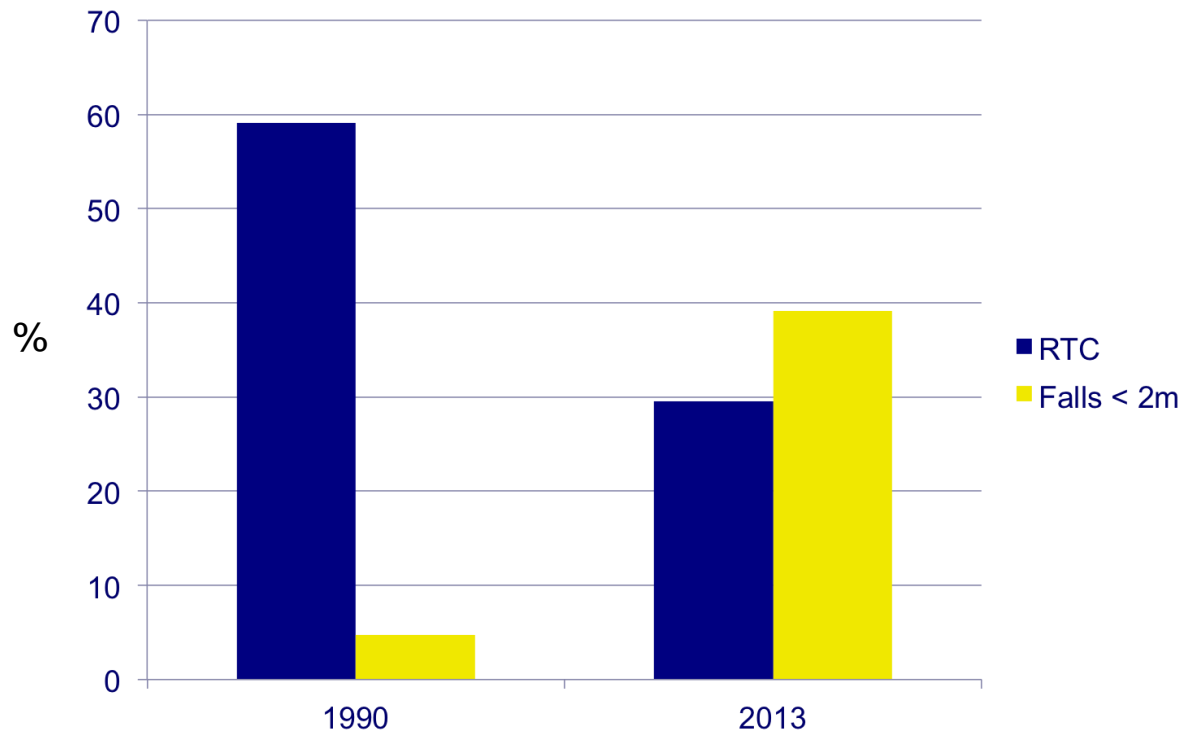


“Sarcopenie”

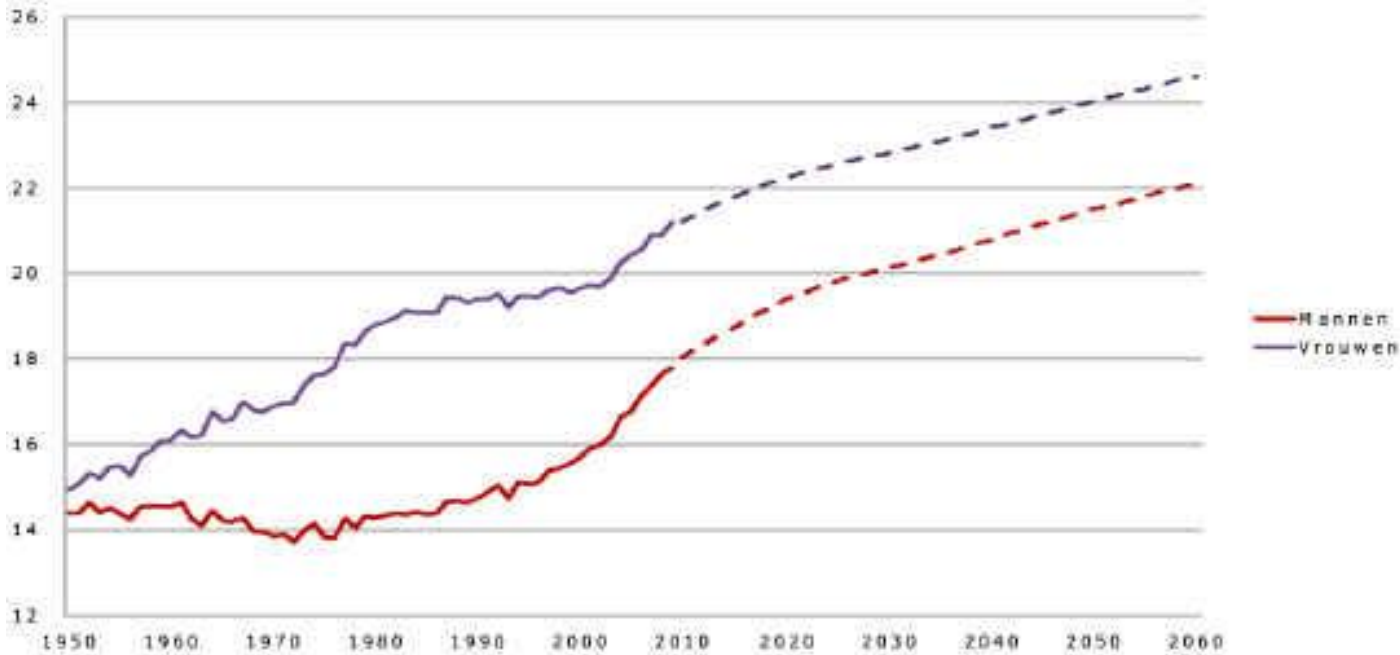
Dr. Carel Meskers, revalidatiearts

Medical revolution





Life expectancy at 65 years





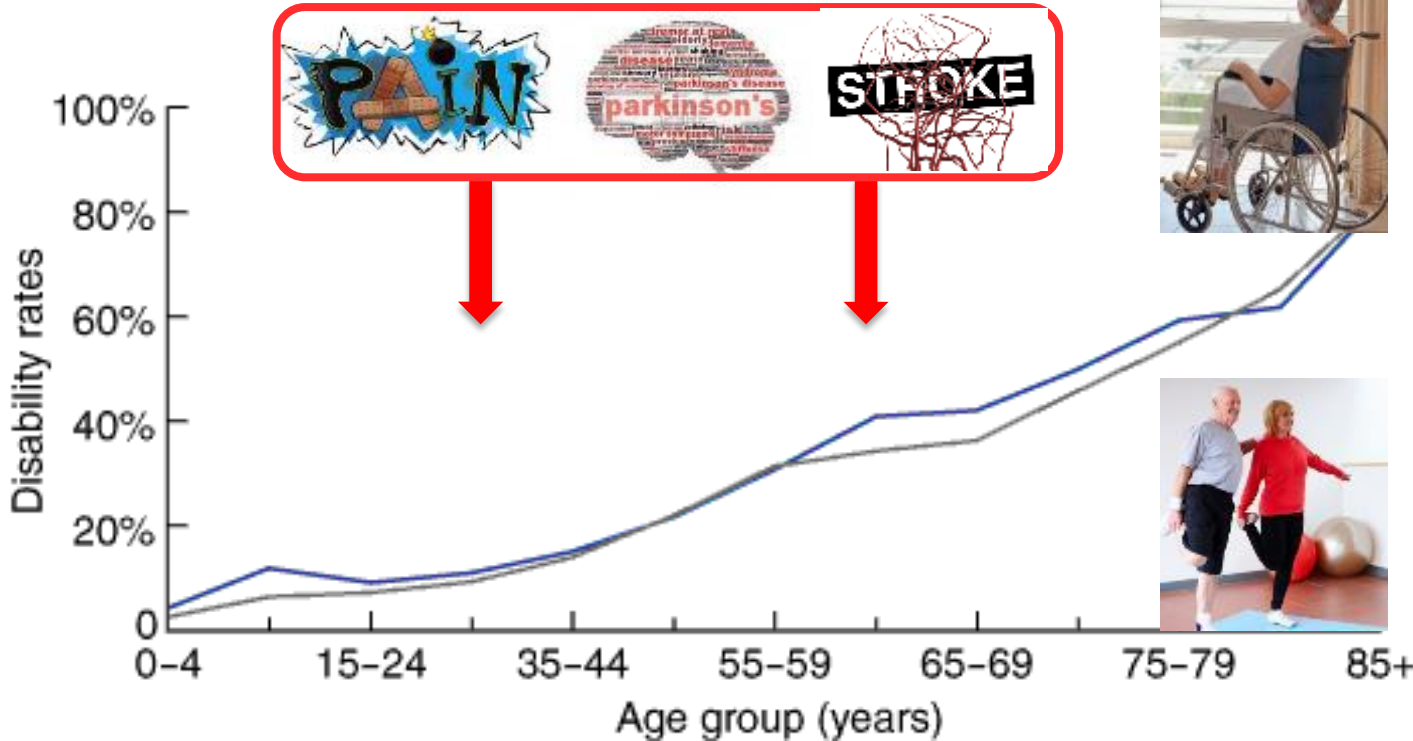
Lifestyle (use, maintenance)



GENETIC (“BRAND”)



The medical challenge...





Muscle

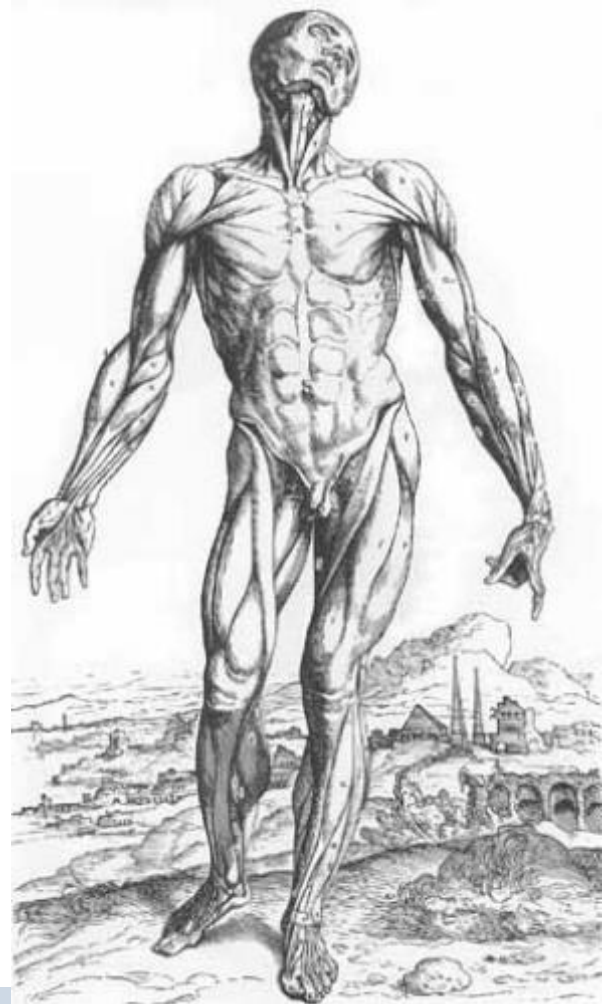
640 muscles

contraction = movement

glucose metabolisme

protein storage

Modifyable!





Muscle

640 muscles

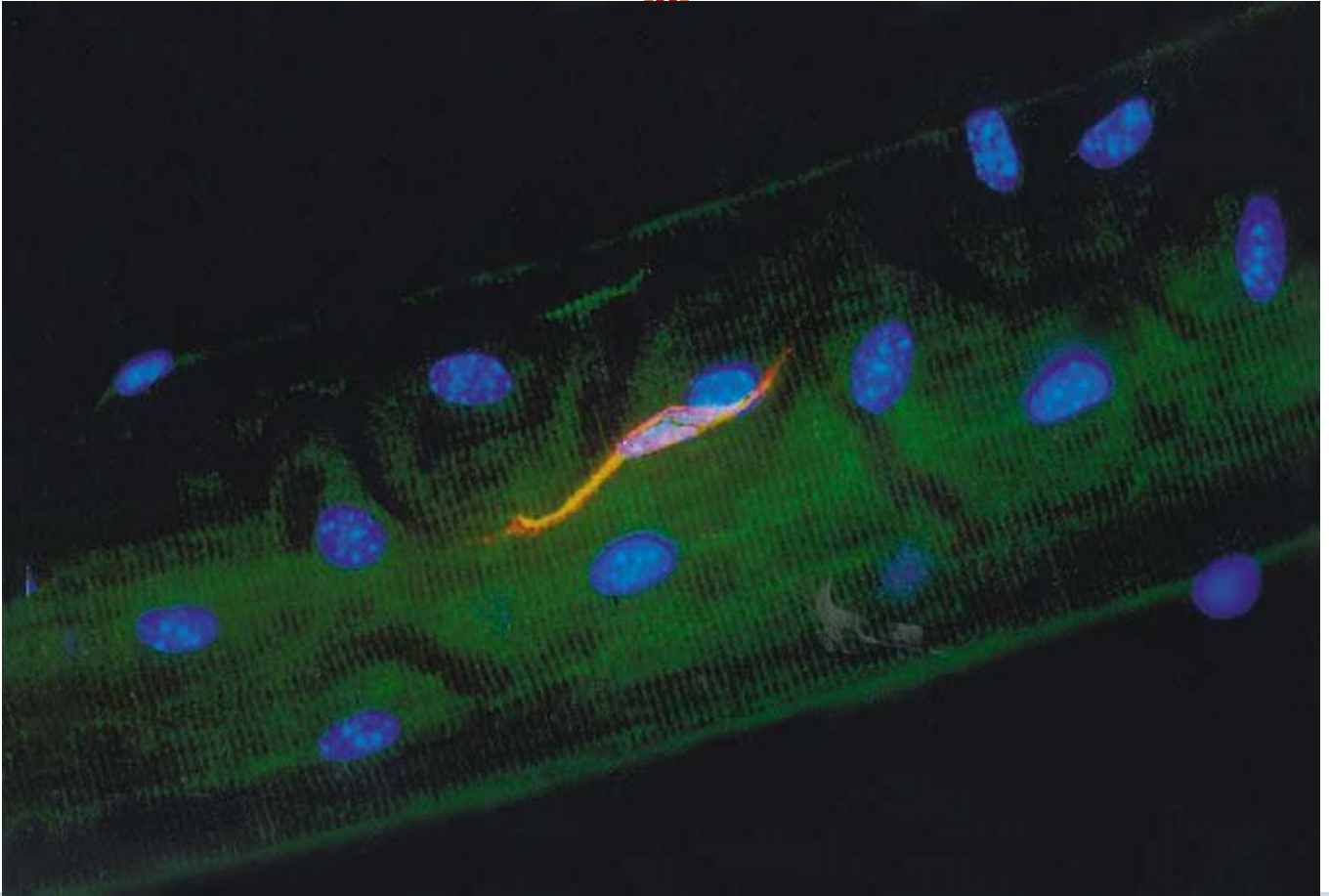
contraction = movement

glucose metabolism

protein storage

Modifiable!







