Frailty and Sarcopenia

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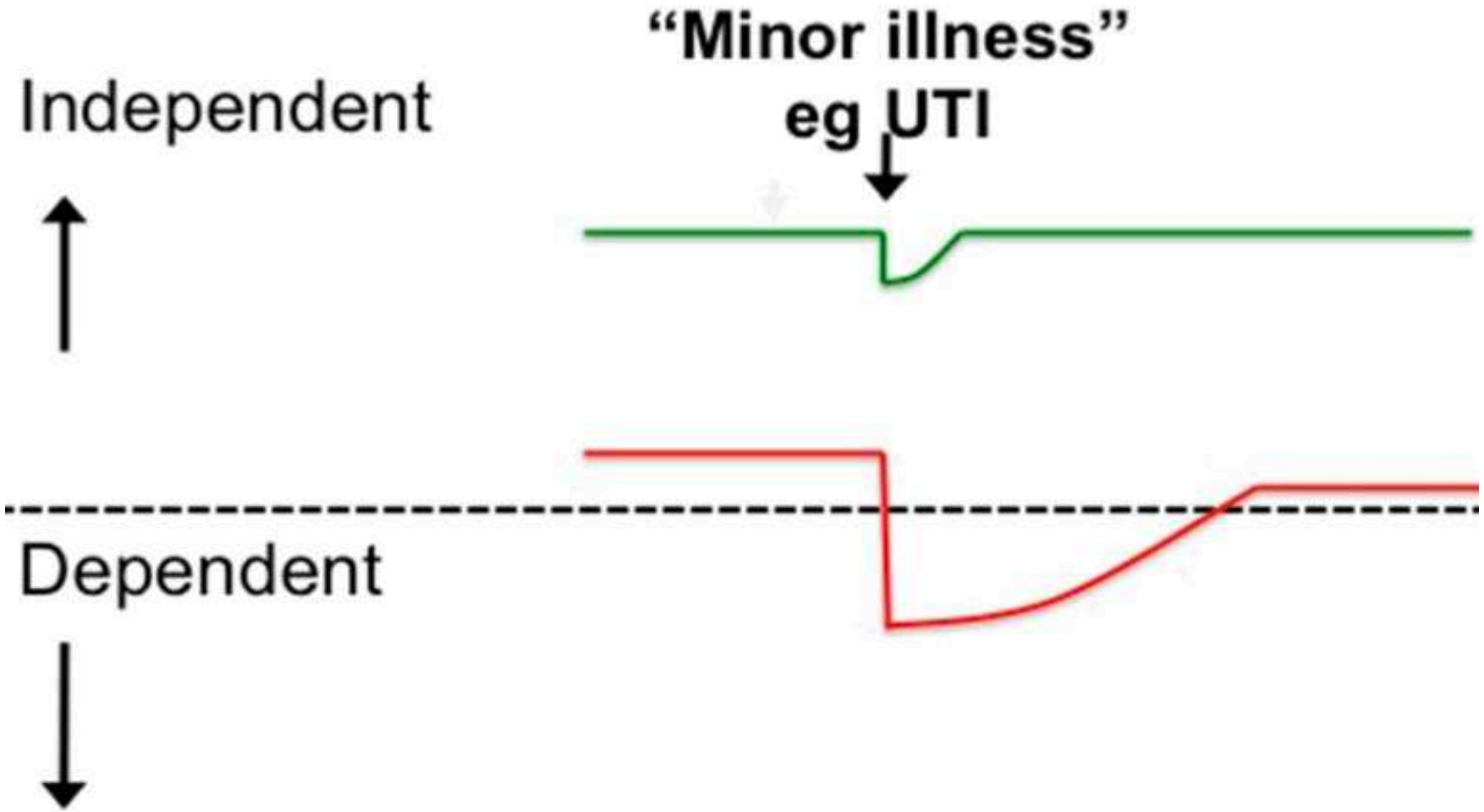
What is Frailty?

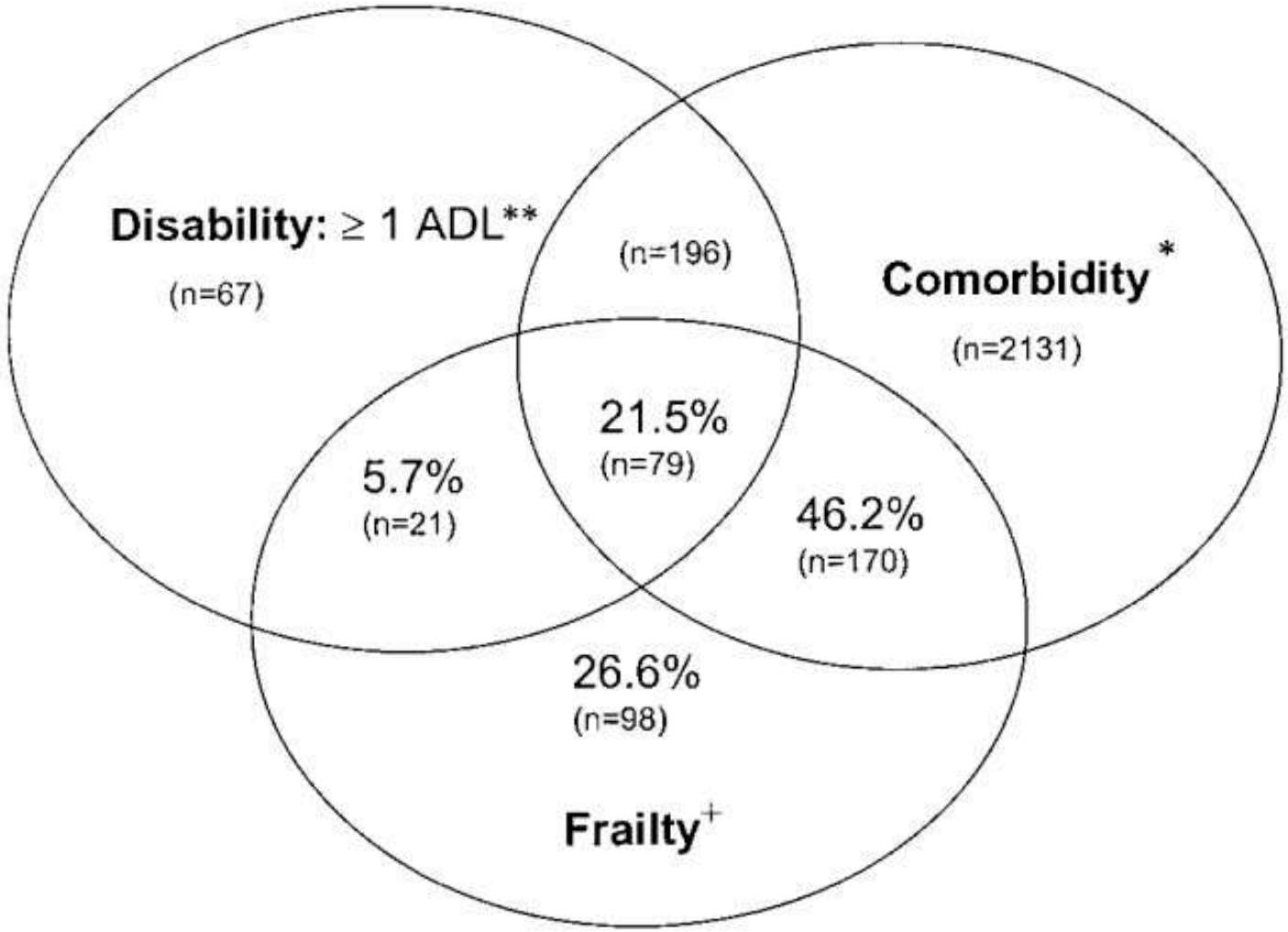
- Decline in physiologic capacity of of several body systems, function greatly reduced; the person is more suspectable to external stressors[1,2]
- Age-related *physiological dysregulation* in multiple body system
- Physical state that exists before occurrence of disability[1,3]
- frailty is potentially reversible and its associated functional decline is also a potentially preventable disability[1,3,4]

[1]Fried et al, J Geron Med Sci, 2001. [2]Crome & Lally, *CMAJ 2011.*
[3] Junius-Walker et al, Eur J Intern Med 2018; 56: 3–10. [4] Baztán JJ et al, Geriatr Gerontol Int 2017; 17: 664–66.

FUNCTIONAL ABILITIES



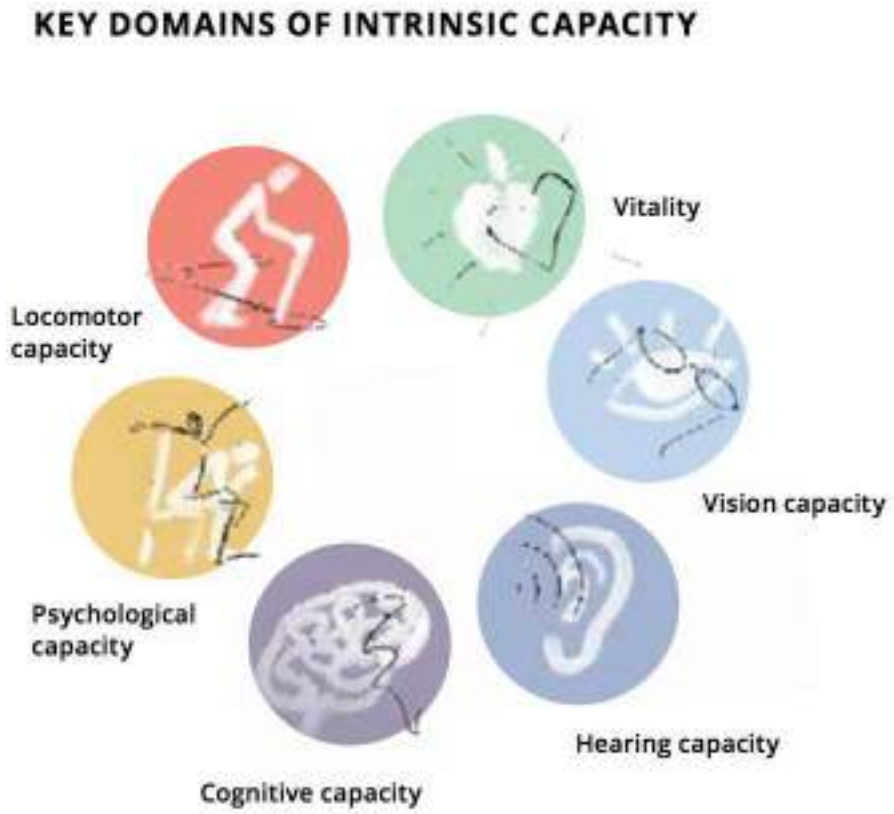
Clegg A et al, The lancet. 2013 Mar 2;381(9868):752-62.



[1]Fried et al, J Geron Med Sci, 2001.

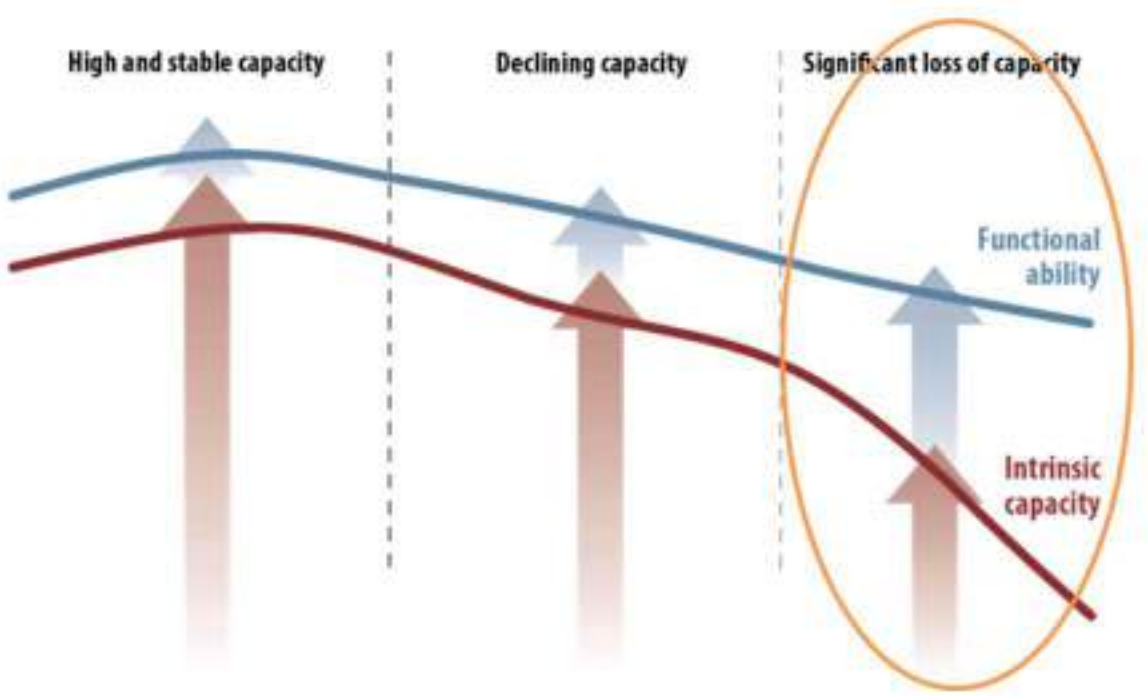
- Resilience: the ability to recover or optimize function in the face of age-related losses, diseases or stressors[1,2]

- Intrinsic capacity: the composite of the physical and mental capacities of an individual[3,4]



1- Resnick B et al, Gerontologist 2011; 51(5): 643-52.
2- Whitson HE etal, J Gerontol A Biol Sci Med Sci 2016; 71(4): 489-95.
3-World Health Organization. World report on ageing and health. World Health Organization. 2015
4- Chenkai Wu et al, *The Journals of Gerontology: Series A*, , glz247.

