beverages.

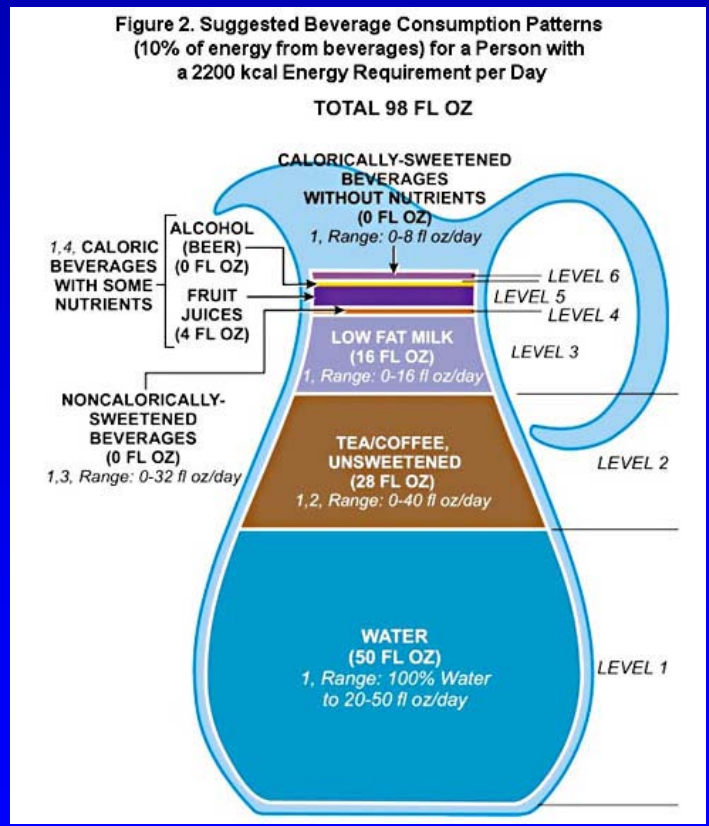
Source: www.beverageguidancepanel.org

Think Before You Drink:
Current Patterns vs. IOM Recommendations

Current Beverage Consumption



Recommended Beverage Consumption



Am J Clin Nutr 2006; 83: 529-42 and www.beverageguidancepanel.org

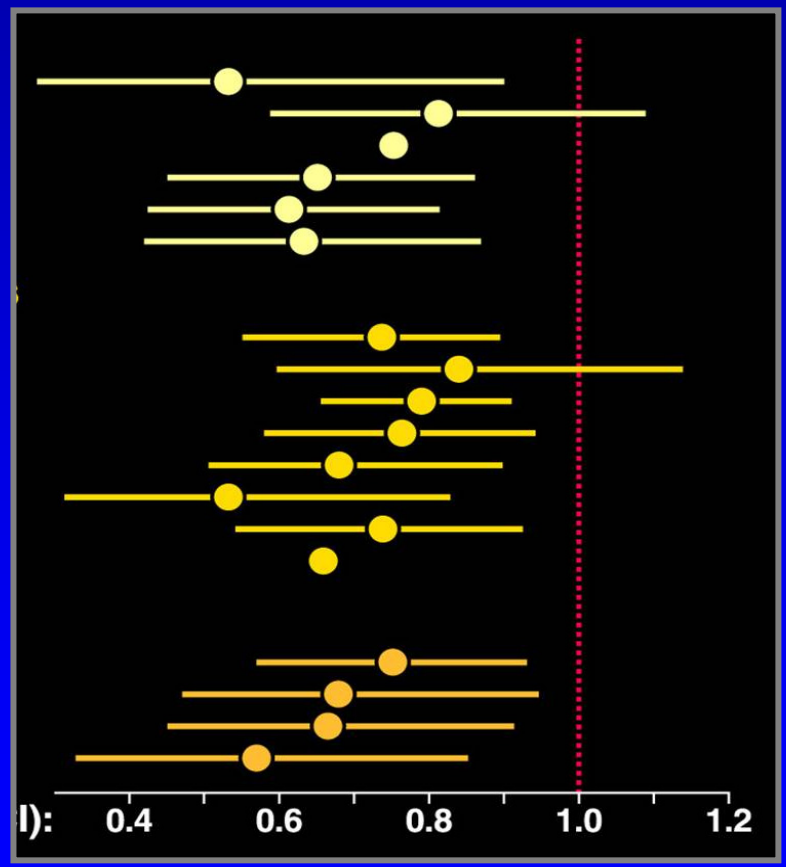
Plasma Lipid Response to Soy for the Modified Diet

