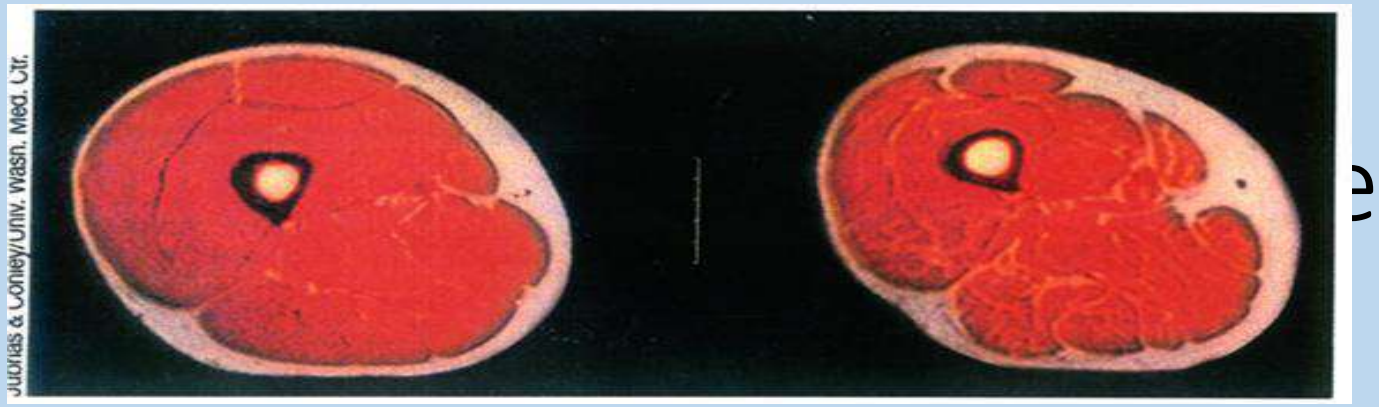
Sarcopenia

TNT GERIATRIC 2.0 SESSION 3



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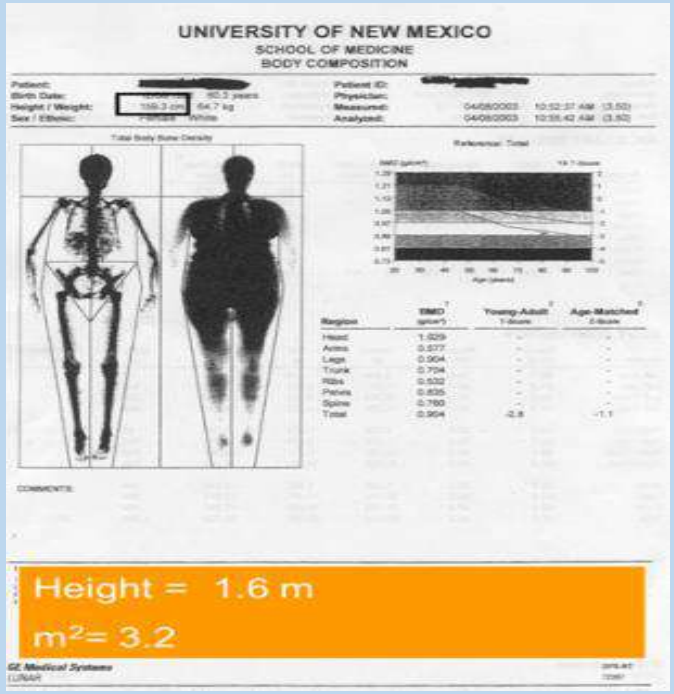
Loss of muscle mass



Dynapenia

Loss of power;
Force X velocity

Kratopenia
(Thinamopenia)

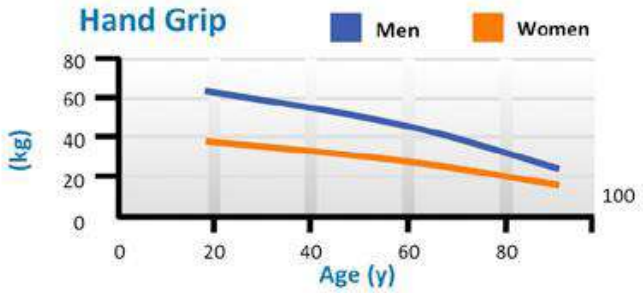
Loss of force
ie strength

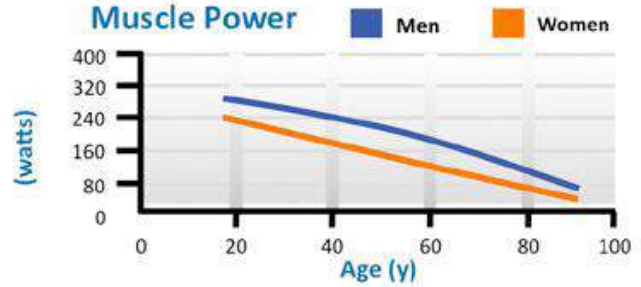
Learning objectives

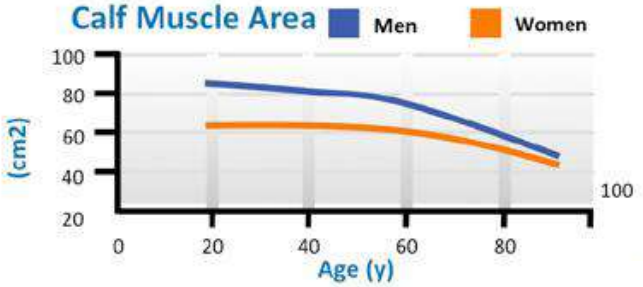
1. **Explain complex effects of aging on muscle mass and function.**
2. Review recent definitions of sarcopenia.
3. Describe the complex causes and consequences of sarcopenia.
4. Determine how nutrition intervention can impact the incidence and course of sarcopenia.

