Age-related body composition changes: impacts on physical function and frailty, and effective interventions

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University Club 2017

Collaboration for Ageing Research Excellence

Sarcopenia Interest Group
http://www.otago.ac.nz/care/

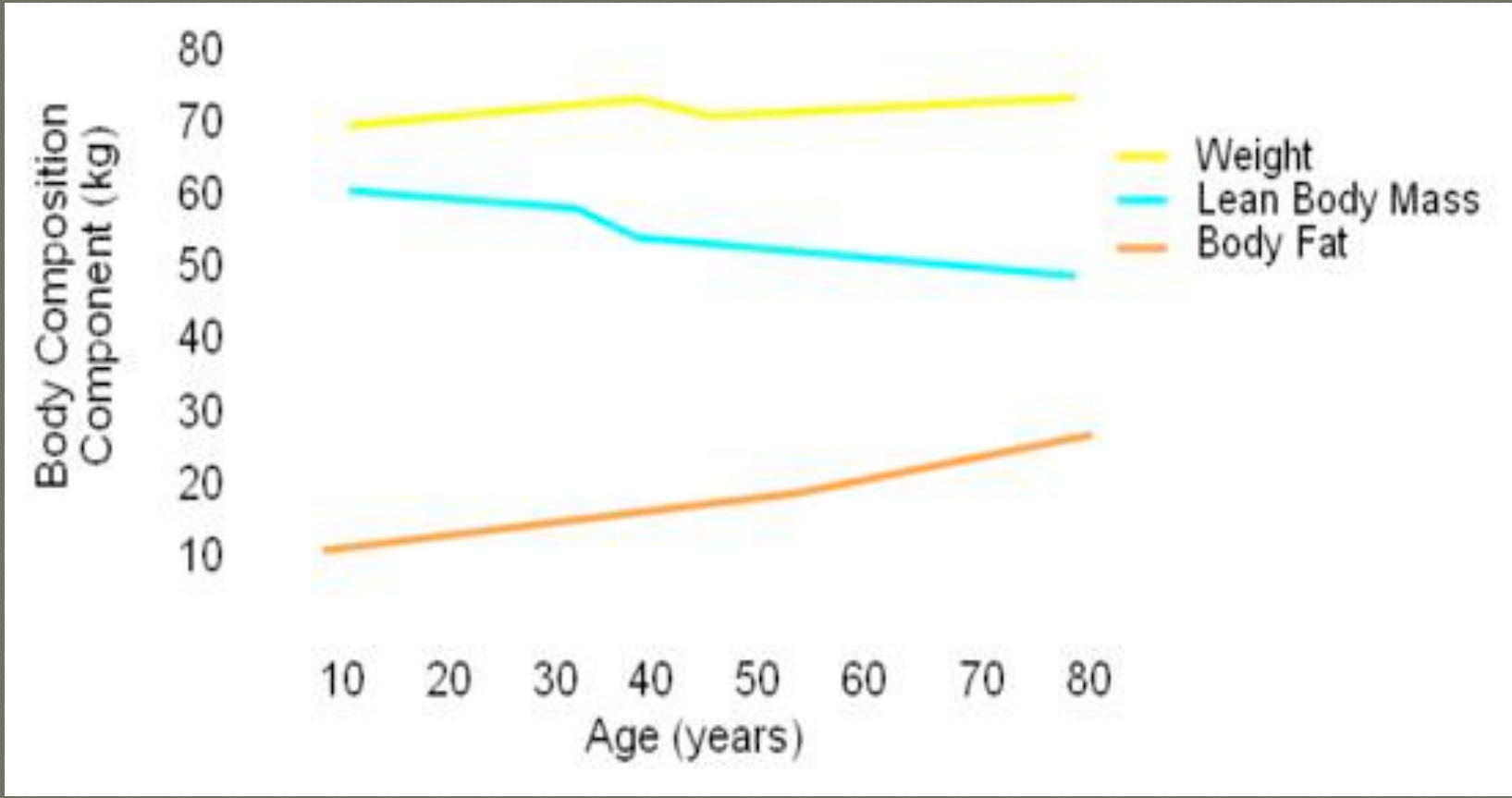
National Science Challenges

AGEING WELL

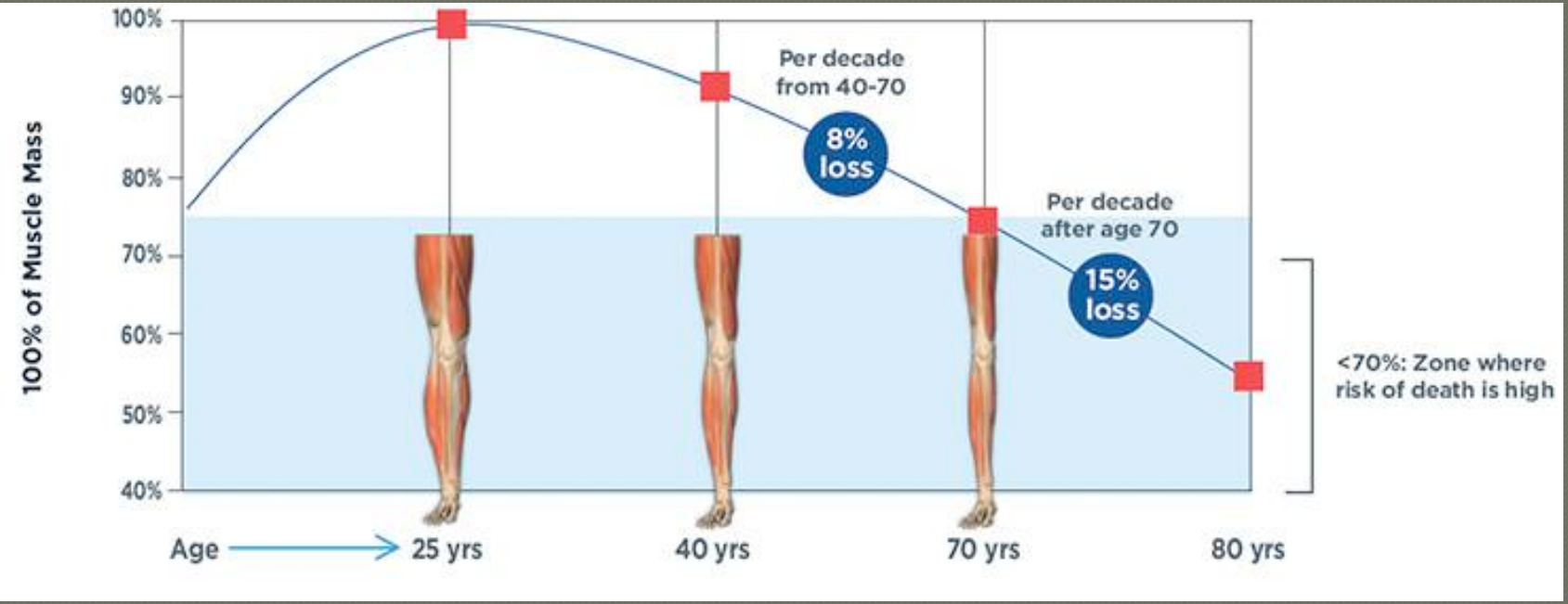
Kia eke kairangi ki te taikaumātuatanga

https://www.ageingwellchallenge.co.nz/

Age-related changes in body composition

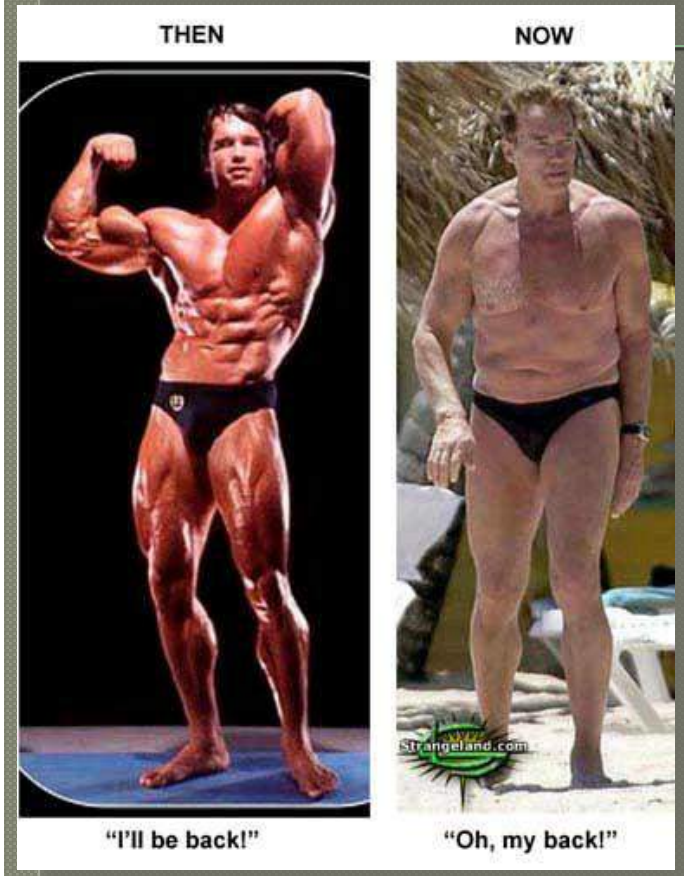


