Fragilidad y Sarcopenia

Dónde estamos y adonde vamos?

DRA. MILENA BOLAÑOS SÁNCHEZ

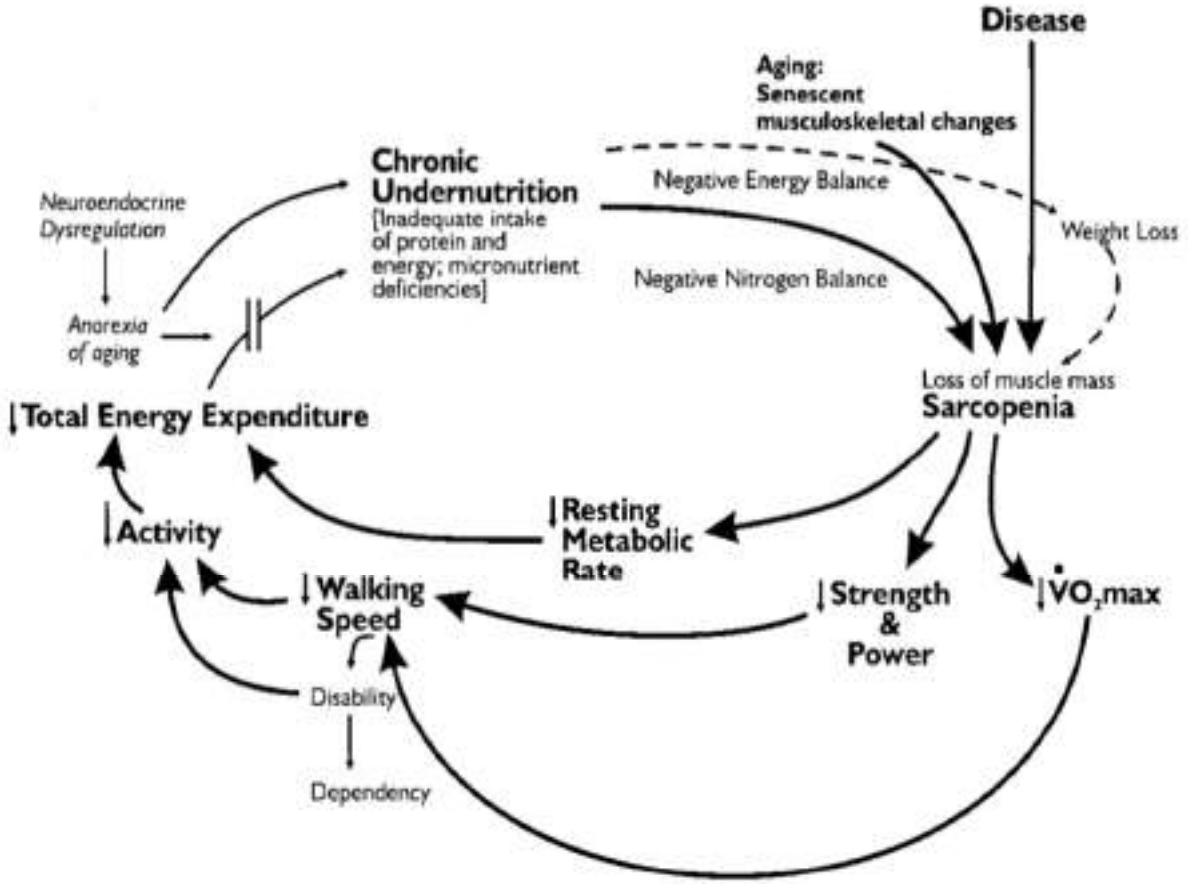
HOSPITAL NACIONAL DE GERIATRIA Y GERONTOLOGIA

UNIVERSIDAD DE COSTA RICA

Frailty in Older Adults:
Evidence for a Phenotype

Fried L, Tangen C, Walston J, Newman A, Hirsch C, et. al.

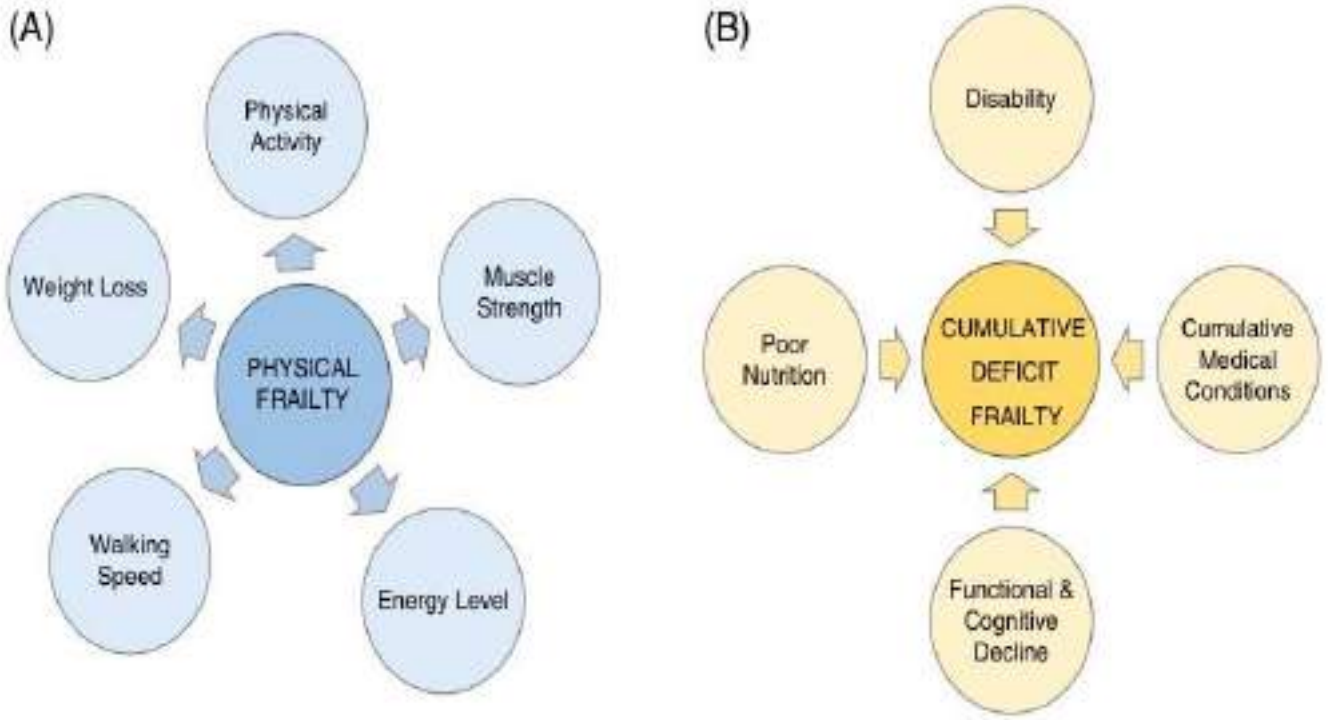
Journal of Gerontology: MEDICAL SCIENCES Copyright
2001 vol. 56 (3) pp. 146-156



Ciclo de la fragilidad



Fragilidad



Representación conceptual de las dos mayores teorías de la fragilidad. A) Fragilidad física, tiene la hipótesis de tener una base biológica dependiente de la edad especifica que lleva a la aparición de signos y síntomas. B) Fragilidad por déficit acumulativo cuya hipótesis esta asociada a la acumulación de deficits no específicos en salud, funcionales, psicológicos y cognitivos. Ambos conceptos de fragilidad predicen la vulnerabilidad a efectos adversos y a la elaboración de múltiples herramientas de detección.