inChianti Study: muscle mass and function decrease with aging

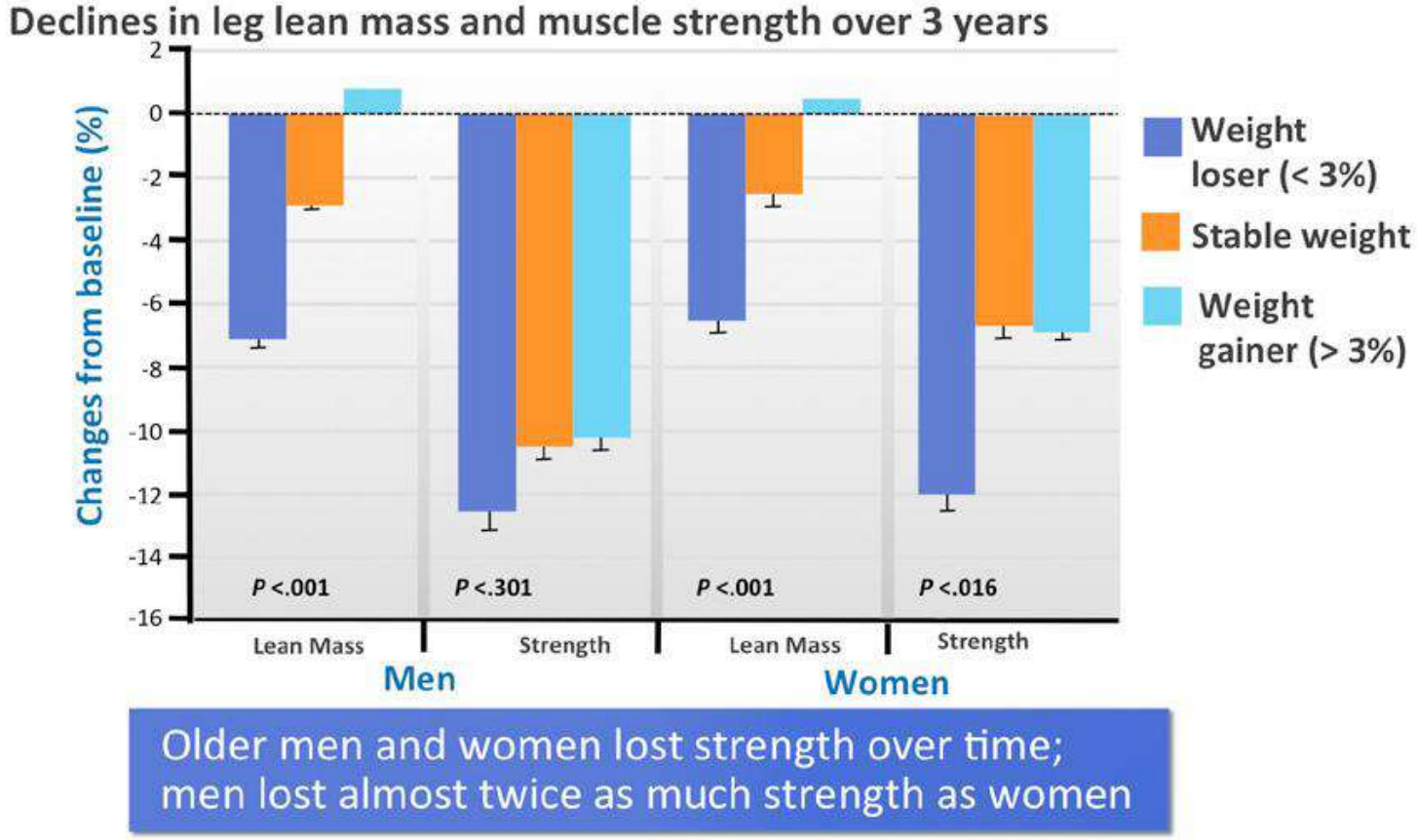
Cross-sectional comparisons: three measures of muscle function and one of muscle mass in men and women







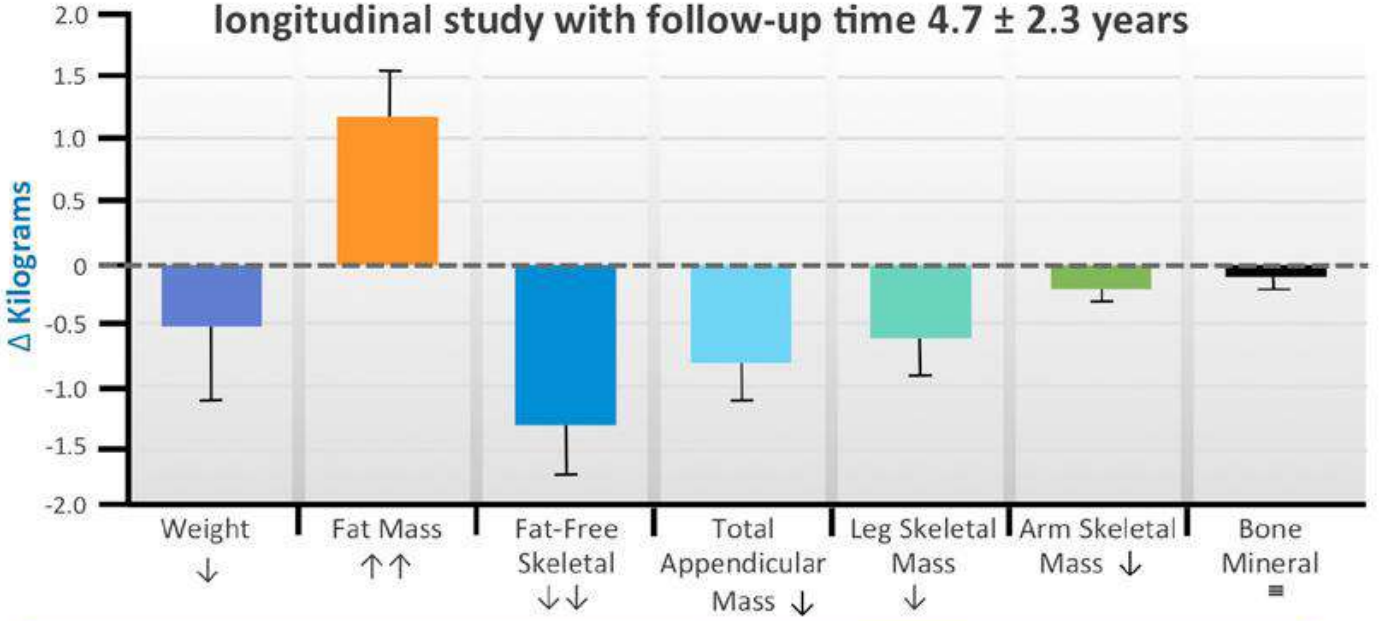
Health ABC Study: muscle strength declines more than muscle mass



Older men and women lost strength over time; men lost almost twice as much strength as women

Stable body weight masks age-related changes in body composition

Changes in body composition after age 60 in healthy older men: longitudinal study with follow-up time 4.7 ± 2.3 years



The 0.5 kg decrease in body weight resulted mainly from a combined
- decrease in fat-free body mass (– 1.4 kg) and
- increase in fat mass (+ 1.2 kg)

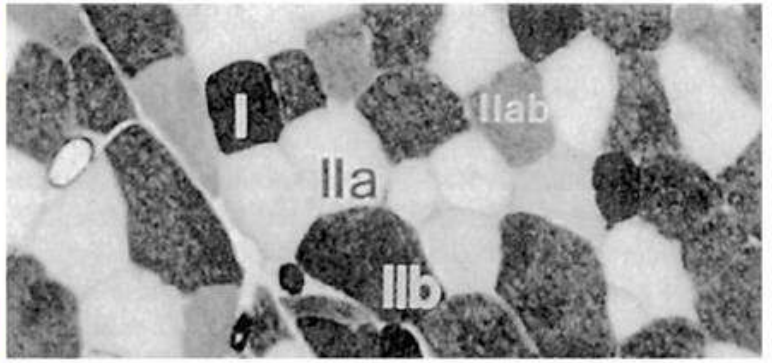
Changes in muscle fibers impact strength, power

Muscle tissue includes type 1 (slow) and type 2 (fast) fibers

- Slow fibers produce sustained but weak forces (low strength, power)
- Fast fibers produce strong forces for a short time (high strength, power)

With aging, there is a net conversion from type 2 → type 1 fibers

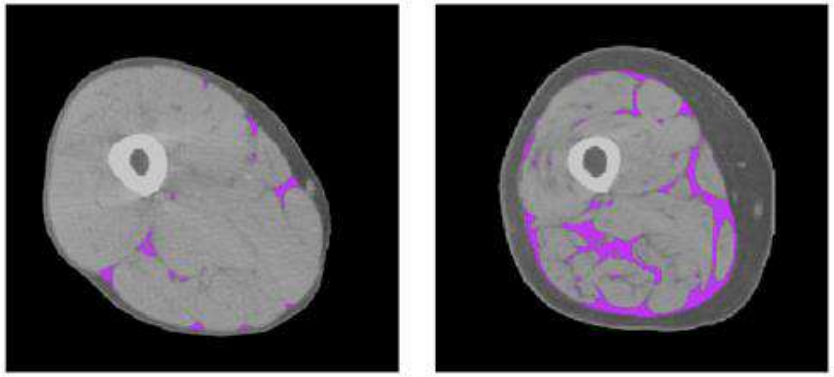
Little force for a long time	
Slow twitch	Type 1
Fast twitch	Type 2a Type 2x Type 2b
Lots of force for little time	