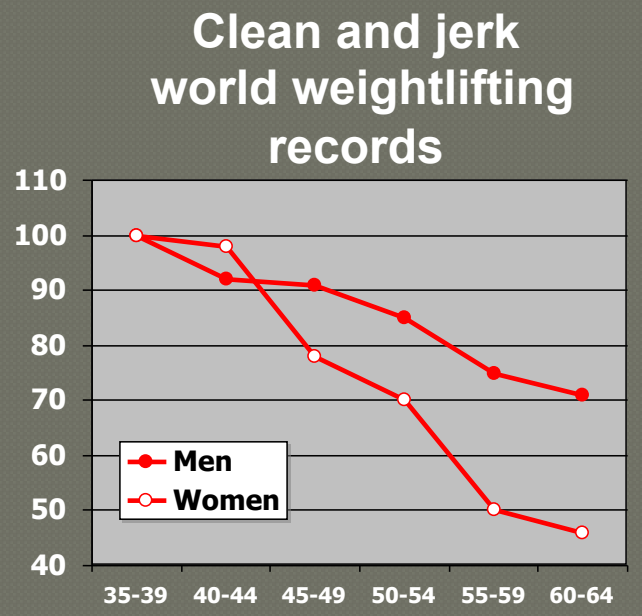
Original definition of sarcopenia:
Age-related loss of skeletal muscle



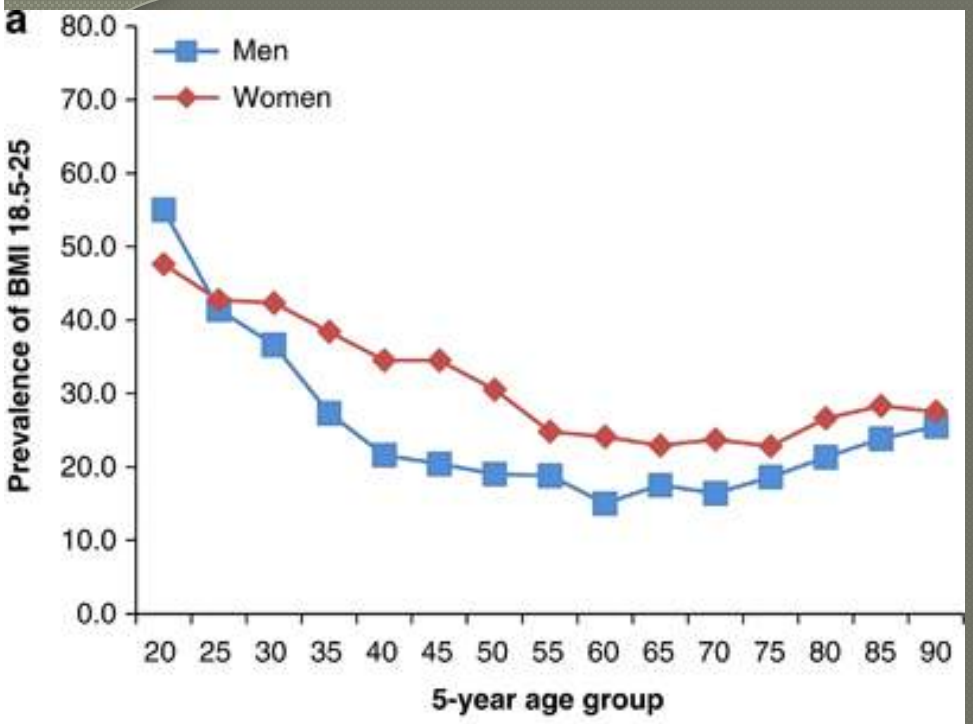
SARCOPENIA:

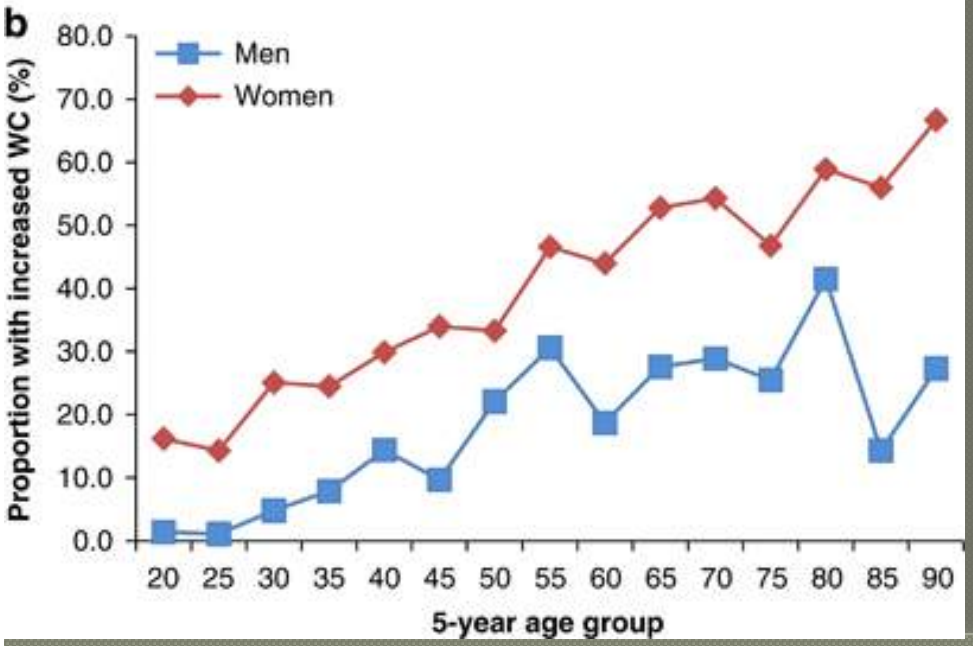
Presence of both low muscle mass and low muscle function (strength or performance)





European Working Group on Sarcopenia in Older People (EWGSOP)
Foundation of the National Institutes of Health Sarcopenia Project





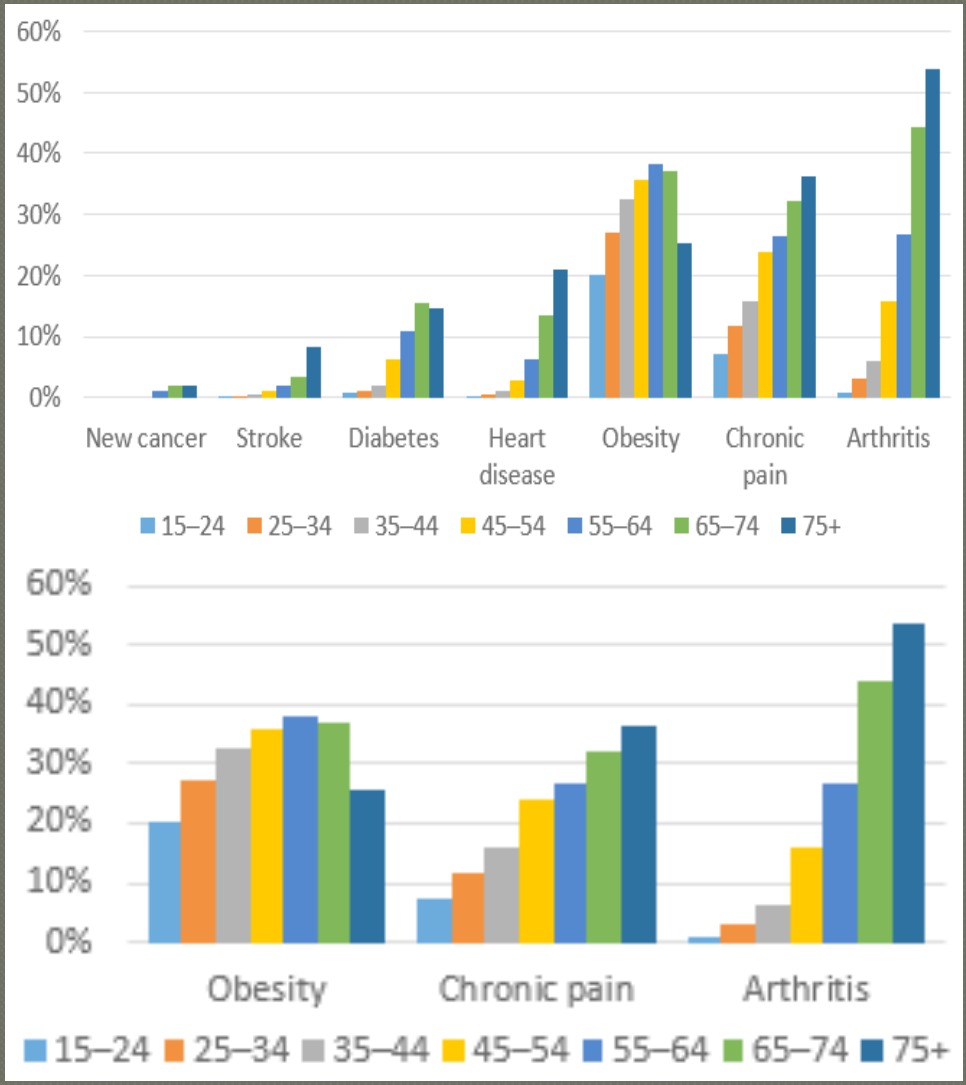
Body Msss Index (BMI wt/ ht^2) is a poor marker of fat distribution, fat mass, and lean body mass in older adults