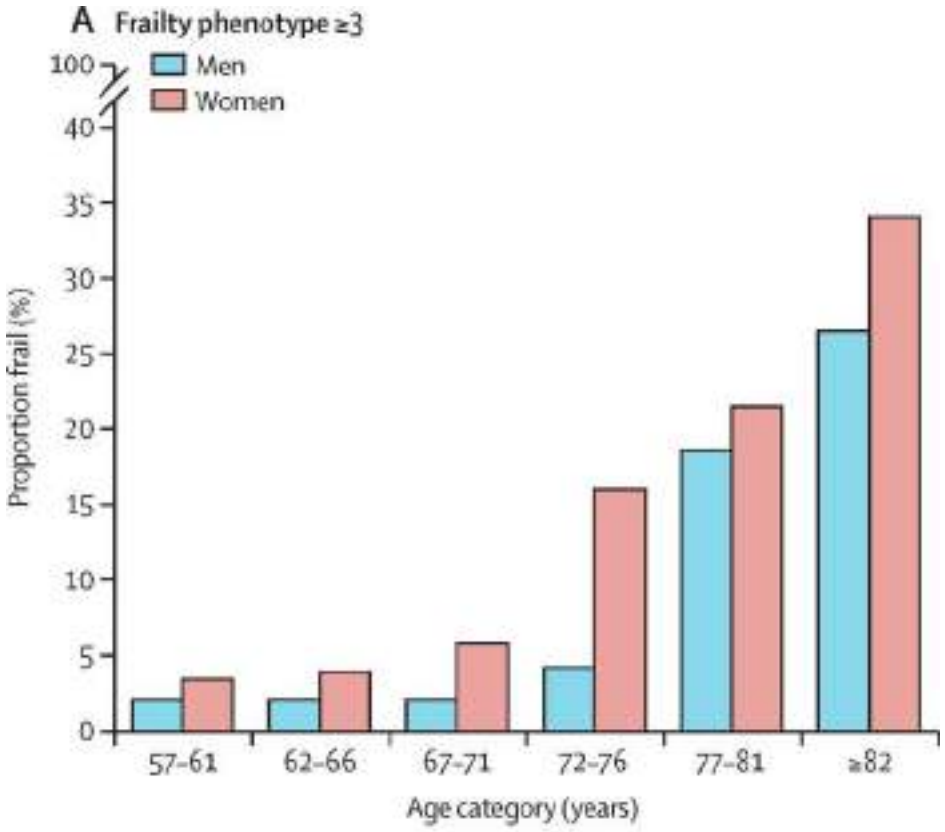
- Losses of intrinsic capacity or lower Resilience in older age are frequently characterized by the manifestation of common problems, such as difficulties with hearing, seeing, memory, walking at usual pace, continence, and positive affect[1,2]

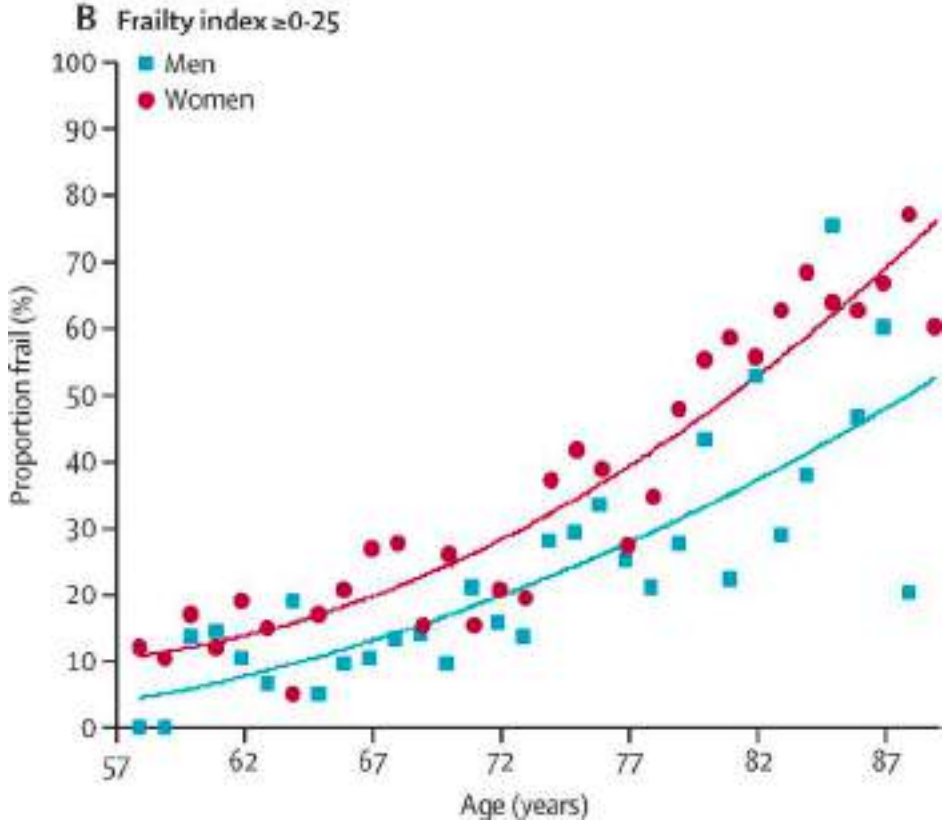


1- Araujo de Carvalho I et al, 2017; 95. 756–763.
2- Thiyagarajan JA et al, 2019; PLoS Med 16(10).

Why frailty in important?

Frailty prevalence





Hoogendijk EO et al, The Lancet. 2019 Oct 12;394(10206):1365-75.

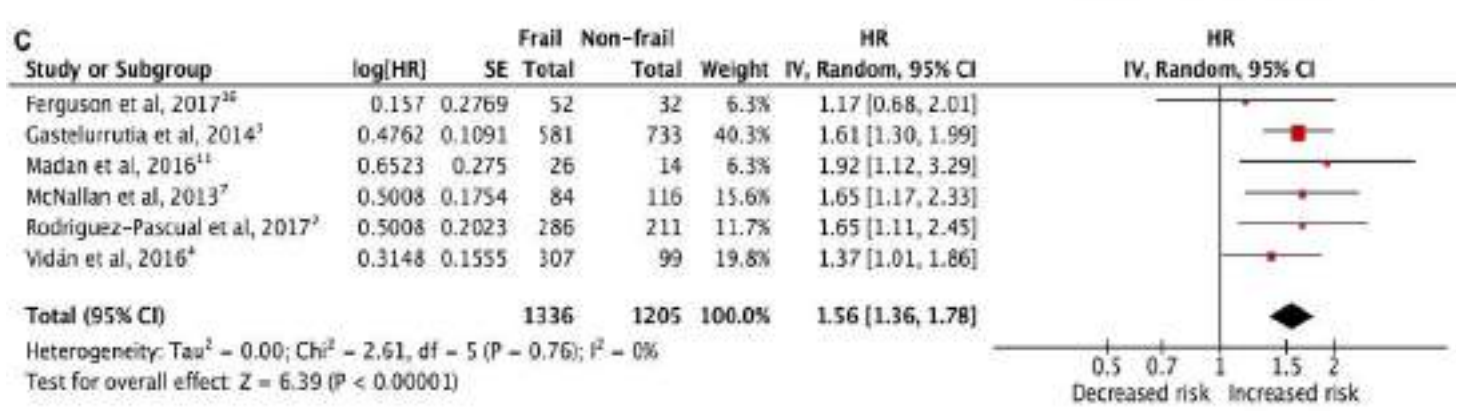
Frailty and adverse outcomes

Study	Year	Country	Number of participants	Length of follow-up	Falls HR/OR 95% CI		Hospitalisation HR/OR 95% CI		Mortality HR/OR 95% CI	
					Intermed frailty	Severe frailty	Intermed frailty	Severe frailty	Intermed frailty	Severe frailty
Cardiovascular Health Study (CHS)[1]	2001	US	5317	7 years	HR 1.12 1.00-1.26	HR 1.23 1.50-2.21	HR 1.11 1.03-1.19	HR 1.27 1.11-1.46	HR 1.32 1.13-1.55	HR 1.63 1.27-2.08
Canadian Study of Health & Aging (CSHA)[2]	2004	Canada	9008	5 years	NA	NA	NA	NA	OR 2.54 1.92-3.37	OR 3.69 2.26-6.02
Women's Health & Aging Study (WHAS)[3]	2006	US	1438	3 years	HR 0.92 0.63-1.64	HR 1.18 0.63-2.19	HR 0.99 0.67-1.47	HR 0.67 0.33-1.35	HR 3.50 1.91-6.39	HR 6.03 3.00-12.0
Study of Osteoporotic Fractures (SOF)[4]	2008	US	6701	4.5 years	OR 1.23 1.02-1.48	OR 2.44 1.95-3.04	NA	NA	OR 1.54 1.40-1.69	HR 2.75 2.46-3.07

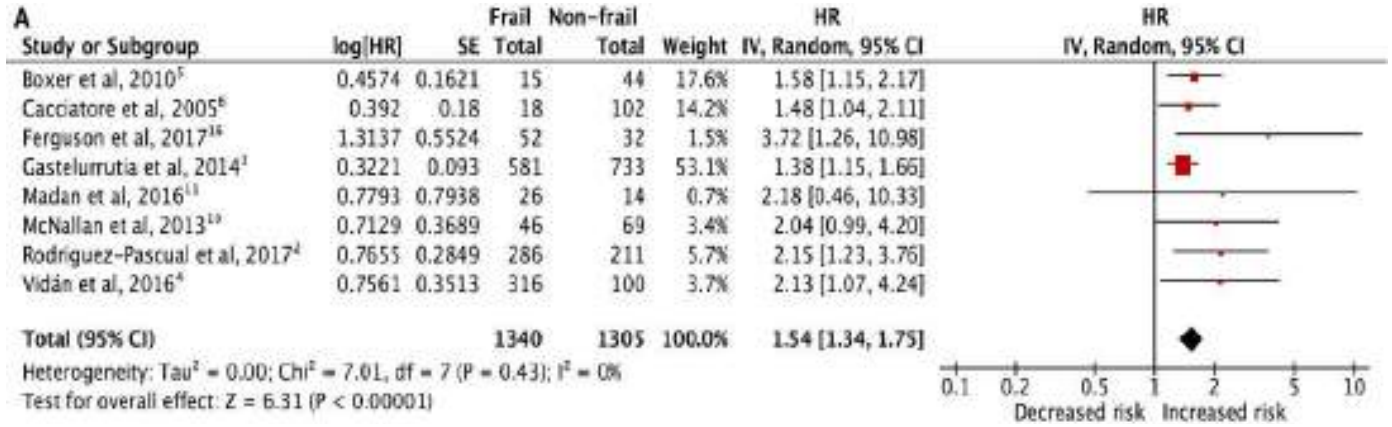
1- Fried LP et al, J Gerontol A Biol Sci Med Sci. 2001;56(3):M146–56. 2- Rockwood K et al, J Gerontol A Biol Sci Med Sci. 2004;59(12):1310–7. 3- Bandeen-Roche K et al, J Gerontol A Biol Sci Med Sci. 2006;61(3):262–6. 4- Ensrud KE, et al, Arch Intern Med. 2008;168(4):382–9. 5- Clegg A et al, The lancet. 2013 Mar 2;381(9868):752-62.

Frailty hospitalization and mortality

- Hospitalizations

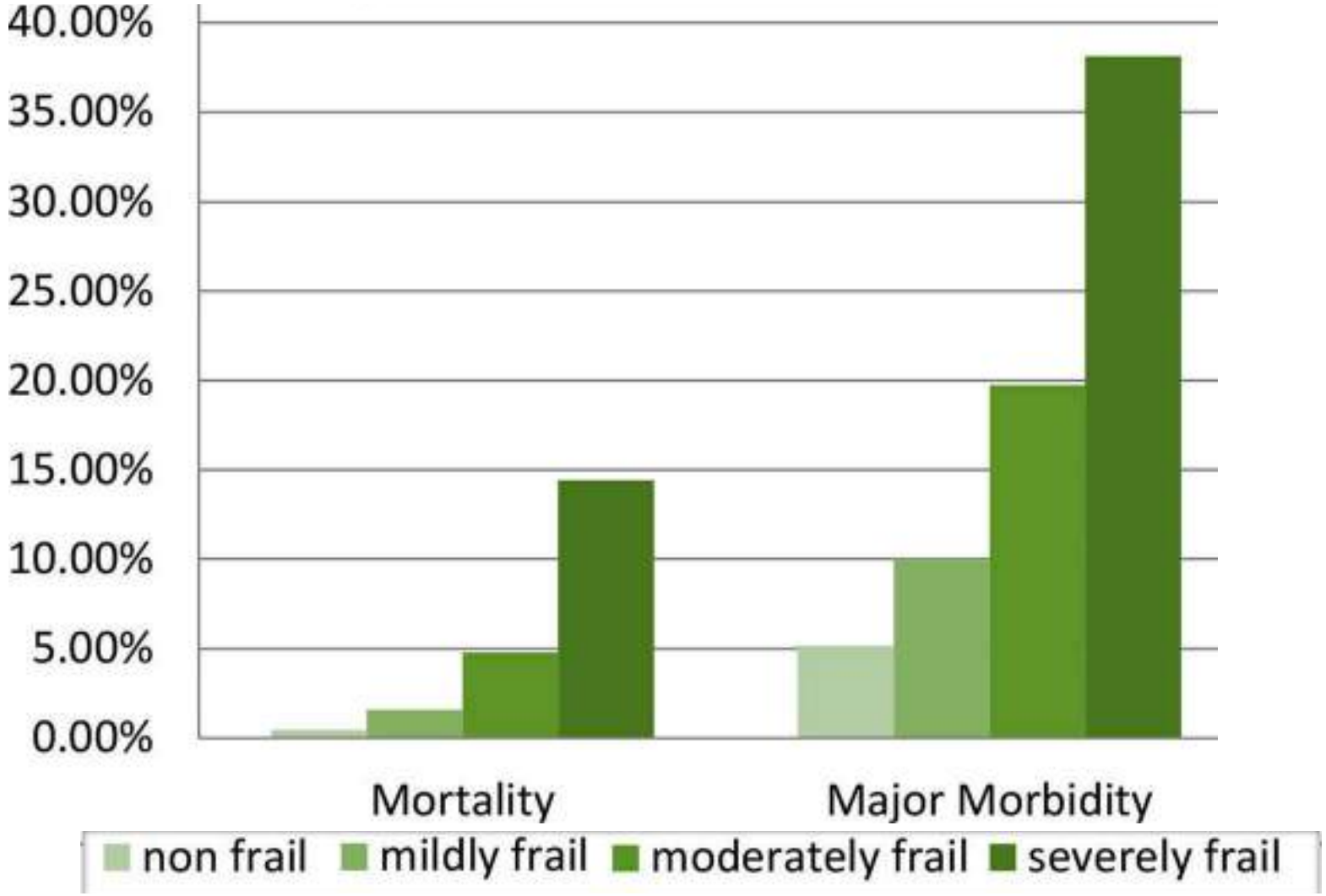


- Mortality



Xiaobo Yang, Journal of the American Heart Association,7: 23.

Frailty, morbidity and mortality



Mosquera C et al, Journal of the American College of Surgeons. 2018 Jun 1;226(6):978-86.