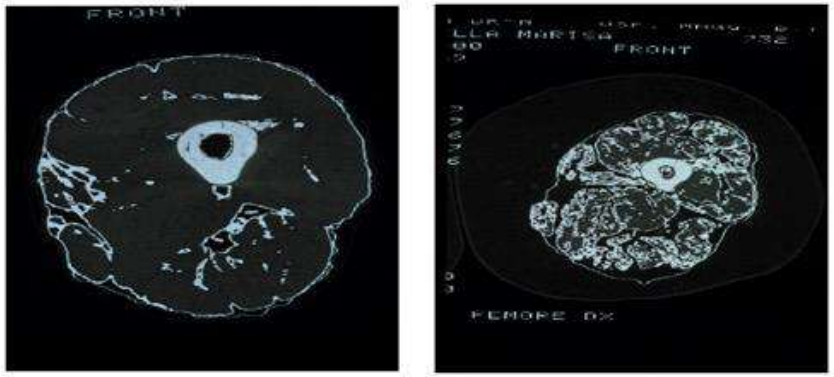
With advancing age, there is an overall loss of strength and power

Health ABC Study: inter- and intra-muscular fat increase even with stable body weight

Thigh cross-section view (magnetic resonance)



Thigh cross-section view (computed tomography)



Low muscle strength predicts mobility disability

- Older adults aged 70-89 years (n=406)
- Lower grip strength at baseline was associated with increased risk for developing mobility disability
  - Mobility disability was defined as inability to walk 400 m in ≤ 15 minutes
  - Adults with the lowest grip strength were 6 times more likely to develop mobility disability compared with those in the highest quartile of (sex-specific) grip strength ($p<0.01$)

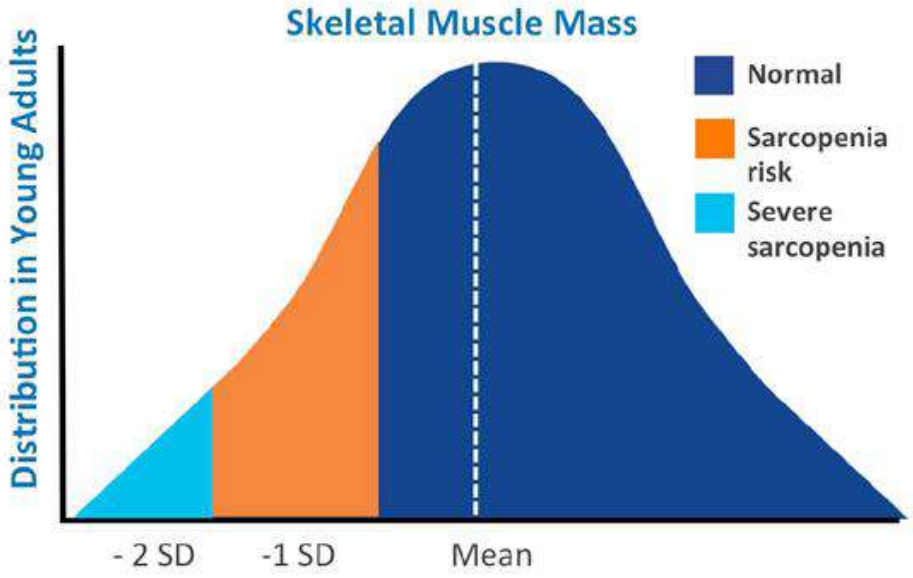
Learning objectives

1. Explain complex effects of aging on muscle mass and function.
2. **Review recent definitions of sarcopenia.**
3. Describe the complex causes and consequences of sarcopenia.
4. Determine how nutrition intervention can impact the incidence and course of sarcopenia.

Classic sarcopenia definition uses muscle mass

- **Appendicular fat-free mass** (kg/m^2)*
- **Total fat-free mass** (kg/body weight in kg)

* Appendicular muscle weight (in kg) divided by height (in meters) squared = (kg/m)



This sarcopenia definition based on skeletal muscle mass parallels the definition of osteopenia/osteoporosis based on bone mineral density.

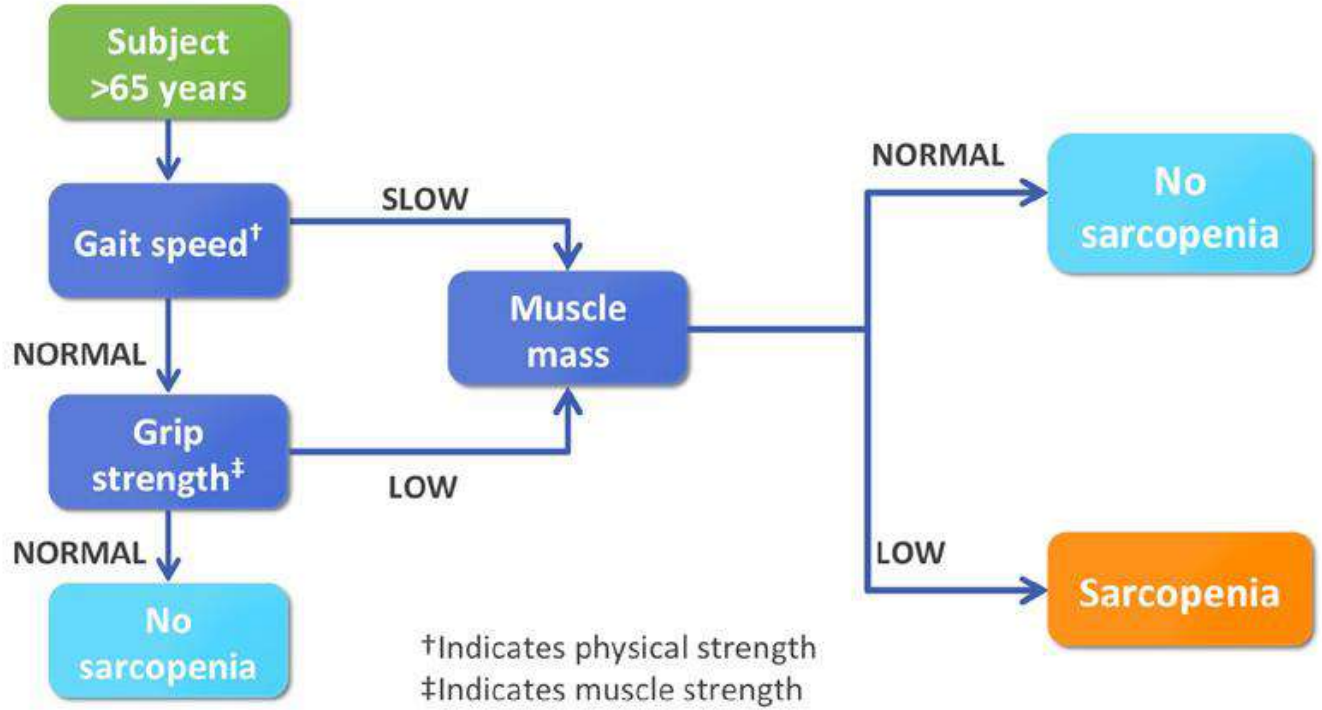
2010 European consensus definition of sarcopenia (EWGSOP*)