Waist circumference appears to continue to increase (higher proportion of population with elevated waist circumference)

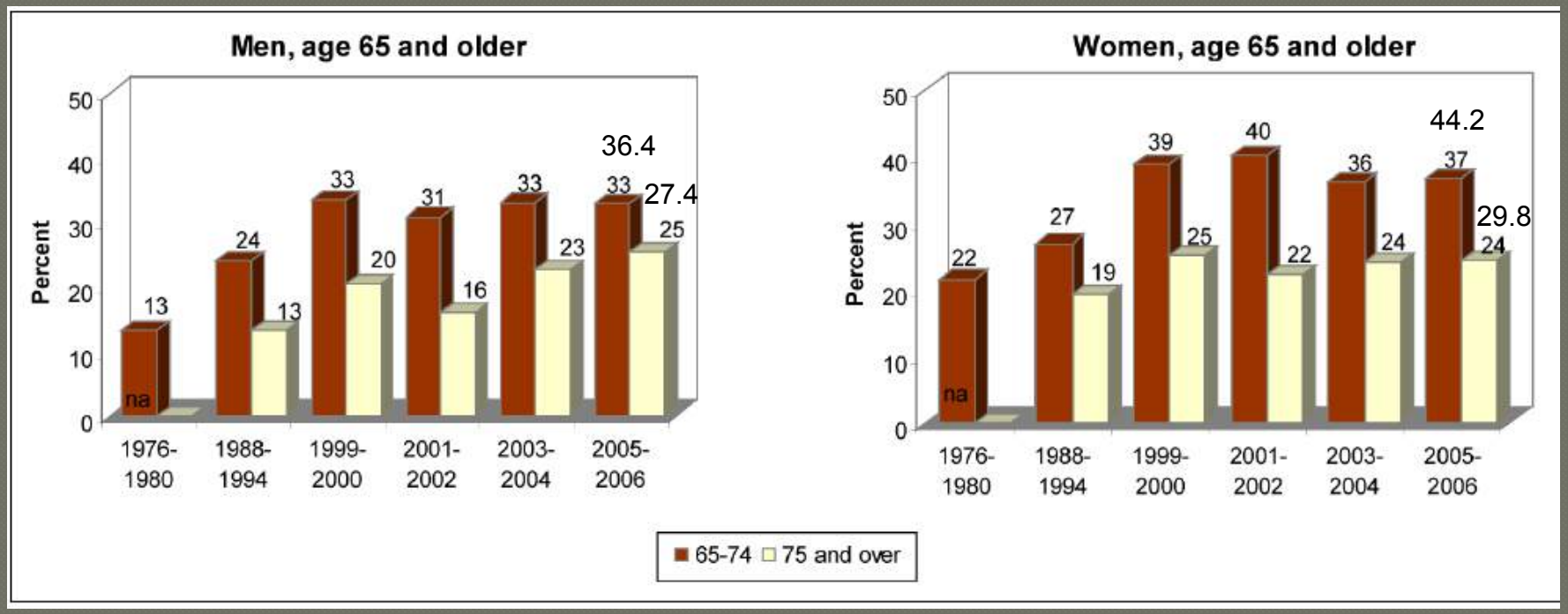
Obesity a crisis of the elderly – report