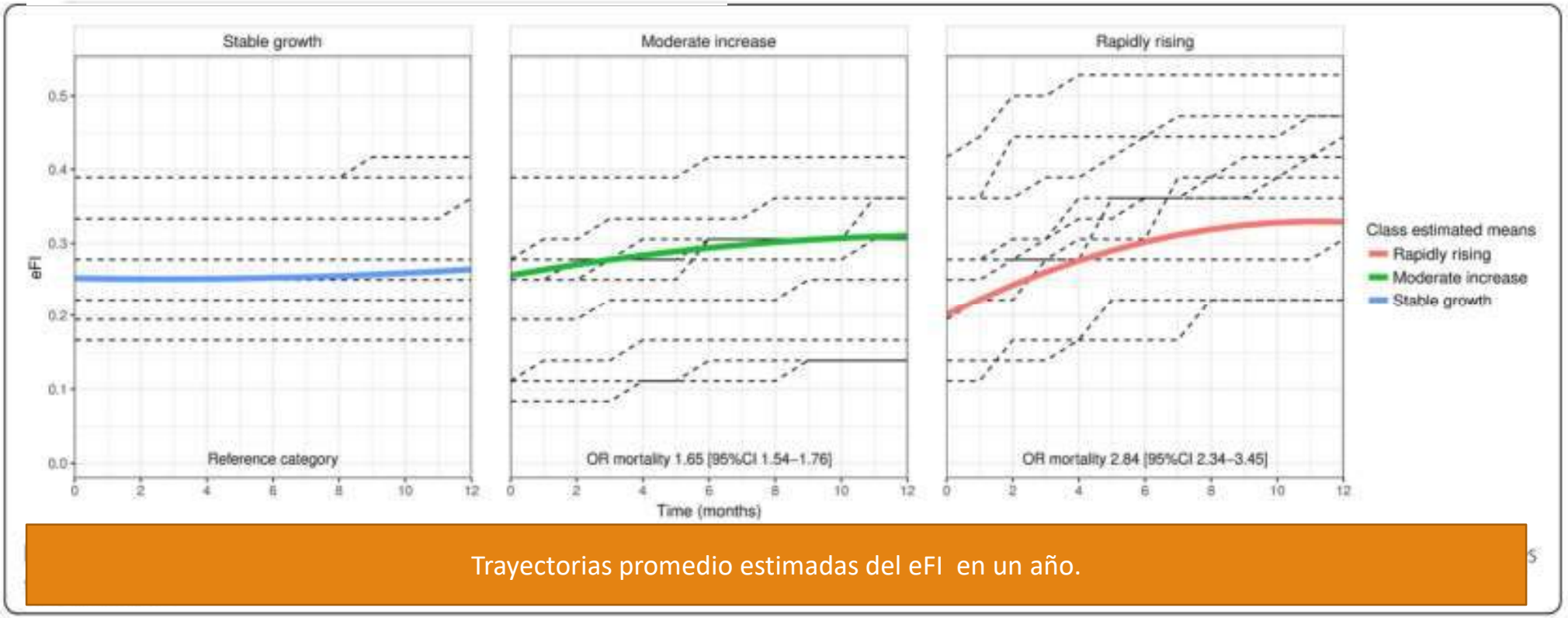
Walston J, et al Moving Frailty tward Clinical Practice. Journal of the American Geriatrics Society. 2019 67(8)
Gobbens, RJ et al. In sear of an integral coneptual definitions of experts. J Am Dir Assoc 2010 11(5)

Frailty trajectories to identify end of life: A longitudinal population-based study

Stow D, Matthews F, Hanratty B

BMC Medicine

2018 vol. 16 (1)



Trayectorias promedio estimadas del eFI en un año.

	Components	Frailty classification	Setting		
			Primary care	Hospital	Long-term care facility
Frailty phenotype[8]	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[21,22]	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[24]	Yes	Yes	Yes
Electronic Frailty Index[25]	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[26]	Visual and written chart for frailty with nine graded pictures: 1=very fit; 9=terminally ill	Frailty: score ≥5	Yes	Yes	Yes
FRAIL scale[31]	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[37]	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[38]	Seven self-reported items: age (>85 years), male, social support, and ADLs	Frailty: score ≥3	Yes	No	No
Tilburg Frailty Indicator[39]	15 self-reported items in three domains: physical, psychological, and social	Frailty: score ≥5	Yes	No	No
Geriatric 8 frailty questionnaire for oncology (G8)[40]	Eight items: function (ADL and IADL), mobility, nutrition, comorbidity, cognition, depression, social support	Frailty: score ≤14	No	Yes	No
Groningen Frailty Indicator[41]	15 self-reported items in four domains: physical, cognitive, social, psychological	Frailty: score ≥4	Yes	No	No
Short Physical Performance Battery[42]	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[43]	Nine items: cognition, health (2 ×), hospitalisation, social support, nutrition, mood, function, continence	Frailty: score ≥7	No	Yes	No
Multidimensional Prognostic Index[44]	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
Kihon Checklist[45]	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[46]	Formula: age (per 10 years) × 4 + male sex × 10 + no partner × 5 + body mass index <18·5 kg/m^2 × 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[47]	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.[33]

Table 1: **Commonly used frailty instruments**

Escalas de fenotipo fragilidad física y el índice de fragilidad no concuerdan en los datos de prevalencia que presentan, evidencia que sugiere que no son intercambiables en la mayoría de los escenarios

- Li,Q et al. Discrpancy in frailty identification Move Beyond Predictive validity. The Journals of Gerontolgy Series A. 2020. 75(2)

Estudios demuestran una marcada heterogeneidad en el grado en el que varias escalas sobre o subestiman la fragilidad y/o concuerdan con la identificación de los individuos frágiles.

- Aguayo,G et al. Agreement between 35 published frailty scores in the general population. American Journal of Epidemiology 2017. 186(4)

FRAGILIDAD

Esta asociada con el aumento de mortalidad, hospitalización, caídas e institucionalización.

Otros resultados adversos asociados a esta entidad incluyen discapacidad, delirium y aumento en la mortalidad

La literatura documenta también deterioro de la calidad de vida y soledad en los individuos frágiles

Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001; 56: 146–56.

Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet 2013; 381: 752–62.

Kojima G, Iliffe S, Jivraj S, Walters K. Association between frailty and quality of life among community-dwelling older people: a systematic review and meta-analysis. J Epidemiol Community Health 2016; 70: 716–21.

Hoogendijk EO, Suanet B, Dent E, Deeg DJ, Aartsen MJ. Adverse effects of frailty on social functioning in older adults: results from the Longitudinal Aging Study Amsterdam. Maturitas 2016; 83: 45–50

Theou O, Brothers TD, Mitnitski A, Rockwood K. Operationalization of frailty using eight commonly used scales and comparison of their ability to predict all-cause mortality. J Am Geriatr Soc. 2013;61(9):1537–51.

Drubbel I, de Wit NJ, Bleijenberg N, Eijkemans RJ, Schuurmans MJ, Numans ME. Prediction of adverse health outcomes in older people using a frailty index based on routine primary care data. J Gerontol A Biol Sci Med Sci. 2013;68(3):301–

Hope AA, Gong MN, Guerra C, Wunsch H. Frailty before critical illness and mortality for elderly Medicare beneficiaries. J Am Geriatr Soc. 2015;63(6): 1121–8



Sarcopenia

Aging Clinical and Experimental Research (2019) 31:793–798
https://doi.org/10.1007/s40520-019-01170-1

REVIEW

Malnutrition and sarcopenia

Cornel C. Sieber[1]

- Luego de los 50 años, cerca de 1-2%de la masa muscular se pierde por año
- La disminucion de la fuerza muscular disminuye aproximadamente de 20-40% cuando individuos de 20 años de edad se comparan con aquellos de 70 años
- Esto se incrementa hasta en un 50% o mas al compararlo con adultos mayores de 90 años.

DEFINICION

- Sarcopenia se ha definido como un desorden del músculo esquelético progresivo y generalizado que involuca la perdida acelerada de masa muscular y función.

Cruz-Jentoft, A, Sayer,A. Sarcopenia. Lancet 2019; 393: 2636–46

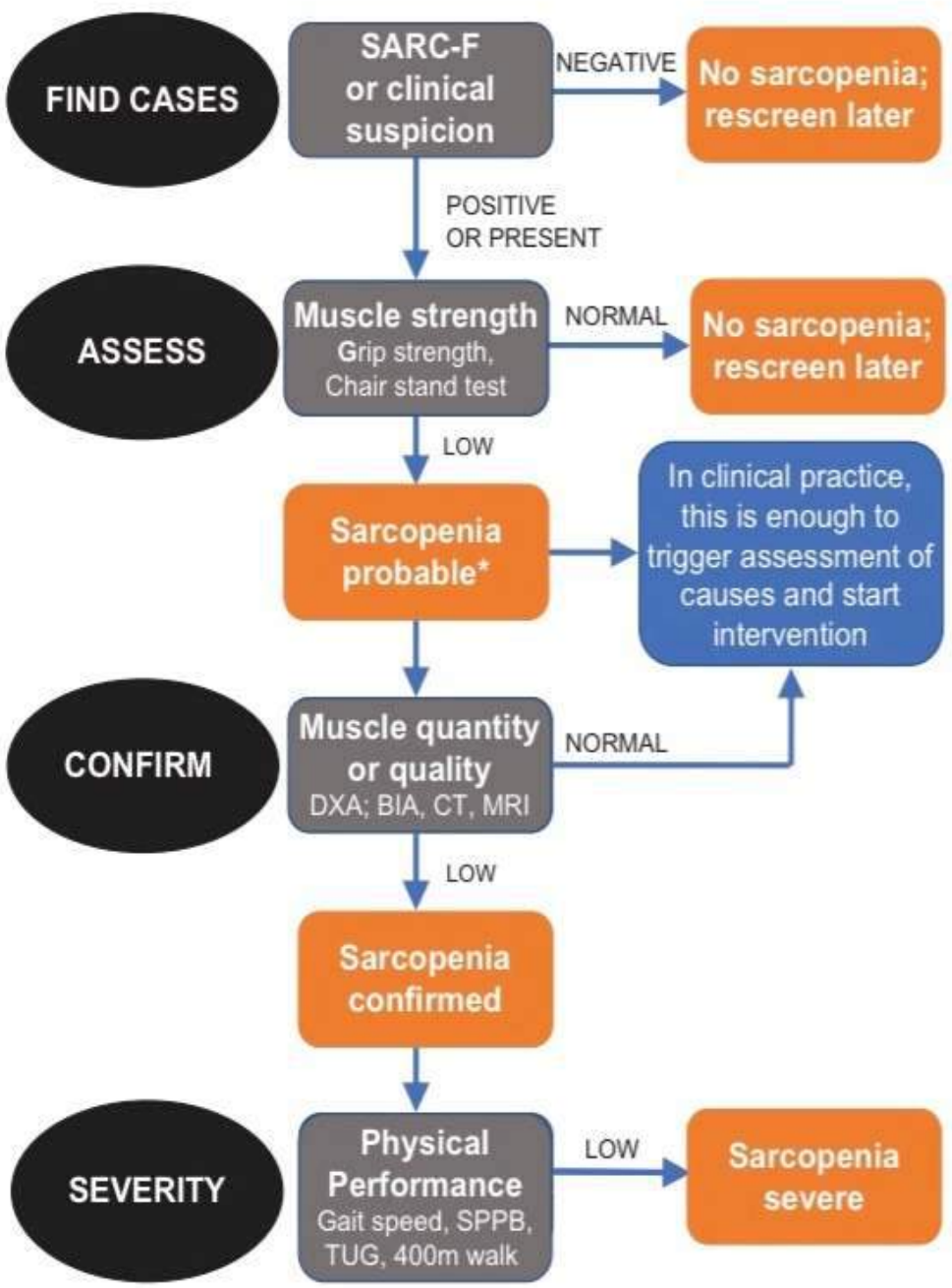
Age and Ageing 2019; 48: 16–31
doi: 10.1093/ageing/afy169
Published electronically 24 September 2018

© The Author(s) 2018. Published by Oxford University Press on behalf of the British Geriatrics Society. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

GUIDELINES

Sarcopenia: revised European consensus on definition and diagnosis

Algoritmo para búsqueda de casos, diagnostico y cuantificación de la severidad.