A syndrome characterized by progressive and generalized loss of skeletal muscle mass and function with a risk of adverse outcomes, such as physical disability, poor quality of life, and death

Stages of Sarcopenia using EWGSOP* definition

STAGE	MUSCLE MASS	MUSCLE STRENGTH	PERFORMANCE
Pre-sarcopenia	↓		
Sarcopenia	↓	↓ OR	↓
Severe sarcopenia	↓	↓	↓

Sarcopenia case-finding algorithm for clinical practice (EWGSOP*)



International working group on sarcopenia (IWGS

Sarcopenia is the age-associated loss of skeletal muscle mass and function

- Another consensus definition was published 2011
- Diagnosis:
  - gait speed of less than 1 meter per second (< 1 m/s)
  - low muscle mass (e.g., appendicular mass relative to height^2, that is ≤ 7.23 kg/m^2 in men and ≤ 5.67 kg/m^2 in women)

Prevalence of sarcopenia (by EWGSOP* definition[1])

Older people :	Age	Prevalence of Sarcopenia
Living in the community	> 65 years > 80 years	5% to 17%[2,3] 29%[4]
In long-term care	> 70 years	33%[5]
In hospital	≥ 65 years	10%[6]

- Prevalence is influenced by age, country, ethnicity, and concomitant disease
- Further studies of prevalence are needed for high-risk populations, e.g., very elderly in the community, people in nursing homes

*European Working Group on Sarcopenia in Older Persons

Sarcopenia and frailty overlap

Diagnostic criteria for:	
Frailty – Fried	**Sarcopenia** – EWGSOP*
• Weight loss • Weakness • Self-reported exhaustion • Slow walking speed • Low physical activity level	• Decreased skeletal muscle mass • Decreased muscle strength • Reduced physical performance

*European Working Group on Sarcopenia in Older Persons

Tools for measuring sarcopenia parameters

Muscle mass	Muscle strength	Physical performance
• **Bioimpedance analysis (BIA)** • Computed tomography (CT) • Magnetic resonance imaging (MRI) • Dual-energy X-ray absorptiometry (DXA) • Body potassium per fat-free mass • Anthropometry (calf or thigh circumference)	• **Hand grip strength** • Knee flexion/ extension • Peak expiratory flow	• **Short Physical Performance Battery (SPPB)** • **Usual gait speed** • **Timed get-up-and-go test** • Stair-climb power test

Bioimpedence Analysis (BIA)

SARC-F score

- More than >4 indicate sarcopenia

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 10 lbs?	None=0 Some=1 a lot, unable =2
Assistance in walking	How much difficulty do you have walking across the room?	None=0 Some=1 a lot, use aids unable =2
Rise from chair	How much difficulty do you have transferring from a chair or a bed?	None=0 Some=1 a lot, unable without help =2
Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	None=0 Some=1 a lot, unable =2
Falls	How many times have you fallen in the past year?	None=0 1-3 fall=1 >4 fall=2

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Primary versus secondary sarcopenia (EWGSOP*)

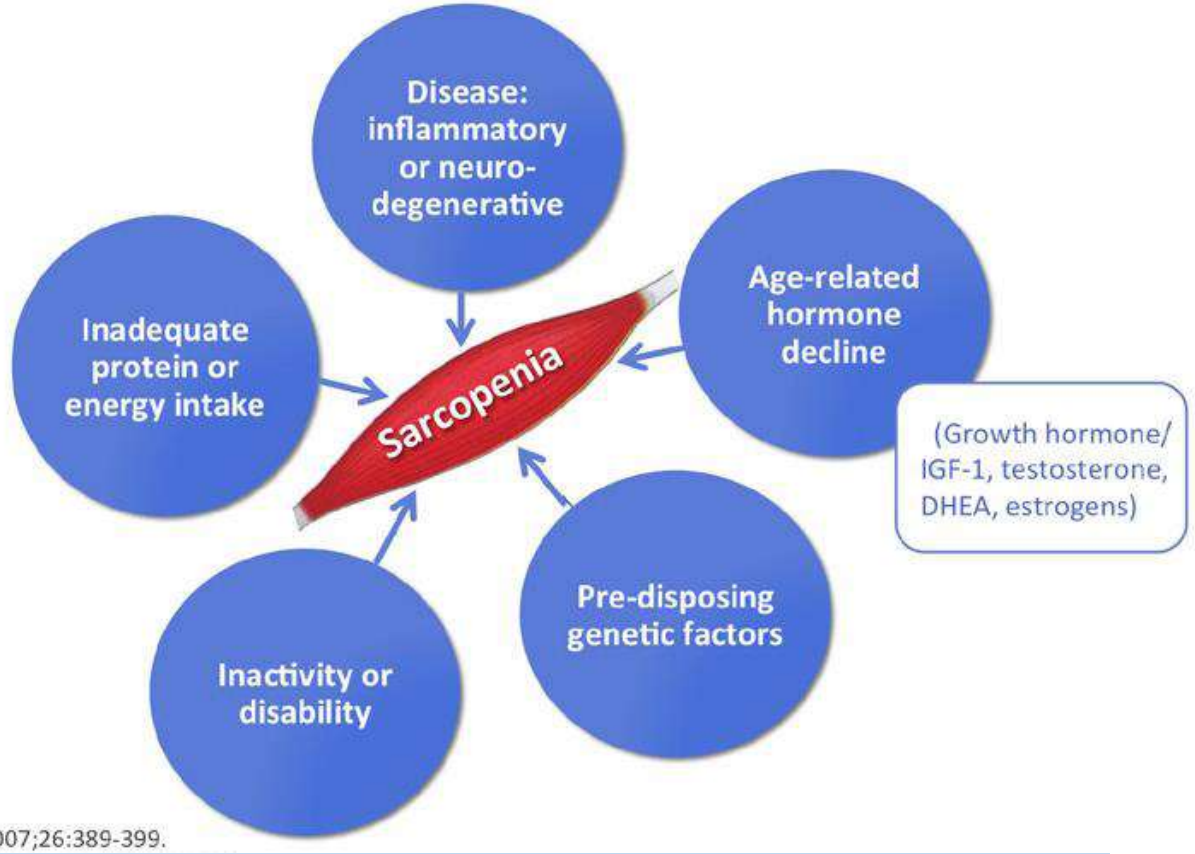
Primary Sarcopenia	
Age	No other cause evident except aging
Secondary Sarcopenia	
Nutrition-related sarcopenia	Inadequate dietary intake of energy and/or protein, malabsorption, gastrointestinal disorders, or use of medications that cause anorexia
Activity-related sarcopenia	Bed rest, sedentary lifestyle, deconditioning or zero-gravity conditions
Disease-related sarcopenia	Advanced organ failure (heart, lung, liver, kidney, brain), inflammatory disease, malignancy, or endocrine disease