Frailty Related to Falls & Fractures

Table 3. Falls, Fracture, and Disability According to 1-Year Follow-Up According to Frailty Status From Age-Adjusted and Multivariable Models

	Age Adjusted			Multivariable		
Frailty Status According to Outcome	n	OR (95% CI)	*P*-Value	n	OR (95% CI)	*P*-Value
Falls	48,154		< .001[a]	44,528		< .001[b]
Prefrail		1.57 (1.47–1.68)			1.23 (1.13–1.32)	
Frail		3.35 (3.13–3.58)			1.68 (1.54–1.83)	
Fracture	47,780		< .001[c]	44,072		< .001[d]
Prefrail		1.39 (1.22–1.58)			1.23 (1.07–1.42)	
Frail		1.97 (1.73–2.25)			1.46 (1.26–1.70)	
Disability	46,273		< .001[e]	40,332		< .001[f]
Prefrail		2.04 (1.90–2.20)			1.85 (1.70–2.01)	
Frail		3.27 (3.03–3.52)			2.29 (2.09–2.51)	

- Frailty is associated with:
  - ≥2 falls: OR = 1.74 (CI, 1.19-2.55)[2]
  - ≥2 fractures: OR of 3.67 (CI, 1.47-9.15)[3]

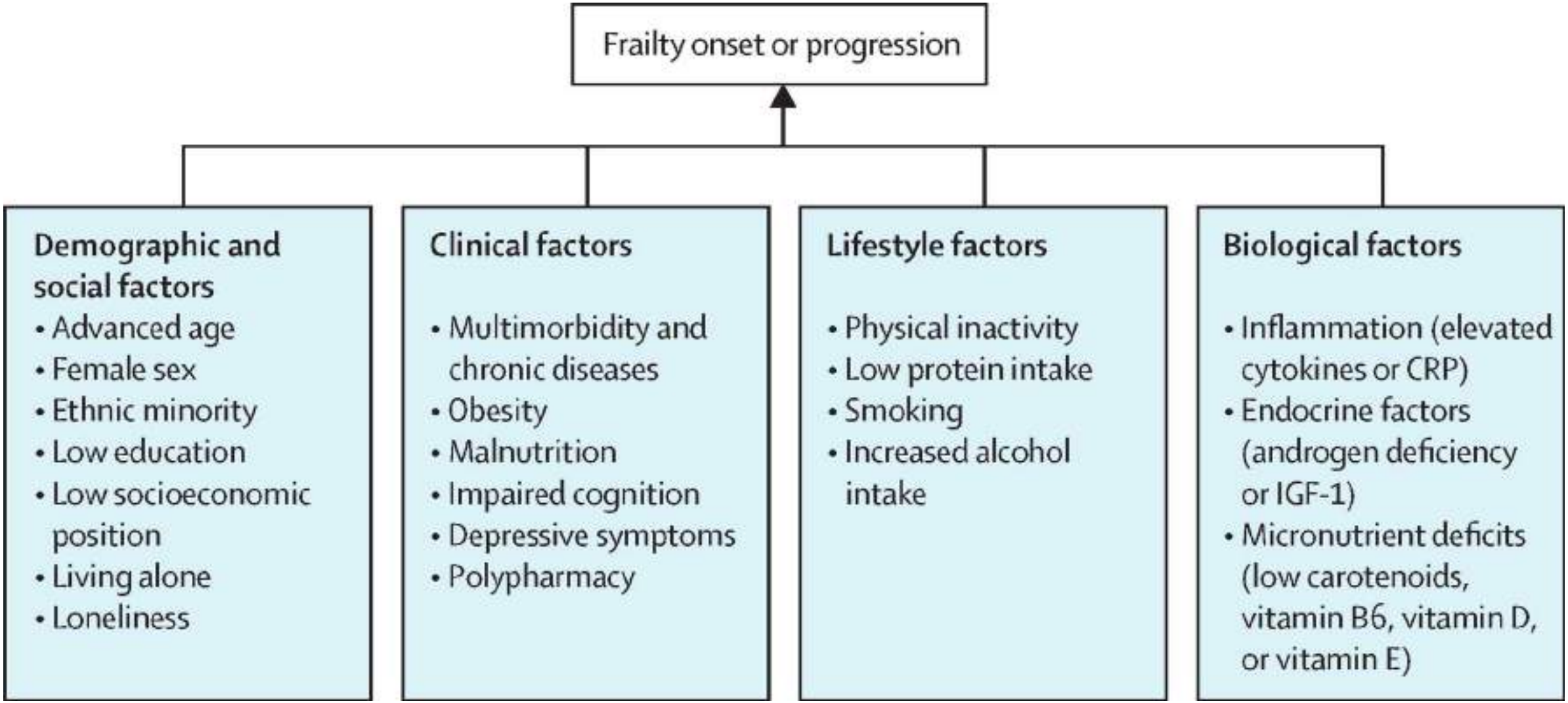
1- Tom SE et al, Journal of the American Geriatrics Society. 2013 Mar;61(3):327-34. 2- de Vries Osteoporos Int 2013. 3- Kojima G J Am Med Dir Assoc 2015

In summary…

- Older people with frailty have an increased likelihood of unmet care needs, falls and fractures, hospitalisations, lowered quality of life, iatrogenic complications, and early mortality[1–6]
- The rapid expansion of the ageing population lead to a concomitant rise in the number of older adults with frailty[7,8]
- Frailty is one of the most serious global public health challenges
- An increased pressure on health-care systems worldwide[9]

1-Clegg A et al, Lancet 2013; 381: 752–62. 2-Hoogendijk EO et al, Arch Gerontol Geriatr 2014; 58: 37–42. 3 Vermeiren S et al, J Am Med Dir Assoc 2016; 17: 1163.e1–17
4-Junius-Walker U et al, Eur J Intern Med 2018; 56: 3–10. 5-Fried LP et al, J Gerontol A Biol Sci Med Sci 2001; 56: M146–56. 6-Yang X et al, J Am Heart Assoc 2018; 7: e008251.
7-Yu R et al, Age Ageing 2018; 47: 254–61. 8-Mousa A et al, Age Ageing 2018; 47: 721–27. 9-Ilinca S et al, Health Serv Res 2015; 50: 305–20.


THE LANCET
Frailty: "the new frontier of medicine".
See Series pages 1301 and 1315
Editorial
Comment
Articles
Articles
Articles



Hoogendijk EO et al, The Lancet. 2019 Oct 12;394(10206):1365-75.

How to measure Frailty?

Measuring Frailty

FRIED phenotype

Physical frailty

- Reduced energy*
- Unintentional Weight loss*
- Poor grip strength*
- Slow walking speed
- Low physical activity

- Categorical classification: Robust, Pre-frail, Frail
- Both self report, physical tests

Fried, J Geron Med. 2001. Ensrud, Arch Intern Med. 2008

Frailty Index

Accumulation of "deficits"

- symptoms, diseases, impairments, activity limitations
- Physical, cognitive & social

- Continuous score
- Quantify *degree* of frailty
- Generalizable

Rockwood, J Geron Med Sci, 2007

Frailty Index (Rockwood)

Frailty as an accumulation of deficits…

"the more things people have wrong with them, the higher the likelihood of frailty"

Rockwood, *J Geron Med Sci*, 2007.
Mitniski, Song, Rockwood , *J Geron Med Sci*, 2004.

CaMos Frailty Index (n=30)

- Osteoarthritis
- Hypertension
- Rheumatoid Arthritis
- Thyroid disease
- Breast cancer
- Uterine/Prostate cancer
- Neuromuscular disease (Parkinson's, MS)
- Inflammatory bowel disease
- Heart attack
- Stroke
- Diabetes (Type 1 & 2)
- Kidney disease
- Phlebitis/thrombophlebitis

- Vision limitation
- Hearing limitation
- Walking limitation
- Dexterity limitation
- Pain (past year)
- Cognition problem

- Reduced daily work/other activities (last 4-wks)
- Interference with social activities (last 4-wks)
- Limitation in moderate activities (e.g. vacuuming)
- Limitation in lifting/carrying groceries
- Limitation climbing flight stairs
- Limitation in bending, kneeling, stooping
- Limitation in bathing/dressing

- Declining general health
- Change in health
- Low Energy
- Feel Tired

$$\text{Frailty score} = \frac{\text{Deficits present}}{\text{Deficits possible}}$$

**Adapted from*: Kennedy et. *Osteoporosis International*, 2014.

Clinical Frailty Scale

Clinician used clinical judgment to assign a frailty score between 1 (robust) and 9 (terminally ill), based on history and physical exam (cognition, mobility, function, co-morbidities)

Clinical Frailty Scale*

1 **Very Fit** – People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2 **Well** – People who have **no active disease symptoms** but are less fit than category 1. Often, they exercise or are very **active occasionally**, e.g. seasonally.

3 **Managing Well** – People whose **medical problems are well controlled**, but are **not regularly active** beyond routine walking.

4 **Vulnerable** – While **not dependent** on others for daily help, often **symptoms limit activities**. A common complaint is being "slowed up", and/or being tired during the day.

5 **Mildly Frail** – These people often have **more evident slowing**, and need help in **high order IADLs** (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6 **Moderately Frail** – People need help with **all outside activities** and with **keeping house**. Inside, they often have problems with stairs and need **help with bathing** and might need minimal assistance (cuing, standby) with dressing.

7 **Severely Frail** – **Completely dependent for personal care**, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8 **Very Severely Frail** – Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9. **Terminally Ill** - Approaching the end of life. This category applies to people with **a life expectancy <6 months**, who are **not otherwise evidently frail.**

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common **symptoms in mild dementia** include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/story and social withdrawal.

In **moderate dementia**, recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In **severe dementia**, they cannot do personal care without help.

* 1. Canadian Study on Health & Aging. Revised 2008.
2. K Rockwood et al. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005;173:489-495.

DALHOUSIE UNIVERSITY

Rockwood et al. CMAJ. 2005.

AIMS

This course, developed by the AIMS Research Group led by Dr. Daniel McIsaac, and collaborators, seeks to provide learners with a comprehensive understanding of frailty and how to accurately determine a person's Clinical Frailty Scale score based on their specific circumstances.

https://rise.articulate.com/share/deb4rT02lvONbq4AfcMNRUudcd6QMts3#/

Short Physical Performance Battery

- SPPB[1] is composed of
  A. Chair Stands (0-4)
  B. Balance Test (0-4)
  C. 8 Foot Walk (0-4)

1. Guralnik, *J Gerontol*, 1994.

- SPPB[1] is a continuous measure range: 0-12, when
    - 0-4 = poor lower extremity function
    - 5-7 = intermediate lower extremity function
    - 8-12 = Good lower extremity function

- SPPB has been validated and has demonstrated good internal consistency[2,3]

1. Guralnik, *J Gerontol*, 1994.
2. Volpato et al, J Geron Med Sci 2011
3. Guralnik J, et al N Engl J Med 1995

Research Note/Note de recherche

The Short Performance Physical Battery Is Associated with One-Year Emergency Department Visits and Hospitalization*

Ahmed M. Negm,[1,2] Courtney C. Kennedy,[1,3] Janet M. Pritchard,[1,4] George Ioannidis,[1,3] Vasilia Vastis,[1] Sharon Marr,[1,3] Christopher Patterson,[1,3] Brian Misiaszek,[1,3] Tricia K. W. Woo,[1,3] Lehana Thabane,[5] and Alexandra Papaioannou[1,3]

Commonly used frailty instruments

	Components	Frailty classification	Setting		
			Primary care	Hospital	Long-term care facility
Frailty phenotype[3]	Five items: weight loss, low physical activity, exhaustion, slowness, weakness	Frailty: ≥3 items; pre-frailty: 1–2 items; robust: 0 items	Yes	Yes	Yes
Frailty Index[11,12]	30 or more accumulated health deficits; scores range from 0 (no deficits) to 1 (all deficits)	Continuous score; suggested cutoff score for frailty >0·25[12]	Yes	Yes	Yes
Electronic Frailty Index[13]	As for the Frailty Index, with variables derived from routine electronic health records in primary care; also considered to be a case-finding instrument	Severe frailty: score >0·36; frailty: score >0·24–0·36; mild frailty: score >0·12–0·24; fit: score ≤0·12	Yes	No	No
Clinical Frailty Scale[14]	Visual and written chart for frailty with nine graded pictures: 1=very fit; 9=terminally ill	Frailty: score ≥5	Yes	Yes	Yes
FRAIL scale[15]	Five items: fatigue, resistance, ambulation, illness, loss of weight	Frailty: ≥3 items; pre-frailty: 1–2 items; robust: 0 items	Yes	Yes	Yes
Study of Osteoporotic Fractures frailty criteria[16]	Three items: weight loss, exhaustion, unable to rise from a chair five times	Frailty: ≥2 items; pre-frailty: 1 items; robust: 0 items	Yes	Yes	No
PRISMA-7[17]	Seven self-reported items: age (>85 years), male, social support, and ADLs	Frailty: score ≥3	Yes	No	No
Tilburg Frailty Indicator[18]	15 self-reported items in three domains: physical, psychological, and social	Frailty: score ≥5	Yes	No	No
Geriatric 8 frailty questionnaire for oncology (G8)[19]	Eight items: function (ADL and IADL), mobility, nutrition, comorbidity, cognition, depression, social support	Frailty: score ≤14	No	Yes	No
Groningen Frailty Indicator[20]	15 self-reported items in four domains: physical, cognitive, social, psychological	Frailty: score ≥4	Yes	No	No
Short Physical Performance Battery[21]	Three measured items: gait speed, standing balance, and repeated chair stands; each item scored from 0–4, maximum score of 12	Frailty: score ≤9	Yes	No	No
Edmonton Frailty Scale[22]	Nine items: cognition, health (2×), hospitalisation, social support, nutrition, mood, function, continence	Frailty: score ≥7	No	Yes	No
Multidimensional Prognostic Index[23]	Eight items: comorbidity, nutrition, cognition, polypharmacy, pressure sore risk, living status, ADL, IADL	Frailty: score >0·66; pre-frailty: score 0·34–0·66; robust: score <0·34	Yes	Yes	No
Rikhon Checklist[24]	25 dichotomous items in seven categories: physical strength, nutrition, eating, socialisation, memory, mood, and lifestyle; scoring as per the Frailty Index	Continuous score; suggested frailty cutoff score >0·25	Yes	Yes	No
Frailty Risk Score[25]	Formula: age (per 10 years) × 4 + male sex × 10 + no partner × 5 + body mass index <18·5 kg/m² × 12 + cardiovascular disease × 4 + diabetes × 4 + number of drugs ≥2 × 5, EMS<20 × 5 + ADL motor deficit × 4 + ADL process deficit × 7. Also considered to be a case finding instrument.	Very good: score <45; good: score 45–50; moderate: score 51–55; poor: score 56–61; very poor: score >61	No	Yes	No
Hospital Frailty Risk Score[27]	109 summed items from ICD-10 frailty-relevant codes from administrative hospital data. Also considered to be a case finding instrument.	Low risk: score <5; intermediate risk: score 5–15; high risk: score >15	No	Yes	No

EMS=Elderly Mobility Scale. ADL=activities of daily living. IADL=instrumental activities of daily living. ICD-10=International Statistical Classification of Diseases and Related Health Problems, 10th revision. Derived and modified from Dent and colleagues, 2016.[1]

Table 1: Commonly used frailty instruments

Dent E et al, The Lancet. 2019 Oct 12;394(10206):1376-86.

Treatment/prevention

JAMDA 20 (2019) 1190–1198

JAMDA

journal homepage: www.jamda.com

Review Article

Management of Frailty: A Systematic Review and Network Meta-analysis of Randomized Controlled Trials

Ahmed M. Negm MD, PhD, MSc [a,b,*], Courtney C. Kennedy PhD [a], Lehana Thabane PhD [c], Areti-Angeliki Veroniki PhD [d,e,f], Jonathan D. Adachi MD [g], Julie Richardson PhD [b,c], Ian D. Cameron MBBS, PhD [h], Aidan Giangregorio BSc [a], Maria Petropoulou MSc [d], Saad M. Alsaad MD [i], Jamaan Alzahrani MD [j], Muhammad Maaz BSc [k], Muhammad M. Ahmed BSc [k], Eileen Kim BSc [k], Hadi Tehfe BSc [k], Robert Dima BSc [l], Kalyani Sabanayagam BSc [k], Patricia Hewston PhD [a], Hajar Abu Alrob BSc [c], Alexandra Papaioannou MD [a,c,g]

Frailty Network Meta-analysis

- Aim: to determine the comparative effect of interventions targeting the prevention or treatment of frailty

- We identified relevant RCTs, in any language and publication date, by a systematic search of databases including MEDLINE, EMBASE, CINAHL, AMED, the Cochrane Central Registry of Controlled Trials (CENTRAL), HealthSTAR, DARE, PsychINFO, PEDro, SCOPUS, and Scielo

- We assessed risk of bias (using the Cochrane Risk of Bias tool) of eligible studies

Negm AM et al, JAMDA. 2019 Oct ; 20 (10) 1190-1198.