Sarcopenia

sarx flesh



penia diminished

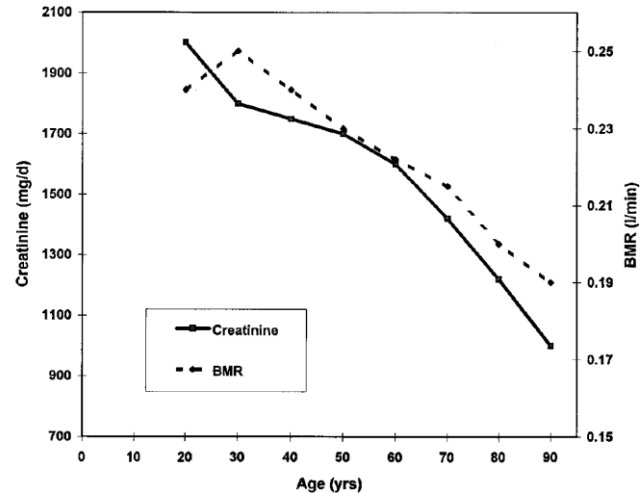


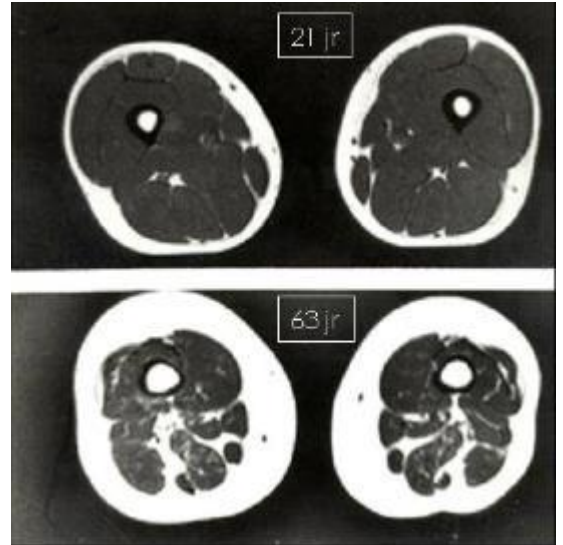
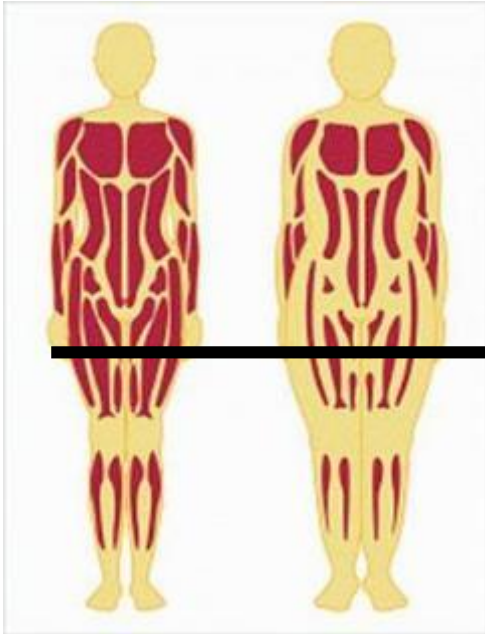
FIGURE 1 Creatinine excretion, a measure of muscle mass, and basal metabolic rate (BMR) as a function of age. Based on original studies of Tzankoff and Norris (1977).

low skeletal muscle mass



21 jr

63 jr

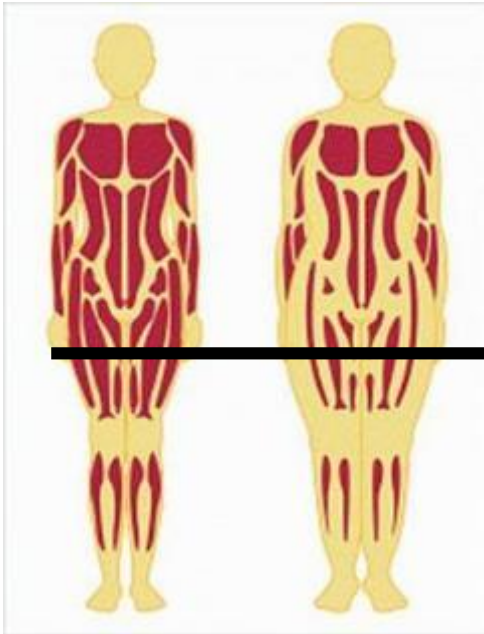




Sarcopenie is een ziekte

21 jr

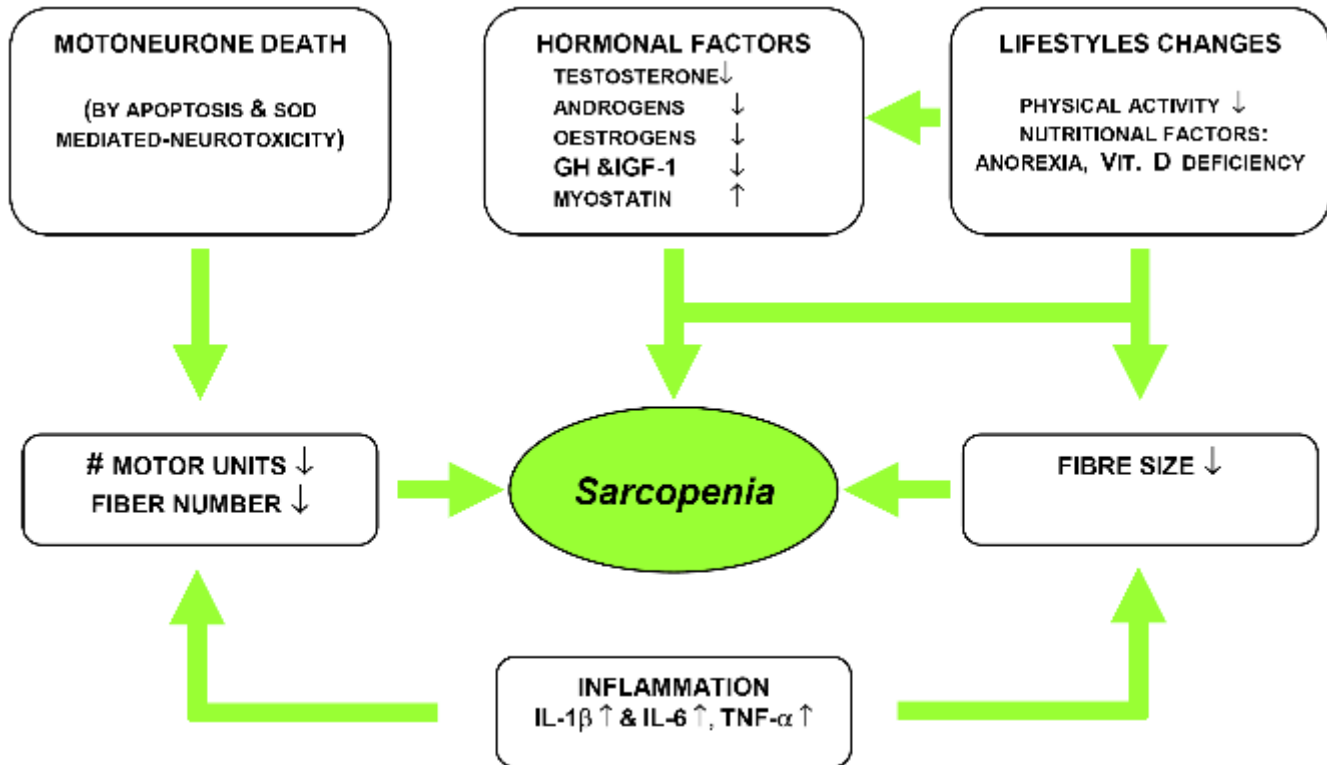
63 jr



M 6 2 . 8 4
AN

**ICD-10 CODE
FOR SARCOPENIA**

Implications for Diagnosis
& Clinical Practice





Muscle strength



Grip strength

Quadriceps strength





Muscle mass

45-90% lean mass

10-40% fat mass





Te mager?



Sarcopeen?



Te dik- verlies van spiermassa?



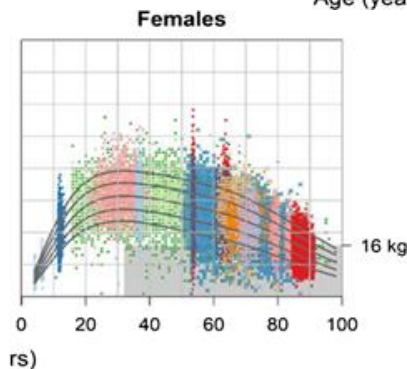
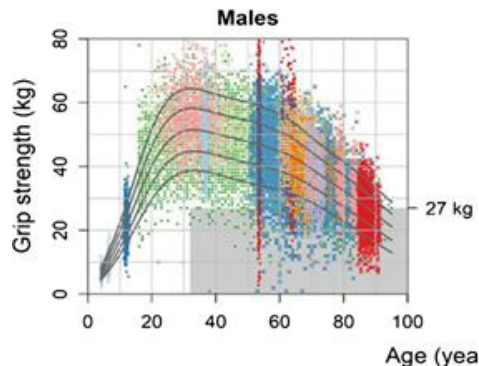
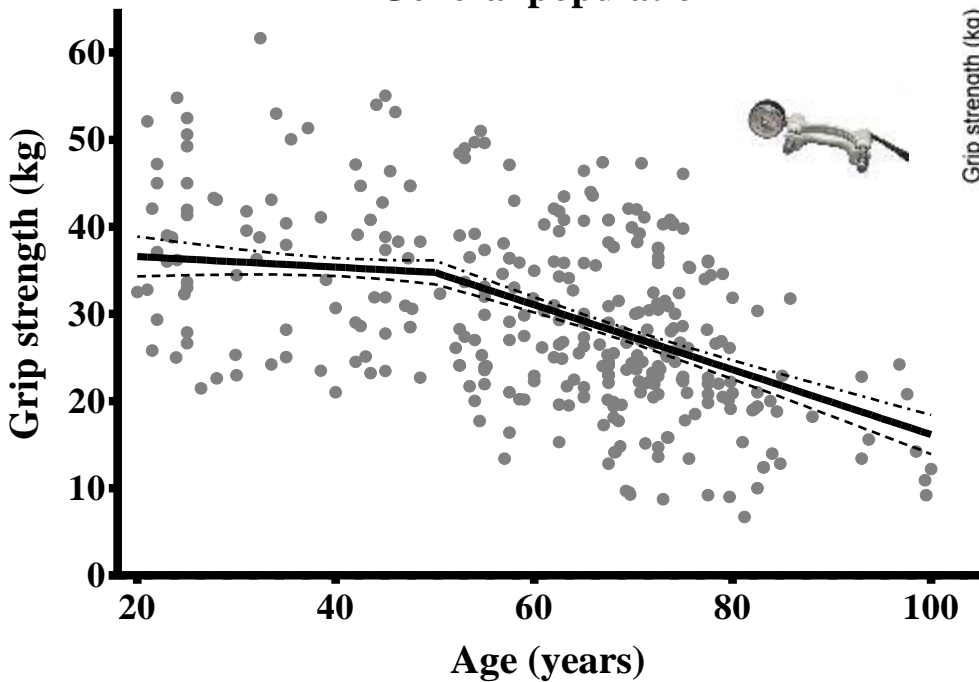
Sarcopeen?



Sarcopeen?



