Part 3: Strategies for successful aging

Avoiding disease with physical activity
Causes of disability and disease with aging

- Causes of death for old individuals
  - Atherosclerosis (CHD)
  - CNS-vascular accidents (stroke)
  - Cancer
  - Hypertension
  - Accidents (falls)
  - Flu/pneumonia
  - Diabetes
How much can exercise help?

• Can exercise prevent the metabolic disease and disuse disabilities?
  – Generally yes, but it varies by organ system

• Can exercise reverse full-blown metabolic disease or disuse disabilities?
  – Generally no because of the limited ability of aging body for growth and remodelling
Causes of death

• Middle aged  45-64
• Young old      65-74
• Old            75-84
• Old old        85-99
• Oldest old     100+
Exercise and atherosclerosis

- Walking > 4 hrs/week decreases incidence of CHD
Exercise and atherosclerosis

- Different amounts of walking with or without other types of vigorous activity decreases incidence of CHD and CVD
Why does walking and vigorous activity help with CVD?

- Plasma lipids
  - insulin sensitivity
  - skeletal muscle LPL
- Endothelial dysfunction
  - blood shear and NO
- Clotting factors
Limitations to what exercise can do and CVD

– Decline in VO2 max with age
– Decline in performance with age
Decline in VO2 max with age: men

- Decline in VO2 max in trained and untrained men
- Relationship to levels of sustained training
Decline in VO2 max with age: women

- Age associated decline in VO2 max
- Slope of decline greater for more fit women
Aerobic fitness and recreational energy expenditure

- The level of aerobic fitness in aged individuals is related to their mean habitual daily energy expenditure.
Decline in VO2 max with age: role of muscle mass

- VO2 max is related to appendicular muscle mass
- In aged, lower maximal oxygen consumption per muscle mass is achieved
Decline in HR max with age

- Maximal heart rate declines with age
  - due to reduced ventricular contractility
  - due to resistance to catecholamine stimulation
  - decline is 5-7 bpm/10 years

- Other changes in heart function with age
  - reduced HR variability
Decline in HR max with age

- While the rate of decline in VO2 max depends on fitness
- the rate of HR max decline is independent of fitness
Aerobic performance with age

• Change in performance with age is a composite of age-related changes in
  – VO2max
  – HR max
Exercise and hypertension in aging

• Hypertension in aging is related to
  – insulin resistance
    • NO mechanism
  – increased sympathetic tone
    • higher plasma NE
Aging and hypertension

- Aged individuals have high plasma NE relative to E
- Training does not correct this
- NE (but not E) is vasoconstrictive
Aging and hypertension

- Epinephrine metabolic clearance is reduced as we age
- Training does not correct this deficit
Aging and hypertension

- Epinephrine becomes less effective in eliciting hepatic glucose release as we age.
- Training does not correct this deficit.
Aging and hypertension

- Epinephrine elicits higher plasma FFA levels in response to E in old untrained individuals
- Training corrects this defect
Exercise and hypertension in aging

• Hypertension in aging is related to
  – endothelial dysfunction
    • NO mechanism
    • angiotensin
  – atherosclerosis
Exercise and increased accidents with aging

• Related to
  – inactivity
  – decreased muscle mass
  – osteoporosis
Muscle mass changes and inactivity

- Maria Fiatarone experiments
- wheel-chair-bound vs
- ambulatory old person
Muscle mass changes and exercise training

- Maria Fiatarone experiments (1990)
- 10 subjects (4M, 6F)
- Strength is related to the ability to walk
Muscle mass changes and exercise training

- Maria Fiatarone experiments (1990)
- 8 weeks of training in nonagenarians and strength increases
Muscle mass changes and exercise training

- Maria Fiatarone experiments (1990)
- 8 weeks of training in nonagenarians and muscle size
Muscle strength and spontaneous physical activity

• Maria Fiatarone experiments (1994)
• 10 weeks of training in 100 nonagenarians (37M, 63F) and spontaneous activity
Muscle mass changes and exercise training

- Maria Fiatarone experiments (1994)
- 8 weeks of training in nonagenarians and food intake
- There was no increase in energy intake to exercise except when nutrient supplements were given
• Maria Fiatarone experiments (1994)
• 10 weeks of training in nonagenarians and strength
• There were significant increases in muscle strength to training
• Increases were greater when nutritional supplements were given
Training reduces incidence of accidents

- Exercise training reduces incidence of falls
- Strength training (in some studies) improves balance
Bone mineral changes and exercise training

- High intensity strength training for 1 year increased mineral density in lumbar spine and femoral neck
- Non-exercising nonagenarians lost mineral
Bone mineral changes and exercise training

• High intensity strength training increased whole body bone mineral content
• Non-exercising nonagenarians lost bone mineral content
Bone mineral changes and exercise training

- High intensity strength training increased muscle mass
- Non-exercising nonagenarians lost muscle mass
Exercise attenuates disabilities

- Training raises the baseline VO2max and helps attenuate the magnitude of VO2max decline
Exercise prevents disabilities

- Exercise training prevents development of excessive obesity after menopause
Exercise prevents disabilities

- Exercise training prevents development of insulin resistance/diabetes
- It increases GLUT-4 glucose transporter translocation
Exercise prevents disabilities

- Exercise training prevents development of insulin resistance/diabetes
- It increases glucose clearance and decreases insulin secretion to glucose challenge
Aging, exercise training, and substrate oxidation

• Endurance exercise training (16 weeks, open circles) in old:
  – increases fat oxidation
  – decreases carbohydrate oxidation

• Similar to changes in young
Exercise prevents disabilities

- Exercise training in old individuals (open circles)
  - decreases the rate of glucose appearance
  - increases the rate of FFA (squares) and glycerol (triangles) appearance during an exercise bout
Exercise and aging

- Prevention of disabilities is more easily achieved than reversal once they develop