	Placebo		Soy		
Variables	**Baseline**	**Final**	**Baseline**	**Final**	**p**
Total cholesterol (mg/dL)	236.2	229.3	240.15	238.9	0.15
LDL (mg/dL)	159.4	152.8	161.0	159.8	0.12
HDL (mg/dL)	59.0	56.7	59.8	59.5	0.09
Triglycerides (mg/dL)	110.6	121.2	120.3	122.12	0.14
Lipoprotein (a) (g/L)	0.24	0.24	0.27	0.31	0.14

Kreijkamp-Kaspers S et al. *JAMA* 2004; 292:65-74.

Prospective Cohort Studies of CVD and Consumption of Nuts, Fruits and Vegetables, or Whole Grains

- **Nuts**
  - Albert *et al*, 2002
  - Ellsworth *et al*, 2001
  - Brown *et al*, 1999*
  - Hu *et al*, 1998
  - Fraser and Shavlik, 1997
  - Fraser *et al*, 1992
- **Fruits & Vegetables**
  - Bazzano *et al*, 2002
  - Liu *et al*, 2000
  - Joshipura *et al*, 1999
  - Gaziano *et al*, 1995
  - Gillman *et al*, 1995
  - Knekt *et al*, 1994*
- **Whole Grains**
  - Lutsey et al, 2007
  - Jensen, AK et al, 2006
  - Liu *et al*, 2000
  - Liu *et al*, 1999



Relative Risks (RR) and 95% Confidence Intervals (CI) between the incidence rates of the highest versus lowest consumption group. Data adjusted for nondietary and/or dietary covariates. Asterick means no CI was published in the article. Hu et al., *JAMA*, 2002, 288:2569-2578

Classification and Management of Adult Blood Pressure

BP Classification	SBP, mm Hg	DBP, mm Hg	Lifestyle Modification
Normal	<120	<80	Encourage
Prehypertension	120-139	80-89	Yes
Stage 1 hypertension	149-159	90-99	Yes
Stage 2 hypertension	≥160	≥100	Yes

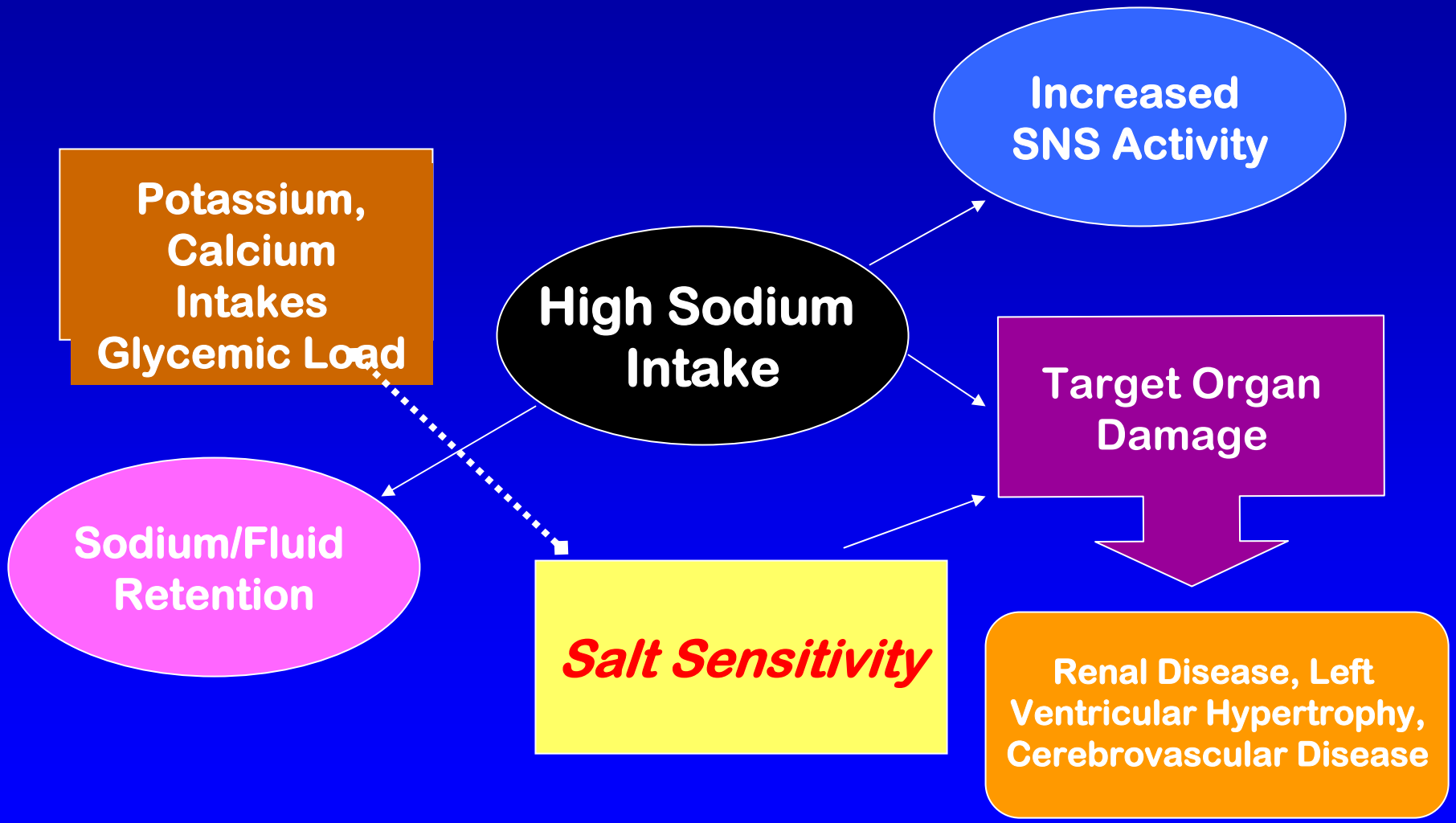
Chobanian A V, et al. *JAMA*. 2003;289:2560-2572.