Stuff.co.nz
Dec 17, 2013

Obesity in New Zealand

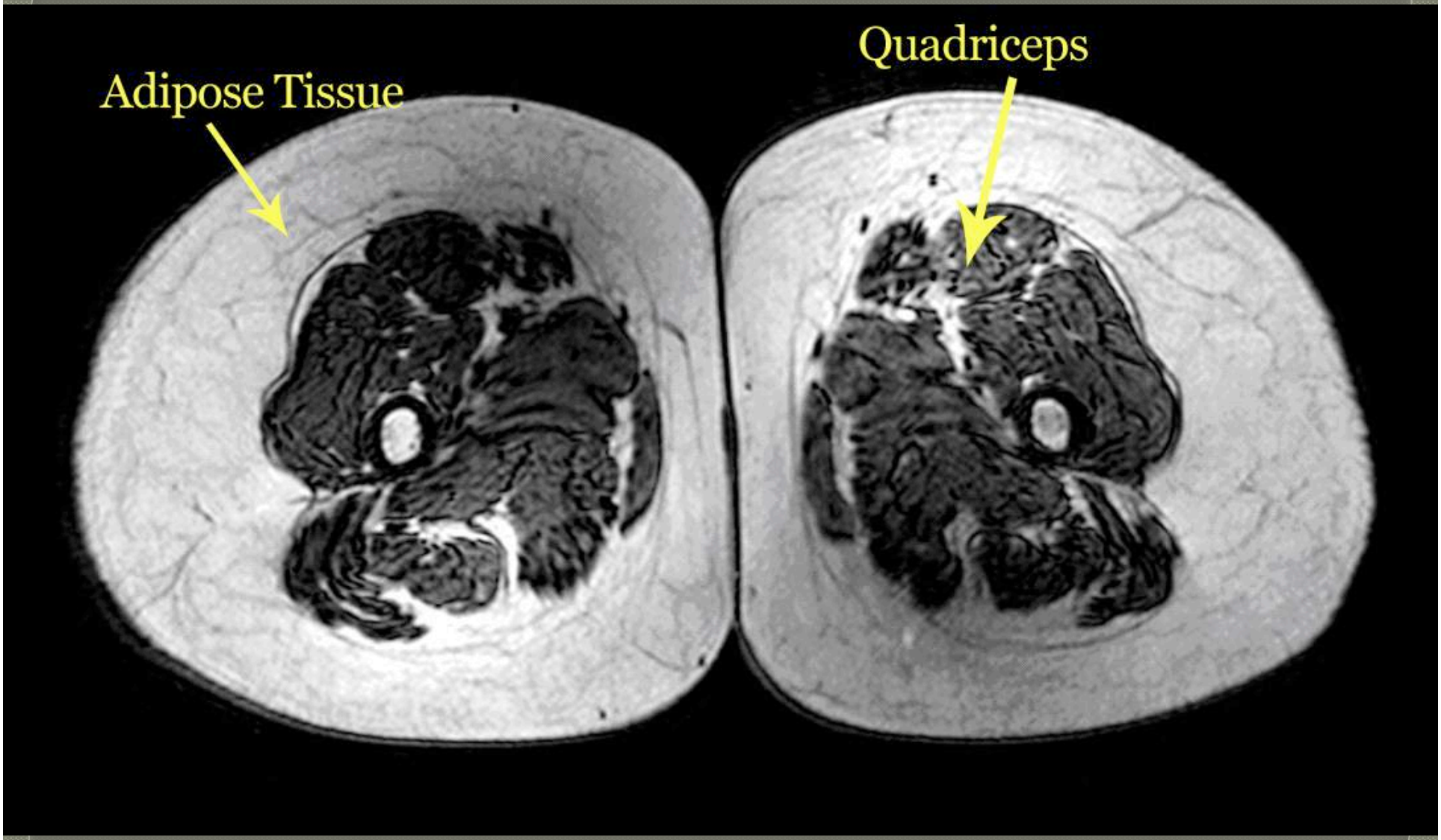


Obesity Trends Among Elderly Americans 1976-2006

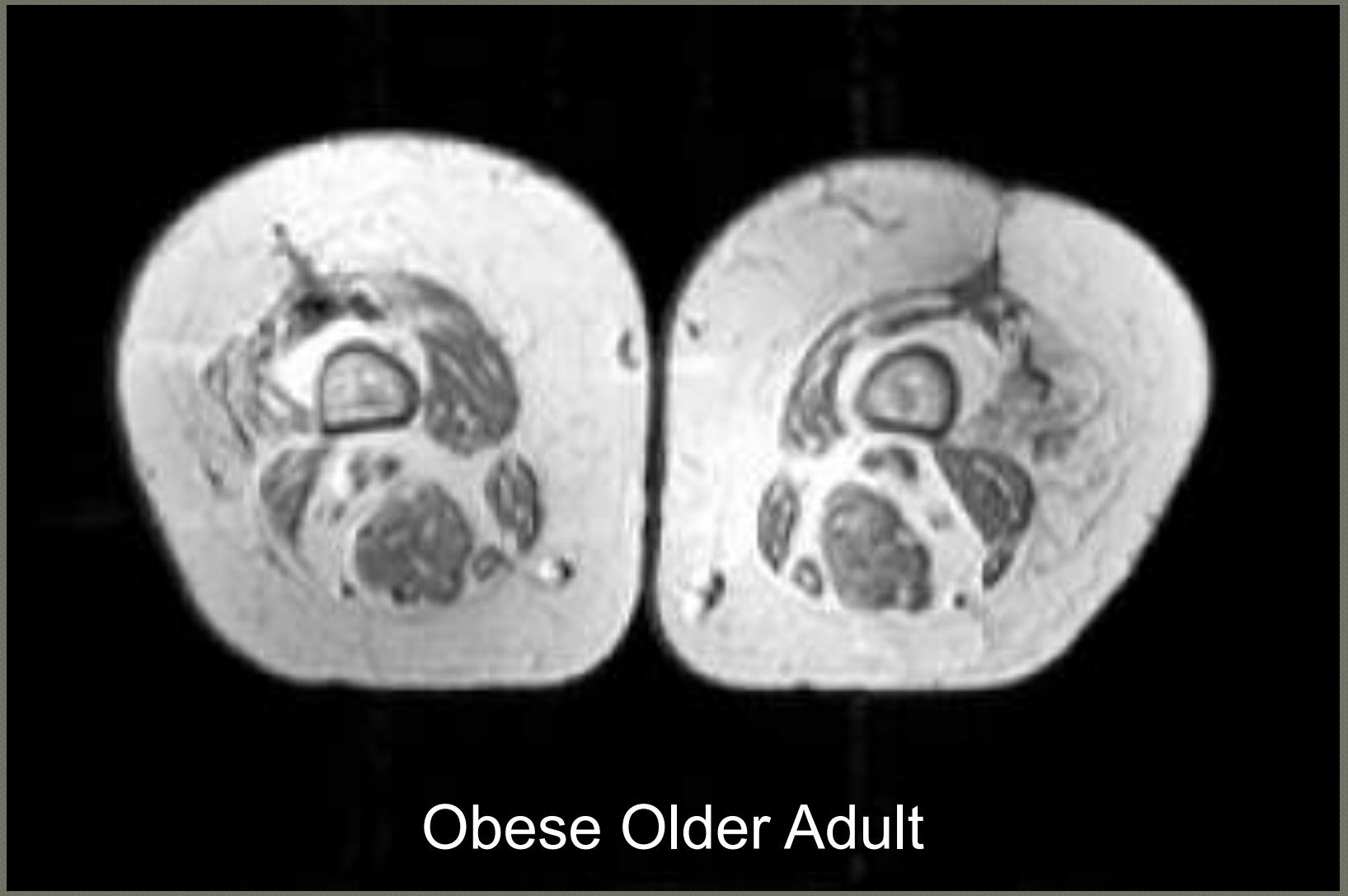


Federal interagency forum on aging-related statistics

Sarcopenic-obesity

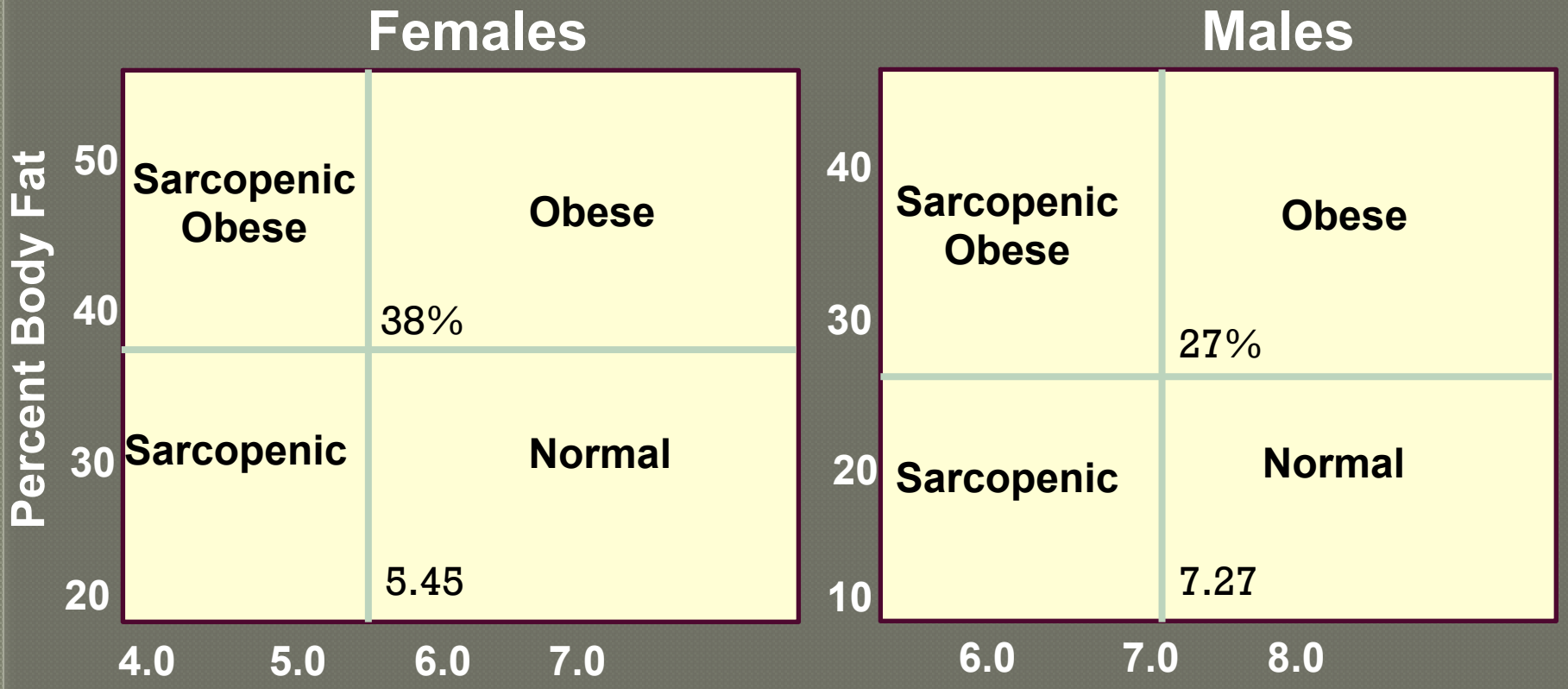


Severe Sarcopenic-obesity



Obese Older Adult

Body Composition Classifications by DXA



Obesity and Physical Dysfunction in Older Adults

- Increase in 3 units BMI ~ 1-pt decrease in physical performance

  Apovian et al, '96

- Highest quintile of FM ~2.6 OR of disability 3 years later

  Visser at al, '98,99

- FM ~ decrease walking speed and functional limitations

  Sternfeld et al, '01

- BMI of > 30 ~ twice likelihood of functional limitations

  Davison et al, 02

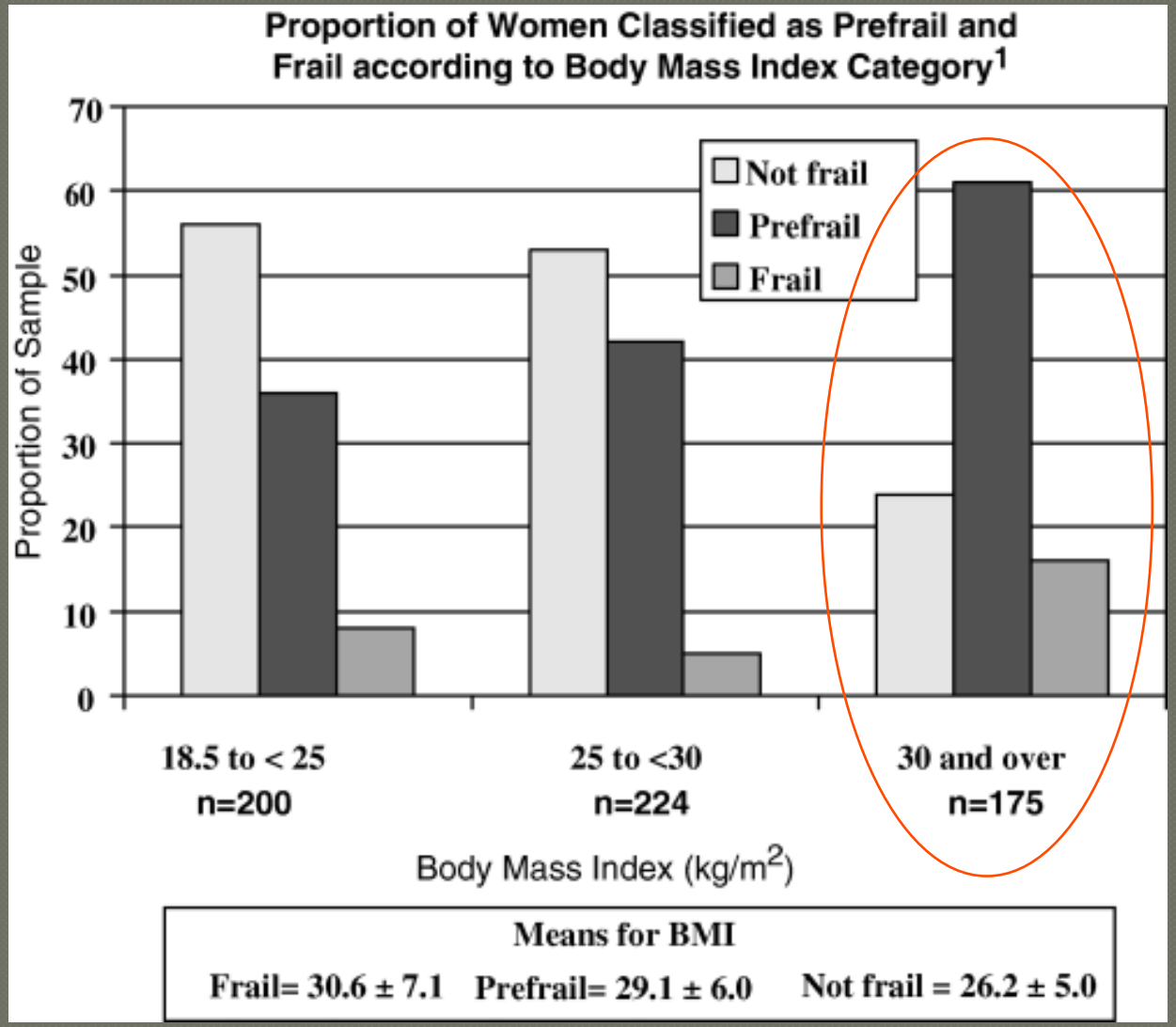
- BMI of > 30 had greater rate of nursing home admission