General population



Beenakker et al., Ageing Res Rev, 2010

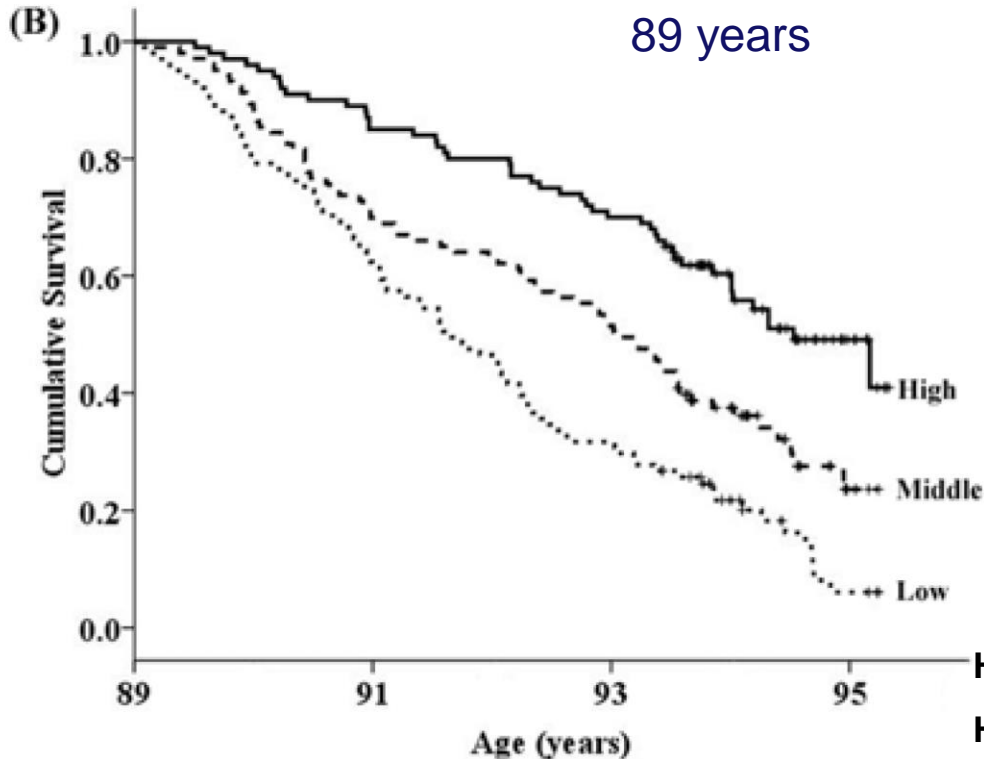
Cruz Jentoft et al. 2018

meta-regression lines with 95% confidence band (adjusted to 50% female)



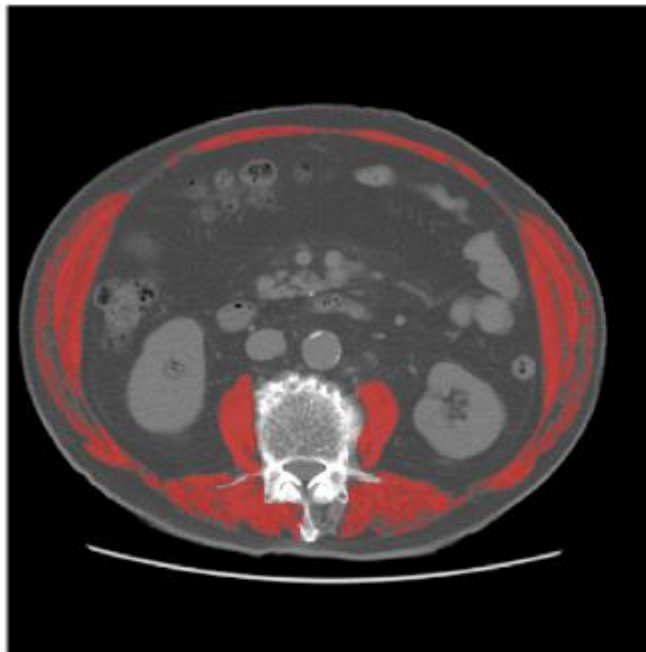
Muscle strength and survival

Leiden
85+
study

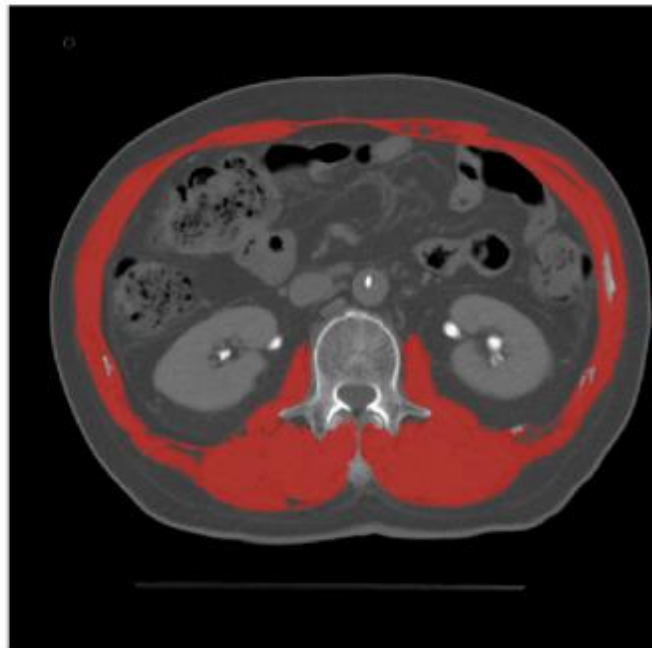




L3 SMI = $32.3 \text{ cm}^2/\text{m}^2$



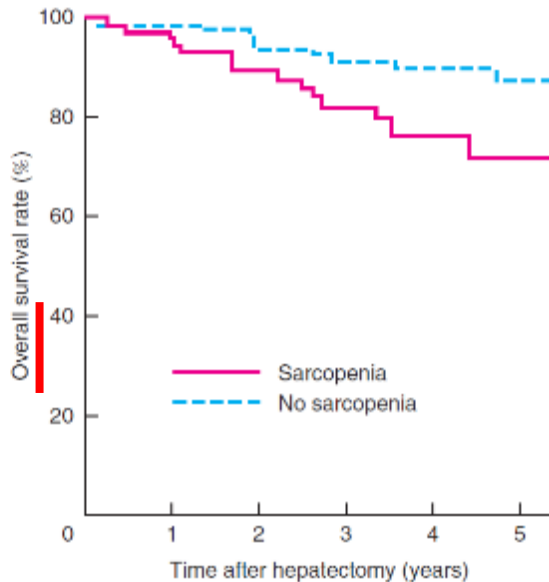
L3 SMI = $51.1 \text{ cm}^2/\text{m}^2$





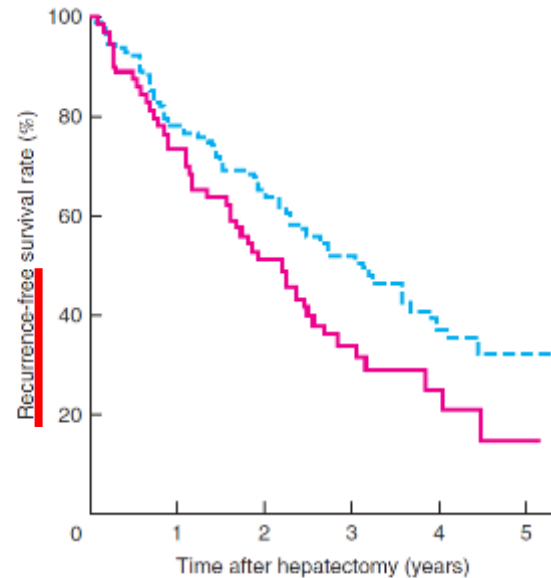
Hepatocellular carcinoma - survival

196 pt hepatocellular carcinoma undergoing hepatectomy, CT L3, 40% sarcopenic



| No. at risk | | 0 | 1 | 2 | 3 | 4 | 5 |
|---------------|-----|-----|----|----|----|----|---|
| Sarcopenia | 75 | 66 | 53 | 35 | 23 | 12 | |
| No sarcopenia | 111 | 102 | 84 | 64 | 50 | 35 | |

a Overall survival

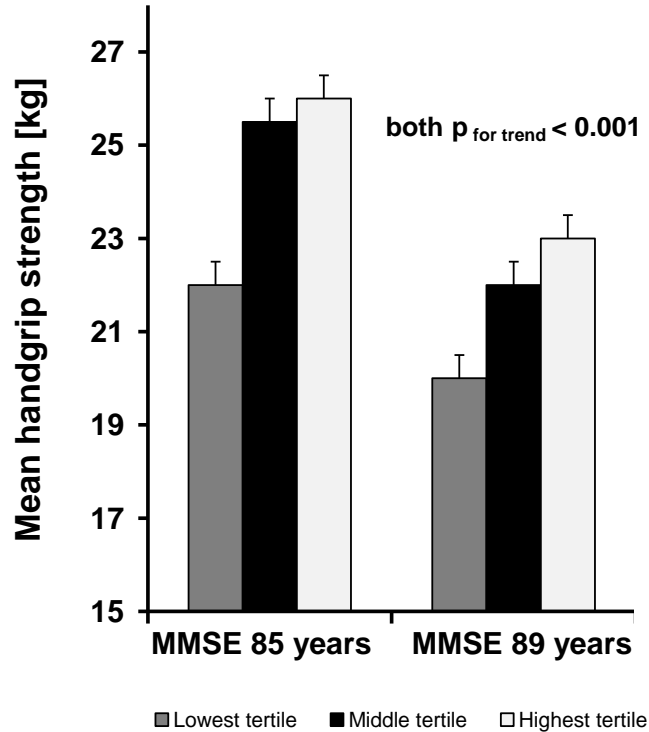


| No. at risk | | 0 | 1 | 2 | 3 | 4 | 5 |
|---------------|-----|----|----|----|----|----|---|
| Sarcopenia | 75 | 45 | 30 | 14 | 7 | 2 | |
| No sarcopenia | 111 | 80 | 61 | 40 | 22 | 12 | |

b Recurrence-free survival



Muscle strength and cognition

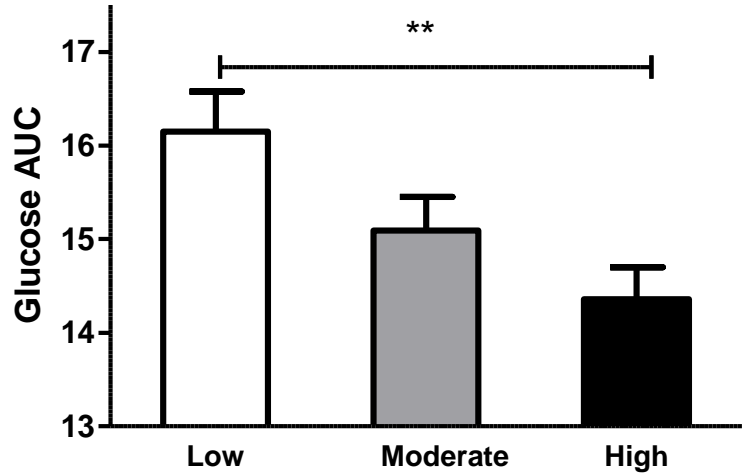




SPIERMASSA (DEXA)



GLUCOSE METABOLISME

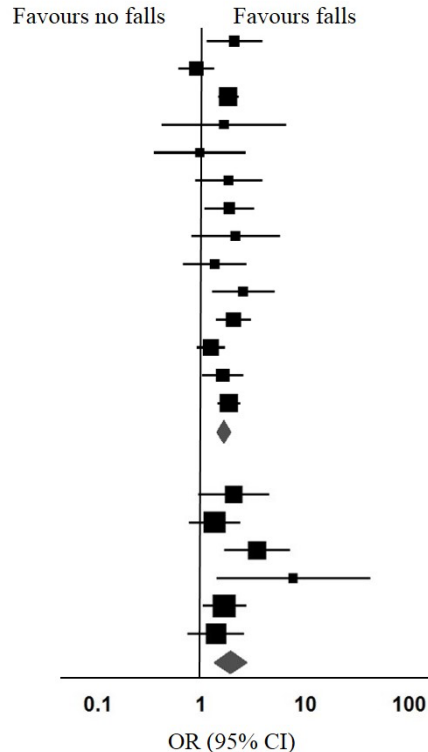


ALM percentage in tertiles
(Relative muscle measure)

Consistent association sarcopenia and falls



| First author, year | N | OR (95% CI) |
|---------------------------------------|------|-------------------------|
| <u>Cross-sectional design</u> | | |
| Bae, 2017 | 3827 | 2.05 (1.12-3.75) |
| Benjumea, 2018 | 512 | 0.88 (0.60-1.30) |
| Chalhoub, 2015 | 6658 | 1.79 (1.43-2.23) |
| Clynes, 2015 | 298 | 1.62 (0.41-6.36) |
| Dietzel, 2015 | 288 | 0.95 (0.35-2.61) |
| Gadelha, 2018 | 196 | 1.81 (0.87-3.78) |
| Lera, 2017 | 1006 | 1.83 (1.07-3.14) |
| Martinez, 2015 | 110 | 2.10 (0.79-5.56) |
| Meng, 2015 | 771 | 1.32 (0.66-2.62) |
| Sjoblom, 2013 | 590 | 2.50 (1.26-4.95) |
| Tanimoto, 2014 | 1110 | 2.01 (1.38-2.93) |
| Trajanoska, 2018 | 2301 | 1.22 (0.90-1.66) |
| Woo, 2014 | 2848 | 1.59 (1.02-2.48) |
| Yamada, 2013 | 1882 | 1.81 (1.43-2.30) |
| <i>Subgroup (I²=33.9%)</i> | | <i>1.60 (1.37-1.86)</i> |
| <u>Prospective design</u> | | |
| Bischoff-Ferrari, 2015 | 445 | 2.07 (0.95-4.51) |
| Buckinx, 2018 | 247 | 1.35 (0.78-2.35) |
| Landi, 2012 | 260 | 3.45 (1.68-7.09) |
| Matsumoto, 2017 | 162 | 7.68 (1.41-41.8) |
| Menant, 2017 | 419 | 1.67 (1.04-2.69) |
| Van Puyenbroeck, 2012 | 276 | 1.39 (0.75-2.57) |
| <i>Subgroup (I²=36.6%)</i> | | <i>1.89 (1.33-2.68)</i> |





Sarcopenia predicts
detrimental outcome.