Effect on systolic BP for lower vs intermediate vs higher sodium intakes in the DASH diet vs control diet arms

Group	23-41 years	42-47 years	48-54 years	55-76 years
Control diet				
•Lower vs higher	-4.8	-5.9	-7.5	-8.1
•Lower vs intermed	-3.6	-3.7	-5.3	-5.2
•Intermed vs higher	-1.2	-2.2	-2.1	-2.8
DASH diet				
•Lower vs higher	-1.0	-1.8	-4.3	-6.0
•Lower vs intermed	+0.8	-1.3	-2.6	-4.3
•Intermed vs higher	-1.8	-0.5	-1.7	-1.7

Bray GA et al. *Am J Cardiol* 2004; 94:222-227.

Physiological Effects of Dietary Sodium



Definition: Salt-Sensitivity

- **Response defined as:**
  - 10 mm Hg increase with sodium loading following a period of sodium restriction

  OR
  - 5% increase in BP with sodium repletion following restriction

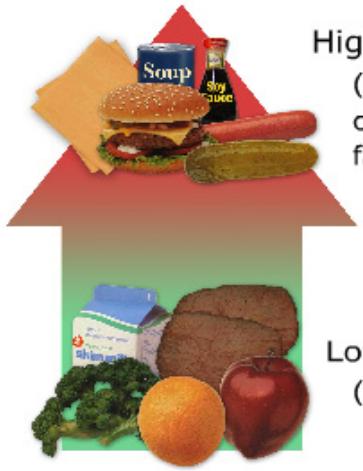
- **Estimated prevalence**
  - 30-50% of hypertensives
  - 15-20% of normotensives

- **Highest prevalence associated with:**
  - obesity
  - African-American
  - diabetes (type II)
  - age > 65 years
  - family history of hypertension

Dietary Sodium

Role of Minerals in Hypertension

Sodium is one of several minerals (sodium, calcium, potassium and magnesium) that play a role in hypertension.