  Zissa et al, 02

- Sarcopenic-obesity predicts incident disability

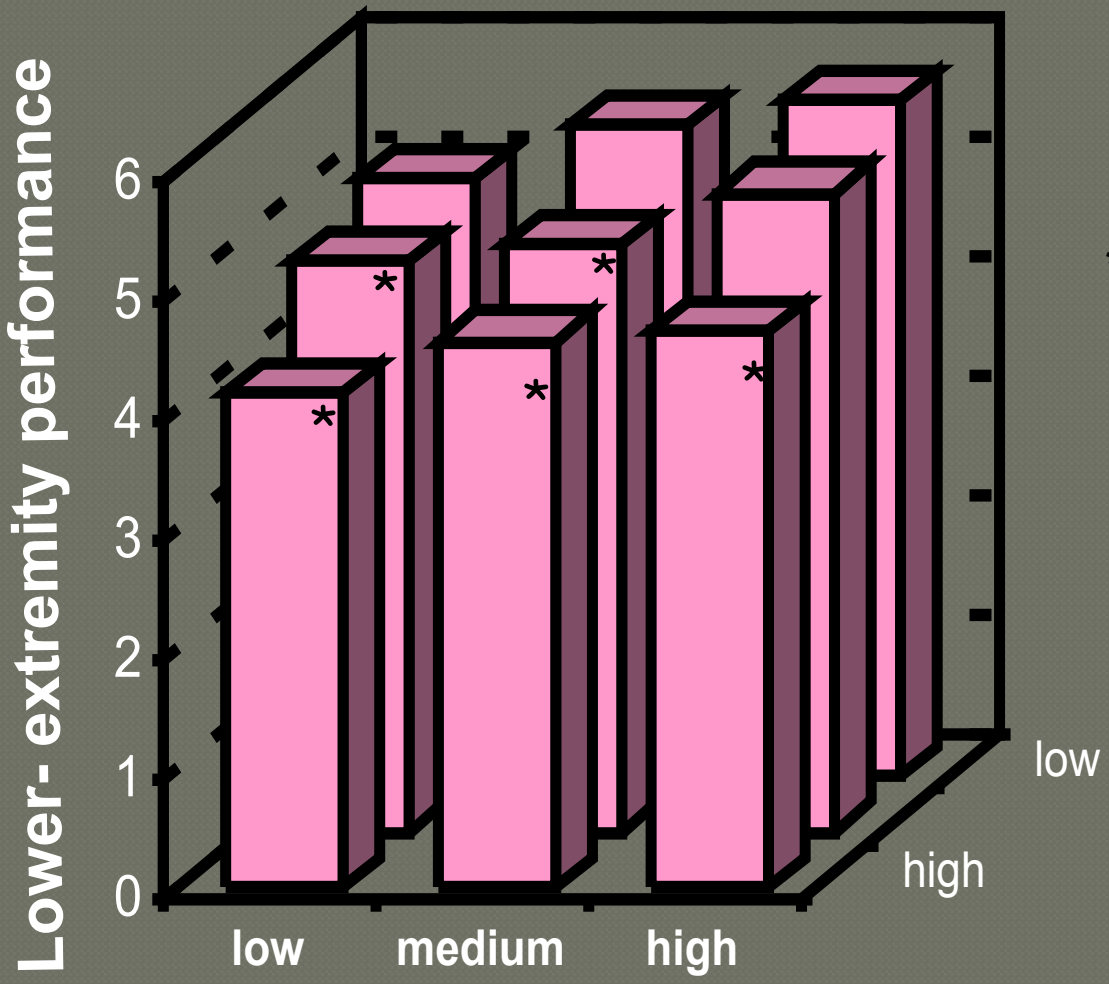
  Baumgartner et al 04

Association between Obesity and Frailty Syndrome



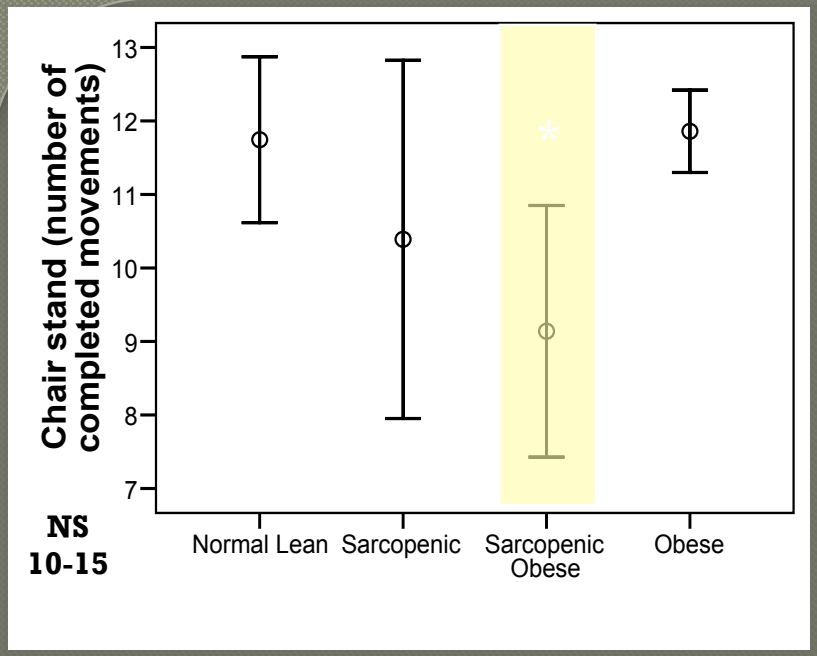
Blaum CS et al, *J Am Geriatr Soc*, 2005:53:928

Lower extremity function is worse with higher fat and lower muscle area – Health ABC



*P<0.01

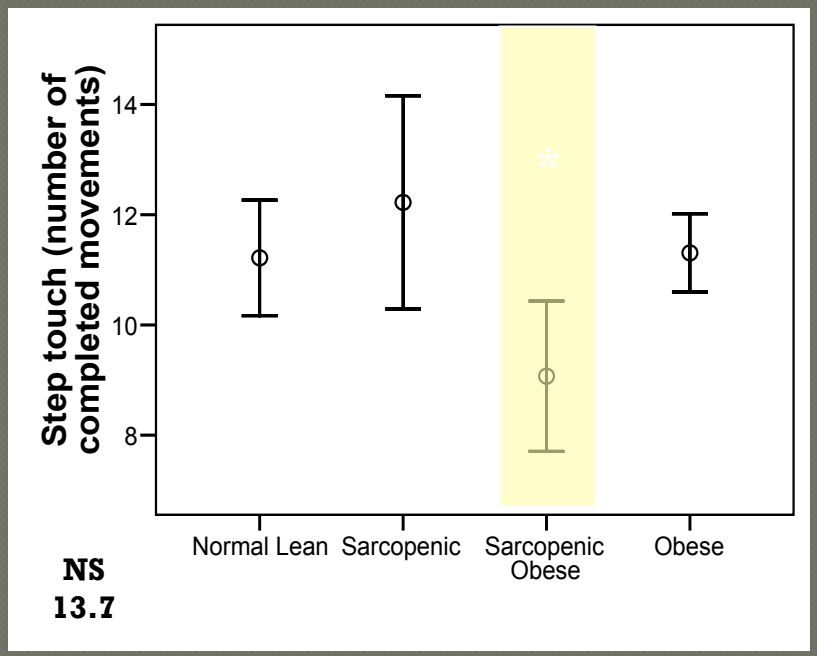
Visser M, et al J Am Geriatr Soc. 2005 May;53(5):762-70.