Used definitions



| Code | Reference | Diagnostic criteria | Cut-off point | |
|------|------------------|---|--------------------------|-------------------------|
| | | | Males | Females |
| A | Baumgartner 1998 | ALM/height ² | ≤7.26 kg/m ² | ≤5.45 kg/m ² |
| B | Delmonico 2007 | ALM/height ² | ≤7.25 kg/m ² | ≤5.67 kg/m ² |
| C | Kelly 2009 | ALM/height ² | ≤6.19 kg/m ² | ≤4.73 kg/m ² |
| D | Janssen 2002 | (Skeletal muscle mass (SM) /body mass)x100% | <37% | <28% |
| | Class I | | <31% | <22% |
| | Class II | | | |
| E | Janssen 2004 | SMI (skeletal muscle mass (SM)/height ²) | ≤10.75 kg/m ² | ≤6.75 kg/m ² |
| | Moderate | | ≤8.50 kg/m ² | ≤5.75 kg/m ² |
| | Severe | | | |
| F | Lauretani 2003 | Handgrip strength | <30.3 kg | <19.3 kg |
| G | EWGSOP 2010 | Gait speed | ≤0.8 m/s | ≤0.8 m/s |
| | | Handgrip strength | <30 kg | <20 kg |
| | | DXA: ALM/height ² | ≤7.23 kg/m ² | ≤5.67 kg/m ² |
| | | BIA: SMI (SM/height ²) | ≤10.75 kg/m ² | ≤6.75 kg/m ² |
| H | IWGS 2011 | Gait speed | <1.0 m/s | <1.0 m/s |
| | | ALM/height ² | ≤7.23 kg/m ² | ≤5.67 kg/m ² |
| I | FNIH 2014 | Gait speed | ≤0.8 m/s | ≤0.8 m/s |
| | | Handgrip strength | <26 kg | <16 kg |
| | | ALM/BMI | <0.789 | <0.512 |

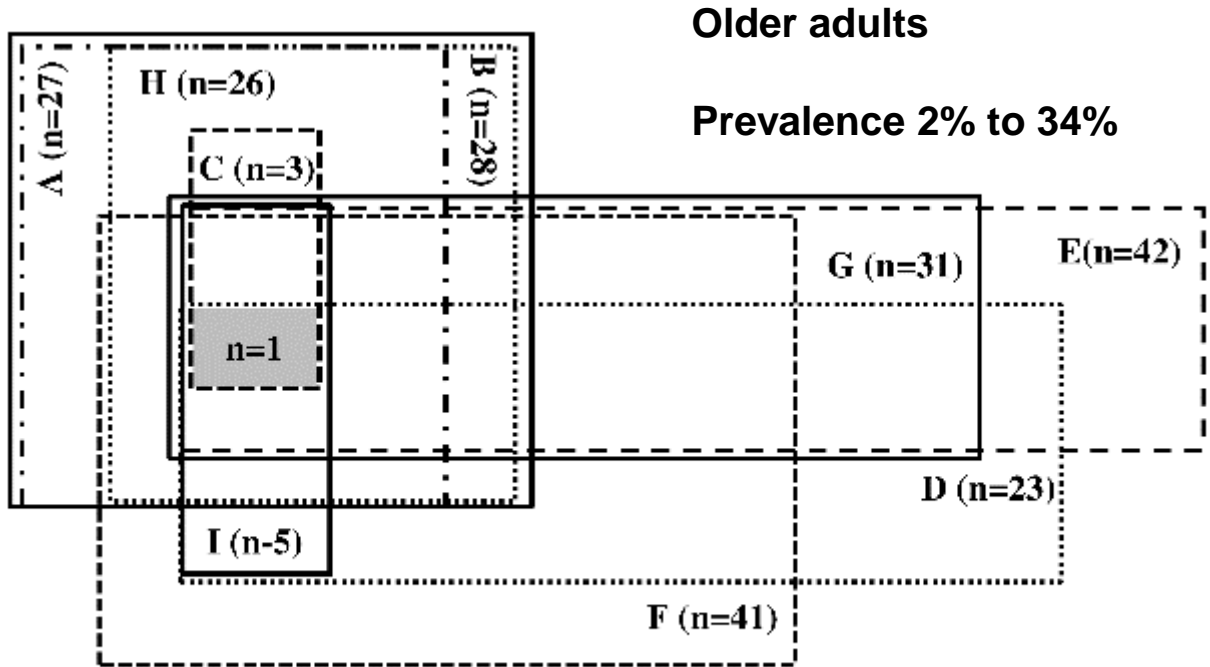
Used definitions

| Code | Reference | Diagnostic criteria | Cut-off point | |
|------|------------------|---|---|--|
| | | | Males | Females |
| A | Baumgartner 1998 | ALM/height ² | ≤7.26 kg/m ² | ≤5.45 kg/m ² |
| B | Delmonico 2007 | ALM/height ² | ≤7.25 kg/m ² | ≤5.67 kg/m ² |
| C | Kelly 2009 | ALM/height ² | ≤6.19 kg/m ² | ≤4.73 kg/m ² |
| D | Janssen 2002 | (Skeletal muscle mass (SM) /body mass)x100% | <37% | <28% |
| | Class I | | <31% | <22% |
| | Class II | | | |
| E | Janssen 2004 | SMI (skeletal muscle mass (SM)/height ²) | ≤10.75 kg/m ² | ≤6.75 kg/m ² |
| | Moderate | | ≤8.50 kg/m ² | ≤5.75 kg/m ² |
| | Severe | | | |
| F | Lauretani 2003 | Handgrip strength | <30.3 kg | <19.3 kg |
| G | EWGSOP 2010 | Gait speed Handgrip strength DXA: ALM/height ² BIA: SMI (SM/height ²) | ≤0.8 m/s <30 kg ≤7.23 kg/m ² ≤10.75 kg/m ² | ≤0.8 m/s <20 kg ≤5.67 kg/m ² ≤6.75 kg/m ² |
| H | IWGS 2011 | Gait speed ALM/height ² | <1.0 m/s ≤7.23 kg/m ² | <1.0 m/s ≤5.67 kg/m ² |
| I | FNIH 2014 | Gait speed Handgrip strength ALM/BMI | ≤0.8 m/s <26 kg <0.789 | ≤0.8 m/s <16 kg <0.512 |



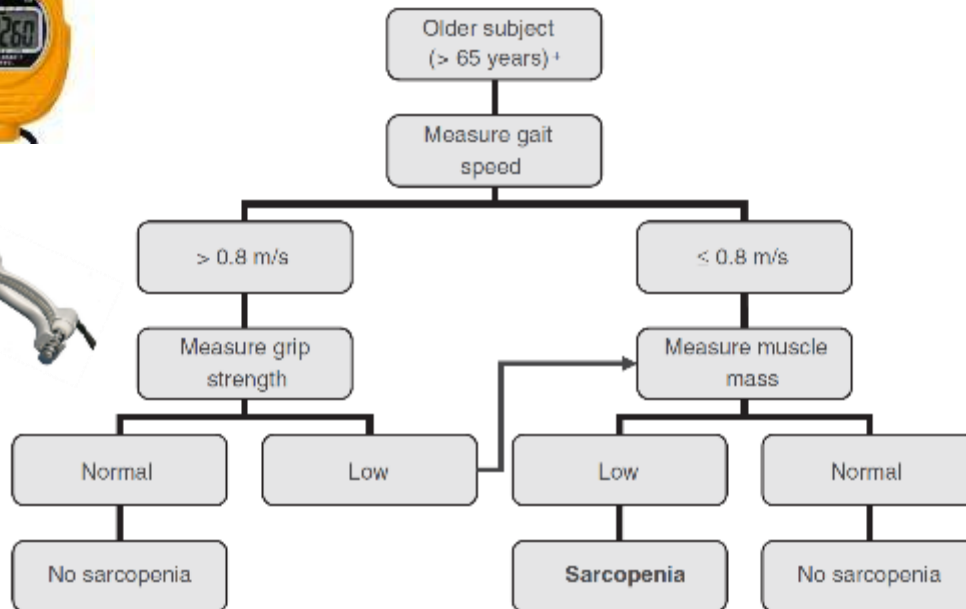


'Concordance' sarcopenia



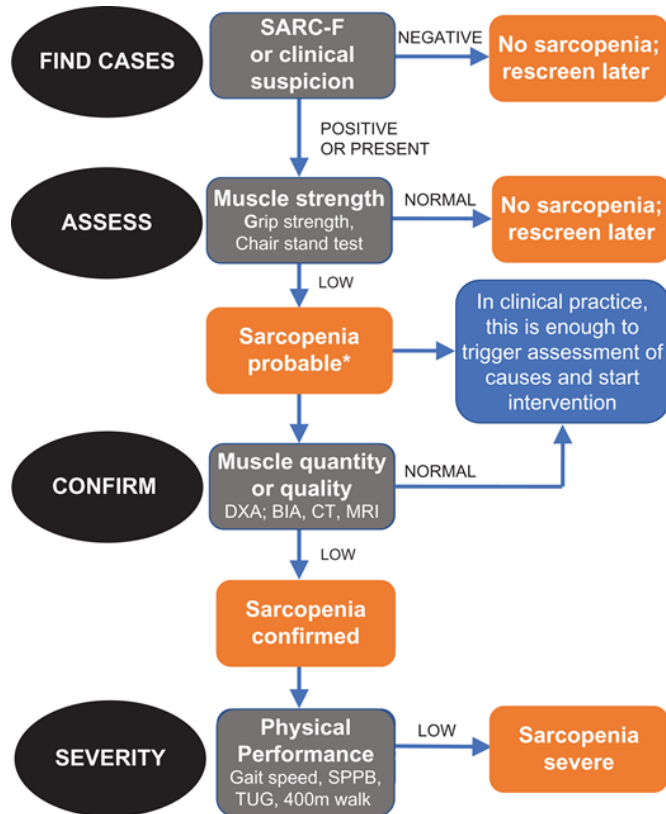


Prevalence of sarcopenia is highly dependent on the applied set of diagnostic criteria.



* Comorbidity and individual circumstances that may explain each finding must be considered

* This algorithm can also be applied to younger individuals at risk





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



Sarcopenia predicts
detrimental outcome.

‘Consensus like situation’.





Review Cruz-Jentoft 2014

- > 50 years, community dwelling
- 7 studies (2000-2013)
- Median quality
- Resistance training may improving muscle strength and physical performance
- Time of intervention of **at least 3 months** and probably longer



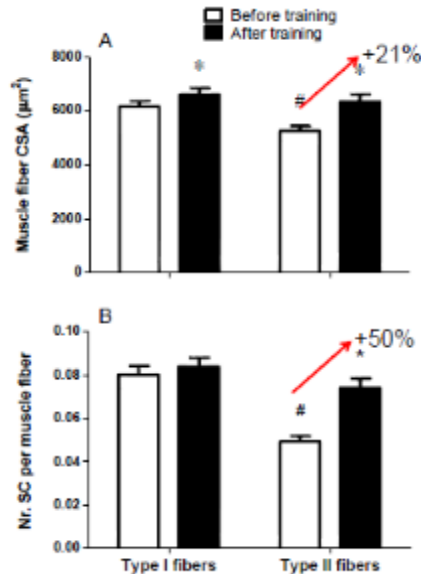
Progressive resistance training- recommendations

- Per week 150 min. moderate or 60 min. high intensity
- Intensity: experienced load 5-6/10 of 7-8/10 Borg
- 3 or more times a week.
- 8-10 whole body excercises.
- Most important muscle groups of legs, hips, chest, back, belly, shoulders and arms.
- 8-12 repetitions per muscle group.
- 2 minutes of rest between excercises.



