CARDIOVASCULAR DISEASES (CVD) and NUTRITION

- Major cause of morbidity & mortality in Canada & other developed countries
  - e.g., majority of approved health claims on food labels relate to lowering CVD
  - Relation of CHD risk to plasma cholesterol
- Diet has a role in CVD risk, also genetics, exercise, smoking, etc...affect plasma cholesterol.
  - Adults >30 yr. [cholesterol.]
    - >240 mg/dl: diet & pharmacotherapy
    - 200-240: dietary changes +/- pharma.
    - <200 mg/dl optimal (<180 younger adults)
- CVD mortality over last few decades relates to different factors
  - e.g., changes to diet & medical care

Dietary fatty acids

- Saturated (all C-C)
- Unsaturated (at least one C=C)
- Essential
  - linoleic (ω-6 or n-6; 18:2)
  - alpha-linolenic (ω-3 or n-3; 18:3) below
- Trans-fatty acids
  - natural sources: meats/animal products
  - man-made: chemical/partial hydrogenation (also heating)
- Fats/oils
  - often classified based on most abundant fatty acid...but relatively minor components may have roles in health

Phospholipids:

prostaglandins, prostacyclins, thromboxanes
  - autocrine/paracrine signalling lipids derived from some fatty acids...affect vasodilation, inflammation, etc
Lipoproteins

- aggregates of lipids (TG, PL, Chol, etc) & proteins (apolipoproteins)
  - **LDL**: includes apo B; **HDL**: includes apo A-I
- spectrum of particles (varying density)
- atherogenicity (CHD risk):
  - LDL highest
  - HDL protective

Chylomicrons (CM)

- formed mainly in enterocytes...include dietary lipids
- enter blood via lymph
- lipid delivery (high TG)
  - adipose/muscle tissues
  - LPL action: CM remnants
  - CM remnants taken up by liver
- Low atherogenicity (higher for CM remnants)

VLDL

- produced mainly by liver
- low atherogenicity (higher for remnants, IDL)
- lipid delivery (high TG) to tissues
  - adipose/muscle tissues etc
  - Lipoprotein lipase (LPL): IDL...LDL
**LDL**

- mainly produced in circulation through metabolism of VLDL…IDL…
- major source of exogenous cholesterol tissues
- LDL can get oxidized (damaged)…atherogenic

**HDL**

- produced by liver/other cells & through association of AI with other lipoprotein components
- anti-atherogenic: reverse cholesterol transport (RCT)
  - ↑ HDL cholesterol typically associated with ↓ CHD risk
    - due to RCT & other HDL properties

**Cholesterol**

- obtained from diet and also produced by the body's cells
- total serum cholesterol:
  - LDL (↑LDL)  HDL  VLDL: approx. 65%  25%  10%
    - influences on circulating levels:
      - diet, sex hormones, age, physical activity…
- quantitative relations have been developed to estimate effect of dietary changes on plasma [cholesterol] (e.g., ↑ PUFA ~ 2X less effective than ↓ SFA)…
Cardiovascular diseases

- hypertension

- most strokes
  - coronary heart disease (CHD)

  - Atherosclerosis (cf. atherogenic factors)
  - Thrombosis (cf. thrombogenic factors)
  - Inflammation (cf. pro-inflammatory factors)

Atherosclerosis

- involves several stages & typically chronic, progressive development

- Progression
  - promoted by dietary (& non-dietary) factors that↑:
    - serum cholesterol, LDL-chol:HDL-chol ratio
    - triglyceride (TG)
    - inflammation
    - oxidized LDL (oxLDL)
    - homocysteine
Diet and CHD

• many dietary factors influence CHD risk
  – e.g., amount and types of fats consumed
  • estimated relative risks of dietary fats..