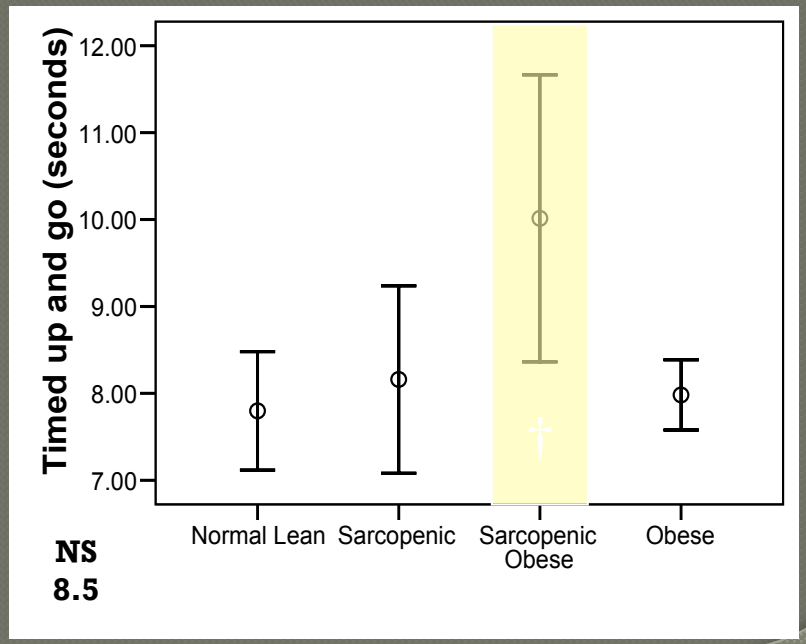


Waters DL, Grant AM, Herbison P, Hale L, Goulding A. Osteoporos Int. 2010 Feb;21(2):351-7.

Functional tests

- Chair stand (p = 0.03 NL OO)
- Step test (p=0.03 NL, p=0.008 OO)
- TUG (p=0.06 all groups)





Weight Loss and Exercise in Frail Obese Elderly

- Central Hypothesis
  - Weight loss will improve physical function and quality of life
  - The addition of exercise will
    - augment improvement in these outcomes
    - attenuate the adverse effects of weight loss on muscle mass and bone mass

R01AG025501 (2005-09) DT Villareal

Participants

- N=107
- BMI ≥ 30 kg/m^2, age ≥ 65 yrs
- Sedentary, stable weight, stable medications
- Excluded
  - severe cardiopulmonary disease
  - musculoskeletal/neuromuscular impairments
  - sensory or cognitive deficits
  - history of malignancy
  - steroid, androgen, and estrogen use

Evidence of Physical Frailty

- Two of the following operational criteria
  - Physical Performance Test (PPT)
    - 18 to 32
    - 7 standardized tests score for each task
      - 0-4 perfect score =36
      - Walking 50 ft, putting on and removing a coat, Romberg test, picking up a penny, standing up from a chair, lifting a book, climbing 1 flight of stairs, plus 2 additional tasks
        - Climbing 4 flights of stairs and performing 360 degree turn.
  - VO_2 peak –graded treadmill walking
    - 11 to 18 L/min/kg
  - Functional Status Questionaire
    - Difficulty or need for assistance in 1 basic or 2 instrumental ADL

Intervention Arms

- Participants randomized to:
  - Healthy-lifestyle education
    - Control group
  - Weight-management
    - Diet group
  - Exercise training
    - Exercise group
  - Weight-management plus exercise training
    - Diet-exercise group

Diet Intervention

- Balanced Diet
  - Energy deficit of ~750 kcal/day
    - 1g/kg protein, Vit D and Ca+ supplements
  - Goal of 10% weight loss
    - 1.5% body wt max per week
- Weekly Group Behavioral Therapy
  - Goal setting
  - Self-monitoring
  - Stimulus control
  - Problem solving skills
  - Relapse prevention training

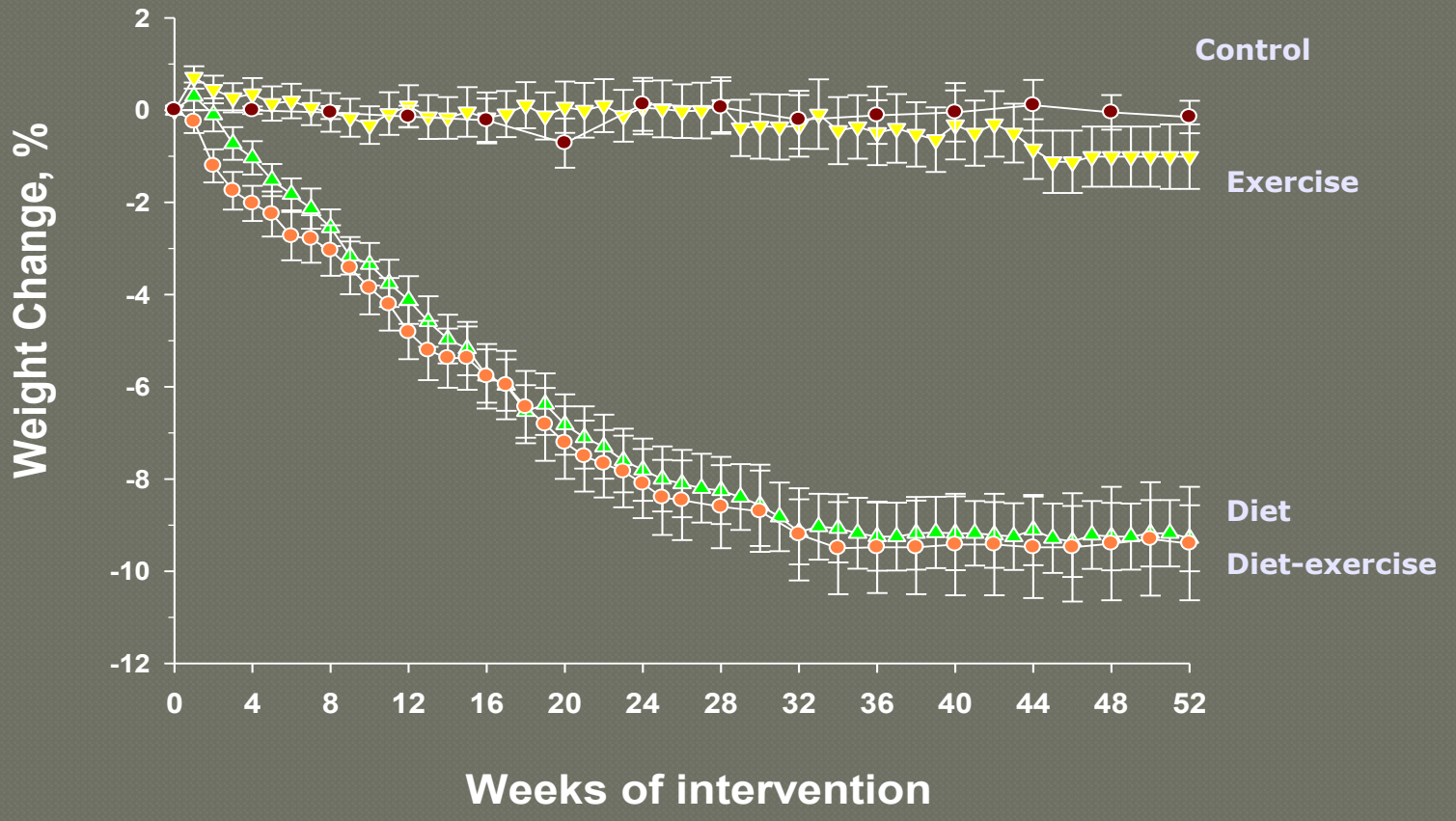
Exercise Intervention

- **Group Exercise-Training Sessions**
  - 3 nonconsecutive days a week
  - Supervised by a physical therapist
    - 15-min flexibility
    - 30-min endurance (~80% of VO_{2peak})
    - 30-min resistance (~80% of 1-RM)
    - 15-min balance

Outcomes

- Frailty (PPT, VO_{2peak}, FSQ)
- Specific physical functions
  - strength, gait speed, static balance, dynamic balance
- Body composition
  - DXA and MRI
- Biopsy
  - Muscle protein synthesis
  - Whole body proteolysis
- Serum
  - Inflammatory cytokines
- Bone turnover
- Health related quality of life
  - SF-36