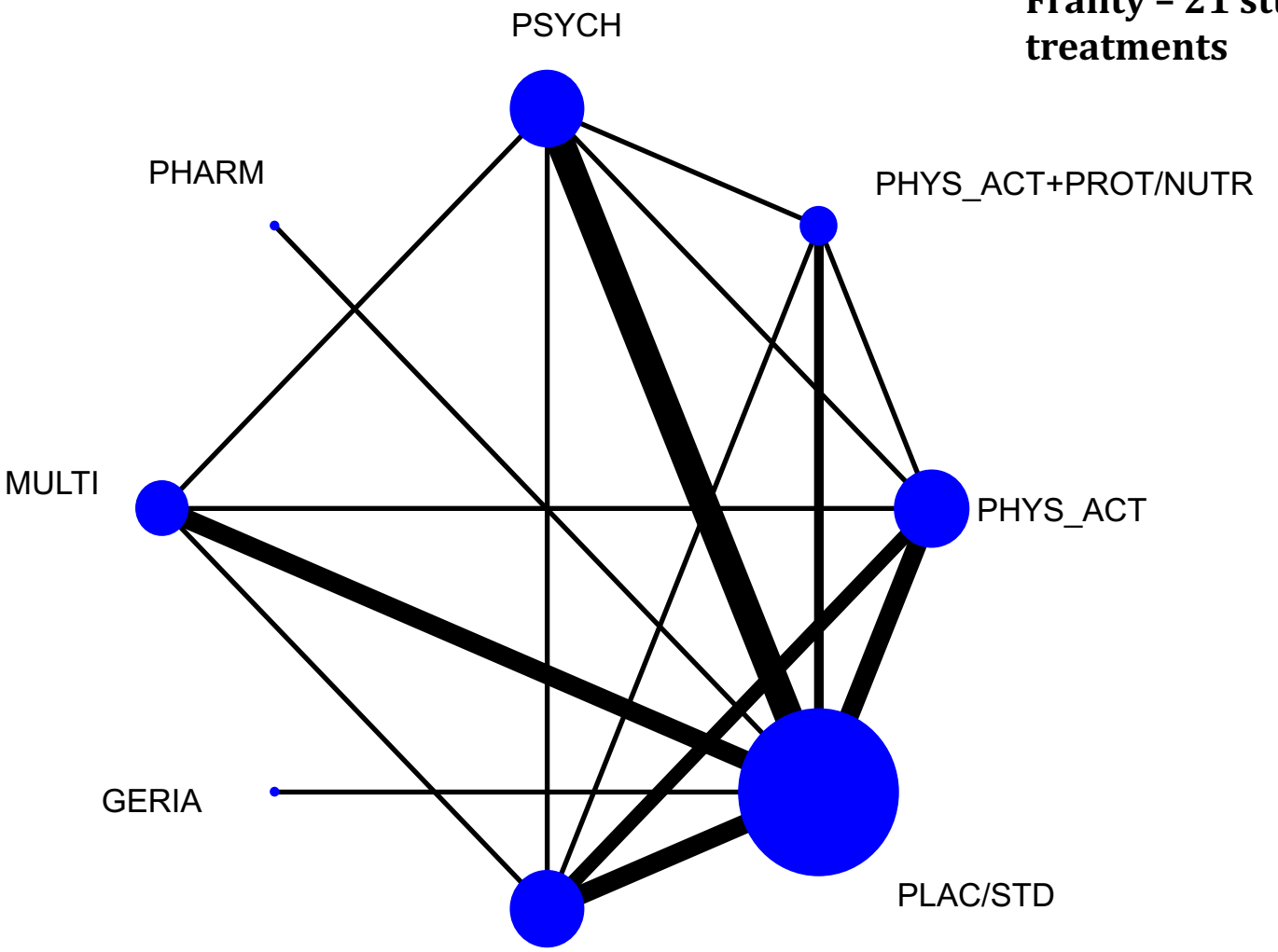
Frailty Interventions

- We compared 10 types of interventions
  - Physical activity
  - Physical activity and Protein or Nutrition supplementation
  - Psychosocial or cognitive training
  - Medication management
  - Pharmacotherapy
  - Multifaceted interventions
  - Geriatric Comprehensive Assessments
  - Nutrition Only
  - Placebo/standard care
  - Vibration wave or sound waves

Negm AM et al, JAMDA. 2019 Oct ; 20 (10) 1190-1198.

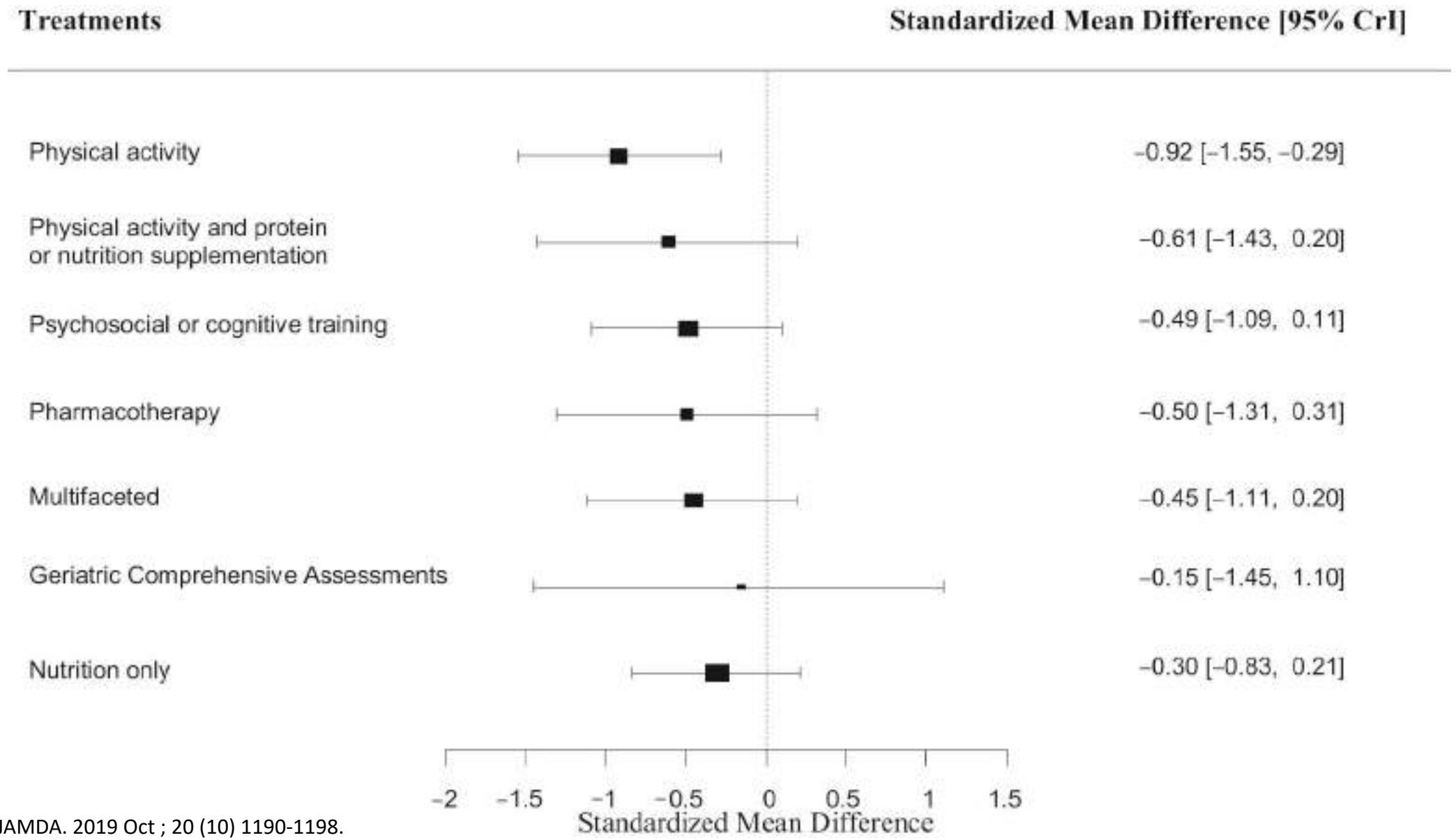
Frailty Interventions Network

Frailty – 21 studies, 5262 patients, 8 treatments



Negm AM et al, JAMDA. 2019 Oct ; 20 (10) 1190-1198.

Frailty Interventions Vs. Control



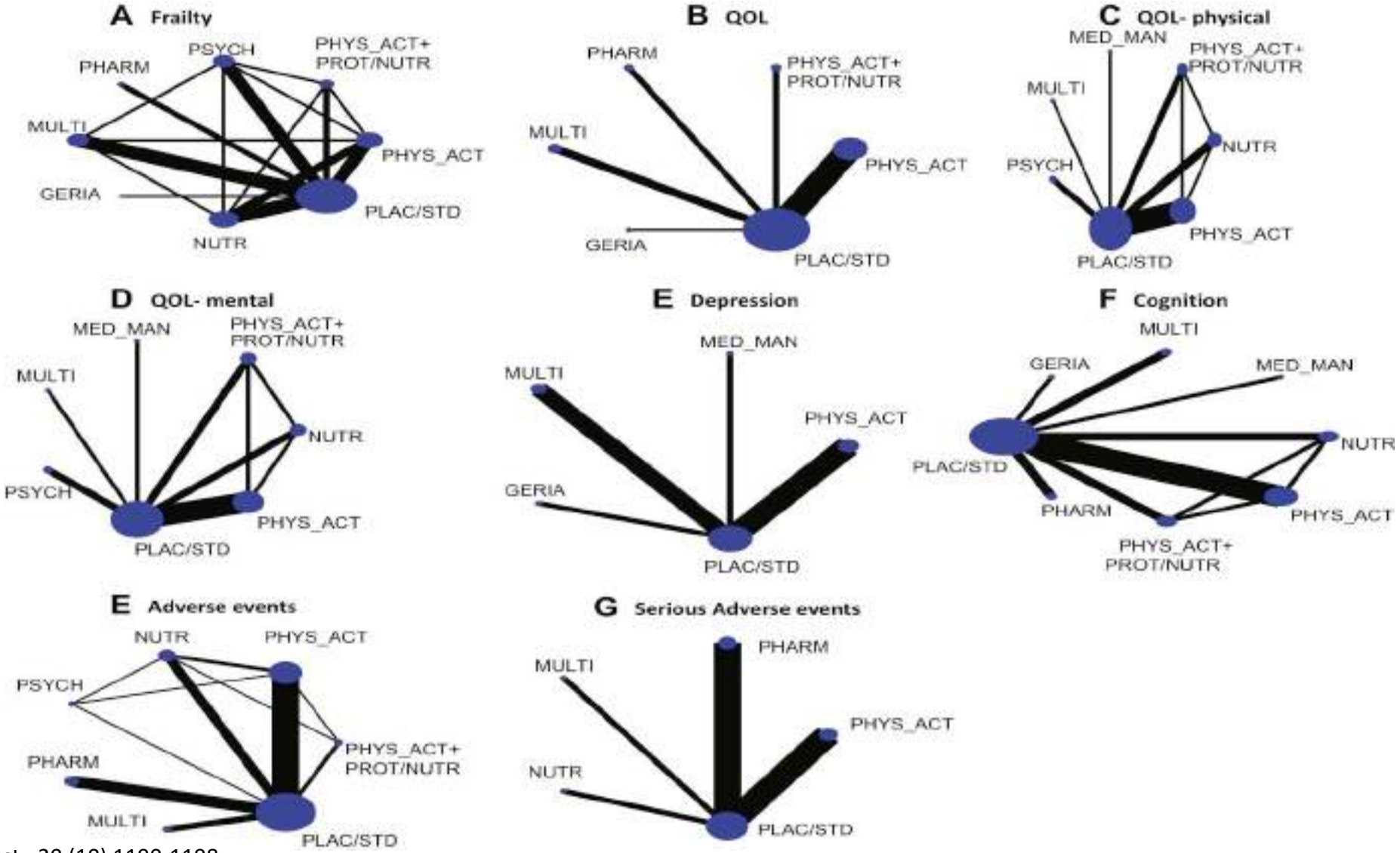
Negm AM et al, JAMDA. 2019 Oct ; 20 (10) 1190-1198.

Most effective treatment

Treatment Ranking			
Treatment	***median SUCRA***	***Low CrI***	***High CrI***
PHYS_ACT	0.86	0.43	1.00
PHYS_ACT+PROT/NUTR	0.71	0.00	1.00
PSYCH	0.57	0.00	1.00
PHARM	0.57	0.00	1.00
MULTI	0.43	0.00	1.00
GERIA	0.29	0.00	1.00
NUTR	0.43	0.00	0.86
PLAC/STD	0.14	0.00	0.57

Negm AM et al, JAMDA. 2019 Oct ; 20 (10) 1190-1198.

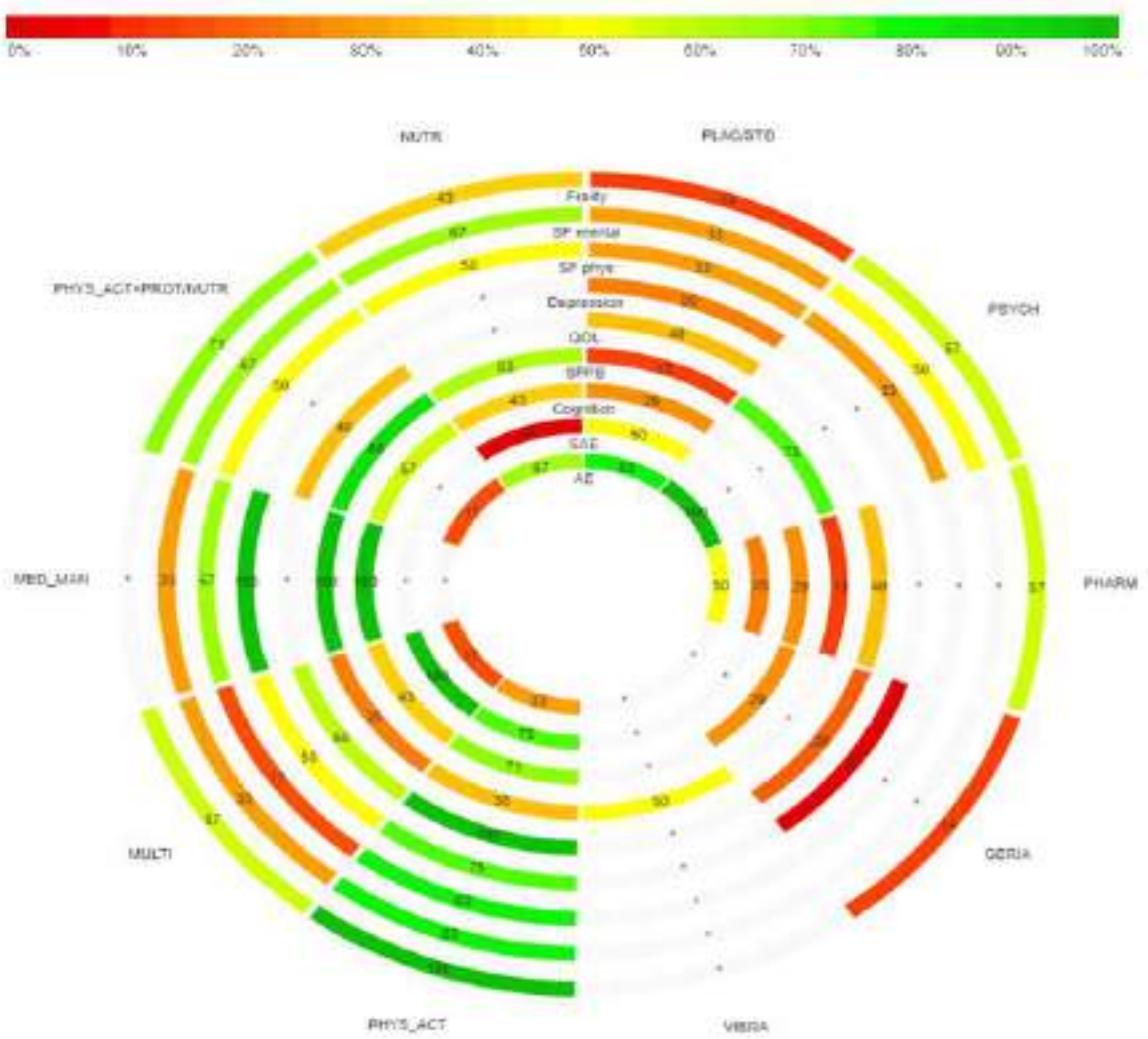
Secondary Outcomes Network



Negm AM et al, JAMDA. 2019 Oct ; 20 (10) 1190-1198.