Progressive resistance training muscle volume (CSA) and satellite cells

- n = 51 men,
- 72 ± 2 y
- 3 mth RT,
- 3x/wk



Verdijk et al., AGE, 2013



Nutritional state & physical performance are associated

N=286 geriatric outpatients

Table 2. The association between malnutrition and standardized measures of physical performance in geriatric outpatients referred to mobility clinics (n= 286)

| | Z HGS | Z LN CST | Z Gait speed | Z LN TUG | Z SPPB Score | Side by side | Semi-tandem | Tandem |
|--|---------------------|--------------------------|-----------------------------|--------------------------|-----------------------------|-------------------|-------------------|-------------------|
| Crude | | | | | | | | |
| β (95% CI) | -0.27 (-0.58, 0.04) | 0.52 (0.18, 0.86) | -0.56 (-0.86, -0.25) | 0.37 (0.03, 0.72) | -0.42 (-0.74, -0.11) | 0.66 (0.25, 1.76) | 0.67 (0.33, 1.34) | 0.97 (0.48, 1.80) |
| p-value | 0.083* | 0.003 | 0.000 | 0.034 | 0.008 | 0.406 | 0.251 | 0.913 |
| β x SD | -2.42 | -5.05 | -0.16 | 5.63 | -1.37 | -- | -- | -- |
| Model adjusted for age, sex, and multimorbidity | | | | | | | | |
| β (95% CI) | -0.24 (-0.54, 0.07) | 0.53 (0.19, 0.87) | -0.49 (-0.78, -0.20) | 0.37 (0.03, 0.70) | -0.40 (-0.70, -0.10) | 0.69 (0.23, 2.02) | 0.67 (0.31, 1.43) | 1.02 (0.48, 2.04) |
| p-value | 0.131 | 0.003 | 0.001 | 0.032 | 0.009 | 0.497 | 0.294 | 0.957 |
| β x SD | -2.15 | -5.15 | -0.14 | 5.63 | -1.30 | -- | -- | -- |

*Statistically significant results are presented in bold. SPPB = short physical performance battery; CST = chair stand test; TUG = timed up and go; HGS = handgrip strength; β = beta; CI = confidence interval.

**All measures of physical performance were standardized and presented as gender specific z-scores.

***Interpretation: The β represents the average difference between participants with the presence of malnutrition on physical performance standard deviations (SD) compared to outpatients without malnutrition. β coefficients were transformed from units of SD to the physical performance measures' original units by using the equation β x SD.



Nutritional state & physical performance are associated

SNAQ score

N=286 geriatric outpatients

Table 2. The association between malnutrition and standardized measures of physical performance in geriatric outpatients referred to mobility clinics (n= 286)

| | Z HGS | Z LN CST | Z Gait speed | Z LN TUG | Z SPPB Score | Side by side | Semi-tandem | Tandem |
|--|---------------------|--------------------------|-----------------------------|--------------------------|-----------------------------|-------------------|-------------------|-------------------|
| Crude | | | | | | | | |
| β (95% CI) | -0.27 (-0.58, 0.04) | 0.52 (0.18, 0.86) | -0.56 (-0.86, -0.25) | 0.37 (0.03, 0.72) | -0.42 (-0.74, -0.11) | 0.66 (0.25, 1.76) | 0.67 (0.33, 1.34) | 0.97 (0.31, 1.80) |
| p-value | 0.083* | 0.003 | 0.000 | 0.034 | 0.008 | 0.406 | 0.251 | 0.913 |
| β x SD | -2.42 | -5.05 | -0.16 | 5.63 | -1.37 | -- | -- | -- |
| Model adjusted for age, sex, and multimorbidity | | | | | | | | |
| β (95% CI) | -0.24 (-0.54, 0.07) | 0.53 (0.19, 0.87) | -0.49 (-0.78, -0.20) | 0.37 (0.03, 0.70) | -0.40 (-0.70, -0.10) | 0.69 (0.23, 2.02) | 0.67 (0.31, 1.43) | 1.02 (0.31, 2.04) |
| p-value | 0.131 | 0.003 | 0.001 | 0.032 | 0.009 | 0.497 | 0.294 | 0.957 |
| β x SD | -2.15 | -5.15 | -0.14 | 5.63 | -1.30 | -- | -- | -- |

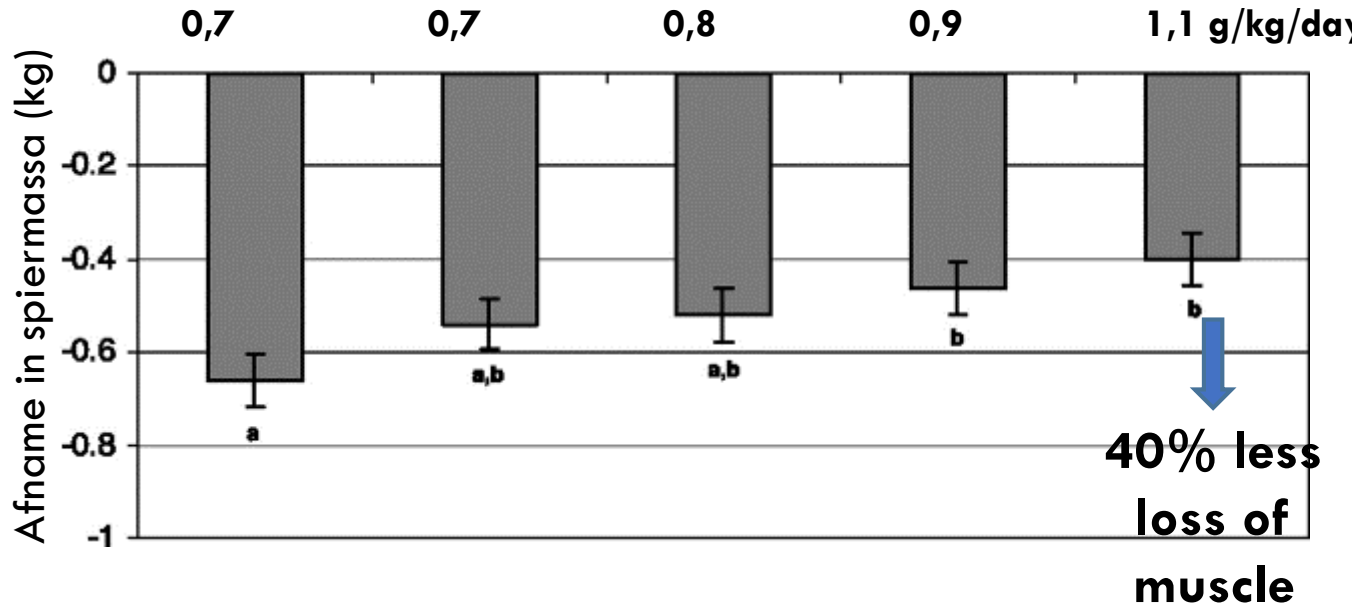
*Statistically significant results are presented in bold. SPPB = short physical performance battery; CST = chair stand test; TUG = timed up and go; HGS = handgrip strength; β = beta; CI = confidence interval.

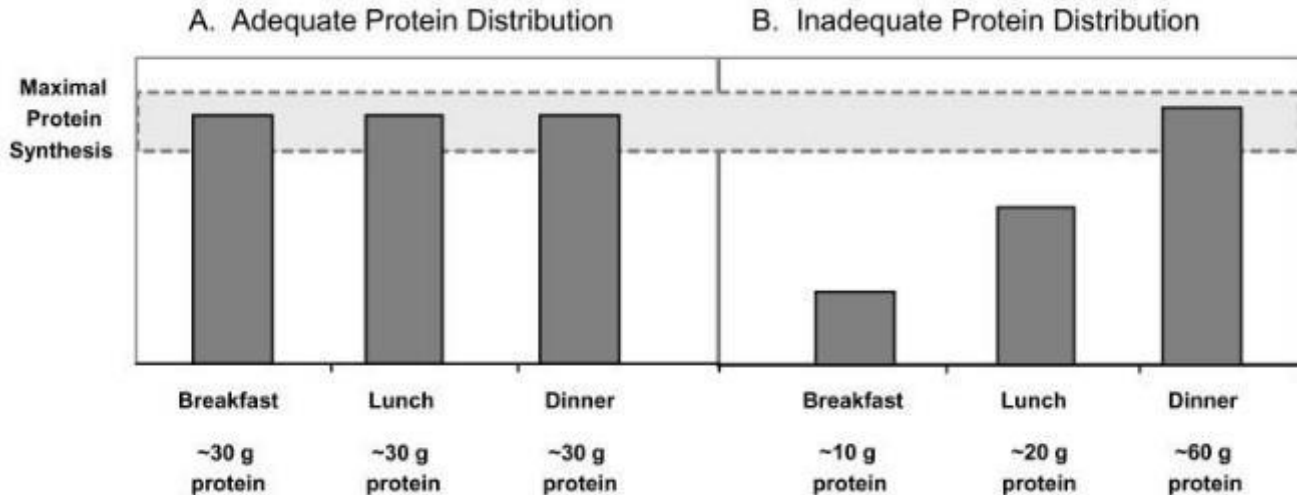
**All measures of physical performance were standardized and presented as gender specific z-scores.

***Interpretation: The β represents the average difference between participants with the presence of malnutrition on physical performance standard deviations (SD) compared to outpatients without malnutrition. β coefficients were transformed from units of SD to the physical performance measures' original units by using the equation β x SD.



Protein intake and loss of muscle mass





Optimal protein synthesis at 25-30 grams protein per meal

Paddon-Jones, Curr Opin Clin Nutr Metab Care. 2009, Jan;12(1):86-90. Review.



Extra protein (during breakfast and lunch) + resistance training

Increase in muscle mass

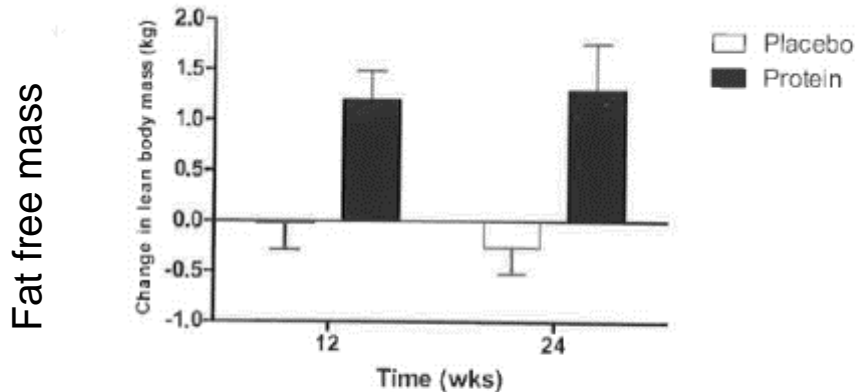
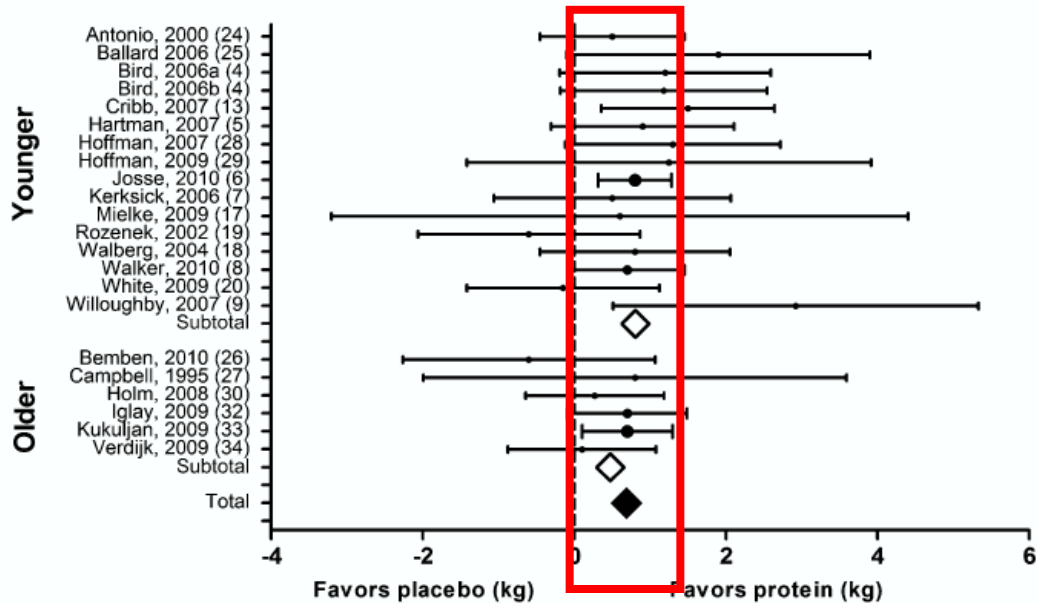


Figure 4.2 Intention to treat analysis on total lean body mass in the placebo and protein group (n=62). Data represent mean change in total lean mass after 12 and 24 wks relative to baseline (means \pm SEM). P-value for treatment x time interaction = 0.006.



Resistance training and protein supplementation-effect on fat free mass





Sarcopenia predicts
detrimental outcome.

‘Consensus like situation’.

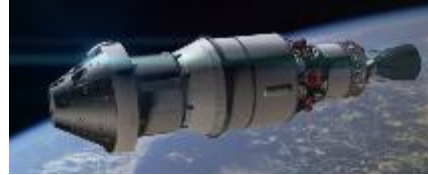
Targeted intervention,
including the old!

Multidisciplinary diagnosis &
treatment



Bed rest: a potentially harmful treatment needing more careful evaluation

Chris Allen, Paul Glasziou, Chris Del Mar



Functional Impact of 10 Days of Bed Rest in Healthy Older Adults

Journal of Gerontology: MEDICAL SCIENCES
2008, Vol. 63A, No. 10, 1076–1081

70 years, hazard ratio for the development of disability after hospitalisation : 61.8

Gill et al JAMA. 2004 Nov 3;292(17):2115-24.