Body Weight Changes during Intervention



Villareal N Engl J Med 2011;31:1218-1229

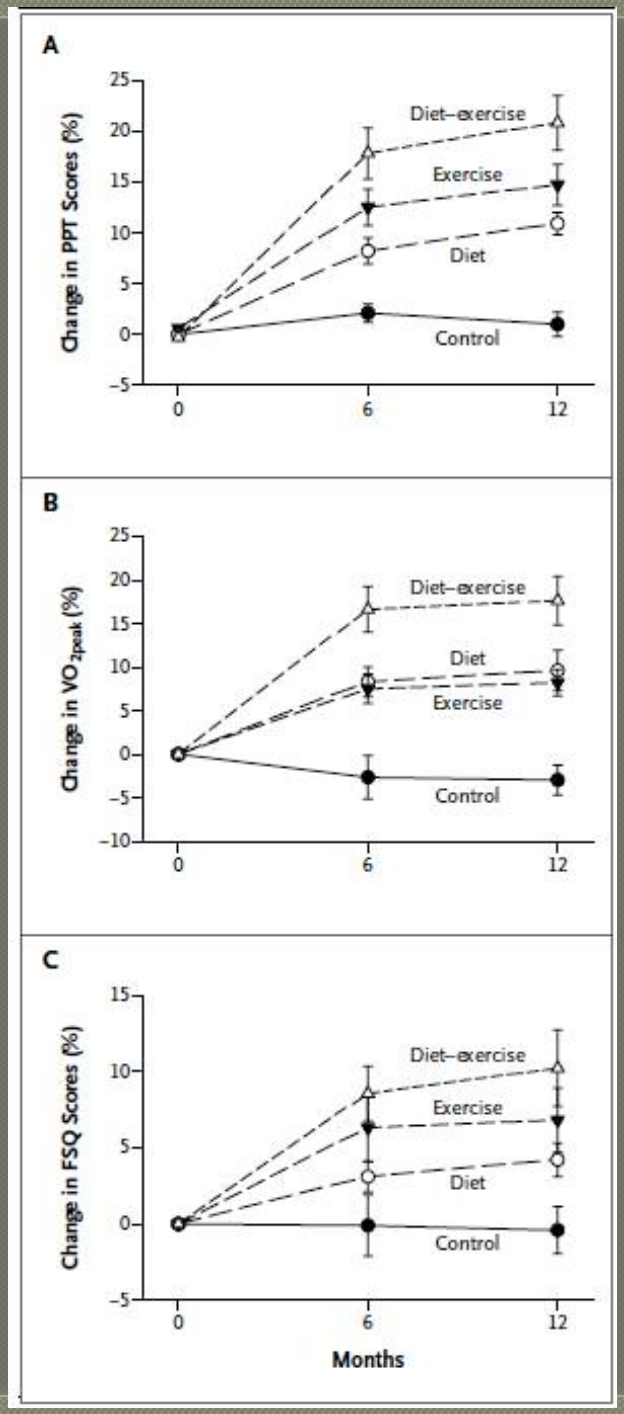
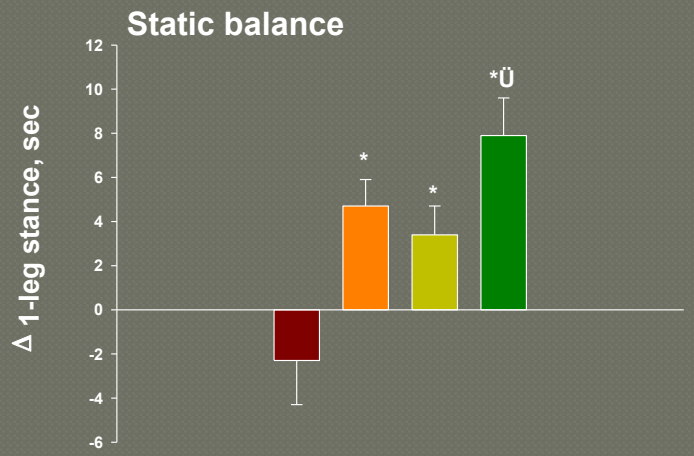


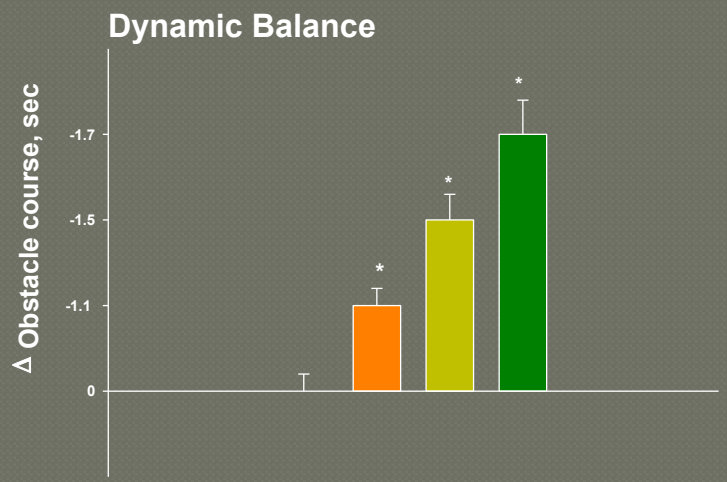
Figure 2. Mean Percentage Changes in Objective and Subjective Measures of Frailty during the 1-Year Intervention.

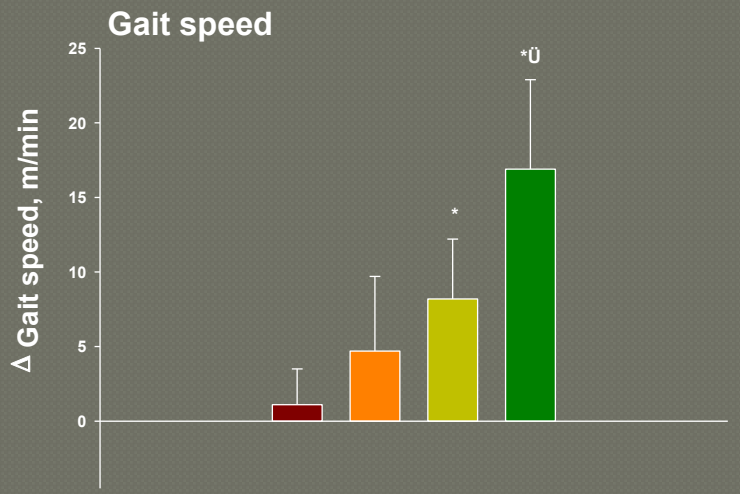
The objective measures of frailty included the scores on the Physical Performance Test (PPT), which range from 0 to 36, with higher scores indicating better physical status (Panel A), and the peak oxygen consumption (VO_{2peak}) (Panel B). The scores on the Functional Status Questionnaire (FSQ), which range from 0 to 36, with higher scores indicating better functional status, were used as a subjective measure of frailty (Panel C). The change in the scores on the PPT was the primary outcome. In Panels A and B, the change in the diet–exercise group differed significantly from the changes in the exercise group and in the diet group, and the changes in the exercise group and in the diet group differed significantly from that in the control group. In Panel C, the change in the diet–exercise group differed significantly from that in the diet group, and the changes in the exercise group and in the diet group differed significantly from that in the control group. I bars indicate standard errors.

Villareal N Engl J Med 2011;31:1218-1229


Total Strength
Δ 1-RM, lb
250
200
150
100
50
0
-50
*
*


Static balance
Δ 1-leg stance, sec
12
10
8
6
4
2
0
-2
-4
-6
*
*
*Ü

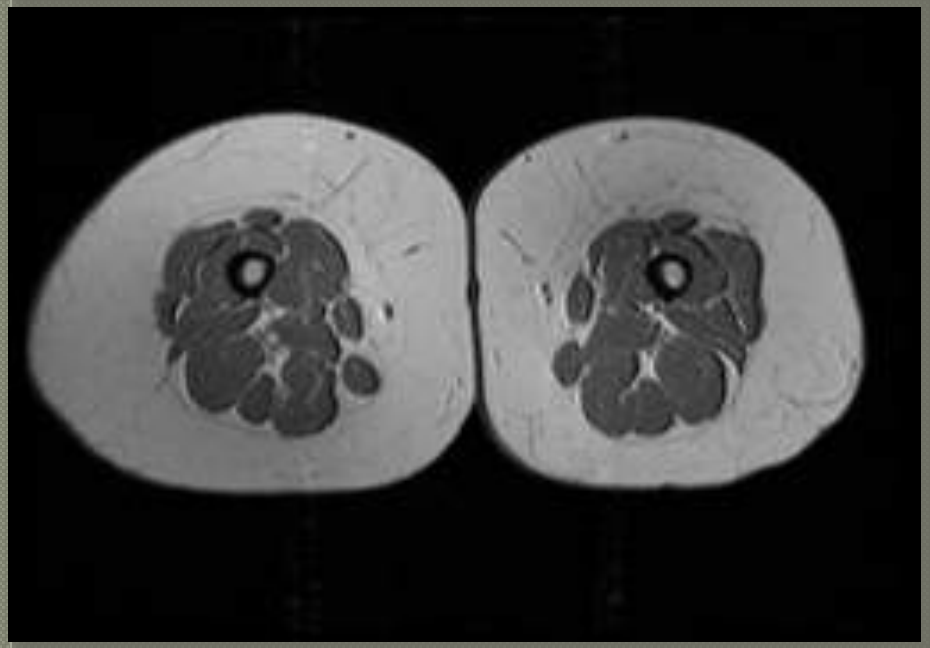

Dynamic Balance
Δ Obstacle course, sec
-1.7
-1.5
-1.1
0
*
*
*


Gait speed
Δ Gait speed, m/min
25
20
15
10
5
0
*
*Ü


Control
Diet
Exercise
Diet+Exercise

Diet Alone Improves Body Composition and Function

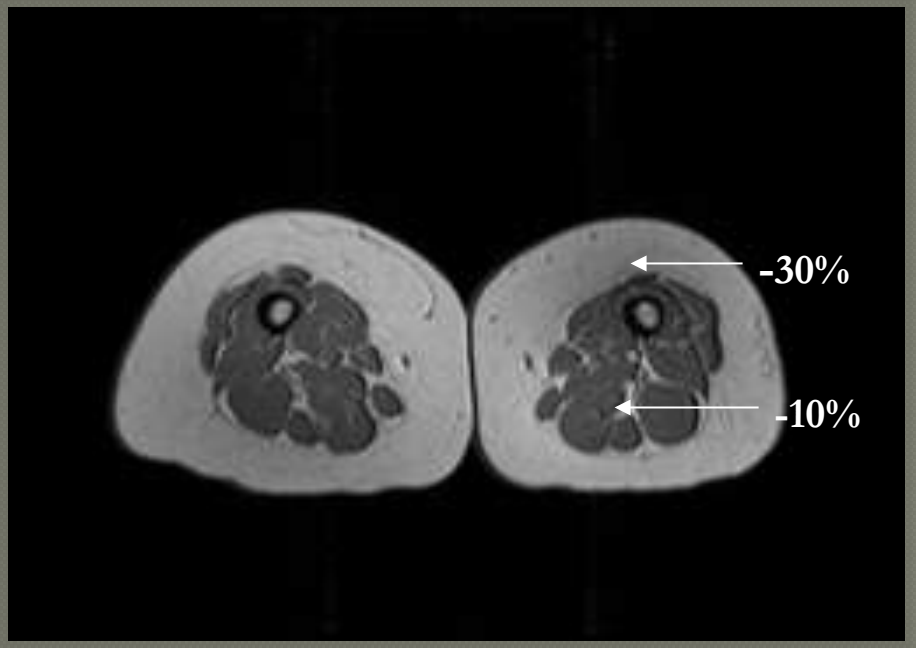
Before (Wt = 95 kg)