Rank-heat plot All outcomes

Outcomes
Circles from outside in refer to :
1st: Frailty
2nd: SF mental
3rd: SF phys
4th: Depression
5th: QOL
6th: SPPB
7th: Cognition
8th: SAE
9th: AE
White sectors including a '*' refer to treatments without data on the outcome within the circle.



Negm AM et al, JAMDA. 2019 Oct ; 20 (10) 1190-1198.

J Nutr Health Aging. 2019;23(9):771-787

PHYSICAL FRAILTY: ICFSR INTERNATIONAL CLINICAL PRACTICE GUIDELINES FOR IDENTIFICATION AND MANAGEMENT

E. DENT[1,2], J.E. MORLEY[3], A.J. CRUZ-JENTOFT[4], L. WOODHOUSE[5], L. RODRÍGUEZ-MAÑAS[6], L.P. FRIED[7], J. WOO[8], I. APRAHAMIAN[9], A. SANFORD[3], J. LUNDY[10], F. LANDI[11], J. BEILBY[1], F.C. MARTIN[12], J.M. BAUER[13], L. FERRUCCI[14], R.A. MERCHANT[15], B. DONG[16], H. ARAI[17], E.O. HOOGENDIJK[18], C.W. WON[19], A. ABBATECOLA[20], T. CEDERHOLM[21], T. STRANDBERG[22,23], L.M. GUTIÉRREZ ROBLEDO[24], L. FLICKER[25], S. BHASIN[26], M. AUBERTIN-LEHEUDRE[27], H.A. BISCHOFF-FERRARI[28], J.M. GURALNIK[29], J. MUSCEDERE[30], M. PAHOR[31], J. RUIZ[32], A.M. NEGM[33], J.Y. REGINSTER[34], D.L. WATERS[35], B. VELLAS[36]

	Recommendation	Grade	Certainty of Evidence
Frailty Screening			
1	All adults aged 65-75 years and over should be offered screening for frailty using a validated rapid frailty instrument suitable to the specific setting or context	Strong	Low
Frailty Assessment			
2	Clinical assessment of frailty should be performed for all older adults screening as positive for frailty or pre-frailty	Strong	Low
Development of a Comprehensive Management Plan			
3	A comprehensive care plan for frailty should systematically address **polypharmacy, the management of sarcopenia, treatable causes of weight loss, and the causes of fatigue (depression, anemia, hypotension, hypothyroidism, and vitamin B12 deficiency)**	Strong	Very Low
4	Where appropriate, persons with advanced (severe) frailty should be referred to a geriatrician	CBR	No data†
Physical Activity/Exercise			
5	Older people with frailty should be offered a **multi-component physical activity program** (or those with pre-frailty as a preventative component)	Strong	Moderate
6	Health practitioners are strongly encouraged to refer older people with frailty **to physical activity programmes with a progressive, resistance-training component**	Strong	Moderate

Dent E et al, The journal of nutrition, health & aging, 23 (9) 771-787 (2019).

	Recommendation	Grade	Certainty of Evidence
Nutrition and Oral Health			
7	**Protein/caloric supplementation** can be considered for persons with frailty when **weight loss or undernutrition** has been diagnosed	Conditional	Very Low
8	Health practitioners may offer **nutritional/protein supplementation paired with physical activity prescription**	Conditional	Low
9	Advise older adults with frailty about the importance of oral health	CBR	No data†
Pharmacological Intervention			
10	**Pharmacological treatment as presently available is not recommended** therapy for the treatment of frailty	CBR	Very Low
Additional Therapies and Treatments			
11	**Vitamin D supplementation is not recommended** for the treatment of frailty unless vitamin D deficiency is present	CBR	Very low
12	**Cognitive or problem-solving therapy is not systematically recommended** for the treatment of frailty	CBR	Very low
13	**Hormone therapy is not recommended** for the treatment of frailty	CBR	Very low
14	All persons with frailty may be offered **social support** as needed to address unmet needs and encourage adherence to the Comprehensive Management Plan	Strong	Very low
15	Persons with frailty can be referred to **home-based training**	Conditional	Low

Dent E et al, The journal of nutrition, health & aging, 23 (9) 771-787 (2019).

Sarcopenia

What is sarcopenia?

- Sarcopenia, derived from the Greek term meaning “poverty of flesh,” was first described by Irwin Rosenberg in the 1980s[1]
- Originally conceived as a loss of muscle mass in an older adult
- In 2010, it was redefined as the loss of muscle function or strength in the presence of low lean body mass[2,3]

1- Rosenberg IH. Sarcopenia: Origins and clinical relevance. J Nutr 1997;127:9905- 9915. 2- Cruz-Jentoft et al, Age Ageing 2010;39:412-423.
3- Fielding RA et al, J Am Med Dir Assoc 2011;12:249-256.

Author, year and study name (when applicable)	Sarcopenia component
Newman, 2003[1]	Muscle Mass
Baumgartner, 2000[2]	
Baumgartner, 2004[3]	
Villareal, 2005, ASN–TOS[4]	
Bouchard, 2009[5]	
Fielding, 2011, IWGSP[6]	Physical function
	Muscle Mass
Cruz-Jentoft, 2010, EWGSOP[7]	Muscle Mass
	Muscle strength
	Physical performance
Studenski, 2014, FNIH[8]	Muscle Mass
	Muscle strength
Asian Working Group for Sarcopenia, 2014[9]	Muscle Mass
	Muscle strength
	Physical performance

1- Newman AB et al, J. Am. Geriatr. Soc 51, 1602–1609 (2003). 2- Baumgartner RN, Ann. NY Acad. Sci 904, 437–448 (2000). 3- Baumgartner RN et al. Obes. Res 12, 1995–2004 (2004). 4- Villareal DT et al. Am. J. Clin. Nutr 82, 923–934 (2005). 5- Bouchard DR et al, Obesity (Silver Spring) 17, 2082–2088 (2009). 6- Fielding RA et al, J. Am. Med. Dir. Assoc 12, 249–256 (2011). 7- Cruz-Jentoft AJ et al, Age Ageing 39, 412–423 (2010). 8- Studenski SA et al, J. Gerontol. A Biol. Sci. Med. Sci 69, 547–558 (2014). 9- Chen LK et al, J. Am. Med. Dir. Assoc 15, 95–101 (2014). 10- Batsis JA et al, *Nat Rev Endocrinol*. 2018;14(9):513–537

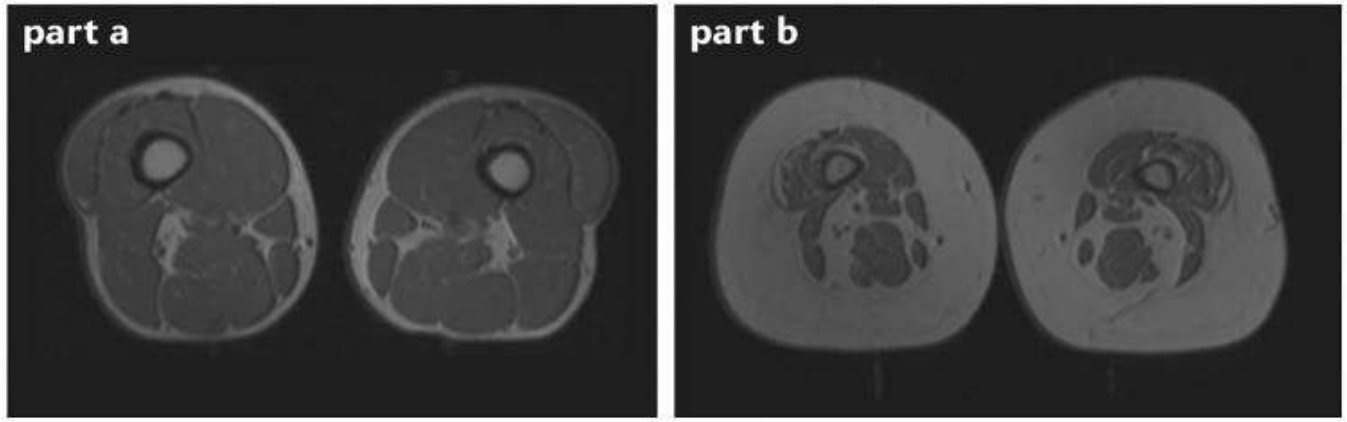
- Secondary sarcopenia: occurs in persons with chronic diseases, e.g., diabetes mellitus[1]

- Dyapenia: loss of muscle strength

- Sarcopenic obesity: the excess adipose tissue masks the loss of muscle, but yet the loss of muscle results in profound loss of strength and function[2]

1- McKee A et al, Endocr Pract 2017;23:1140-1149. 2- Baumgartner RN et al, Obes Res 2004;12:1995-2004

- Obesity is defined as an unhealthy excess body fat that increases the risk of medical illness and mortality[1,2]

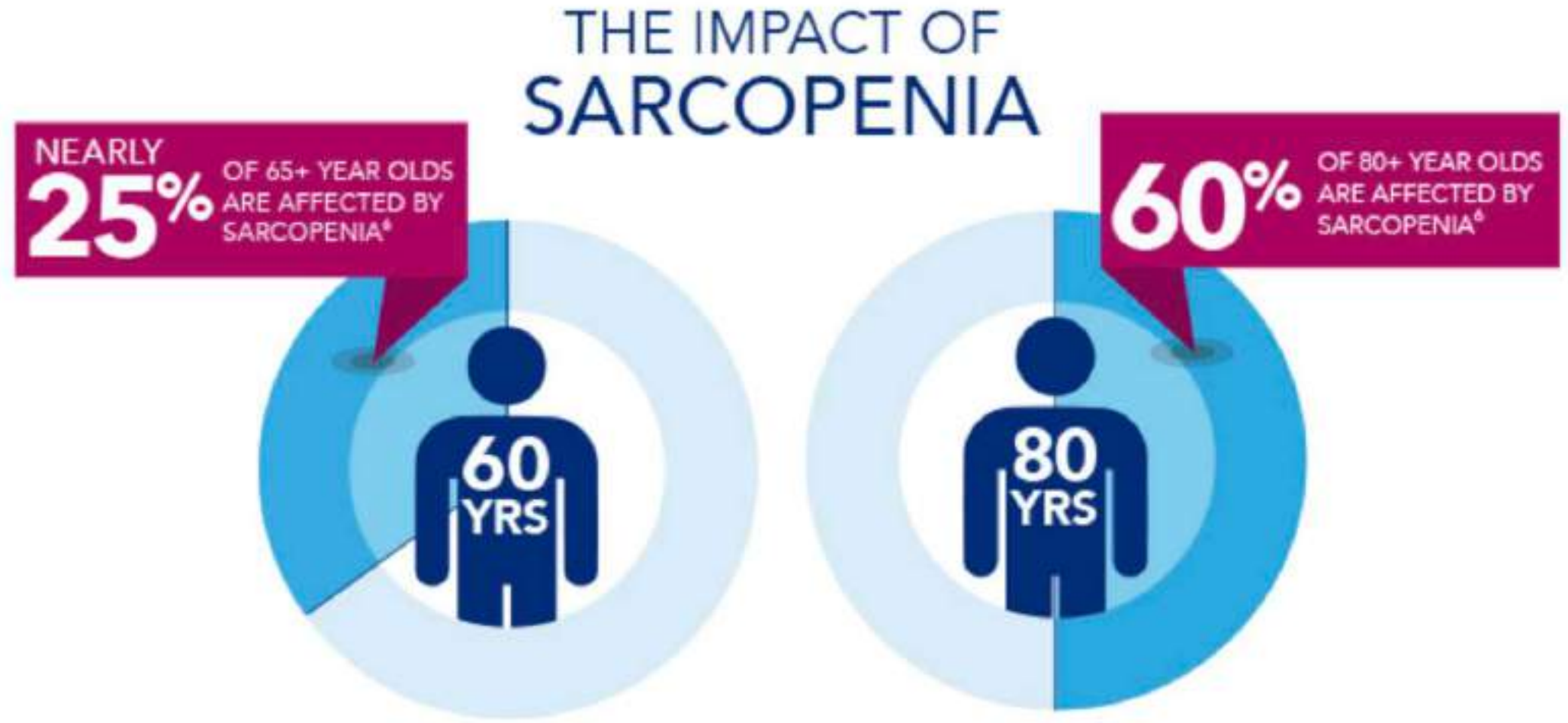


MRI of individuals with and without obesity.

1- Villareal DT et al, Am. J. Clin. Nutr 82, 923–934 (2005). 2- Batsis JA et al, *Nat Rev Endocrinol*. 2018;14(9):513–537
Images courtesy of Edward Weiss, St Louis University School of Medicine, St Louis, MO, USA

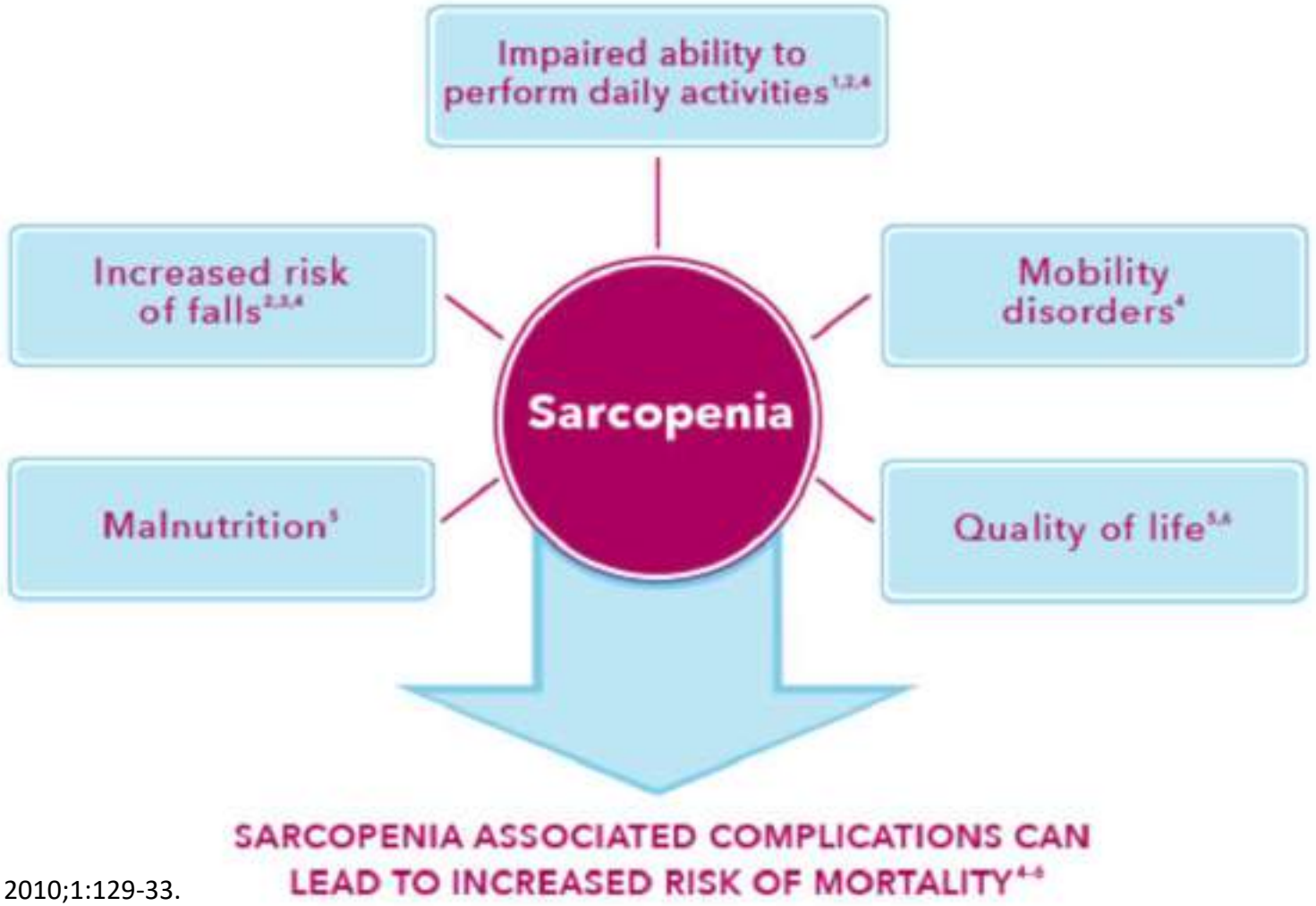

Why Sarcopenia is important?