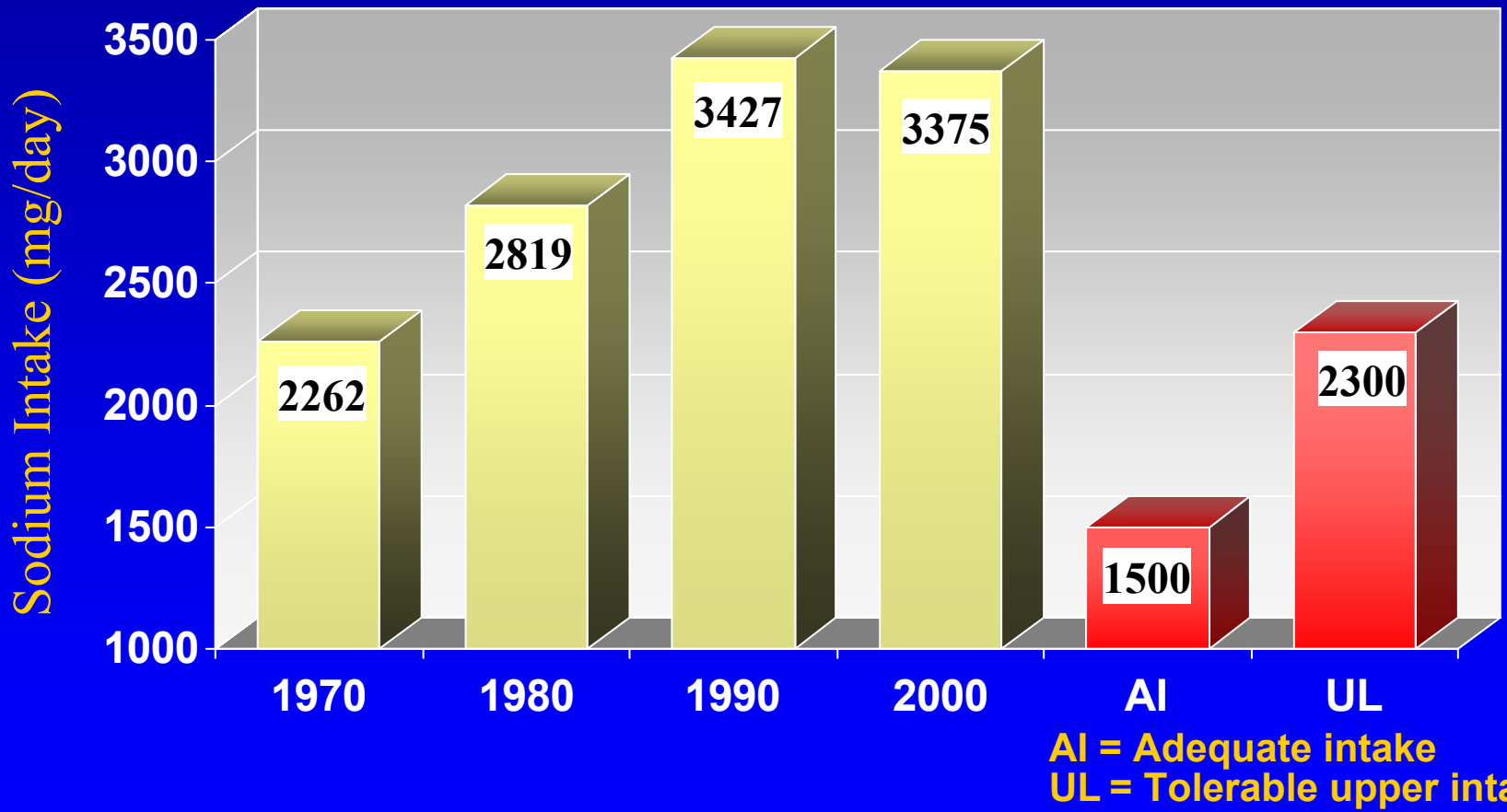
Sodium Content of Food

High
(processed, smoked, cured, or pickled foods, fast foods, condiments)

Low
(mostly fresh foods)

Source: Nutrition in Medicine *CVD: Hypertension & Other Risk Factors* Web Course, 2006

Sodium Guidelines



Sources: *Am J Clin Nutr*. 2005;81:941-2. Institute of Medicine Recommended Intakes

Vascular Effects of Potassium

- **Determines resting membrane potential**
  (plasma potassium:intracellular potassium)
  - influences force and timing of cardiac/vascular muscle contractions
  - altered by changes in extracellular [Na^{+}] and [Ca^{+2}]

- **Impacts capacitance of blood vessels**
  - How responsive peripheral vasculature will be to changes in plasma volume.
  - Enables blood pressure to be maintained within a narrow range over wide variations in plasma volume.