Se ha documentado que la Sarcopenia …..

Aumenta el riesgo de caídas y fracturas

- Bischoff-Ferrari HA, Orav JE, Kanis JA et al. Comparative performance of current definitions of sarcopenia against the prospective incidence of falls among community-dwelling seniors age 65 and older. Osteoporos Int 2015; 26: 2793–802
- Schaap LA, van Schoor NM, Lips P et al. Associations of sarcopenia definitions, and their components, with the incidence of recurrent falling and fractures: the longitudinal aging study Amsterdam. J Gerontol A Biol Sci Med Sci 2018; 73: 1199–204

Deteriora la habilidad de realizar las ABVD

- Malmstrom TK, Miller DK, Simonsick EM et al. SARC-F: a symptom score to predict persons with sarcopenia at risk for poor functional outcomes. J Cachexia Sarcopenia Muscle 2016; 7: 28–36

Esta asociada con enfermedad cardiaca, respiratoria y deterioro cognitivo

- Bahat G, Ilhan B. Sarcopenia and the cardiometabolic syndrome: a narrative review. Eur Geriatr Med 2016; 6: 220–23. 14.
- Bone AE, Hepgul N, Kon S et al. Sarcopenia and frailty in chronic respiratory disease. Chron Respir Dis 2017; 14: 85–99. 15.
- Chang KV, Hsu TH, Wu WT et al. Association between sarcopenia and cognitive impairment: a systematic review and metaanalysis. J Am Med Dir Assoc 2016; 17: 1164.e7–64.e15.

Produce desordenes de la movilidad

- Morley JE, Abbatecola AM, Argiles JM et al. Sarcopenia with limited mobility: an international consensus. J Am Med Dir Assoc 2011; 12: 403–9

Deteriora la calidad de vida

- Beaudart C, Biver E, Reginster JY et al. Validation of the SarQoL(R), a specific health-related quality of life questionnaire for Sarcopenia. J Cachexia Sarcopenia Muscle 2017; 8: 238–44. 17.

Aumenta la necesidad de institucionalización

- Dos Santos L, Cyrino ES, Antunes M et al. Sarcopenia and physical independence in older adults: the independent and synergic role of muscle mass and muscle function. J Cachexia Sarcopenia Muscle 2017; 8: 245–50
- Steffl M, Bohannon RW, Sontakova L et al. Relationship between sarcopenia and physical activity in older people: a systematic review and meta-analysis. Clin Interv Aging 2017; 12: 835–45. 20.

Aumenta el riesgo de muerte

- De Buyser SL, Petrovic M, Taes YE et al. Validation of the FNIH sarcopenia criteria and SOF frailty index as predictors of long-term mortality in ambulatory older men. Age Ageing 2016; 45: 602–8

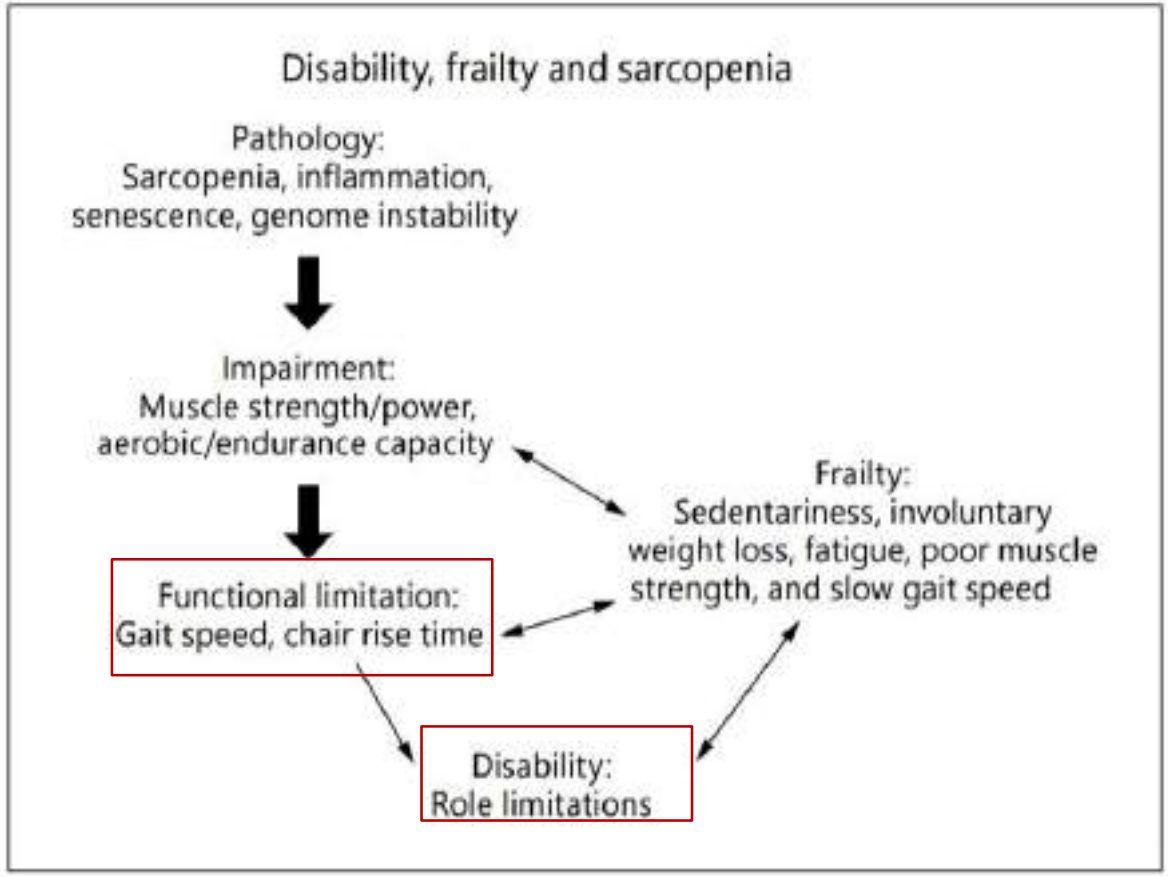


Intervenciones

A Summary of the Biological Basis of Frailty

Fielding R

Nestle Nutrition Institute Workshop Series
2015 vol. 83 pp. 41-44



Relación entre Fragilidad, Sarcopenia y Discapacidad

EJERCICIO

FRAGILIDAD

En comparación con el cuidado usual , los programas de actividad fisica (basados en entrenamiento de Resistencia, aerobico o balance y coordinación) reportan mejoria de la velocidad de la marcha, movilidad, y desempeño fisico en adultos mayores con fragilidad

de Labra C, Guimaraes?Pinheiro C, Maseda A, Lorenzo T, Millan?Calenti JC. Effects of physical exercise interventions in frail older adults: a systematic review of randomized controlled trials. BMC Geriatr 2015; 15: 154.

63 Gine?Garriga M, Roque?Figuls M, Coll?Planas L, Sitja?Rabert M, Salva A. Physical exercise interventions for improving performance?based measures of physical function in community?dwelling, frail older adults: a systematic review and meta?analysis. Arch Phys Med Rehabil 2014; 95: 753–69.e3.