Sarcopenia prevalence



6- Janssen I et al, J Am Geriatr Soc. 2002;50:889–96.
7- http://fightsarcopenia.com/

Sarcopenia and adverse outcomes



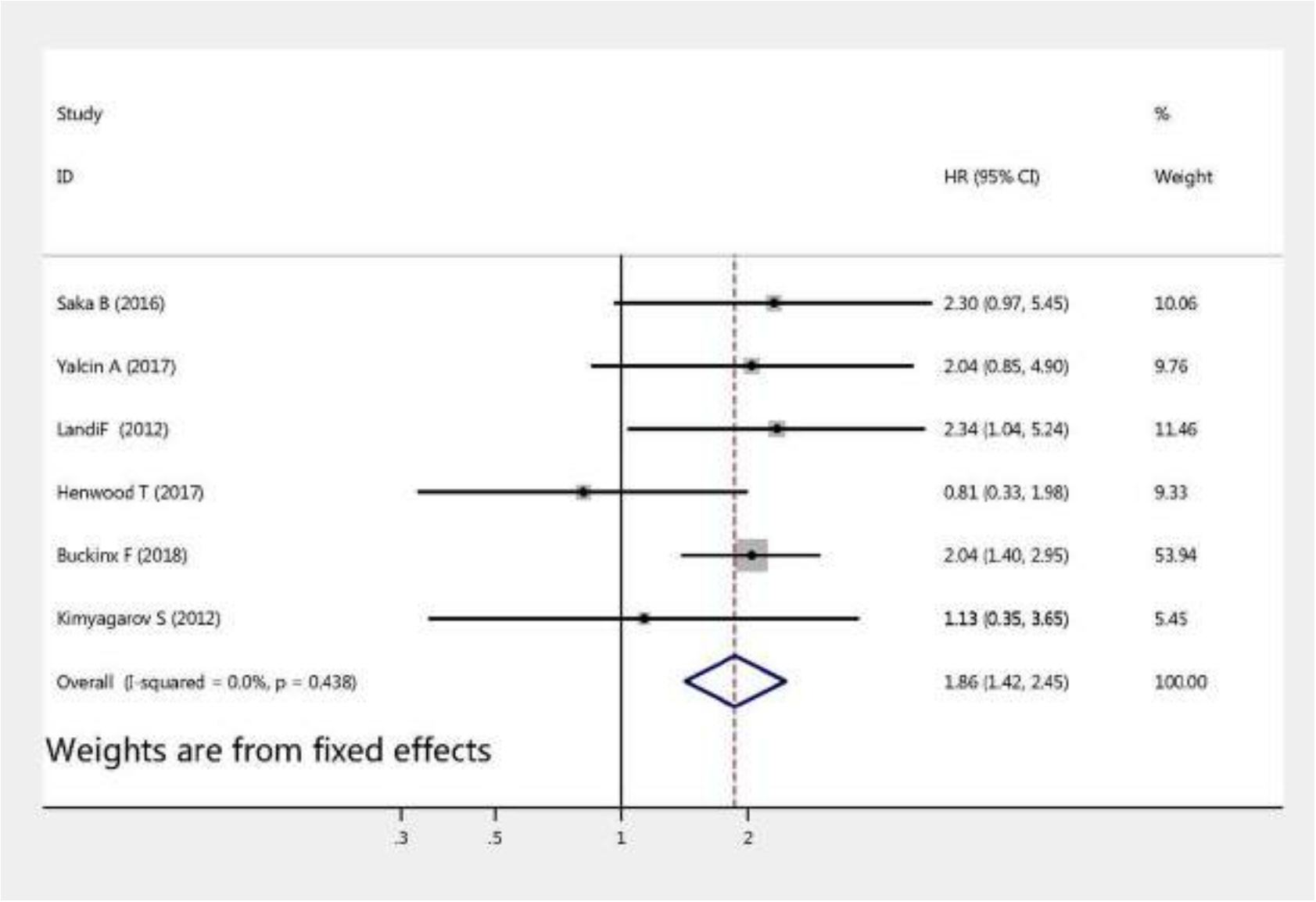
1- Pichard C et al, *Am J Clin Nutr.* 2004;79:613-618.
2- Wolfe RR, *Am J Clin Nutr.* 2006;84(3):475-482.
3- von Haehling S et al, *J Cachexia Sarcopenia Muscle*. 2010;1:129-33.
4- Cruz-Jentoft AJ et al, *Age Ageing*. 2010;39:412-23.
5- Litchford, MD, *Nutrition in Clinical Practice*. 2014;29(4)428-434
6- Janssen I et al, J Am Geriatr Soc. 2002;50:889–96.
7- http://fightsarcopenia.com/

Sarcopenia has a negative impact on patients' quality of life and often leads to:

- Increased inpatient length of stay[1]
- A decline in daily activities and ambulatory function, Reduced day-to-day activities[1,2]
- Increased risk of illness and infection[2,3]
- Reduced recovery from surgery, illness, and injury[2,3]
- Poor wound healing[3]
- hip fracture[4]
- Increased mortality[3]

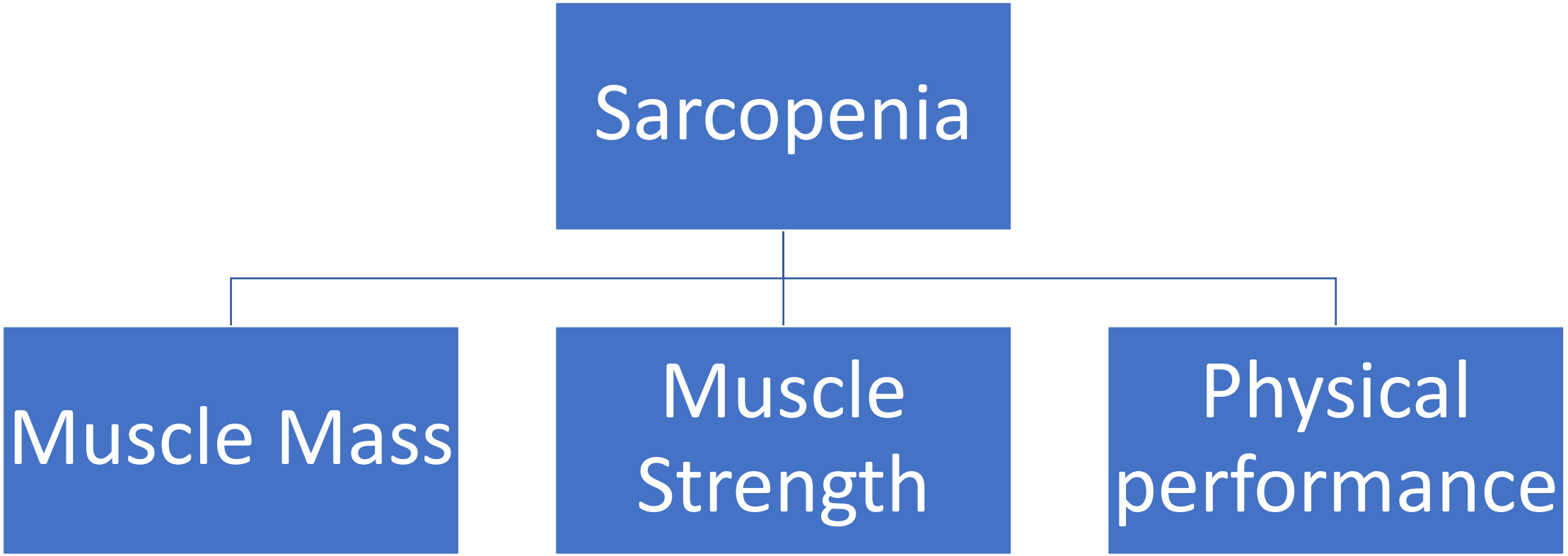
1- Pitchard C et al, *Am J Clin Nutr*. 2004;79:613-618. 2- Wolfe RR. *Am J Clin Nutr.* 2006;84(3):475-482.
3- Demling RH. *Eplasty*. 2009;9:65-94. 4- Morley JE et al, J Nutr Health Aging (2019) 23: 768.

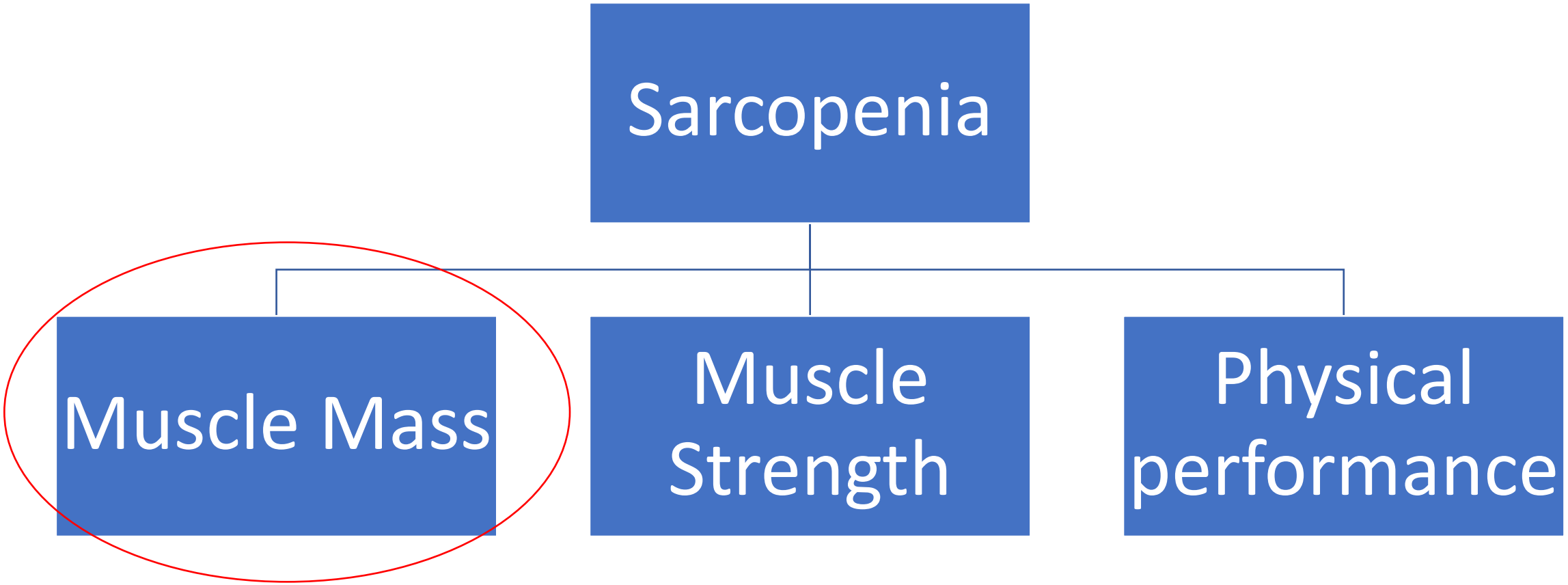
Sarcopenia and mortality



Xiaoming Zhang et al. BMJ Open 2018;8:e021252

How to measure Sarcopenia?


Sarcopenia
Muscle Mass
Muscle Strength
Physical performance


Sarcopenia
Muscle Mass
Muscle Strength
Physical performance

Anthropometry

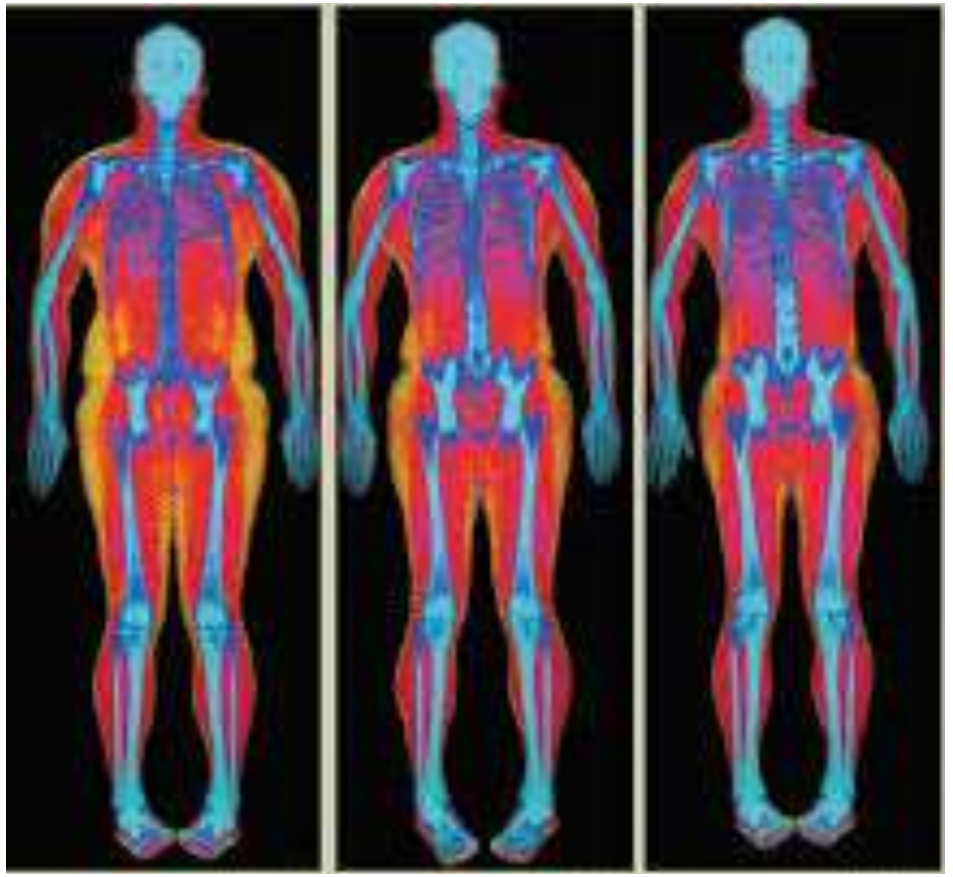
Skinfold thickness[1]

Calf circumferences[2]

1- https://weightology.net/the-pitfalls-of-body-fat-measurement-part-5-skinfolds/
2- http://www.lymphedemablog.com/2011/09/15/measuring-for-compression-stockings/