Vascular Effects of Calcium

- **Increase in intracellular concentration**
  - stimulates muscle contraction
  - promotes release of neurotransmitters

- **Decrease in extracellular concentration**
  - lowers of membrane depolarization
  - activates voltage-gated Na channels
  - increases membrane excitability

- **Calcium dependence** ↑
  - synthesis of vasoactive prostaglandins
    - cofactor for phospholipase A_2 which releases fatty acids from cell membrane phospholipids

Vascular Effects of Magnesium

- **Anti-arrhythmic**
  - Maintains intracellular potassium levels
- **Vasodilatory**
  - Antagonist of calcium effects:
    - Regulates calcium efflux into cytosol (physiological calcium channel blocker)
    - Inhibits vascular smooth muscle contraction

Benefits of Weight Loss on Blood Pressure

Weight Loss

Lowers SBP

Lowers DBP

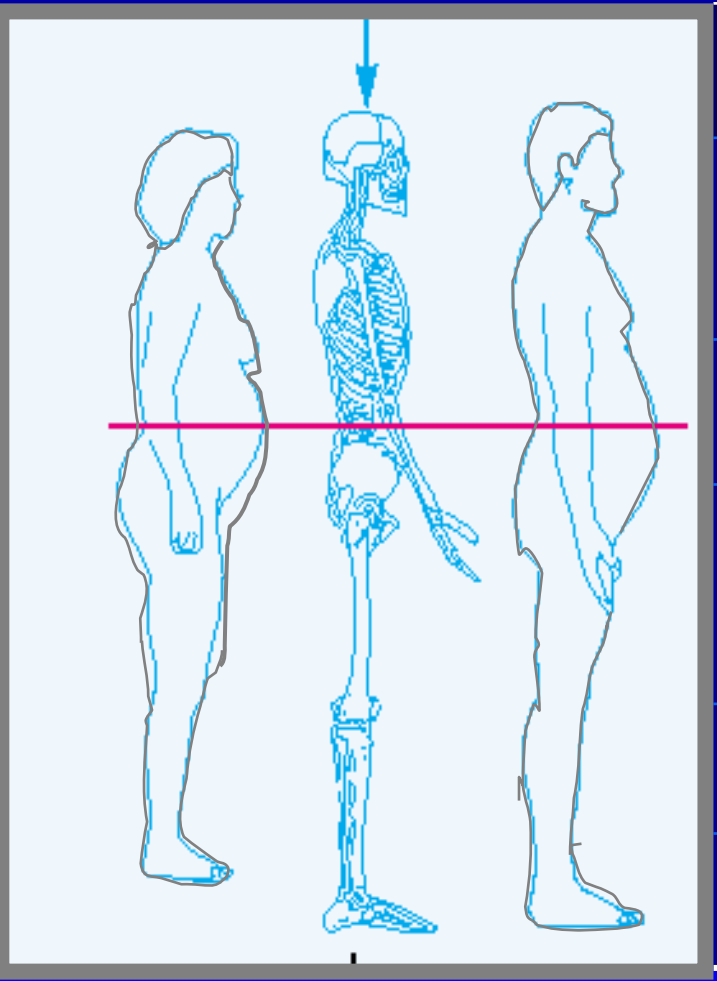
Increases Insulin Sensitivity

Normalizes Blood Pressure

Increases Effectiveness of Antihypertensive Drug Therapy

Reduced Dosage & Number of BP Drugs

Metabolic Syndrome: Definition



3 or more Risk Factors	Defining Level
Abdominal obesity	Waist circumference Men: >40 in (102 cm); Women >35 in (88 cm)
Triglycerides	≥150 mg/dl
HDL-C	<40 mg/dl in men; <50 mg/dl in women
Blood pressure	≥130/≥85 mm Hg
Fasting glucose	≥110 mg/dl

Expert Panel. *JAMA* 2001;285:2486-2497.