64 Cadore EL, Rodriguez?Manas L, Sinclair A, Izquierdo M. Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. Rejuvenation Res 2013; 16: 105–14

SARCOPENIA

Varios meta-analisis documentan que la fuerza de extension en la rodilla ($P \leq 0.01$), Prueba Up and go minutada ($P < 0.0001$), Masa muscular apendicula ($P = 0.04$) y masa muscular de la pierna ($P = 0.04$) mejoran significativamente en respuesta a las intervenciones de ejercicio

Vlietstra, L, Hendrick,WExercise interventions in healthy older adults with sarcopenia: A systematic review and meta-analysis Australasian Journal on Ageing, Vol 37 No 3 September 2018, 169–183

Free Radical Biology and Medicine 132 (2019) 42–49

Contents lists available at ScienceDirect

Free Radical Biology and Medicine

journal homepage: www.elsevier.com/locate/freeradbiomed



Review Article

Sarcopenia, frailty and their prevention by exercise

C.M. Nascimento[c], M. Ingles[b], A. Salvador-Pascual[a], M.R. Cominetti[c], M.C. Gomez-Cabrera[a,*], J. Viña[a]

Recomendaciones generales de intervenciones basadas en ejercicio para tratar sarcopenia y fragilidad

Exercise modality	Duration	Volume	Intensity	Frequency	Indication
RESISTANCE	Variable (10–60 min) 3 months (range 2–12 months)	8–10 exercises involving major muscle groups. Progressive (1–3 sets, 6–12 repetitions)	Progressive (until 80% 1RM)	2–3 times/week (range 1–6)	SARCOPENIA (+ + +) FRAILTY (+ +)
ENDURANCE	20–60 min 3 months (range 2–12 months)	Progressive	Progressive (moderate to high; 6–8 points on a RPE scale)	3–5 days/week	SARCOPENIA (+ +) FRAILTY (+ +)
MULTICOMPONENT: RESITANCE (R) + ENDURANCE (E) + BALANCE (B) + FLEXIBILITY (F)	45–60 min *Pre-frail:* 20 min R + 10 min E + 20 min B + 10 min F *Frail:* 10 min R + 20 min E + 8 min B + 7 min F 3 months (range 1–18 months)	Progressive	Progressive (moderate to high; 6–8 points on a RPE scale)	2–3 times/week (range 1–7)	SARCOPENIA (+ + +) FRAILTY (+ + +)

NUTRICION

FRAGILIDAD

Proveer suplementos nutricionales solos , incluido la membrana de globulo de grasa de leche(MFGM) y formulas con energia proteica o incrementar las calorias proteicas y los micronutrientes, son estrategias que han probado ser favorables para la prevencion del progreso de la fragilidad

Kim H, Suzuki T, Kim M, Kojima N, Ota N, Shimotoyodome A, et al. Effects of exercise and milk fat globule membrane (MFGM)supplementationonbodycomposition,physical func- tion, and hematological parameters in community-dwelling frail Japanese women: A randomized double blind, placebo- controlled, follow-up trial. PLoS ONE 2015;10(2):e0116256.

Kim Ch-O, Lee K-R. Preventive effect of protein-energy supplementation on the functional decline of frail older adults with low socioeconomic status: a community-based randomized controlled study. J Gerontol A Biol Sci Med Sci 2013;68(3):309–16.

Ng TP, Feng L, Nyunt MS, Feng L, Niti M, Tan BY, et al. Nutritional, physical, cognitive, and combination interven- tions and frailty reversal among older adults: A randomized controlled trial. Am J Med 2015;128(11):1225–36

SARCOPENIA

Existe evidencia de los beneficios tanto para mejorar la masa muscular como las pruebas de desempeño de tener una dieta saludable que cuente con patrones adecuados de ingesta proteica, vitamina D, nutrientes antioxidantes y acidos grasos polinsaturados de cadena larga.

Robinson SM, Reginster JY, Rizzoli R, et al. Does nutrition play a role in the prevention and management of sarcopenia? Clin Nutr 2018; 37: 1121–32.

Deer RR, Volpi E. Protein intake and muscle function in older adults. Curr Opin Clin Nutr Metab Care 2015; 18: 248–53.

Bauer J, Biolo G, Cederholm T, et al. Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group. J Am Med Dir Assoc 2013; 14: 542–59.

Deutz NEP, Bauer JM, Barazzoni R, et al. Protein intake and exercise for optimal muscle function with aging: recommendations from the ESPEN Expert Group. Clin Nutr 2014; 33: 929–36.

Effectiveness of interventions to prevent pre-frailty and frailty progression in older adults: a systematic review

João Apóstolo[1] · Richard Cooke[2] · Elzbieta Bobrowicz-Campos[1] · Silvina Santana[3] · Maura Marcucci[4,5] · Antonio Cano[6] · Miriam Vollenbroek-Hutten[7] · Federico Germini[5] · Barbara D'Avanzo[8] · Holly Gwyther[2] · Carol Holland[2]

JBI Database of Systematic Reviews and Implementation Reports. 2018 16(1)

- Los estudios de esta revisión multicéntrica llegan a la conclusión, luego de todas la intervenciones, de que el ejercicio y la nutrición son los mas exitosos en reducir fragilidad, juntos o como intervenciones aisladas.

HACIA DONDE VAMOS

GEROPROTECTORES

- Geroprotectores han mostrado la habilidad de retrasar el inicio de múltiples disfunciones tisulares así como enfermedades relacionadas a la edad y mejorar la resilencia modulando mecanismos de envejecimientos como la senesencia, autofagia y la inflamación.
- Drogas como la rapamicina, resveratrol, metformina, inhibidores de la ECA pueden mejorar la sobrevida de miltiples sistemas incluyendo el cardiaco, cognitivo, neuromuscular, metabólico e inmune
- Han demostrado en retraso de la fragilidad en modelos animales

Trendelenburg, A et al. Geroprotectors: A role in the treatment of frailty. Mechanisms of Ageing and Development 180 (2019) 11–20

Drogas que tiene potencial para tratar la sarcopenia incluyen la testosterona y anabólicos esteroideos, anticuerpos anti miostatina, anticuerpos receptores activina y agonista de grelina (anamorelina)

El interés esta también en el rol de los betabloqueadores, inhibidores de la ECA

Morley, J Treatment of sarcopenia: the road to the futureJournal of Cachexia, Sarcopenia and Muscle 2018; 9: 1196–1199

Además se requieren…

- Nuevos estudios que permitan:
  - Estandarización de conceptos
  - Evidencia robusta de como es la mejor forma de manejar la fragilidad y la sarcopenia (costo efectividad)
  - Definición de los escenarios y los métodos para tamizaje de ambas entidades a fin de tomar decisiones apropiadas en políticas publicas

www.thelancet.com Vol 394 October 12, 2019

Según recomendaciones de la OMS

- DEFINIR INTERVENCIONES BASADAS EN LA EVIDENCIA
  - QUE TENGAN ENFOQUE EN EL CURSO DE VIDA
  - QUE LOGREN OPTIMIZAR LA TRAYECTORIA DE LA CAPACIDAD INTRINSECA DE LOS INDIVIDUOS
  - QUE FORTALEZCAN LA IMPLEMENTACION DE MODELOS DE CUIDADO INTERDICIPLINARIO PARA EL MANEJO DE PACIENTES GERIATICOS (UNIDADES ORTOGERIATRIA)

CONCLUSIONES



- Tanto la fragilidad como la sarcopenia resultan de gran importancia en la Geriatría dado el impacto que tienen en la salud y calidad de vida de los adultos mayores
- Se tiene gran cantidad de evidencia de la detección e intervenciones de estas entidades
- Se requiere mayor evidencia que fundamente temas críticos como el tamizaje generalizado, estandarización de las intervenciones y nuevos tratamientos que permitan un mejor abordaje



Muchas Gracias

Casas-Herrero et al. Trials (2019) 20:362
https://doi.org/10.1186/s13063-019-3426-0

Trials

STUDY PROTOCOL Open Access

Effect of a multicomponent exercise programme (VIVIFRAIL) on functional capacity in frail community elders with cognitive decline: study protocol for a randomized multicentre control trial

Alvaro Casas-Herrero[1,2,3], Ivan Anton-Rodrigo[4,6], Fabricio Zambom-Ferraresi[2,3], Mikel L. Sáez de Asteasu[2,3,5], Nicolás Martínez-Velilla[1,2,3], Jaione Ekspuru-Estomba[4], Itxaso Marín-Epelde[1,2], Fernanda Ramon-Espinoza[1,2], Roberto Petidier-Torregrosa[7], Juan L. Sanchez-Sanchez[7], Berta Ibañez[8] and Mikel Izquierdo[2,3,5]*