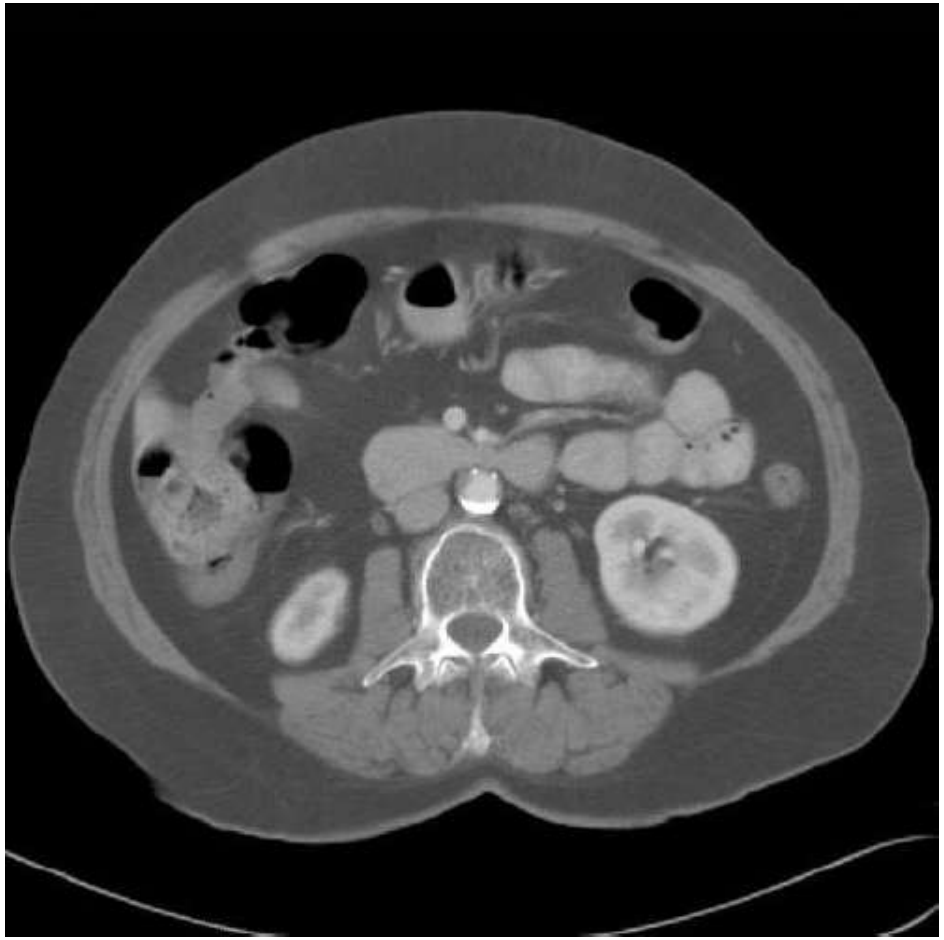
Bioelectrical impedance analysis (BIA)

Dual energy X-ray absorptiometry (DEXA)



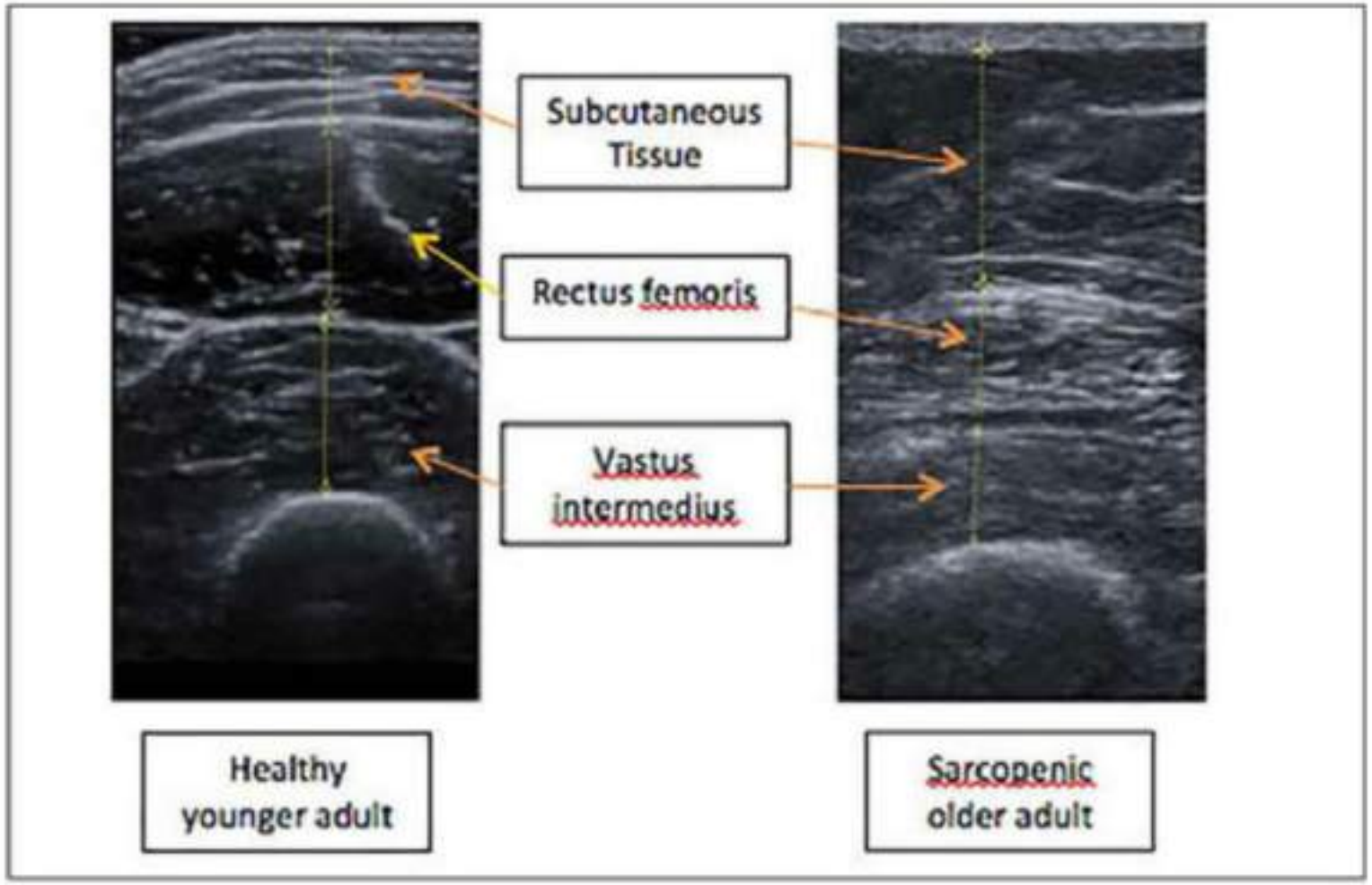
1- https://physics.stackexchange.com/questions/190986/how-are-dual-energy-x-ray-absorptiometry-dxa-dexa-scans-affected-by-surface-st
2- http://www.hiphealth.ca/facilities/our-equipment/dual-energy_x-ray_absorptiometry

Computer tomography (CT)/Magnetic resonance imaging (MRI)



1- http://www.tomovision.com/Sarcopenia_Help/index.htm?context=310

Ultrasound



Stringer HJ et al, *J Frailty Aging*. 2018;7(4):258-261.

Table 1

Characteristics of techniques for the diagnosis of sarcopenia.

	Anthropometry	BIA	DEXA	CT/MRI	Ultrasound
Simplicity	+++	++	+	−	+
Low cost	+++	++	+	−	+
Validity	−	+	++	+++	?
Clinical application	+	+	+	−	−
Research application	−	+	++	+++	?

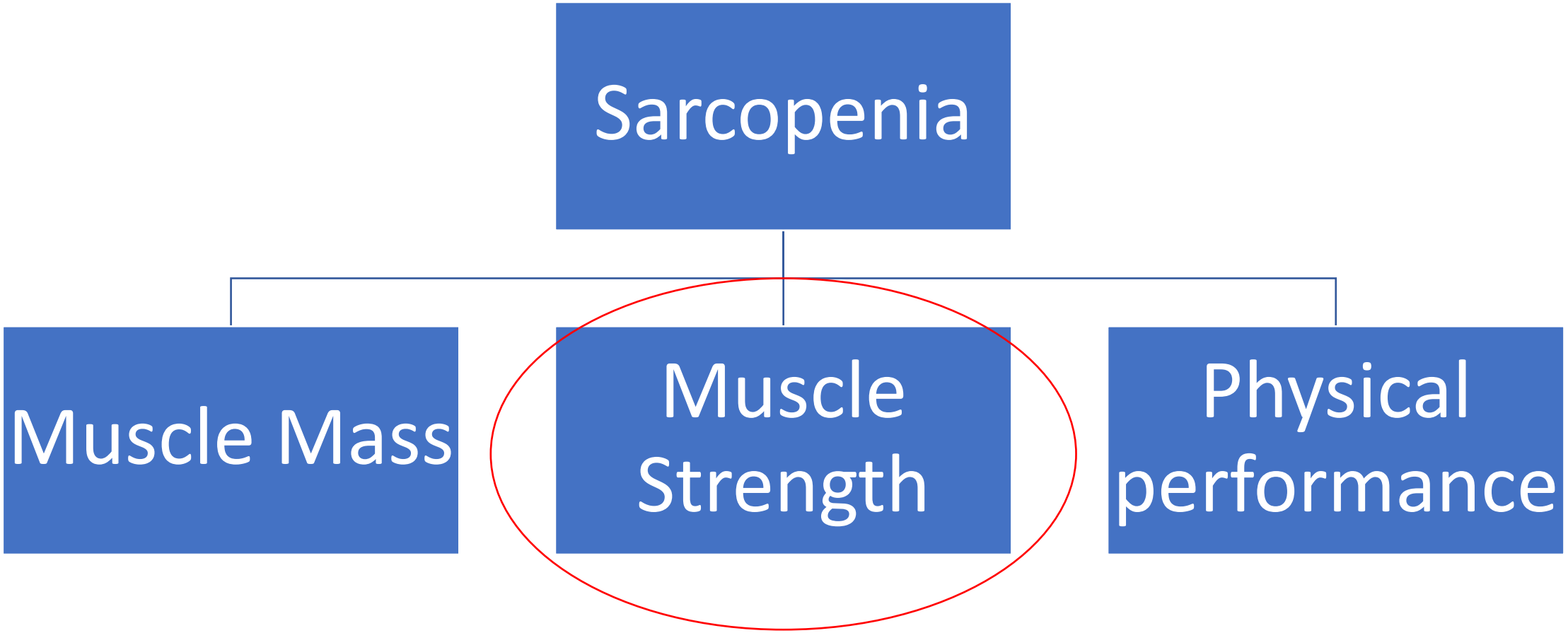
Rubbieri G et al, *Clin Cases Miner Bone Metab*. 2014 Sep;11(3):181-4.

Creatine dilution test

- Excess circulating creatine is changed to creatinine and excreted in urine
- The excretion rate of creatinine is a promising proxy measure for estimating whole-body muscle mass.
- Total body creatine pool size and muscle mass are calculated from D_3-creatinine enrichment in urine
- Creatine dilution test results correlate well with MRI-based measures of muscle mass and modestly with measures from BIA and DXA[1,2]
- The creatine dilution test is mostly used in research

1. Clark RV et al, J Appl Physiol 2018; 124: 1–9. 2- Buehring B et al, Osteoporos Int 2018; 29: 675–83.
3- Evans WJ et al, J Cachexia Sarcopenia Muscle 2019;10:14-21. 4. Cawthon PM et al, J Gerontol A Biol Sci Med Sci 2019;74:844-852.

How to measure sarcopenia



Grip Strength

- Measuring grip strength is simple and inexpensive[1]
- Requires a calibrated handheld dynamometer[1]
- The Jamar dynamometer is validated and widely used for measuring grip strength[1]

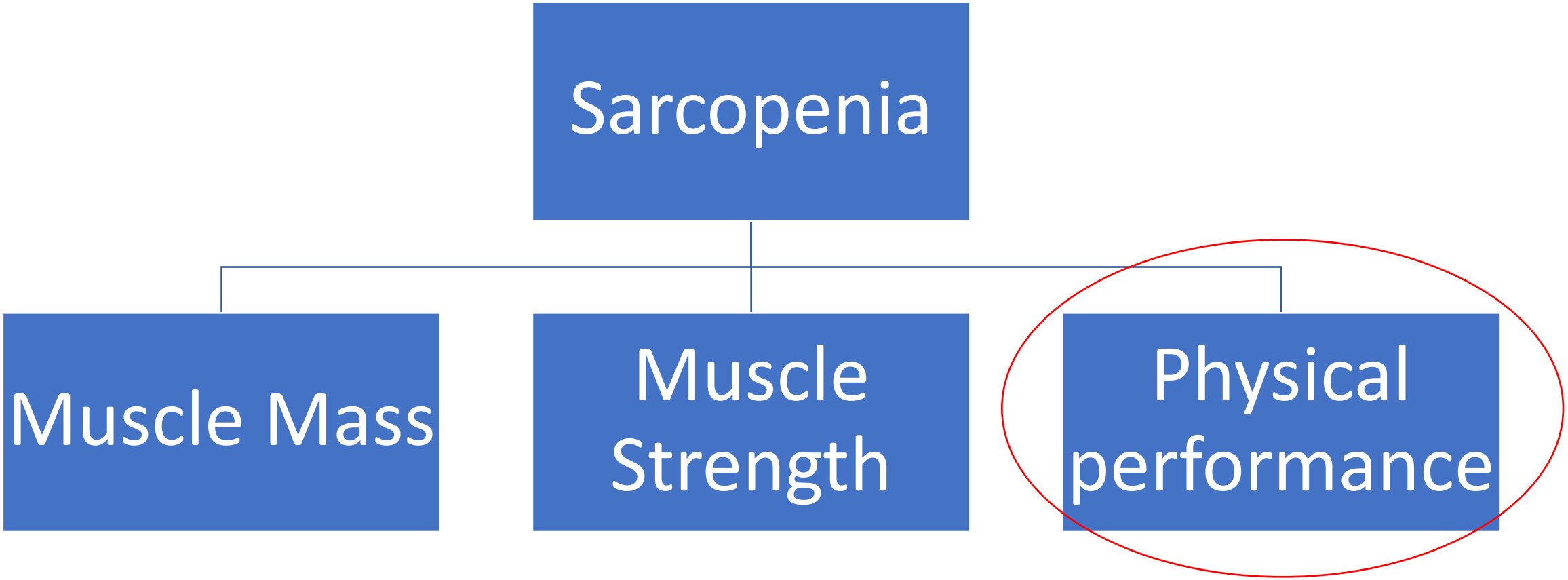
1- Roberts HC et al, Age Ageing 40, 423–429 (2011).
2- https://www.healthprofessionalsolutions.com.au/Jamar_Hydraulic_Hand_Grip_Dynamometer_p/jamhd.htm
3- https://today.uconn.edu/2011/06/grip-strength-is-good-indicator-of-overall-health/

Chair Stand Test

- The chair stand test is a proxy for strength of leg muscles
- It measures the amount of time needed for a patient to rise five times from a seated position without using his or her arms
- The timed chair stand test is a variation that counts how many times a patient can rise and sit in the chair over a 30-second interval[1,2,3]

1- Beaudart C et al, BMC Geriatr 2016; 16: 170
2- Cesari M et al, *J Am Geriatr Soc* 2009; 57: 251–9
3- Jones CJ et al, *Res Q Exerc Sport* 1999; 70: 113–9
4- https://sielearning.tafensw.edu.au/toolboxes/Toolbox805/fit_tb/fit011_1_lr10/fit011_1_lr10_1_1.htm

How to measure sarcopenia



Gait speed

- Gait speed is considered a quick, safe and highly reliable test for sarcopenia, and it is widely used in practice[1]
- A commonly used gait speed test is called the 4-m usual walking speed test[2,3]

- 400-m walk test: walking ability and endurance[4]