*European Working Group on Sarcopenia in Older Persons definition

Comparing sarcopenia and cachexia

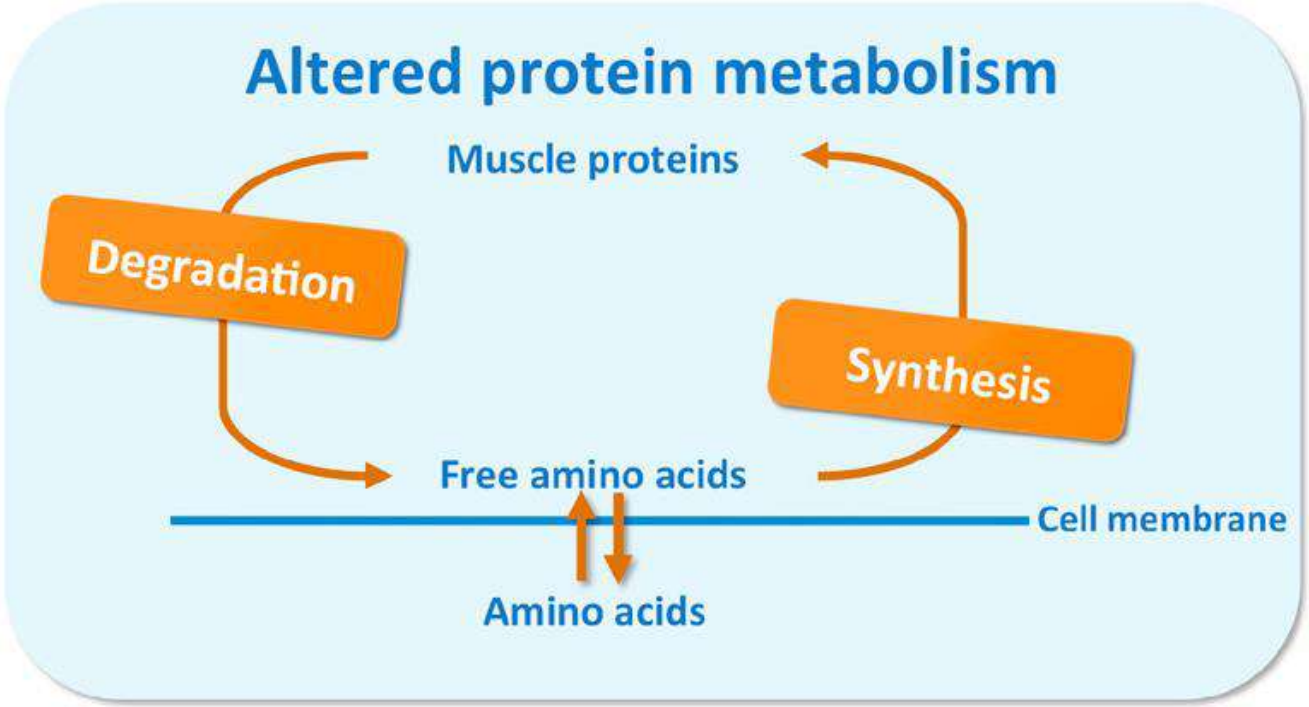
	Sarcopenia	Cachexia
Weight	=	↓↓
Lean tissue	↓	↓↓
Fat tissue	= or ↑	↓
Appetite	=	↓
Cortisol	=	↑
Inflammatory disease	No	Yes
Pathway	Does not lead to cachexia	May lead to sarcopenia

The etiology of sarcopenia

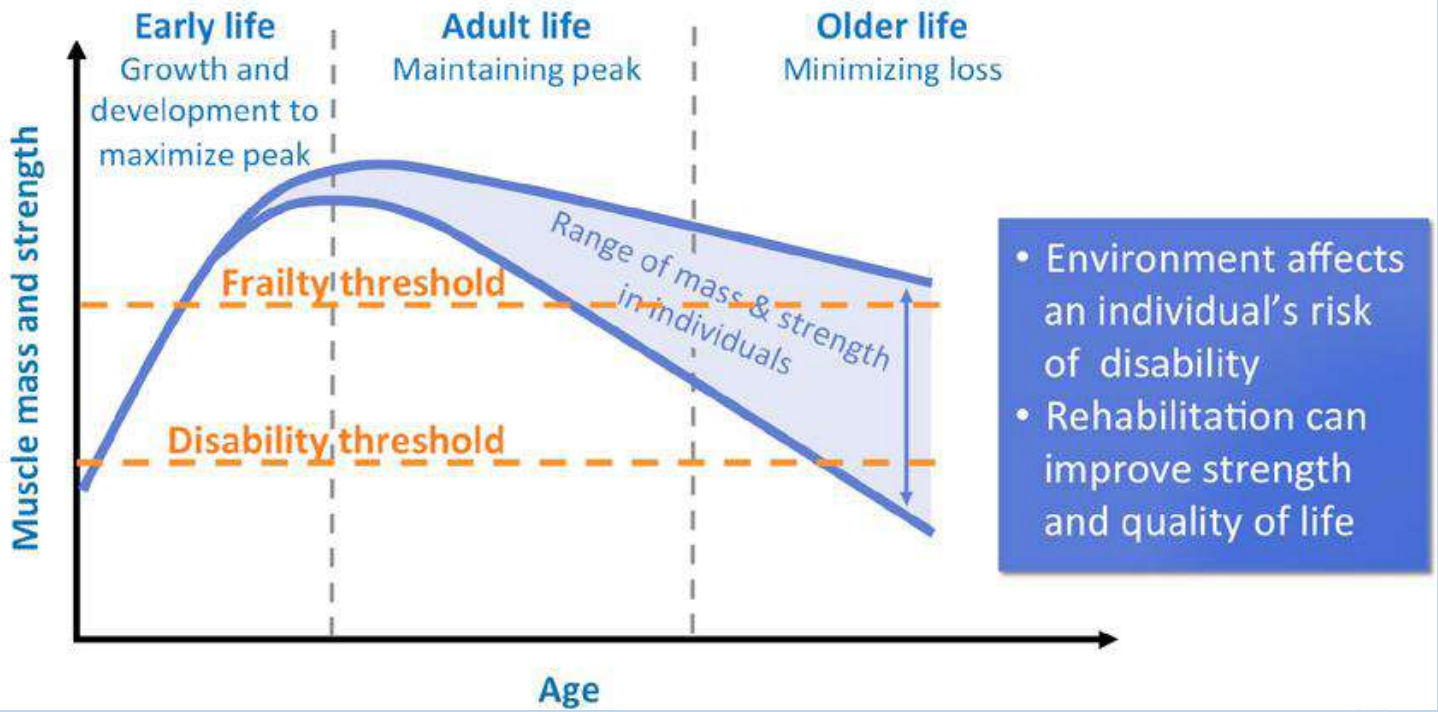


1.Thomas DR. *Clin Nutr.* 2007;26:389-399.

Skeletal muscle mass: factors affecting the balance of protein synthesis and degradation