Markers of CHD Risk: *Metabolic Syndrome*

Abdominal Obesity

Atherogenic Dyslipidemia
↑Triglycerides
↓ HDL cholesterol
↑Cholesterol/HDL cholesterol ratio
"Normal" LDL cholesterol but ↑ apo B
Small, dense LDL and HDL
Postprandial hyperlipidemia

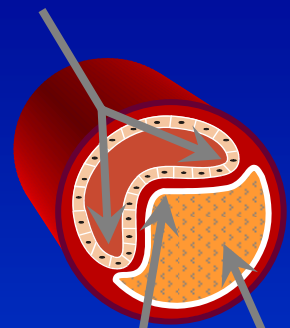
Insulin Resistance
Insulin resistance
Hyperinsulinemia
Hyperglycemia
Type 2 diabetes

Thrombotic State
↑ PAI-1
↑Fibrinogen

Inflammatory State
↑CRP
↑ Cytokines

Metabolic Risk Factors

Inflammation



Thin fibrous cap

Lipid Core

Coronary Atherosclerosis Unstable Plaque

↑ Risk of Acute Coronary Syndrome

Adapted from Després JP, et al. *Progress in Obesity Research: 9;* 2003:29-35

POUNDS LOST STUDY:

***P**reventing **O**verweight **U**sing **N**ovel **D**ietary **S**trategies*

- Funded by the NHLBI, 2004 - 2007
- Participating institutions:
  - Harvard School of Public Health
  - Women's Hospital in Boston
- Objective:
  - Evaluate the effect of diet composition on:
    - Weight lost at 6 months
    - Maintenance of weight loss after 2 years

Sacks FM et al. N Engl J Med 2009; 360: 859-873

POUNDS LOST STUDY
(continued)

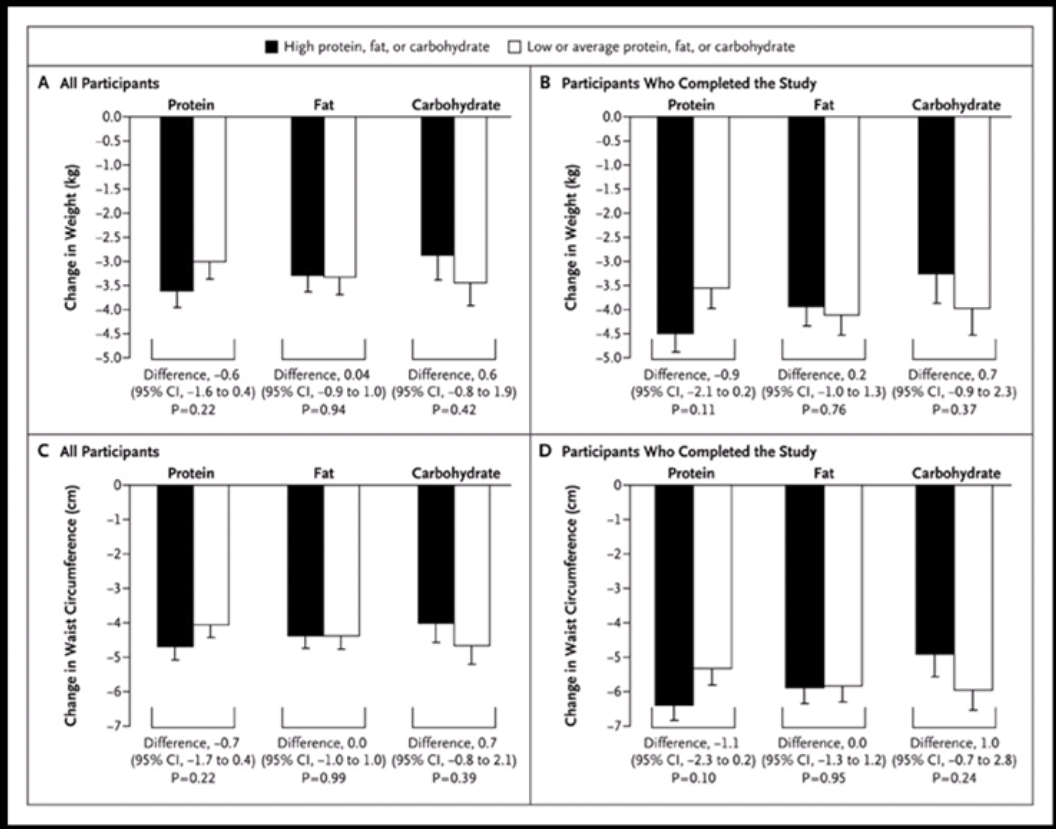
- Sample:
  - 811 overweight/obese men & women
  - Ages 30 to 70 years.
- Mean weight loss:
  - 13 pounds at six months
  - Maintenance of a 9 pound loss at 24 months.
- The varied protein/fat/carbohydrate compositions of reduced-calorie diets (1400-2000 calories/day) had comparable effects on weight loss.
- Dietary compliance was not high.