The Empower study

Inception cohort study

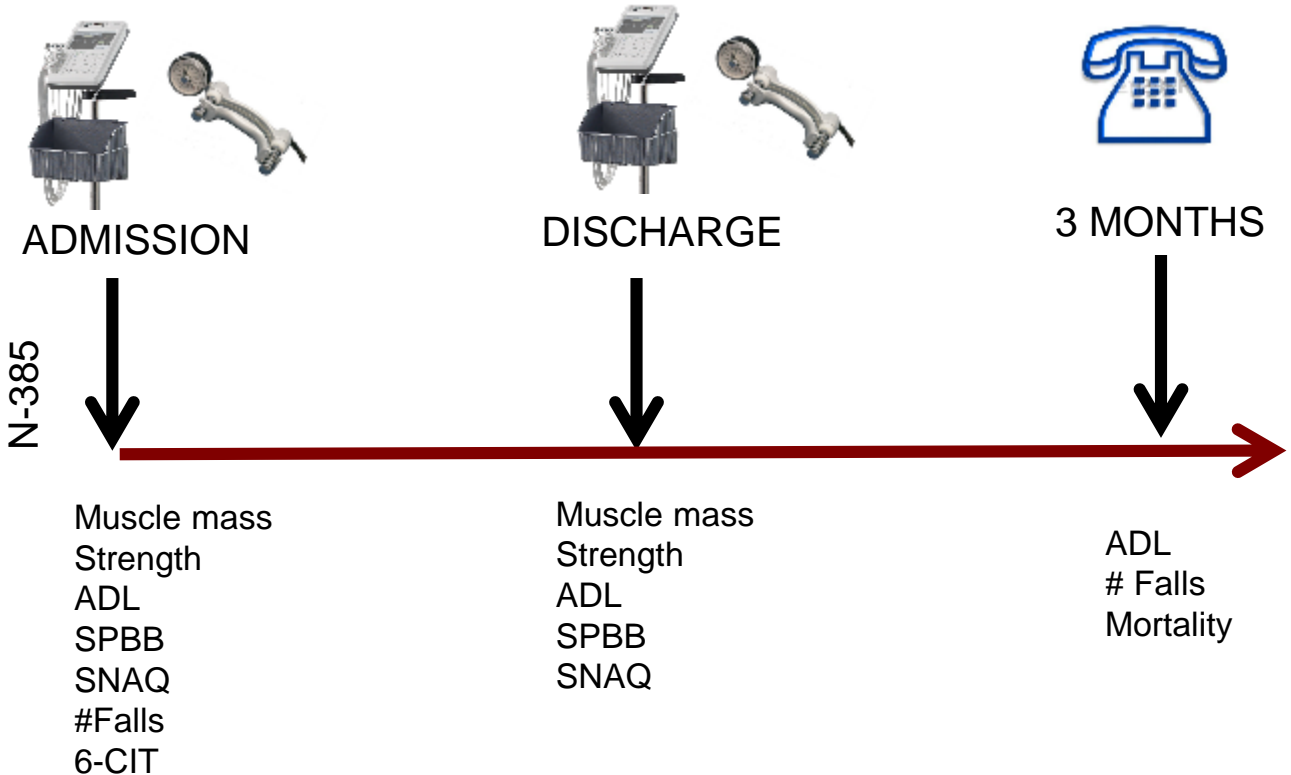
Predictive value of muscle mass and handgrip strength at admission and discharge in hospitalized older adults.

- Elderly aged >70
- Admitted to VU Medial Center
- From April to December 2015
- Minimal inclusion criteria.

EMPOWER 



Study design (n=385)





- Muscle strength: handgrip strenght



- Muscle mass: Bio Impedance Analyzer





In elderly hospitalized patients

At admission:

- ↓HGS /muscle mass *with* ↑physical disability (ADL).
- ↓HGS /muscle mass *with* ↑# falls
- ↓HGS/ muscle mass *with* ↓cognition
- ↓HGS/ muscle mass *with* ↑geriatric risk factors



Table 3 Handgrip strength and muscle mass of patients at admission and in-hospital change, stratified by sex.

| | Female | | | Male | | |
|--------------------------|----------------------|----------------------------------|----------------|----------------------|----------------------------------|----------------|
| | Admission (N=182) | In-hospital change (N=120) | <i>p</i> value | Admission (N=191) | In-hospital change (N=101) | <i>p</i> value |
| HGS, kg | 15.1 (5.61) | 0.89 (4.04) | 0.017 | 26.1 (9.91) | 0.94 (4.38) | 0.033 |
| SMM, kg* | 22.6 (3.70) | 0.01 (2.24) | 0.958 | 29.8 (5.63) | -0.05 (1.74) | 0.811 |
| ALM, kg* | 16.9 (3.50) | 0.55 (2.14) | 0.011 | 23.2 (4.74) | 0.44 (1.97) | 0.033 |
| SMI, kg/m ² * | 8.65 (1.22) | -0.00 (0.88) | 0.985 | 9.71 (1.47) | -0.02 (0.58) | 0.814 |
| Relative SMM, %* | 33.7 (5.56) | 0.03 (3.56) | 0.930 | 39.0 (4.84) | -0.03 (2.36) | 0.905 |
| Relative ALM, %* | 25.0 (4.01) | 0.98 (3.41) | 0.005 | 30.4 (3.85) | 0.64 (2.41) | 0.022 |

All variables are presented as mean (SD). HGS: Hand Grip Strength. SMM: Skeletal Muscle Mass. ALM: Appendicular Lean Mass. SMI: Skeletal Muscle Index. kg: kilograms. m: meters. SD: Standard Deviation. * For measures of muscle mass: Admission: Female N=158, Male N=156. In-hospital change: Female N=101, Male N=78.

Study **N** **SMD** **95% CI**

A: HAND GRIP STRENGTH

Elective admission

| | | | |
|---------------------------|------------|--------------|-----------------------|
| Barr | 10 | -1.27 | (-2.10, -0.43) |
| Gatt | 20 | -0.47 | (-0.93, -0.01) |
| Houborg | 53 | -0.29 | (-0.57, -0.02) |
| Mathur | 73 | -0.21 | (-0.44, 0.02) |
| Munk | 35 | -0.09 | (-0.43, 0.24) |
| Nygren | 69 | -0.72 | (-0.99, -0.46) |
| Overall | 260 | -0.42 | (-0.66, -0.17) |
| Heterogeneity (I squared) | 69.2% | | |

Acute admission

| | | | |
|-------------------------------------|------------|-------------|----------------------|
| Arezzo di Trifiletti (anorexic) | 51 | 0.19 | (-0.09, 0.47) |
| Arezzo di Trifiletti (non-anorexic) | 54 | 0.36 | (0.08, 0.63) |
| Bautmans (inflammatory) | 39 | 0.82 | (0.46, 1.18) |
| Bautmans (non-inflammatory) | 13 | 0.44 | (-0.13, 1.01) |
| Bodilsen | 23 | -0.50 | (-0.93, -0.06) |
| Blanc-Bisson | 29 | 0.41 | (0.04, 0.79) |
| De Buyser | 635 | 0.08 | (0.00, 0.15) |
| Matin-Salvador | 48 | -0.39 | (-0.69, -0.10) |
| Mets | 15 | 0.61 | (0.06, 1.16) |
| Sloan | 14 | 0.09 | (-0.43, 0.62) |
| Vermeeren | 22 | 0.00 | (-0.42, 0.42) |
| Overall | 943 | 0.18 | (-0.02, 0.37) |
| Heterogeneity (I squared) | 77.7% | | |

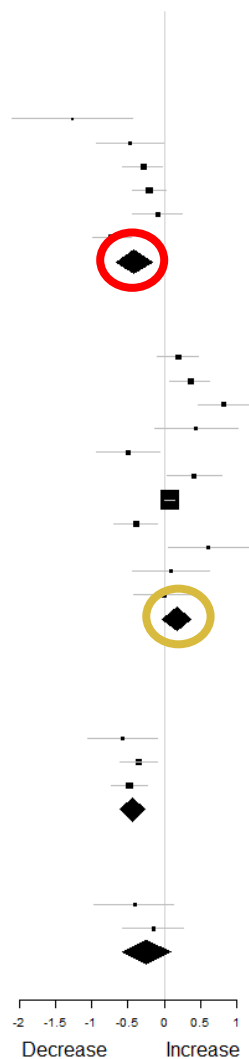
B: MUSCLE MASS

Elective admission

| | | | |
|---------------------------|------------|--------------|-----------------------|
| Henriksen | 20 | -0.58 | (-1.05, -0.10) |
| Houborg | 59 | -0.35 | (-0.09, -0.61) |
| Nygren | 69 | -0.48 | (-0.73, -0.23) |
| Overall | 148 | -0.44 | (-0.61, -0.27) |
| Heterogeneity (I squared) | 0.0% | | |

Acute admission

| | | | |
|---------------------------|-----------|--------------|----------------------|
| Sloan | 14 | -0.41 | (-0.96, 0.13) |
| Vermeeren | 22 | -0.15 | (-0.57, 0.27) |
| Overall | 36 | -0.25 | (-0.58, 0.09) |
| Heterogeneity (I squared) | 0.0% | | |



Rehab: literature review



Stimulation of physical performance and physical activity in older patients during hospitalization: a systematic review.

Inclusion criteria

- Hospitalized older patients with a mean age of 65 years and older,
- Physical interventions with physical performance or physical activity as outcome measures



Literature review



Stimulation of physical performance and physical activity in older patients during hospitalization: a systematic review.

- Twelve RCT's
- Large heterogeneity in applied interventions, dose and outcome measures.
- Insufficient report on dose

Literature review



Stimulation of physical performance and physical activity in older patients during hospitalization: a systematic review.

- Evidence of positive effect of patient- tailored interventions on muscle measures and physical performance

Patient tailored= Physical interventions adapted to the capabilities of the patient

- No evidence of effect of non- patient tailored intervention

Follow-up (3 months)

Table 3. Associations between muscle measures and nutritional status at hospital admission and mortality within 3 months after hospitalization and living situation (odds ratios (95% CI), adjusted for age and sex)

| | Mortality | Living independently before hospital admission | Living independently 3 months after hospital admission |
|--------------------------------|----------------------------|--|--|
| Skeletal Muscle Mass (SMM), kg | 0.88 (0.81-0.95) | 1.13 (1.01-1.25) | 1.01 (0.93-1.10) |
| Handgrip Strength (HGS), kg | 0.98 (0.94-1.02) | 1.13 (1.07-1.20) | 1.06 (1.01-1.12) |

Hospital admission

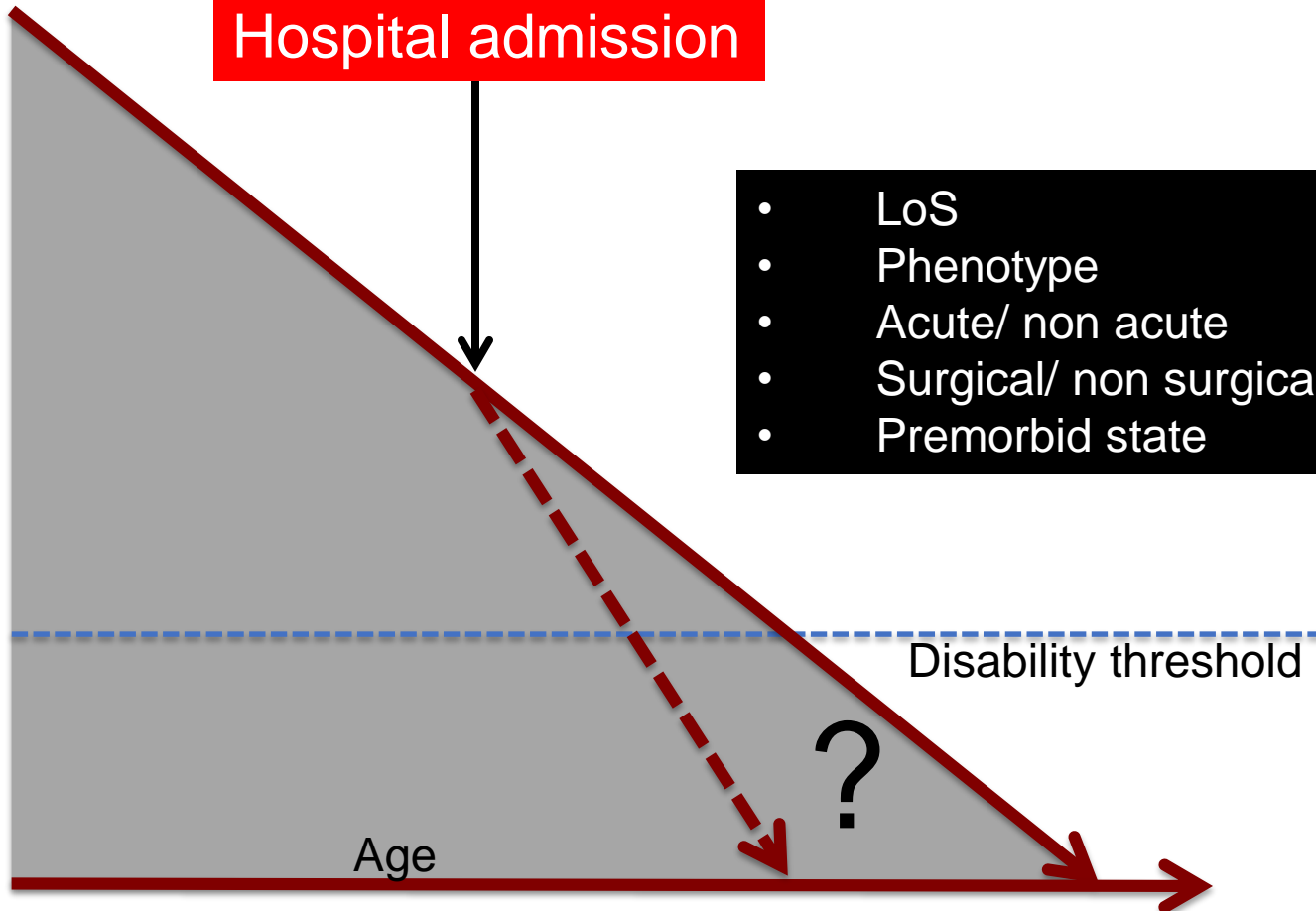
SYSTEM DECLINE

- LoS
- Phenotype
- Acute/ non acute
- Surgical/ non surgical
- Premorbid state

Disability threshold

Age

?