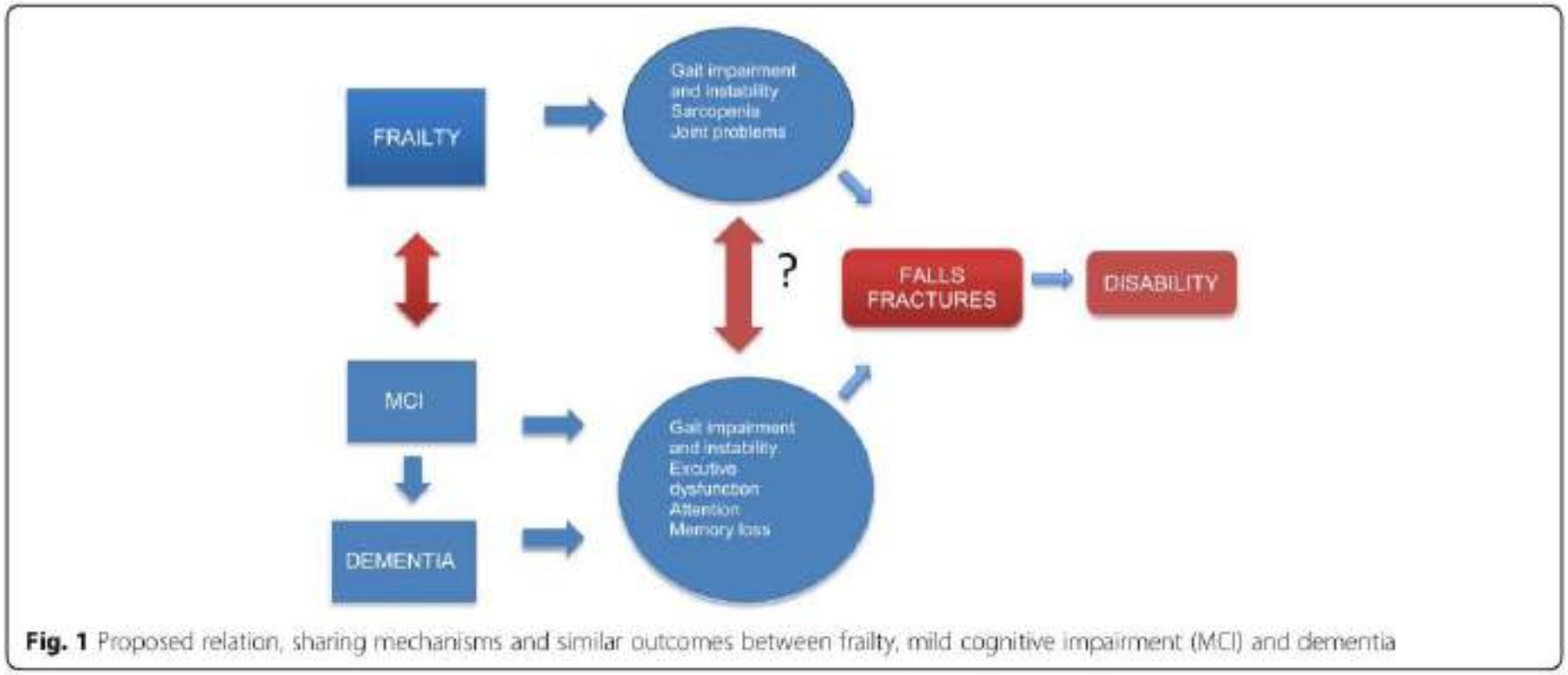


Fig. 1 Proposed relation, sharing mechanisms and similar outcomes between frailty, mild cognitive impairment (MCI) and dementia

Component	Maximum point	Maximum score	Minimum score
Total fruit	5	≥0.8 cup/1,000 kcal	No fruit
Whole fruit	5	≥0.4 cup/1,000 kcal	No whole fruit
Total vegetables	5	≥1.1 cup/1,000 kcal	No vegetables
Greens and beans	5	≥ 0.2 cup/1,000 kcal	No dark green vegetables or beans and peas
Whole grain	10	≥1.5 Oz/1,000 kcal	No whole grains
Dairy	10	≥1.3 cup/1,000 kcal	No dairy
Total protein foods	5	≥2.5 Oz/1,000 kcal	No protein foods
Seafood and plant proteins	5	≥0.8 Oz/1,000 kcal	No seafood or plant proteins
Fatty acids	10	(PUFAs + MUFAs)/SFAs >2.5	(PUFAs + MUFAs)/SFAs <1.2
Refined grains	10	≤1.8 Oz/1,000 kcal	≥4.3 Oz/1,000 kcal
Sodium	10	≤1.1 g/1,000 kcal	≥2.0 g/1,000 kcal
Empty calories	20	≤19% of energy	≥50% of energy

PUFAs: Polyunsaturated fatty acids; MUFAs: Monounsaturated fatty acids; SFAs: Saturated fatty acids

adjustment for confounders including energy intake, those consuming poor- and medium-quality diets had a higher frailty incidence than those consuming good-quality diets (hazard ratio [HR] = 1.92 [95% confidence interval [CI] = 1.17-3.17] and HR = 1.40 [95% CI = 0.99-1.98], respectively). No associations for energy or protein intake were observed. Competing risk analyses yielded similar results. Among the robust, those with lower vegetable protein intake had a higher "pre-frailty or frailty" incidence (per −10 g/d: HR = 1.20; 95% CI = 1.04-1.39). No other associations were observed.

CONCLUSION: Poorer overall diet quality and lower vegetable protein intake may increase the risk of becoming frail in old age. We found no association for intakes of energy, total protein, or animal protein. J Am Geriatr Soc 00:1-8, 2019.

CLINICAL INVESTIGATION

Prospective Associations of Diet Quality With Incident Frailty in Older Adults: The Health, Aging, and Body Composition Study

Linda M. Hengeveld, MSc, Hanneke A. H. Wijnhoven, PhD,* Margreet R. Olthof, PhD,* Ingeborg A. Brouwer, PhD,* Eleanor M. Simonsick, PhD,† Stephen B. Kritchevsky, PhD,‡ Denise K. Houston, PhD,‡ Anne B. Newman, MD, MPH,§ and Marjolein Visser, PhD**

Malnutrition-sarcopenia syndrome: Is this the future of nutrition screening and assessment for older adults?

Vandewoude M, Alish C, Sauer A, Hegazi R

Journal of Aging Research
2012 vol. 2012

Table 1: Prevalence of malnutrition and sarcopenia in older adults across clinical settings.

Patient Population/Setting	Malnutrition	Sarcopenia
Hospital/Acute Care	56% [11]	
	23% [15]	
Long Term Care	21% [15]	32.8% [21]
	2–9% [15]	25% [20]
Community	1–10% [15]	37–61% (class I sarcopenia) [22]
	(41–48% at risk) [14]	5–11% (class II sarcopenia) [22]

JAMDA 17 (2016) 789–796

JAMDA

journal homepage: www.jamda.com

Review Article

Skeletal Muscle Regulates Metabolism via Interorgan Crosstalk: Roles in Health and Disease

Josep M. Argilés PhD [a,*], Nefertiti Campos PhD [b], José M. Lopez-Pedrosa PhD [b], Ricardo Rueda MD, PhD [b], Leocadio Rodriguez-Mañas PhD [c]

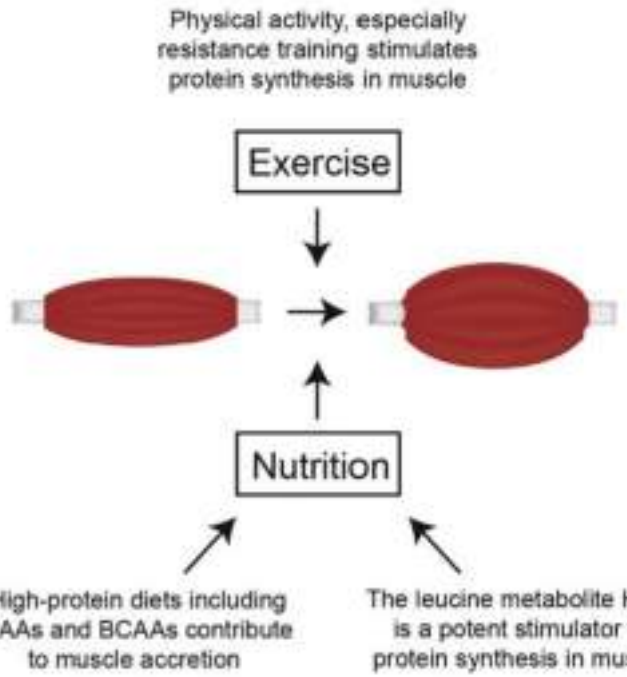


Fig. 4. Treatments for sarcopenia. It is currently recommended that patients at risk of or suffering from sarcopenia consume a diet high in protein, engage in resistance exercise, and take supplements of the leucine metabolite HMB.

Bone 105 (2017) 276–286

Contents lists available at ScienceDirect

Bone

journal homepage: www.elsevier.com/locate/bone

Review Article

A review of sarcopenia: Enhancing awareness of an increasingly prevalent disease

Eric Marty, Yi Liu, Andre Samuel, Omer Or, Joseph Lane *

Department of Orthopedic Surgery, Hospital for Special Surgery, New York, NY 10021, United States

Table 2

Studies of current treatment options for sarcopenia.

Intervention(s)	Regimen(s)	Population(s)	Observed outcomes	Reference(s)
Resistance training	3×/week for 12 weeks	Elderly hip surgery patients	Decreased hospital length of stay, increased muscle strength and muscle cross-sectional area versus control	[117]
Resistance training	2×/week for 24 weeks	Nursing care facility residents	Increased grip strength versus control	[118]
Resistance training	3×/week 1–8 2×/week 9–24 Monthly/week 25–52	Sarcopenic adults	No statistical significance versus non-training controls at 12 months	[119]
3 g leucine enriched supplement + 60 min training	2×/day for 12 weeks	Sarcopenic older women	Increased knee extension strength versus exercise or nutritional supplementation alone	[111]
20 g whey protein + 3 g leucine + 800 IU vitamin D	2×/day for 13 weeks	Sarcopenic older adults	Increased muscle mass and improved chair-stand test versus iso caloric control	[112]
14–20 g protein + 147–499 IU vitamin D ± 1.5 g β-hydroxy β-methylbutyrate (HMB)	2×/day for 24 weeks	Malnourished sarcopenic adults	Increased isokinetic peak torque Increased grip strength Improved gait speed	[113]
2–3 g β-hydroxy β-methylbutyrate (HMB)	1×/day for 2–12 months	Elderly adults	Improved muscle mass, muscle strength, and physical performance	[116] (review)
5–20 g creatine + resistance training	1×/day for 12–24 weeks	Elderly adults	Increased muscle mass, chair rise performance, and knee extension strength	[115] (meta-analysis)
400–4000 IUs vitamin D	1×/day for 1–60 months	Various populations	Improved muscle strength, particularly in ages >65 or starting <30 nmol/L	[114] (meta-analysis)
1–7 sessions per week whole body vibrational therapy	6 weeks-18 months	Elderly adults	Increased muscle strength Improved jumping height and sit to stand performance	[120] (meta-analysis)

Physical Frailty: ICFSR International Clinical Practice Guidelines for Identification and Management

Dent E, Morley J, Cruz-Jentoft A, Woodhouse L, Rodríguez-Mañas L, et. al.