Sacks FM et al. N Engl J Med 2009; 360: 859-873

POUNDS LOST STUDY:

Preventing Overweight Using Novel Dietary Strategies

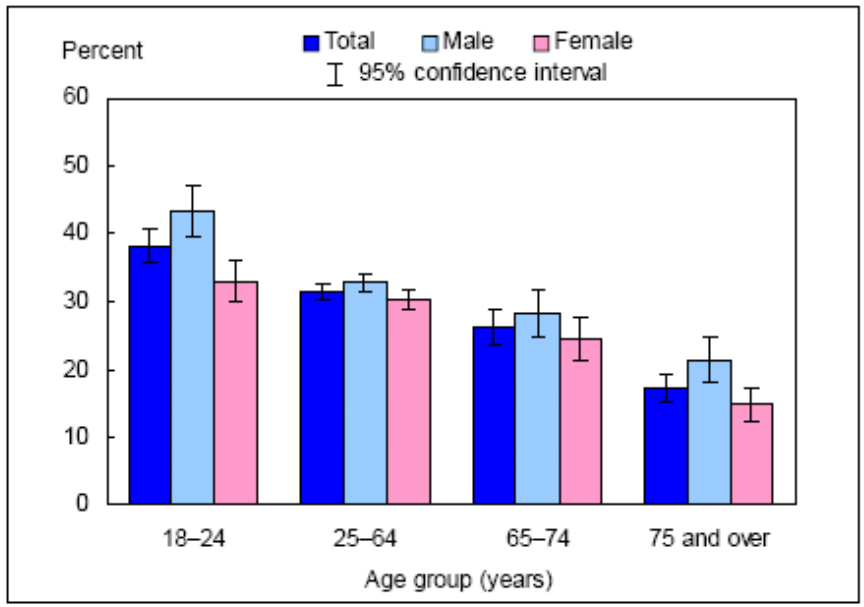
Mean Change in Body Weight and Waist Circumference from Baseline to 2 Years According to Dietary Macronutrient Content



Sacks FM et al. N Engl J Med 2009;360:859-873

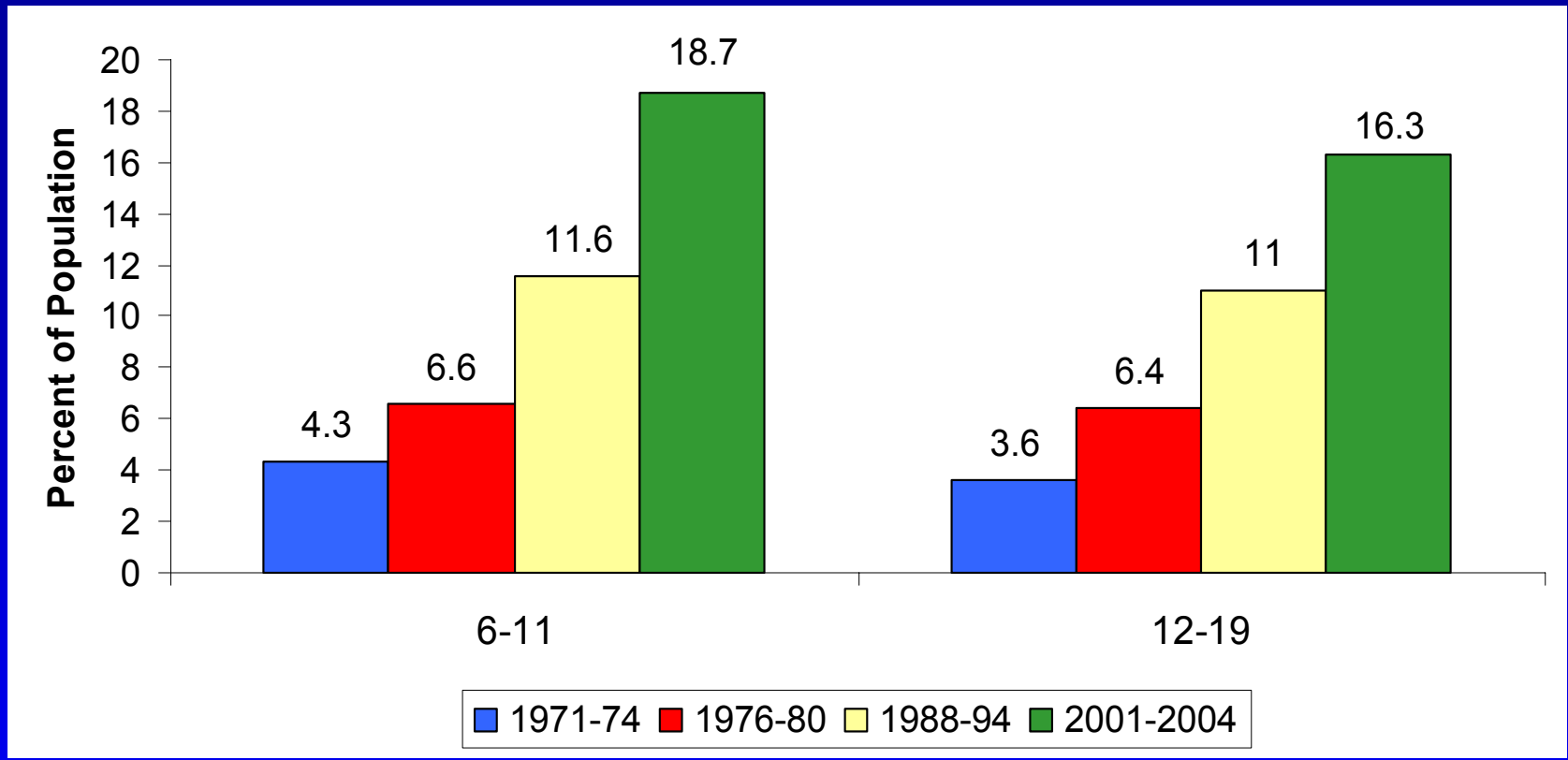
% Adult Americans Meeting Daily Physical Activity Recommendations*