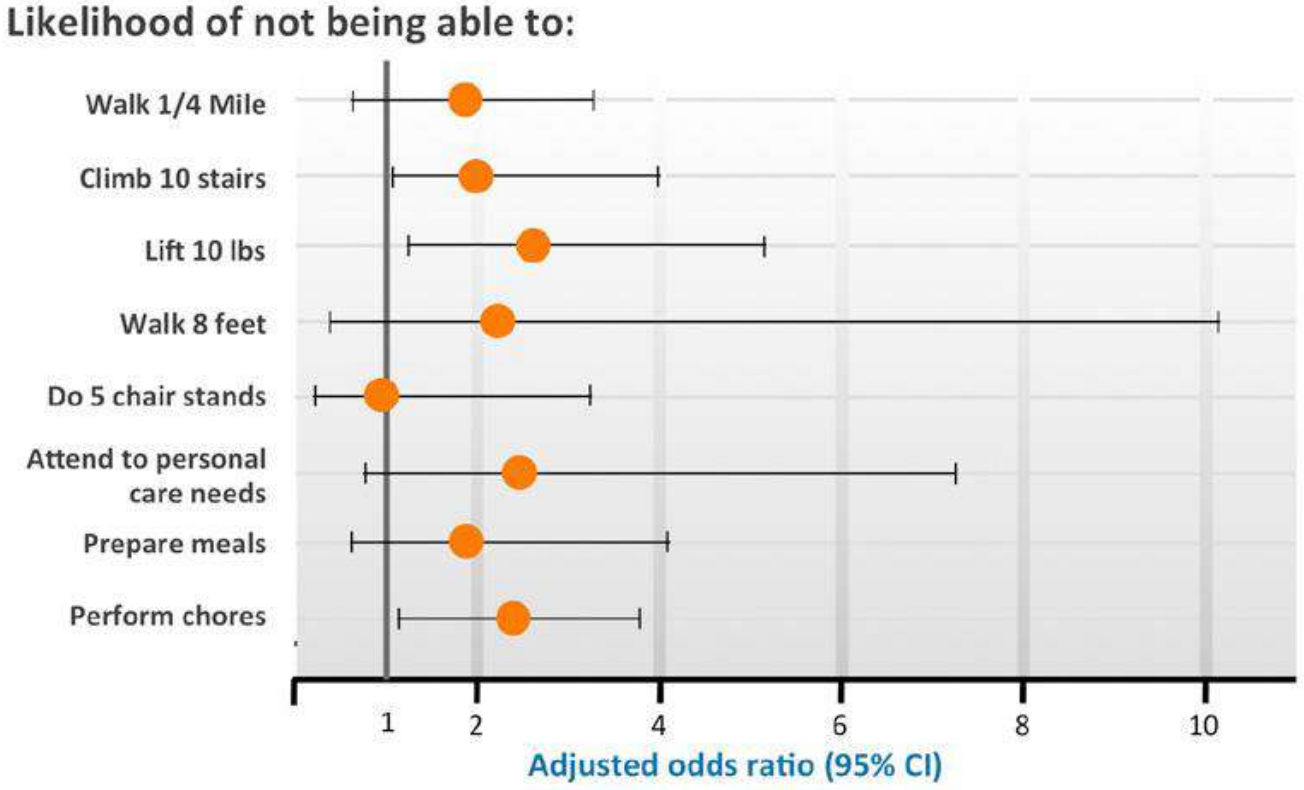


Lifecourse approach to sarcopenia



- Environment affects an individual's risk of disability
- Rehabilitation can improve strength and quality of life

Sarcopenia increases likelihood of poor physical function and increased disability

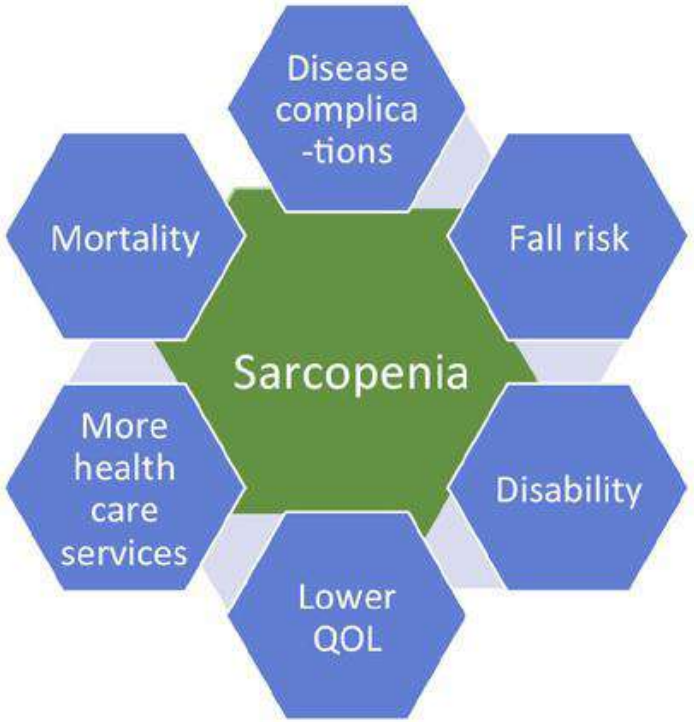


Age-related sarcopenia has high health care costs

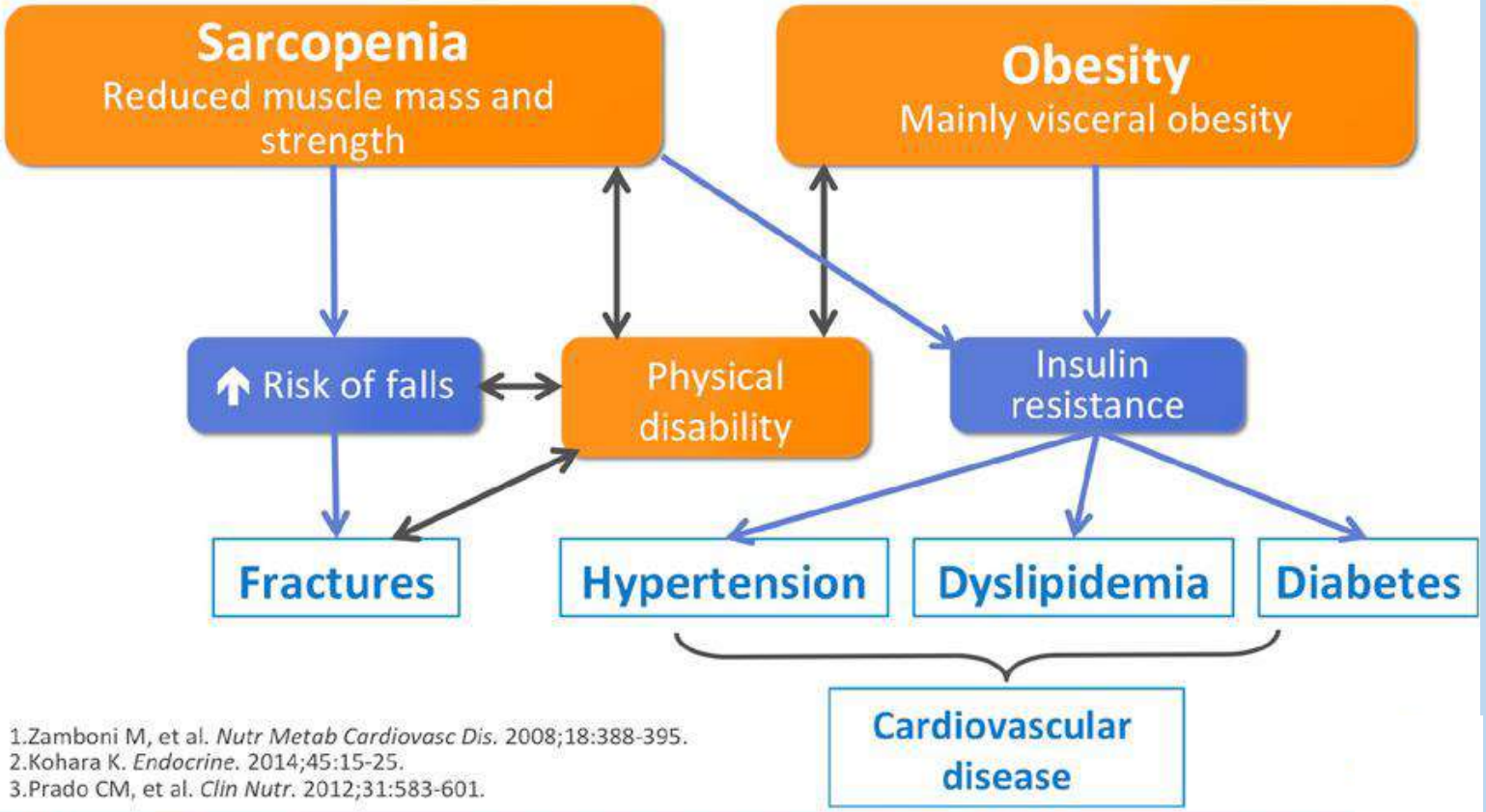
	MALES			FEMALES		
	Normal	Moderate sarcopenia	Severe sarcopenia	Normal	Moderate sarcopenia	Severe sarcopenia
Prevalence	36%	53%	11%	69%	22%	9%
Relative risk of disability %	1.00	3.48	4.60	1.00	1.46	3.15
Cost, billion $	-	$7.2 B	$3.6 B	-	$2.7 B	$5.0 B