Journal of Nutrition, Health and Aging
2019 vol. 23 (9) pp. 771-787

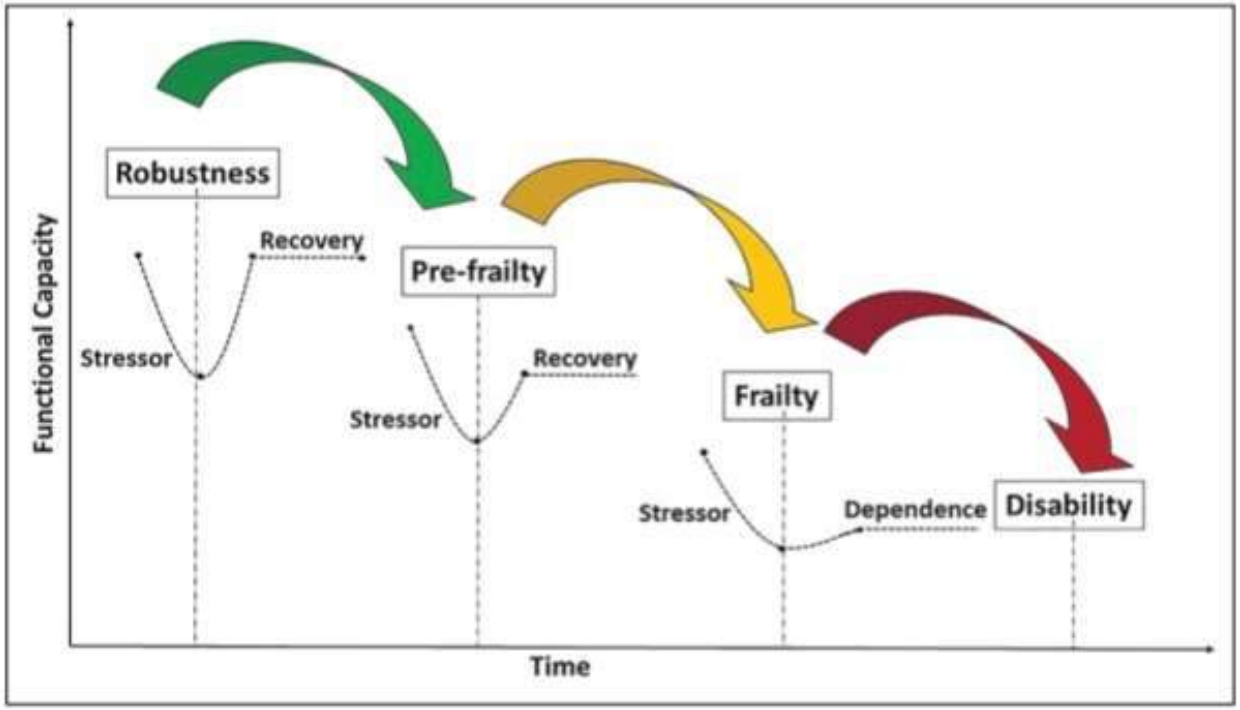
Table 1
Summary of ICFSR evidence-based recommendations and clinical considerations for the identification and management of frailty in older adults

	Recommendation	Grade	Certainty of Evidence
Frailty Screening			
1	All adults aged 65 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, anaemia, 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 programme (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
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

Where sufficient evidence was available from systematic reviews/meta-analyses, recommendations were ranked according to the GRADE approach (1). Where evidence was limited in systematic reviews/meta-analyses or for topics beyond the scope of systematic reviews, Consensus Based Recommendations (CBR) were formulated by the International Conference of Frailty and Sarcopenia Research (ICFSR) task force on frailty; † 'No data' indicates no data identified by systematic reviews.

Figure 1

The cascade of functional decline in older adults from independence, through to frailty and disability (in the absence of intervention) [Based on concepts and findings by Dapp et al. (34) Hoogendijk et al. (35), Clegg et al. (36) and Fried et al. (37)]



Nutritional recommendations for the management of sarcopenia

Morley J, Argiles J, Evans W, Bhasin S, Cella D, et. al.

Journal of the American Medical Directors Association
2010 vol. 11 (6) pp. 391-396

Table 2. *Sarcopenia Recommendations*

- Aging is associated with a physiological anorexia, decreased protein and energy intake, and weight loss. This is associated with a decline in muscle mass and increased mortality.
- The metabolic efficiency in older persons is decreasing, requiring a higher protein intake for protein synthesis than in younger persons.
- This suggests that a balanced protein and energy supplement may be useful in preventing and reversing sarcopenia as part of a multimodal therapeutic approach. (A)
- Persons with obesity and sarcopenia have very poor outcomes. Appropriate dietary approaches for this group, other than aggressive resistance exercise, are unknown.
- As 15% to 38% of older men and 27% to 41% of older women ingest less than the recommended daily allowance for protein it is suggested that protein intake be increased. (B)
- It is recommended that the total protein intake should be 1 to 1.5 g/kg/day. (B)
- It is suggested that a leucine-enriched balanced essential amino acid mix may be added to the diet. (B)
- A trial of balanced amino acid supplementation alone and with exercise in sarcopenia is recommended.
- Creatine may enhance the effects of exercise in sarcopenic patients. (A)
- Long-term studies of the effect of creatine on sarcopenia need to be carried out.
- Based on treatment trials in patients with sarcopenia and on well-established human physiology, patients receiving anabolic therapies will have increased dietary energy needs to support increases in lean body mass. Whether the increase in dietary energy needs will require explicit nutritional support is an individualized decision. (B)
- Based on some treatment trials in patients with sarcopenia and on physiologic hypotheses, for optimal deposition of muscle mass, patients receiving anabolic therapies probably require adequate protein intake. Whether meeting dietary protein needs will require explicit nutritional support is an individualized decision. (B)
- There is a need for a reasonably powered clinical trial to test these hypotheses in sarcopenic patients.
- 25(OH) vitamin D levels should be measured in all sarcopenic patients. (A)
- Vitamin D supplementation in doses sufficient to raise levels above 100 nmol/L should be given as an adjunctive therapy. (A)
- Either vitamin D2 or D3 is an acceptable replacement. (A)
- Doses of 50,000 IU of vitamin D a week are safe. (A)
- Short-term resistance exercise improves strength and gait speed. (A)
- Aerobic exercise improves quality of life years (QALY) and is cost effective. (A)
- Epidemiology studies suggest positive effects of physical fitness on health.
- We recommend resistance and aerobic exercise for 20 to 30 minutes, 3 times a week. (A)

Treatment of sarcopenia: The road to the future

Morley J

Journal of Cachexia, Sarcopenia and Muscle

2018 vol. 9 (7) pp. 1196-1199

Table 1 Patient-centred approach to management of sarcopenia

Early identification	Primary prevention	Secondary prevention	Tertiary prevention
SARC-F or ISHII screening test	Exercise	Resistance exercise	Physical therapy
	Adequate protein diet	Low-protein diet: leucine-enriched essential amino acids or methyl hydroxy butyrate supplementation	Occupational therapy
	In ALL hospitalized: aggressive resistance exercise (include intensive care unit)	Male hypogonadism: testosterone	If dysphagia: speech therapy
		If falling: use CDC STEADI or F3ALLS approach	Provide adequate protein intake
		If low 25(OH) vitamin D—1000 IU vitamin D	Optimal treatment of COPD; CHF and diabetes mellitus Exclude cachexia: elevated CRP + low protein Exclude protein energy malnutrition (anorexia or malabsorption) -Look for treatable causes -Caloric supplement -Future: anamorelin Future: antibodies to myostatin

Updated concept of sarcopenia based on muscle–bone relationship

Yakabe M, Hosoi T, Akishita M, Ogawa S

Journal of Bone and Mineral Metabolism
2020 vol. 38 (1) pp. 7-13

2 Cut-offs in the diagnostic criteria by EWGSOP2

	Men	Women
Strength		
Grip strength	< 27 kg	< 16 kg
Chair stand test	> 15 s for five rises	
Muscle quantity		
ASM	< 20 kg	< 15 kg
SMI	< 7.0 kg/m^2	< 6.0 kg/m^2
Performance		
Gait speed	≤ 0.8 m/s	
SPPB	≤ 8 point score	
TUG	≥ 20 s	
400-m walk test	Noncompletion or ≥ 6 min for completion	

Sarcopenia

Tournadre A, Vial G, Capel F, Soubrier M, Boirie Y

Joint Bone Spine

2019 vol. 86 (3) pp. 309-314

Sarcopenia is defined as a combination of low muscle mass with low muscle function. The term was first used to designate the loss of muscle mass and performance...