ADDITIONAL
TRAINING



NORMAL ACTIVE



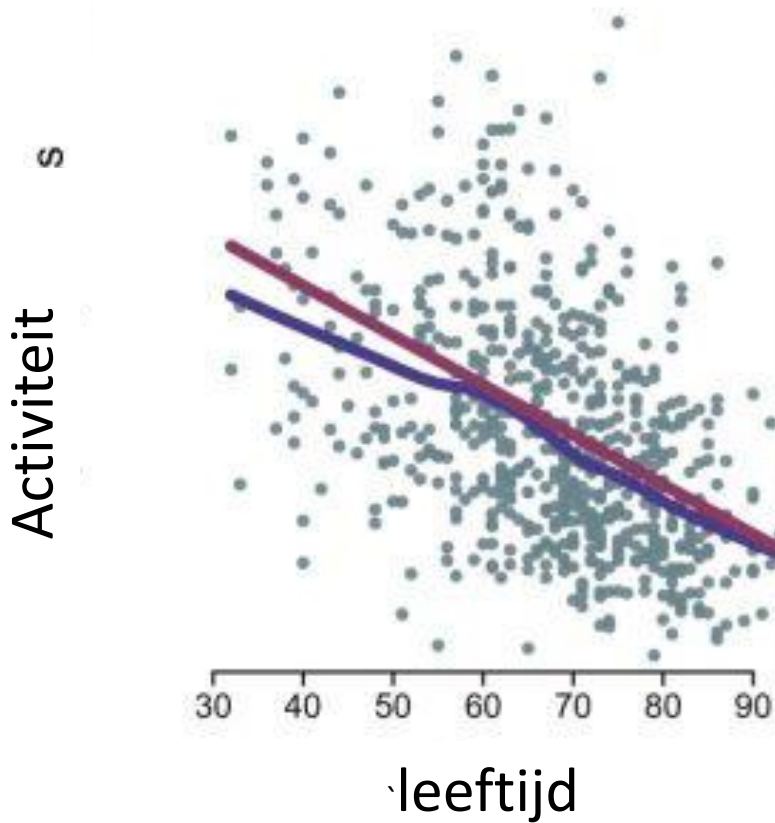
SEDENTARY
(BED REST)



BENEFITS?

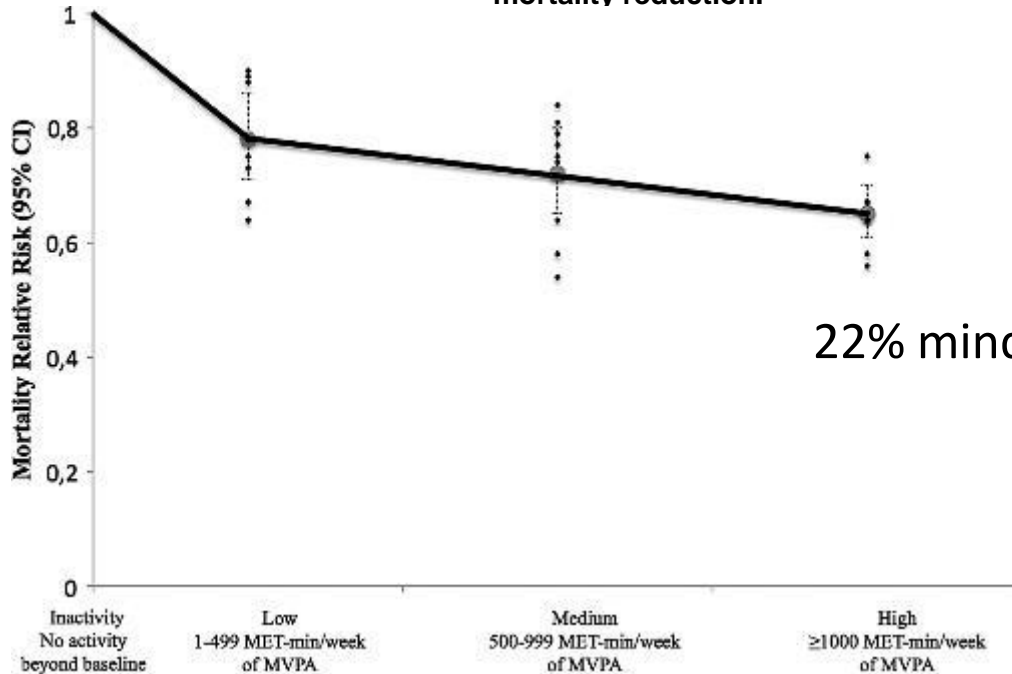


BENEFITS?





Relationship between dose of moderate-to-vigorous-intensity physical activity (MVPA) and mortality reduction.

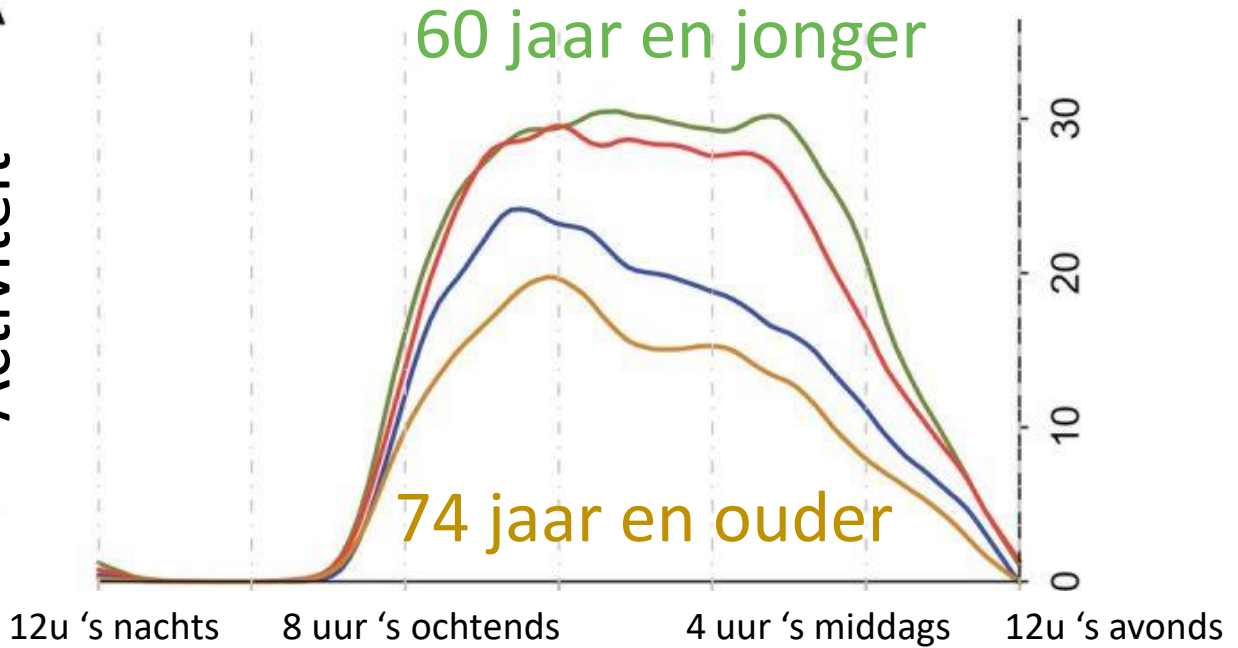


22% minder sterfte

David Hupin et al. Br J Sports Med 2015;49:1262-1267



A
Activiteit



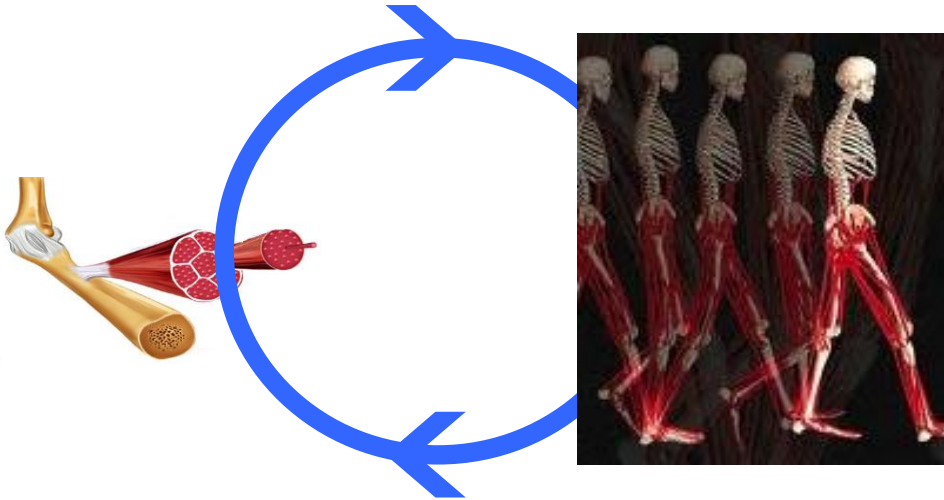


- Vermoeidheid?
- “Het hoort erbij”
- Gebrek aan activiteiten buiten de deur
- Gewoonte/angst.
- Omgeving?