The estimated direct health care cost of sarcopenia in the United States in 2000 was $18.5 billion; about 1.5% of total health care expenditures

Sarcopenia is associated with adverse outcomes



Health consequences of sarcopenia and obesity



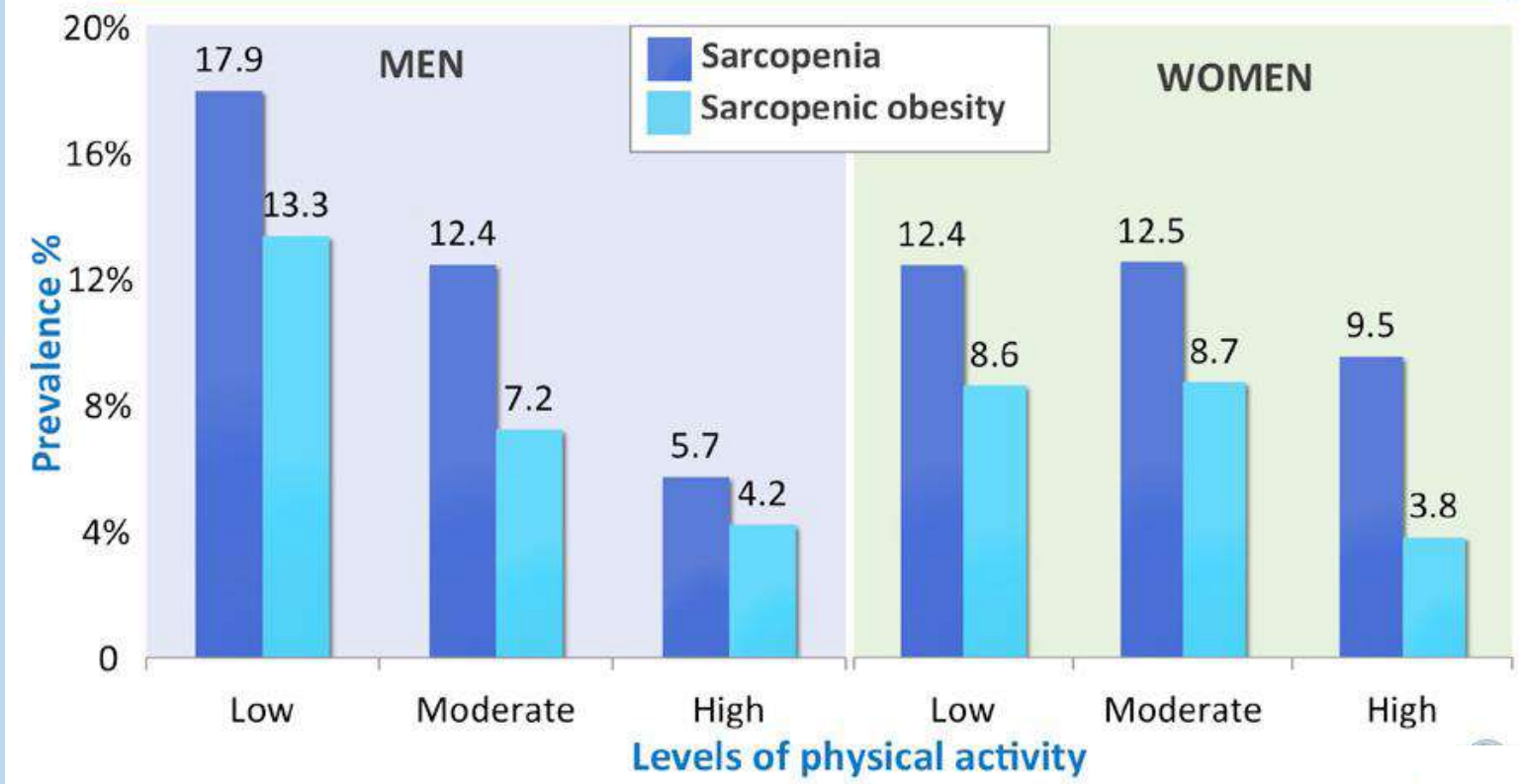
1.Zamboni M, et al. *Nutr Metab Cardiovasc Dis.* 2008;18:388-395.
2.Kohara K. *Endocrine.* 2014;45:15-25.
3.Prado CM, et al. *Clin Nutr.* 2012;31:583-601.

Prevalence of sarcopenic obesity varies by definition[1]

	Definitions: sarcopenia and obesity	N	Mean age	Prevalence sarcopenic obesity
New Mexico Aging Process Study, 2000[2]	**Sarcopenia**: skeletal muscle mass -2 SD below mean of young population (or < 7.26 kg/m^2 (M); < 5.45 kg/m^2 (W)) **Obesity:** % body fat > median (or > 27% (M), 38% (W))	831	≥ 60	M: 4.4% W: 3.0%
NHANES III, 1999-2000[3]	**Sarcopenia**: two lower quintiles of muscle mass (or < 9.12 kg/m^2 (M); < 6.53 kg/m^2 (W)) **Obesity**: two highest quintiles of fat mass (or > 37.16% (M); > 40.01% (W))	M:1391 W:1591	M: 76.3 W: 77.3	M: 9.6% W: 7.4%
Zoico et al, 2004[4]	**Sarcopenia**: two lower quintiles of muscle mass (< 5.7 kg/m^2) **Obesity**: two highest quintiles of fat mass (> 42.9%)	W: 167	71.7	12.4%