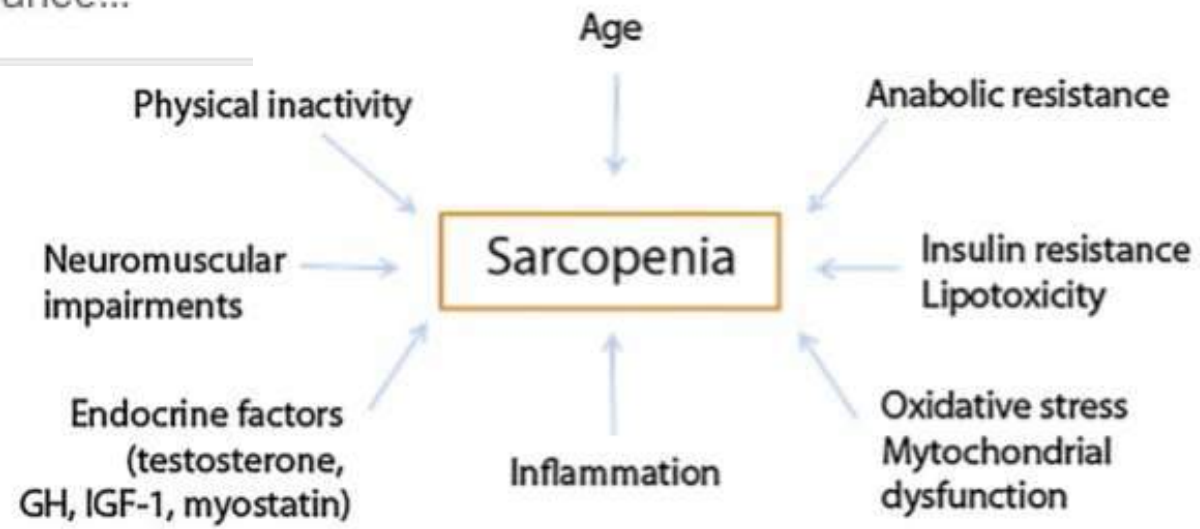


Fig. 1. Mechanisms underlying sarcopenia.

Free Radical Biology and Medicine 132 (2019) 42–49

Contents lists available at ScienceDirect

Free Radical Biology and Medicine

journal homepage: www.elsevier.com/locate/freeradbiomed

Review Article

Sarcopenia, frailty and their prevention by exercise

C.M. Nascimento[c], M. Ingles[b], A. Salvador-Pascual[a], M.R. Cominetti[c], M.C. Gomez-Cabrera[a,*], J. Viña[a]

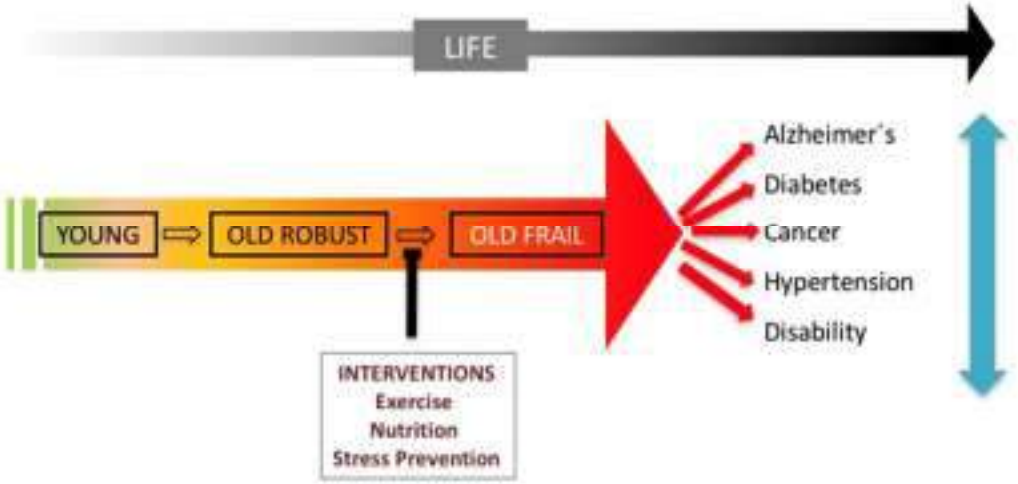


Fig. 4. Physiological interventions to delay frailty and age-associated diseases.

Adherence to Mediterranean Diet and Frailty

Ntanasi E, Yannakoulia M, Kosmidis M, Anastasiou C, Dardiotis E, et. al.

Journal of the American Medical Directors Association

2018 vol. 19 (4) pp. 315-322.e2

---

performed.

Results: Of our participants, 70 (4%), 325 (18.7%), and 442 (25.4%) were identified as frail according to the Fried et al definition, the Frailty Index, and the Tilburg Frailty Indicator, respectively. Adjusting for confounding factors, each additional unit in the MedDietScore was associated with a 5% ($P = .09$), 4% ($P = .005$), and 7% ($P < .001$) decrease in the odds for frailty according to the Fried definition, the Frailty Index, and the Tilburg Frailty Indicator, respectively.

Conclusions: According to study results, a higher adherence to the Mediterranean diet was associated

Frailty: implications for clinical practice and public health

Hoogendijk E, Afilalo J, Ensrud K, Kowal P, Onder G, et. al.

The Lancet
2019 vol. 394 (10206) pp. 1365-1375

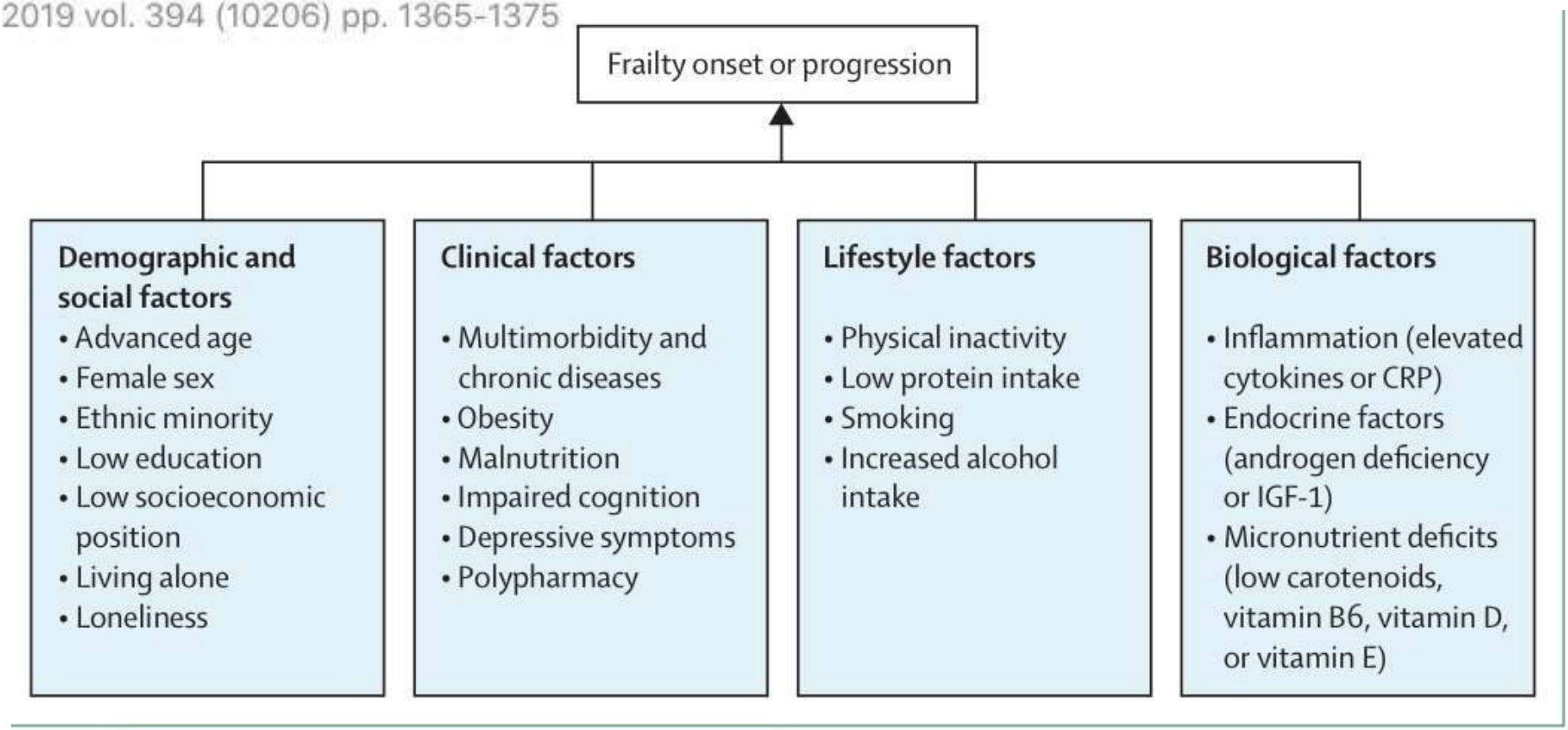


Figure 3: **Risk factors for onset or progression of frailty**

Nutritional interventions to prevent and treat frailty

Cruz-Jentoft A, Woo J

Current opinion in clinical nutrition and metabolic care

2019 vol. 22 (3) pp. 191-195

KEY POINTS

- Poor nutrition, especially in terms of energy, protein, and certain micronutrient intake, represents a key factor in the pathophysiology of frailty.
- Adequate nutrient intake may prevent the onset of frailty.
- Intervention consisting of nutrition, with and without exercise, is effective in frailty and sarcopenia, although the evidence base is currently limited, and there are several randomized controlled trials in progress.
- On the basis of current evidence, public health recommendations may be made, to be implemented on an individualized basis.