Figure 7.2. Percentage of adults aged 18 years and over who engaged in regular leisure-time physical activity, by age group and sex: United States, 2006



Source: www.cdc.gov

**Recommended physical activity is defined as ≥ 5 days a week for 30 minutes a day of moderate intensity activity or at least 3 days a week for 20 minutes a day of vigorous intensity activity.*



Trends in Prevalence of Overweight Among U.S. Children and Adolescents by Age and Survey (NHANES, 1971-74, 1976-80, 1988-94 and 2001-2004)

Source: Health, United States, 2006, unpublished data. NCHS.

DGA Quantitative Advice Related to Fat, 1980-2005

	1980	1985	1990	1995	2000	2005
Total fat	Avoid too Much	Avoid too much	<=30 %	<=30 %	<=30 %	20-35% [1]
Saturated fat	Avoid too Much	Avoid too much	<10%	<10%	<10%	<10%
Cholesterol	Avoid too Much	Avoid too much	Low	<=300 mg	<300 mg	<300 mg

[1] 30-35% for ages 2-3; 25-30% for ages 4-18 yr.

DASH Diet:
Dietary Approaches to Stopping Hypertension

- Multi-center research project
- First trial:
  - Controlled feeding study
  - Emphasis-whole grains, nuts, legumes, fruits/veg, low-fat dairy
  - No sodium restriction
- Second trial:
  - Controlled feeding study
  - Emphasis-whole grains, nuts, legumes, fruits/veg, low-fat dairy
  - 3 levels of sodium restriction-1500, 2400 & 3300 mg/day
- Third trial (PREMIER):
  - DASH diet + exercise + weight loss among 810 free-living participants receiving intensive, some or little behavior counseling.

American versus Mediterranean Diet

Typical US Diet:

Fast food
High saturated fat
Moderate polyunsaturated fat
120 g total fat
low fiber intake
low intake of many B vitamins

Ratio of polyunsaturated to saturated fat (P/S ratio)* = 0.4

LDL cholesterol = 150 mg/dl

*NOTE: P/S ratio close to 1.0 is desirable.

Typical Mediterranean Diet:

Vegetables, olive oil
Low saturated fat
Moderate polyunsaturated fat
High monounsaturated fat
90 g total fat

Ratio of polyunsaturated to saturated fat (P/S ratio)* = 1.0

LDL cholesterol = 100 mg/dl

*NOTE: P/S ratio close to 1.0 is desirable.

Source: Nutrition in Medicine *CVD: Lipoproteins* Web Course, 2006

Diet & CVD Risk: Translating Key Nutrition Concepts into a Heart-Healthy Diet