M = men; W = women

Sarcopenic obesity is reduced in active individuals



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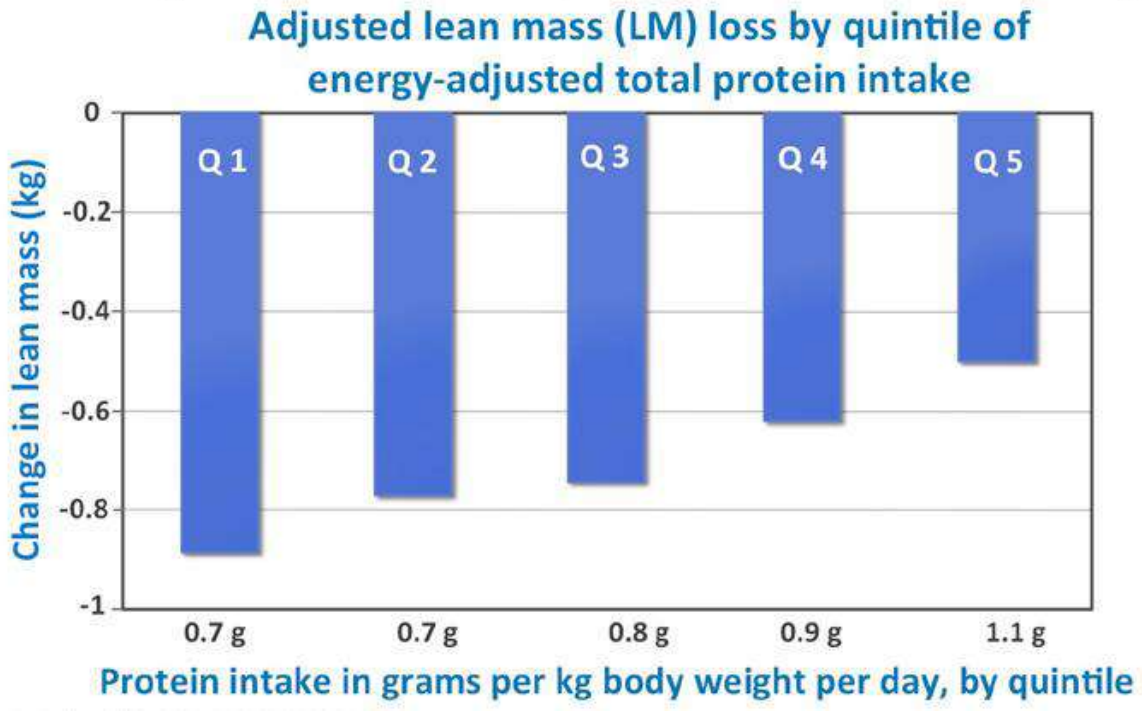
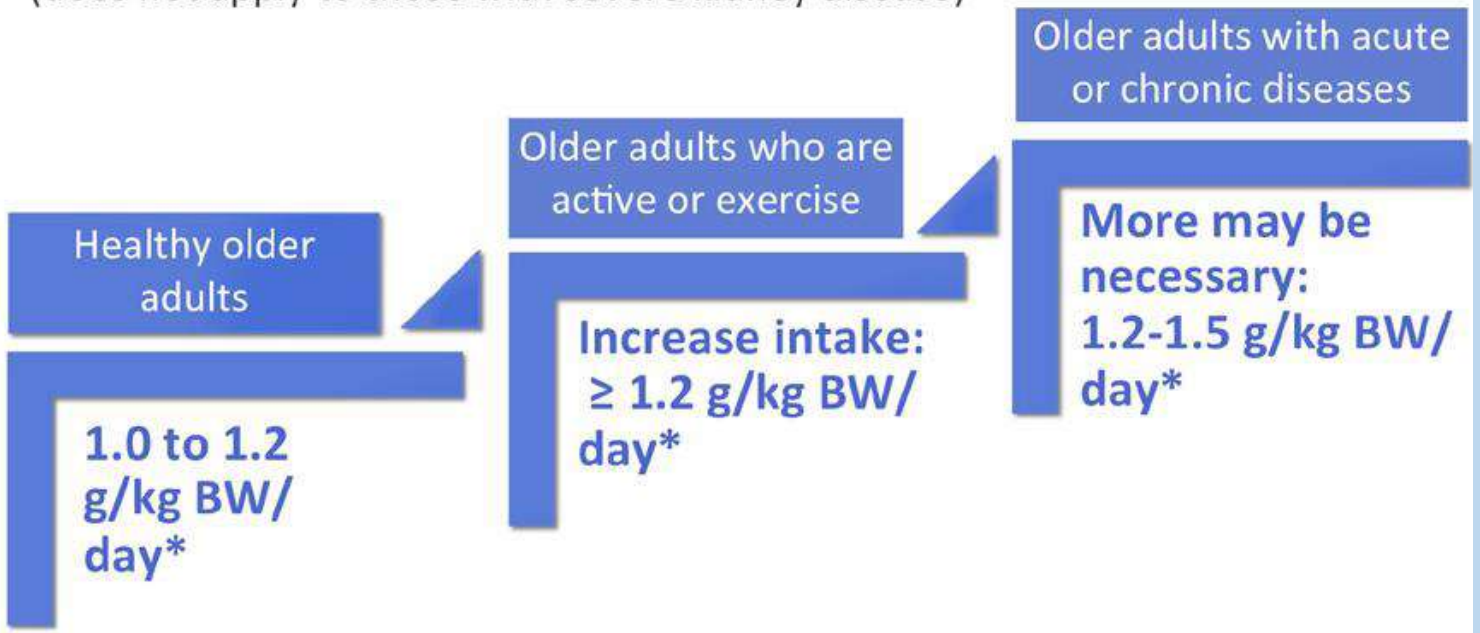
Health ABC Study: low protein intake and loss of lean body mass

- Muscle loss is greatest when protein intake is lowest
- Standard protein intake may not be sufficient in older people



Older people need higher protein intake

Protein intake recommendations from the PROT-AGE study group
(does not apply to those with severe kidney disease)



*Recommended daily intake of protein, expressed in grams of protein per kilogram of body weight per day (g/kg BW/day)

Does increased protein intake improve muscle and physical function?

Group receiving:	Daily protein	Placebo
Skeletal muscle mass (per DXA)	No change	No change
Muscle strength	Significant increase (57 ± 5 to 68 ± 5 kg; $p < 0.01$)	Significant increase (57 ± 5 to 63 ± 5 kg; $p < 0.01$)
Short Physical Performance Battery	Significant improvement (from 8.9 ± 0.6 to 10.0 ± 0.6 points; $p = 0.02$)	No change (from 7.8 ± 0.6 to 7.9 ± 0.6 points)

In frail older people, protein supplements may improve physical function, but do not necessarily increase muscle mass

Effects of exercise can be enhanced by combining with increased protein intake

Study		Key findings
Kim et al 2012[1]	RCT of community-dwelling elderly women with sarcopenia	Exercise and amino acid supplements (high-leucine) together result in improvements in: • muscle strength • the combined variables of muscle mass + walking speed and muscle mass + strength
Yang et al 2012[2]	Dose-response design to determine protein synthesis in healthy, older adults after exercise	Exercised muscles of older adults respond to higher protein doses (20 and 40 g protein) than younger adults, whose post-exercise rates of muscle protein synthesis are maximized with 20 g of protein

These two studies provide supporting evidence, but further research is needed to confirm the effect

Leucine and β-hydroxy-β-methylbutyrate (HMB) improve protein synthesis

Consuming supplemental amino acids rich in leucine is shown to improve muscle protein synthesis in older adults[1]

- Older sarcopenic adults who exercised and took supplements rich in leucine had increased leg muscle mass and strength, and increased walking speed[1]
- Leucine supplementation may not improve muscle strength long-term[2]

HMB supplementation may also improve muscle mass, strength, function, and quality in non-exercising older adults[3]

- Increased muscle strength or function,[4,5] muscle quality[5]
- Preserved muscle mass even during 10 days of bed rest[6]

Both leucine and HMB supplementation may positively effect body composition and muscle strength measures in older adults[1,7]

Attention to diet and exercise throughout life can offset sarcopenia

"Intervention to prevent sarcopenia may need to begin at a much younger age than is currently common.

Lifelong improvements in physical activity and diet are probably the most effective public health interventions for this condition."

Take-home messages: Sarcopenia

- Sarcopenia is common in aging and is associated with declines in muscle mass, strength, and/or function.
- Sarcopenia results from a complex interaction among many factors, including nutrition.
- Low muscle mass in sarcopenia increases risk of frailty and disability and leads to increased healthcare needs and costs.
- Nutrition intervention and exercise may have an impact on sarcopenia's course and prevalence.