



**AGS**

# **AGING: NORMAL PHYSIOLOGY**

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# OBJECTIVES

- Discuss age-related changes in physiological systems
- Make a distinction between normal and pathological aging
- Discuss successful aging and fitness

# CARDIOVASCULAR SYSTEM: CHANGES IN “MECHANICS”

- Decrease in myocytes
- Increase in collagen
- Decreased compliance
- Autonomic tissue replaced by collagen
- Conduction abnormalities
- Decreased compliance of vascular system
- Increased systolic blood pressure
- Left ventricular hypertrophy

# CARDIOVASCULAR SYSTEM: CHANGES IN “CONTROL MECHANISMS”

- Decreased responsiveness to catecholamines
  - Probably due to impaired receptor function
- Decreased maximum heart rate response
- Congestive heart failure or hypotension
- ( $CO = SV \times HR \rightarrow$  preload dependency)

# PULMONARY SYSTEM

- Reduced chest wall compliance
  - Increased work of breathing
  - Reduced maximal minute ventilation
- Reduced respiratory response to hypoxia by 50%
  - Due to impaired chemoreceptor function?
- Decreased ciliary function
- Reduced cough and swallowing function
- Reduced partial pressure of oxygen

# CHANGES IN VISION

- Decreased lens compliance
  - Reduced accommodation
  - Presbyopia
- Reduced tear formation
  - Dry eyes
- Reduced pupil size
  - Reduced night vision
- Loss of cones
  - Reduced color vision

# CHANGES IN HEARING: PRESBYCUSIS

- Reduced acuity
- Due to nerve loss
- Worse for high pitches
- Reduced noise localization

# NEUROLOGIC CHANGES (1 of 2)

- Decreases in:
  - Cortical gray matter
  - Neuronal volume
  - Complexity of neuronal connections
  - Synthesis of neurotransmitters
- Spinal cord changes
  - Neuronal loss
  - Demyelination
  - Reduced reflexes
  - Reduced proprioception



# NEUROLOGIC CHANGES (2 of 2)

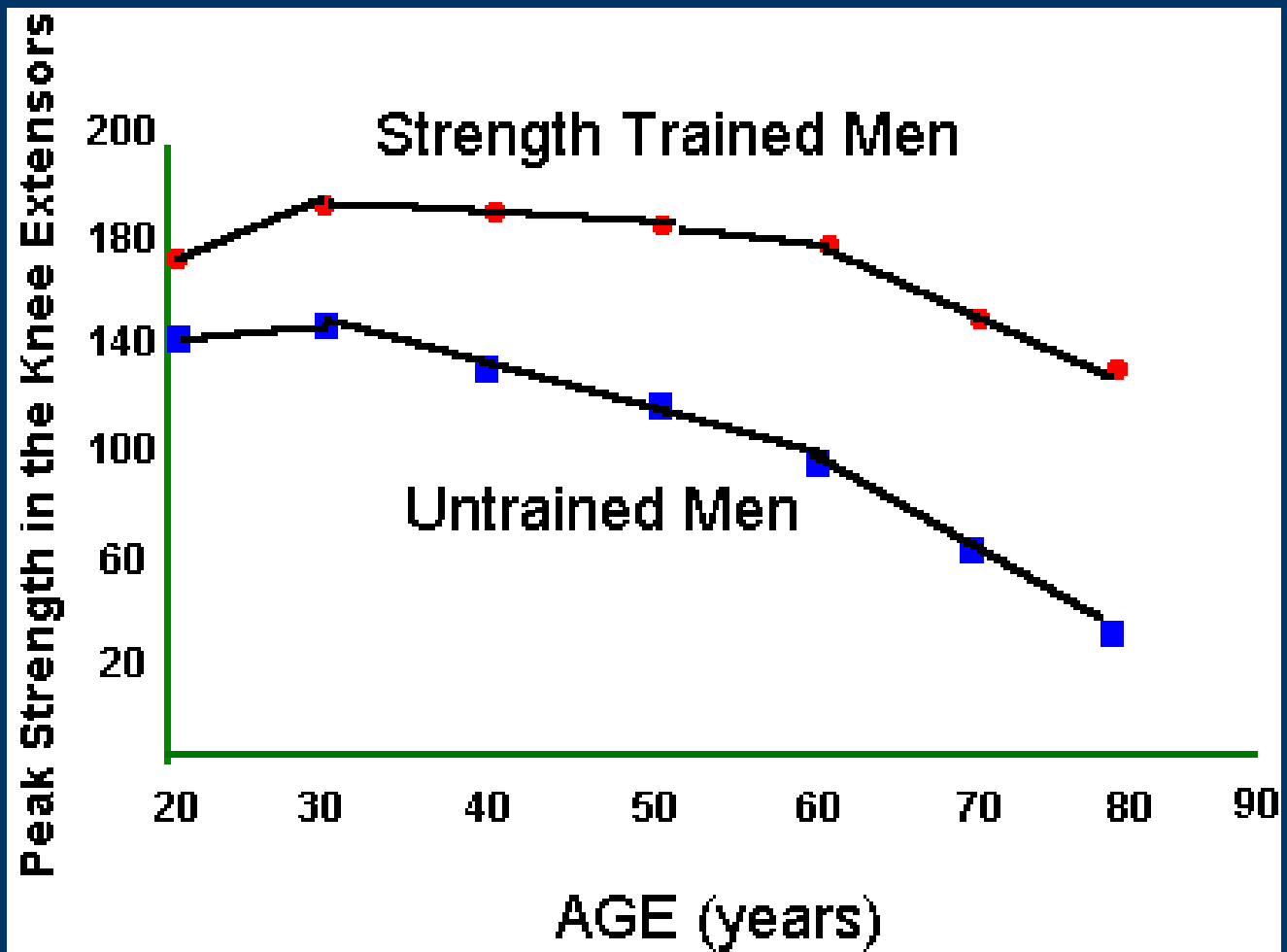
- Vision & hearing loss
  - Processing more difficult
- Decreased adrenoceptor responsiveness
  - Increased concentrations of circulating catecholamines