Fat = 48 kg
Lean = 47 kg
Relative Lean = 49%

Physical Performance Test = 30 (Frail)

After (Wt = 75 kg)

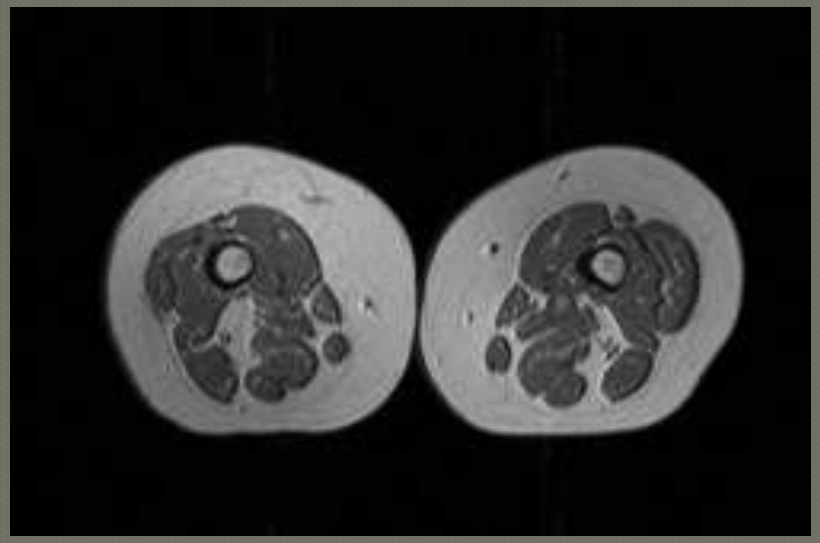


Fat = 33 kg
Lean = 42 kg
Relative Lean = 55%

Physical Performance Test = 35 (NonFrail)

Exercise added to Dieting Preserves Muscle Mass and function

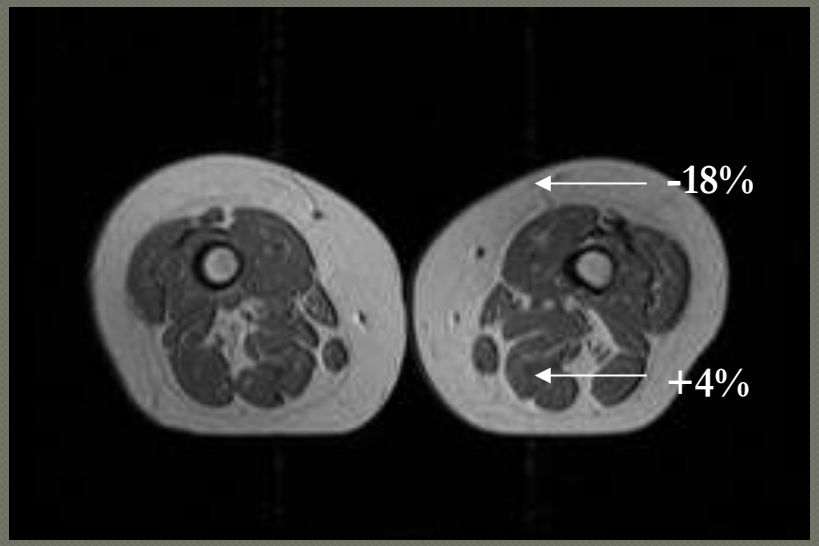
Before (Wt = 91 kg)



Fat = 42 kg
Lean = 50 kg
Relative Lean = 54%

PPT = 25 (Frail)

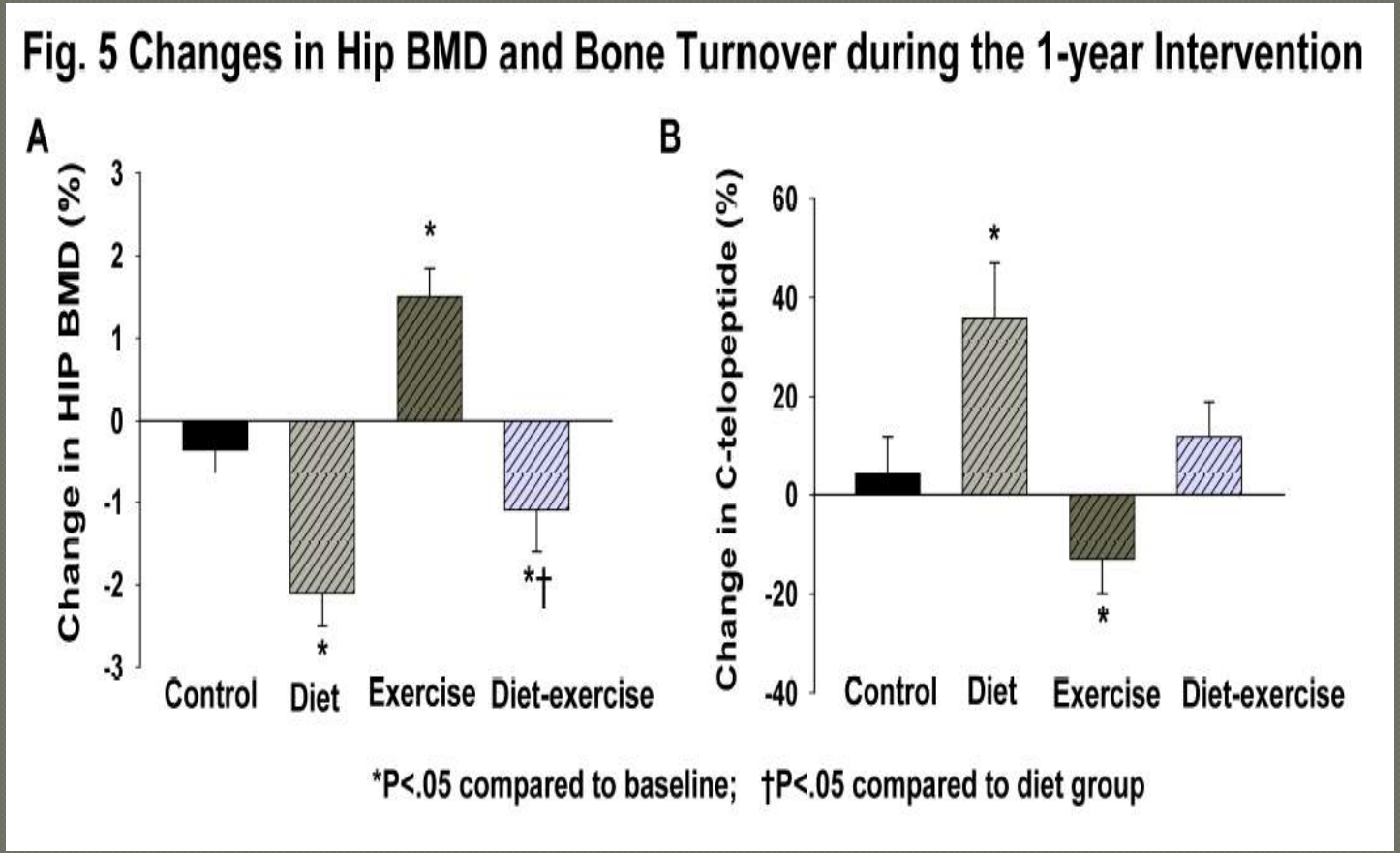
After (Wt = 82 kg)



Fat = 34 kg
Lean = 49 kg
Relative Lean = 60%

PPT = 35 (NonFrail)

Changes in Hip BMD



Armamento-VillarealJ Bone Miner Res 2011;12:2851-2859;

Summary and Conclusions

- Obesity and sarcopenic-obesity are prevalent in older adults
  - Expected to increase with increasing longevity and sedentary behavour
    - SO is difficult to identify clinically
      - but BMI>30 and poor physical function might be useful
- Combined weight loss and exercise provide greater improvement function than individual interventions
  - Exercise should be a combination of resistance training plus aerobic training
  - Resistance training may be better for preserving LBM and BMD while dieting
- Dietary calorie reduction should be modest
  - No more than 500-750 kcal per day
  - Calorie restriction alone (e.g. w/o exercise) should be avoided