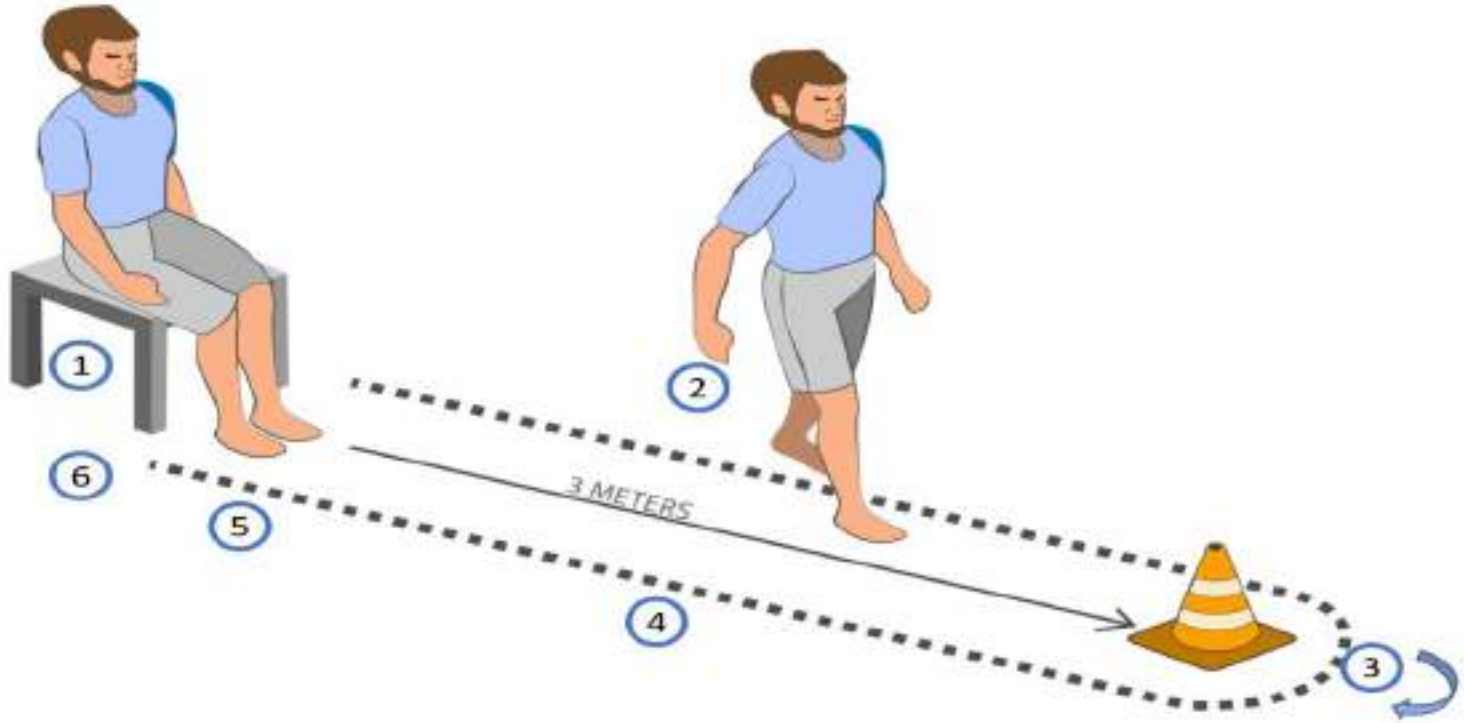
1- Bruyere O et al, *Eur Geriatr Med* 2016; 7: 243–46
2- Maggio M et al, *PLoS One* 2016; 11: e0153583
3- Rydwik E et al, *Physiother Theory Pract* 2012; 28: 238–56
4- Roberts HC et al, *Age Ageing* 2011; 40: 423–9
5- https://www.youtube.com/watch?v=xLScK_NXUN0

Short Physical Performance Battery

1. Guralnik, *J Gerontol*, 1994.

Timed Up and Go (TUG)

- Individuals are asked to rise from a standard chair, walk to a marker 3 m away, turn around, walk back and sit down again[1]



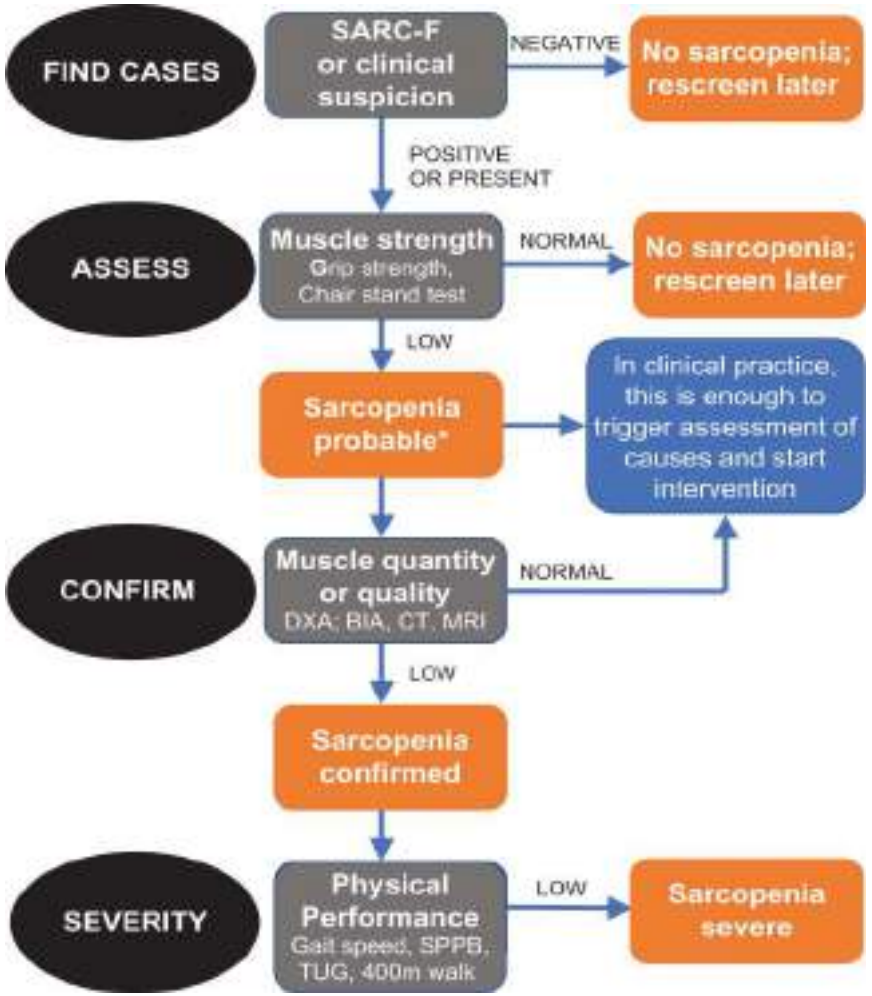
1- Podsiadlo D et al, *J Am Geriatr Soc* 1991; 39: 142–8.
2- Ortega-Bastidas et al, Sensors 2019, 19, 1647

GUIDELINES

Sarcopenia: revised European consensus on definition and diagnosis

Alfonso J. Cruz-Jentoft[1], Gülistan Bahat[2], Jürgen Bauer[3], Yves Boirie[4], Olivier Bruyère[5], Tommy Cederholm[6], Cyrus Cooper[7], Francesco Landi[8], Yves Rolland[9], Avan Aihie Sayer[10], Stéphane M. Schneider[11], Cornel C. Sieber[12], Eva Topinkova[13], Maurits Vandewoude[14], Marjolein Visser[15], Mauro Zamboni[16], Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2

Sarcopenia: EWGSOP2 algorithm for case-finding, making a diagnosis and quantifying severity in practice



1- Cruz-Jentoft AJ et al, Age Ageing 48 (1), 16–31 (2019).

SARC-F questionnaire

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 falls = 2

Journal of Cachexia, Sarcopenia and Muscle, First published: 15 September 2019, DOI: (10.1002/jcsm.12483)

EWGSOP2 sarcopenia cut-off points

Test	Cut-off points for men	Cut-off points for women	References
cut-off points for low strength			
Grip strength	<27 kg	<16 kg	Dodds (2014) [26]
Chair stand	>15 s for five rises		Cesari (2009) [67]
cut-off points for low muscle mass			
ASM	<20 kg	<15 kg	Studenski (2014) [3]
ASM/height^2	<7.0 kg/m^2	<5.5 kg/m^2	Gould (2014) [125]
cut-off points for low performance			
Gait speed	≤0.8 m/s		Cruz-Jentoft (2010) [1]
			Studenski (2011) [84]
SPPB	≤8 point score		Pavasini (2016) [90]
			Guralnik (1995) [126]
TUG	≥20 s		Bischoff (2003) [127]
400 m walk test	Non-completion or ≥6 min for completion		Newman (2006) [128]

1- Cruz-Jentoft AJ et al, Age Ageing 48 (1), 16–31 (2019).

Other guidelines

Author, year and study name (when applicable)	Sarcopenia component	Measurement modality (cut-off points)	Validated population
Newman, 2003[1]	ALM divided by height squared	DXA (men <7.23kg/m^2; women <5.67kg/m^2)	New Mexico Elder Health Survey
	ALM divided by height and fat mass	DXA (lowest twentieth percentile of residuals (sex-specific))	Health ABC study
Baumgartner, 2000[2]	ALM divided by height squared	DXA (men <7.26kg/m^2; women <5.45kg/m^2)	New Mexico Aging Process Study
Baumgartner, 2004[3]	ALM divided by height squared	DXA (men <7.26kg/m^2; women <5.45kg/m^2)	New Mexico Elder Health Survey
Villareal, 2005, ASN–TOS[4]	ALM divided by height squared	ALM (<5.45kg/m^2, sex is not specified)	Young healthy population
Bouchard, 2009[5]	ALM divided by height squared	DXA (men <8.51kg/m^2; women <6.29kg/m^2)	Nutrition as a Determinant of Successful Aging study
Fielding, 2011, IWGSP[6]	Physical function	Gait speed (<1m/s)	NA
	Lean mass	DXA (less than the twentieth percentile healthy adults, ALM divided by height squared: men ≤7.23kg/m^2; women ≤5.67kg/m^2)	Health ABC
Studenski, 2014, FNIH[7]	Weakness	Handgrip strength (men <26kg; women <16kg)	Multiple study cohorts
		Handgrip strength:BMI (men <1.0; women <0.56)	Multiple study cohorts
	ALM	Men <19.75kg; women <15.02kg	Multiple study cohorts
	ALM:BMI	Men <0.789; women <0.512	Multiple study cohorts
Asian Working Group for Sarcopenia, 2014[8]	ALM divided by height squared	DXA (men <7.0kg/m^2; women <5.4kg/m^2)	NA
		BIA (men <7.0kg/m^2; women <5.7kg/m^2)	NA
	Strength	Handgrip strength (men <26kg; women <18kg)	NA
	Performance	Gait speed over 6m (<0.8m/s)	NA

1- Newman AB et al, J. Am. Geriatr. Soc 51, 1602–1609 (2003). 2- Baumgartner RN, Ann. NY Acad. Sci 904, 437–448 (2000). 3- Baumgartner RN et al. Obes. Res 12, 1995–2004 (2004). 4- Villareal DT et al. Am. J. Clin. Nutr 82, 923–934 (2005). 5- Bouchard DR et al, Obesity (Silver Spring) 17, 2082–2088 (2009). 6- Fielding RA et al, J. Am. Med. Dir. Assoc 12, 249–256 (2011). 7- Studenski SA et al, J. Gerontol. A Biol. Sci. Med. Sci 69, 547–558 (2014). 8- Chen LK et al, J. Am. Med. Dir. Assoc 15, 95–101 (2014). 9- Batsis JA et al, *Nat Rev Endocrinol*. 2018;14(9):513–537

INTERNATIONAL CLINICAL PRACTICE GUIDELINES FOR SARCOPENIA (ICFSR): SCREENING, DIAGNOSIS AND MANAGEMENT

E. DENT[1,2], J.E. MORLEY[3], A.J. CRUZ-JENTOFT[4], H. ARAI[5], S.B. KRITCHEVSKY[6], J. GURALNIK[7], J.M. BAUER[8], M. PAHOR[9], B.C. CLARK[10], M. CESARI[11,12], J. RUIZ[13], C.C. SIEBER[14], M. AUBERTIN-LEHEUDRE[15], D.L. WATERS[16], R. VISVANATHAN[17], F. LANDI[18], D.T. VILLAREAL[19], R. FIELDING[20], C.W. WON[21], O. THEOU[17,22], F.C. MARTIN[23], B. DONG[24], J. WOO[25], L. FLICKER[26], L. FERRUCCI[27], R.A. MERCHANT[28], L. CAO[29], T. CEDERHOLM[30], S.M.L. RIBEIRO[31], L. RODRÍGUEZ-MAÑAS[32], S.D. ANKER[33,34], J. LUNDY[35], L.M. GUTIÉRREZ ROBLEDO[36], I. BAUTMANS[37,38,39], I. APRAHAMIAN[40], J.M.G.A. SCHOLS[41], M. IZQUIERDO[42], B. VELLAS[43]

Treatment/Prevention

	Guideline	Strength of Evidence	Certainty of Evidence
1.Screening	1A. Older adults aged 65 years and older should be **screened for sarcopenia annually**, or after the occurrence of major health events	Conditional	++
	1B. Screening for sarcopenia can be performed using **gait speed, or with the SARC-F questionnaire**	Conditional	++
	1C. Individuals screened as positive for sarcopenia should be referred for **further assessment** to confirm the presence of the disease	Conditional	++
2. Diagnosis	2A. It is recommended that health practitioners use an **objective measurement tool** for the diagnosis of Sarcopenia, utilising any of the published consensus definitions	Conditional	+++
	2B. **DXA** should be used to determine low lean mass when diagnosing sarcopenia	Conditional	++
	2C. **Walking speed or grip strength** should be used to determine low levels of muscle strength and physical performance respectively when diagnosing sarcopenia	Strong	+++

Dent E et al, The journal of nutrition, health & aging, 22 (10) 1148-1161 (2018).

Treatment/Prevention

Interventions	Guideline	Strength of Evidence	Certainty of Evidence
3. Physical Activity	3A. In patients with sarcopenia, prescription of **resistance-based training** may be effective to improve lean mass, strength and physical function	Strong	+++
4. Protein	4A. We recommend clinicians consider **protein supplementation/a protein-rich diet** for older adults with sarcopenia	Conditional	++
	4B. Clinicians may also consider discussing with patients the importance of **adequate calorie and protein intake**	Conditional	+
	4C. **Nutritional (protein) intervention should be combined with a physical activity intervention**	Conditional	++
5. Vitamin D	5A. Insufficient evidence exists to determine whether a **Vitamin D supplementation** regime by itself is effective in older adults with sarcopenia	Insufficient evidence	+

Dent E et al, The journal of nutrition, health & aging, 22 (10) 1148-1161 (2018).

Treatment/Prevention

Interventions	Guideline	Strength of Evidence	Certainty of Evidence
6. Anabolic Hormones	6A. The current **evidence is insufficient to recommend anabolic hormones** for the management of sarcopenia	Insufficient evidence	+
7. Pharmacologic Interventions	7A. **Pharmacological interventions are not recommended** as first-line therapy for the management of sarcopenia	Insufficient evidence	+
8. Research	8A.. **Future international collaboration and large-scale RCTs** focusing specifically on older people with sarcopenia are recommended	n/a	n/a

Dent E et al, The journal of nutrition, health & aging, 22 (10) 1148-1161 (2018).

Take Home Message

- Screen/Measure frailty and sarcopenia
- Use an appropriate tool for your setting
- Physical activity is the most effective intervention
- Other interventions are promising
- Future studies are needed to address the knowledge gaps

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Twitter: @_negm_