SPIER

BEWEGING/ACTIVITEIT

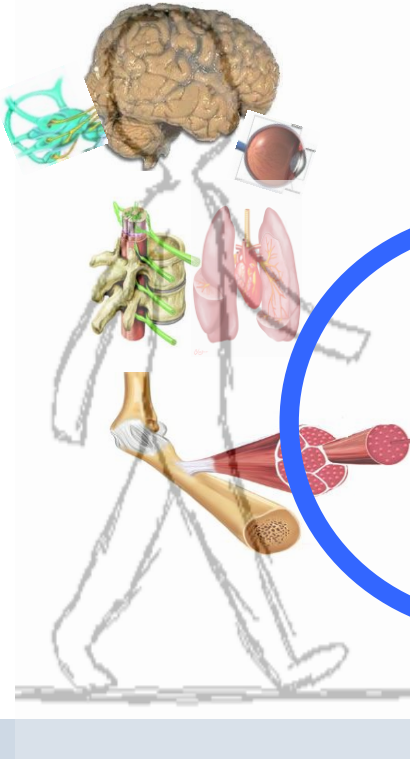


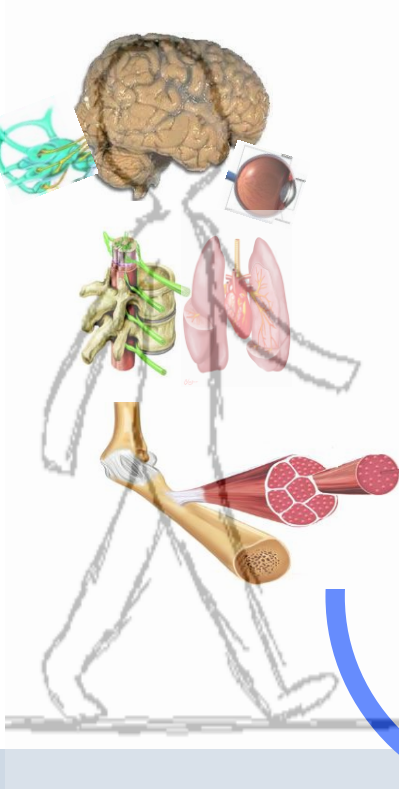


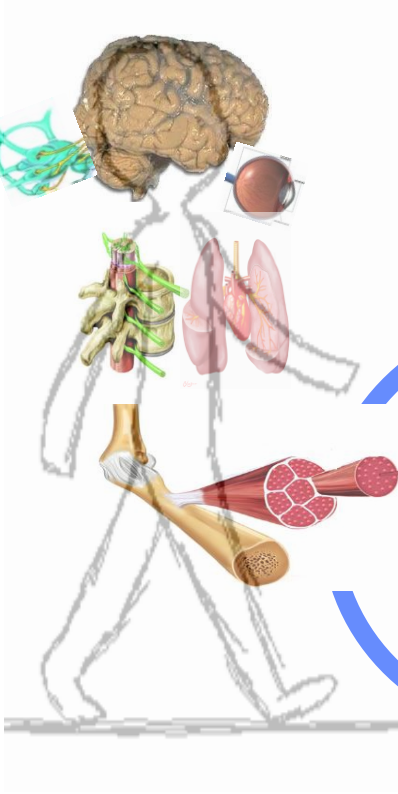
WIJZELF

BEWEGING/ACTIVITEIT

OMGEVING





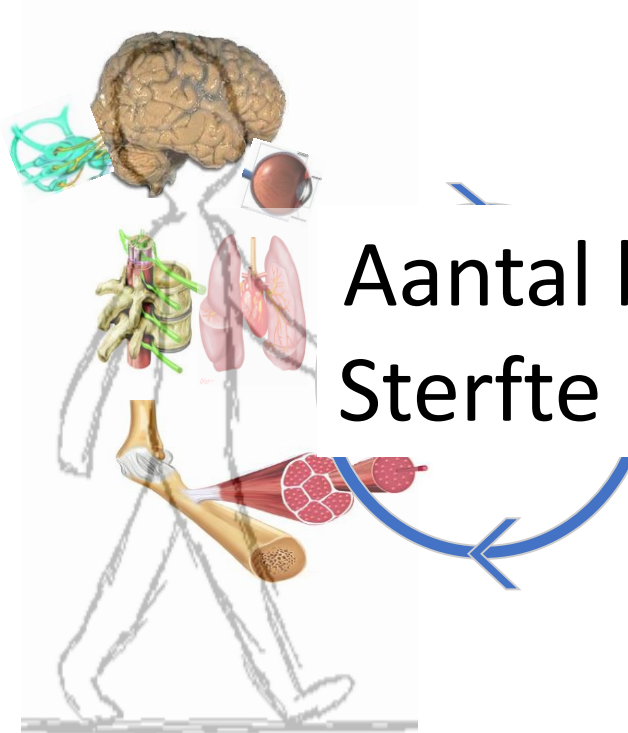


dreamstime.com



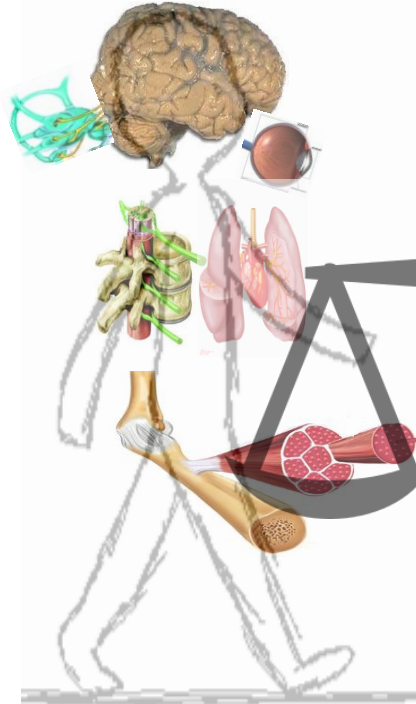
PERSOON

OMGEVING



Aantal barrieres **↑**
Sterfte **↓**





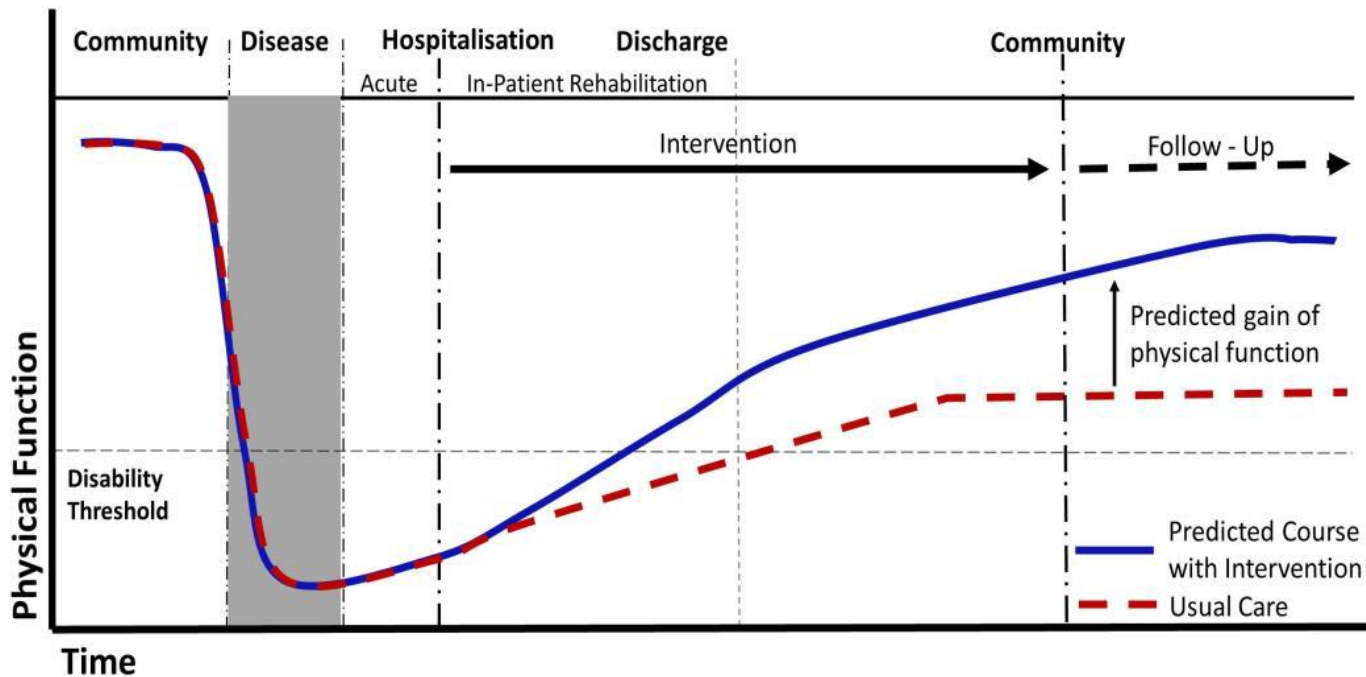


Lichamelijk actief?

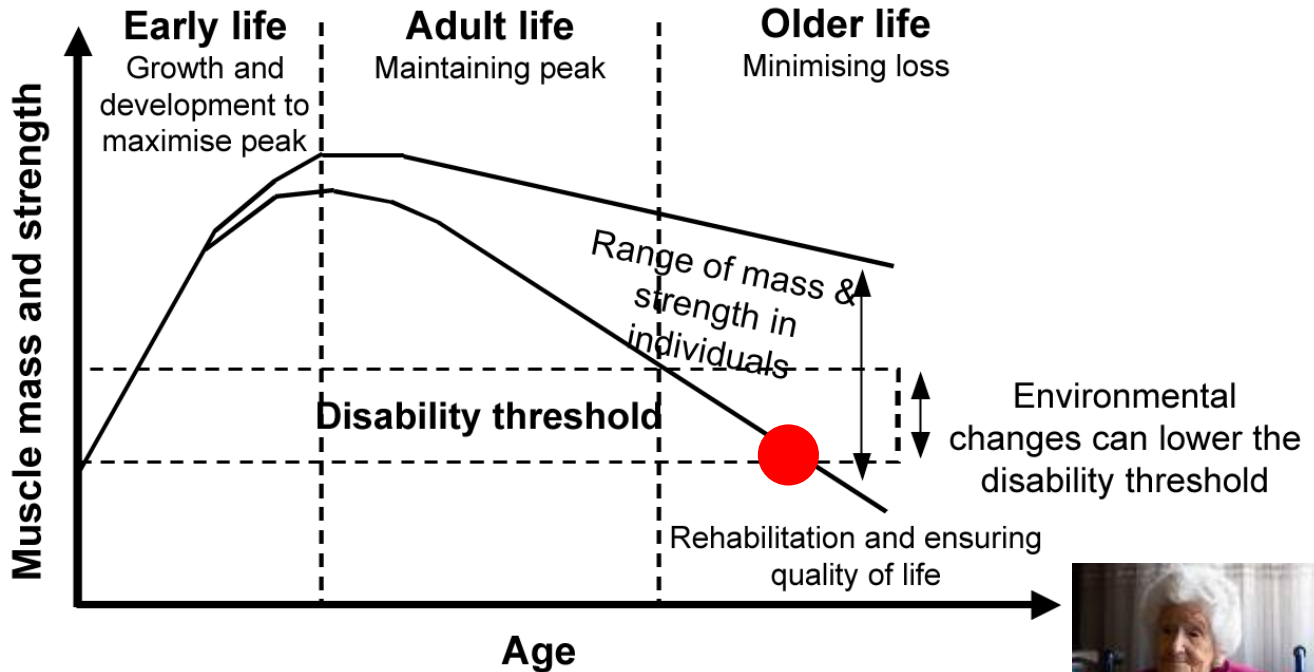


Stairway to
fitness heaven

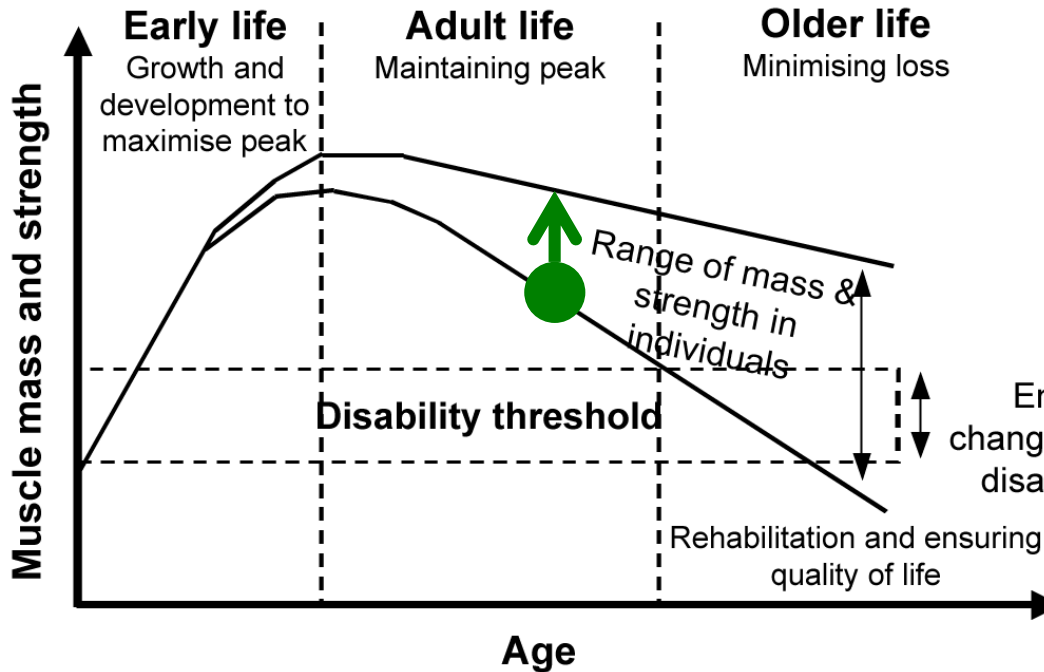
- Maak het leuk
- Niet te snel te simpel
- Inpassen
- Aanpassen



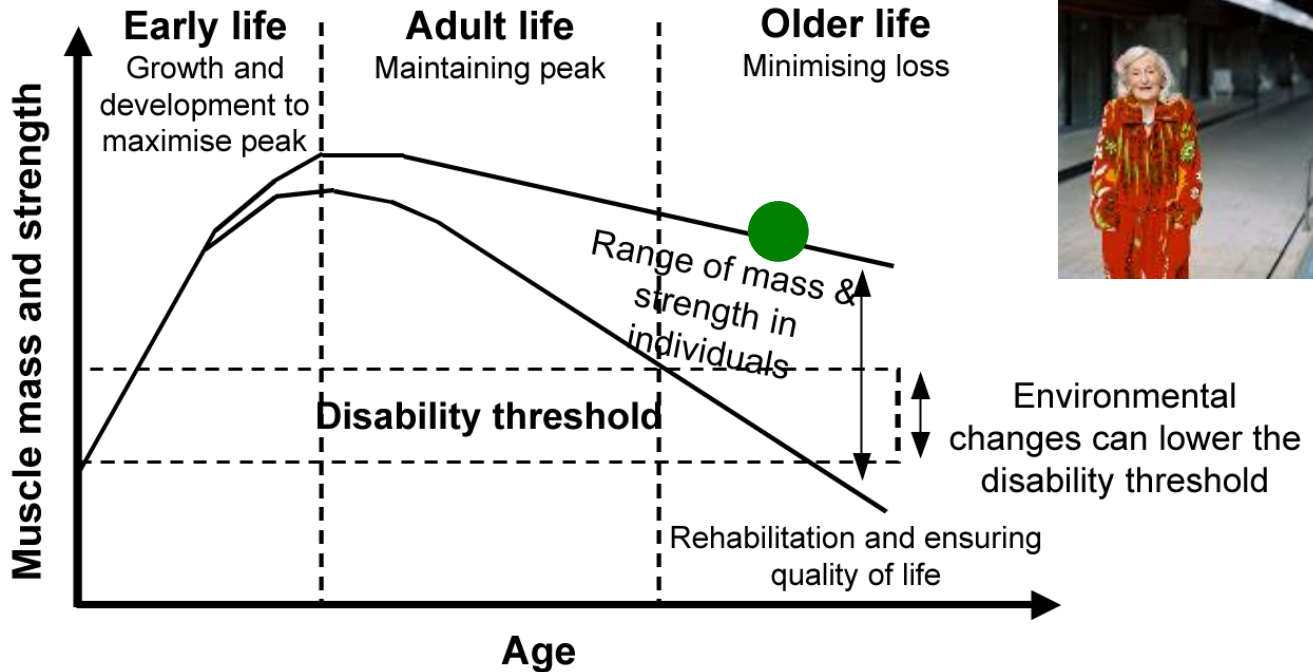
Life trajectories



Life trajectories



Life trajectories





- Care_4_muscles:
 - Motor – physical function
 - Internal organ- health
- Strength training & nutritional state/proteins
- Risks of life events
- Balanced physical activity & Environmental challenges



microberts



NUTRICIA RESEARCH



PANINI

Physical Activity and Nutrition Influences In ageing