# RENAL CHANGES

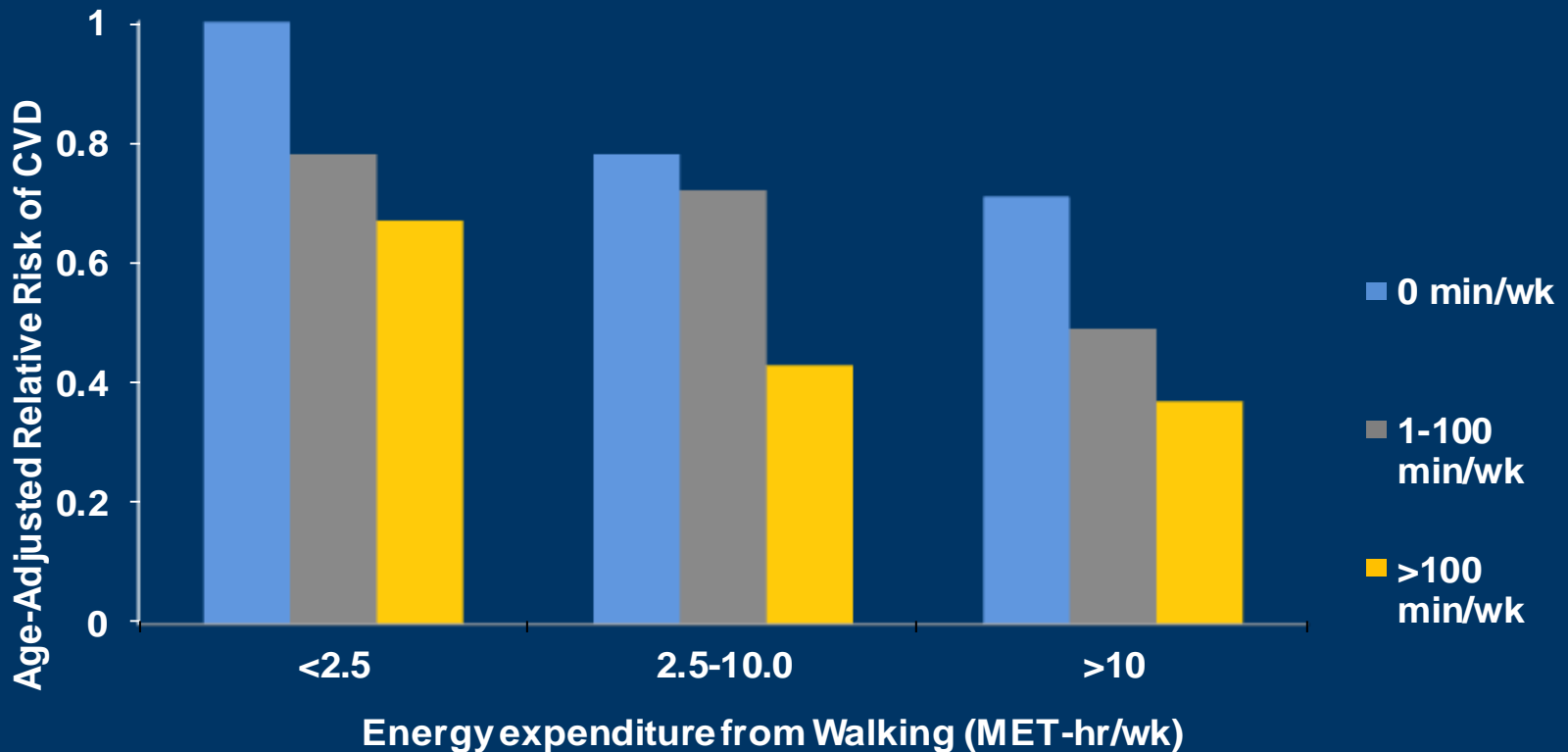
- Decline in renal blood flow
  - 10% per decade after age 50
- Old kidney has difficulty:
  - Maintaining circulating blood volume
  - With sodium homeostasis
  - Removing excess acid
  - Adjusting to hypovolemia, hemorrhage, low cardiac output, and hypotension
- Renal insufficiency may not be appreciated

# ADVERSE DRUG REACTIONS

- Decrease in lean body mass with increased proportion of body fat
- Decreased protein binding of certain drugs
- Alterations in renal, CV, hepatic function may change drug concentrations and their duration of action
- Adverse drug reactions increase with number of drugs administered and linearly with age



# EXERCISE & AGE-ADJUSTED RELATIVE RISK OF CVD



# LIFESTYLE MODIFICATION OR METFORMIN TO REDUCE THE INCIDENCE OF TYPE 2 DIABETES?

- Incidence of diabetes (cases/100 person-years):
  - Placebo: 11
  - Metformin: 7.8
  - Lifestyle modification: 4.8
- Lifestyle intervention was significantly more effective than metformin
- In participants > age 60, *only* lifestyle modification was better than placebo

# LIFESTYLE MODIFICATION OR METFORMIN TO REDUCE THE INCIDENCE OF TYPE 2 DIABETES?

- Conclusions:
  - Lifestyle modification, including exercise of 150 minutes/week, is effective in delaying onset of type 2 diabetes in older adults
  - These interventions have applicability throughout the world

# FLEXIBILITY

- Loss is not an inevitable consequence of aging
- Studies in elderly with yoga and Tai Chi
- Also see improvement in balance and decreased falls



# WHAT WORKS IN HUMANS?

There is, as yet, no convincing evidence that the administration of any specific compound, natural or artificial, can globally slow aging in people, or even in mice or rats

International Longevity Center. *Workshop Report: Is There an Antiaging Medicine?* New York: Canyon Ranch Series; 2002.

Butler R et al. *J Gerontol.* 2002;57:B333-338.

# WHAT WORKS IN HUMANS: BEST ADVICE

- Exercise
- Maintain reasonable body weight
- “Eat your vegetables” and fruits
- Don’t smoke
- Remain socially engaged
- Regular preventive health visits
  - Vision, BP, cholesterol, diabetes

**THANK YOU FOR YOUR TIME!**

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