Saturated fatty acid (SFA) intake

• a most important factor that ↑ CHD risk

• ↑ serum chol.
  – relative to M/PUFA or carbohydrate substitutes

• ↓ LDLR level and activity in cells

• atherogenicity: e.g., myristate>palmitate>laurate

• SOURCES:
  – butter, coconut & palm oils

Polyunsaturated fatty acid (PUFA) intake

• w-6: ↓ serum cholesterol (↓ LDL)
  – e.g., relative to carbohydrate

• excessive w-6 intake may ↓ w-3 elongation

• …oxidation susceptibility

• w-3: can ↓ VLDL synthesis, thrombosis, inflammation

• SOURCES:
  – vegetable oils, fish/shellfish
Monounsaturated fatty acid (MUFA) intake

• ↓ serum cholesterol (when MUFA replaces SFA)
  – to approximately same extent as PUFA

• high in many Mediterranean diets…olive
  – Med. diet often associated with lower CHD incidence…

• SOURCES:
  • some vegetable oils (olive, canola), butter

Trans fatty acid intake

• ↓ HDL-c : LDL-c ratio (↑ LDL chol. & ↓ HDL chol.)

• ↓ w-3 elongation: ALA to DHA

• ↑ serum cholesterol
  – to a lesser extent than myristate

Total fat intake and other nutrients

• ↑ CHD risk with high total fat intake
  – ↑ levels of CM remnants & serum cholesterol
  – types of fat are of major importance
  – fats are high in calories…risk of obesity

• Replacement of fat calories with carbohydrates: some controversies…

• AMDR (acceptable macronutrient distribution range, % total daily calories):
  – 20-35 % fat; 45-65 % carb; 10-35 % protein
  – trans fat recommendation: < 1%

• Cholesterol:
  – higher intake typically increases plasma chol. & LDL chol., but much variability in individual responses
  – synergism with SFA intake in terms of ↑ CHD risk
Vitamin intake

• antioxidant vitamins
  – vitamin E controversy…

• anti-homocysteine vitamins
  – folate, B12, B6
  – homocysteine controversy…

Intake of other dietary factors

• soluble fiber
  – ~25-30 g/d recommended for ♀-♂ adults (~½ soluble)
  – may ↓ LDL chol. by about 10%…

• plant sterols
  – ↓ cholesterol and bile absorption in GI tract
  – ~3g stanol esters (1-2 tsp of stanol-fortified margarine) may ↓ LDL chol by about 10%…

• alcohol
• antioxidants
• soy products
  – ~25g soy (1 serving of tofu - 5g) may ↓ LDL chol. by about 5-10%… limited evidence

Effects on cholesterol lowering usually vary between normo-cholesterolemic and hyper-cholesterolemic people

Dietary Guidelines for prevention

• recommendations on intake of total and specific fats
  – e.g., replace some SFA with MUFA or complex carb; ↑ w-3/w-6 ratio;
  ↓ trans fats; ↓ caloric intake
  – TLC diet therapy to lower CHD risk…

• recommended food choices…follow from the respective changes in nutrients
  – e.g., replace some meat dishes with alternatives: vegetables, legumes, fish; avoid margarines, pastries, etc with trans fats
Some other factors that can have major impact on CHD risk

- smoking
- low physical activity
- diabetes
- age and gender
- other genetic factors: e.g., genetic hyperlipidemias
- physiological state: e.g., post-menopause
- hypertension
  - medications with harmful side effects for heart, vasculature
  - sleep-related problems
- high levels of psychological stress

Hypertension

- Diet-related and non-diet-related factors involved
  - body fat/weight
  - salt intake
  - alcohol intake
  - physical activity
  - genetics

  - hypertension is part of metabolic syndrome
    - includes also dyslipidemias, glucose dysregulation...and often abdominal obesity, pro-inflammatory state...

Diet and Hypertension

- overweight/obese...a most important factor
  - BMI > 30, risk increases 2-6 fold (relative to BMI ≤ 25)
  - weight loss is usually more effective than lowering Na+
  - some become normotensive by weight loss alone

- physical activity: weight loss and more....
**Salt (sodium: Na⁺)**  
ref std ~2.4 g/d or ~100 mEq Na⁺  
- salt sensitivity:  
  - ~40% hypertensives and ~20% of normotensives  
- salt-sensitive hypertension: < 1.8 g/d Na⁺ (78 mEq)  
- DASH diet...