The New Geriatric Giants

Morley J

Clinics in Geriatric Medicine

2017 vol. 33 (3) pp. xi-xii

Table 1

ICOPE: Integrated Care for Older Persons Guidelines

Improve Musculoskeletal function, mobility and vitality
Maintain sensory capacity
Prevent severe cognitive impairment and promote psychological well-being
Manage age-associated conditions such as urinary incontinence
Prevent falls
Support caregivers

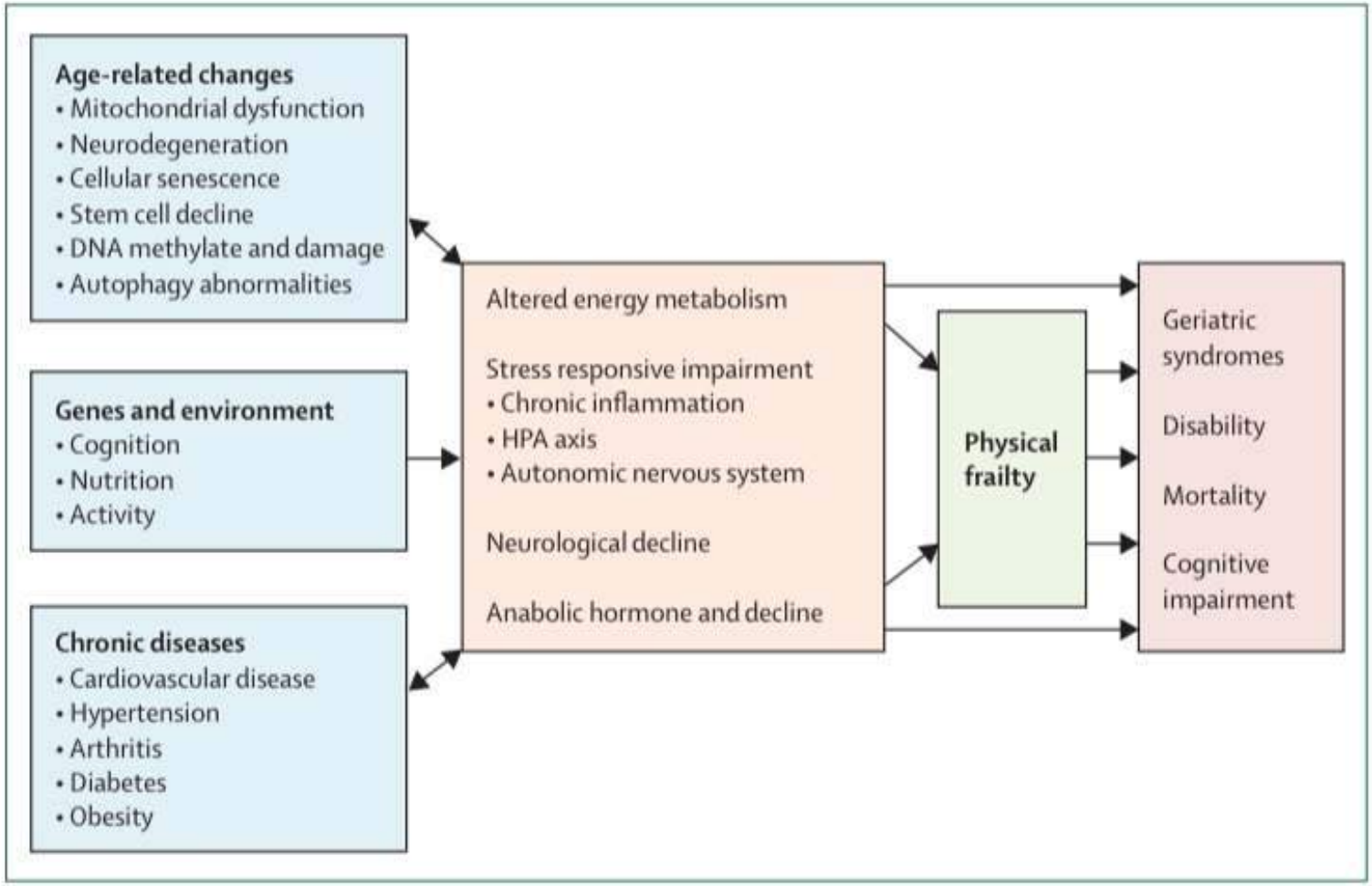


Figure: **Model pathway for physical frailty**

Reproduced from Michel et al[107] by permission of Oxford University Press. HPA=hypothalamic-pituitary-adrenal.

Ageing and endocrinology 4

Frailty and the endocrine system

Andrew Clegg, Zaki Hassan-Smith

Frailty is a condition characterised by loss of biological reserves, failure of homoeostatic mechanisms, and vulnerability to adverse outcomes. The endocrine system is considered particularly important in frailty, because of its complex inter-relationships with the brain, immune system, and skeletal muscle. This Review summarises evidence indicating

Lancet Diabetes Endocrinol 2018
Published Online

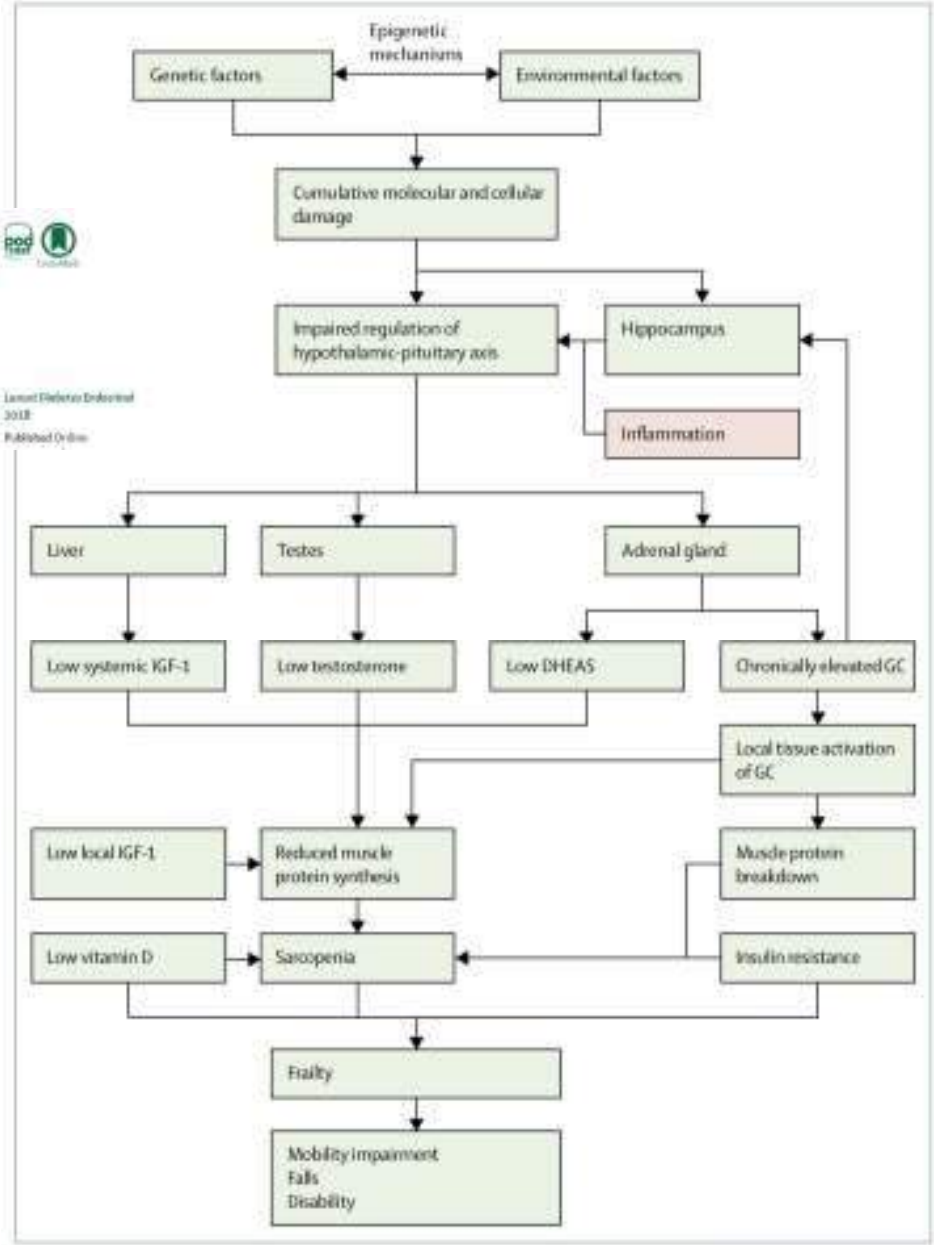


Figure 2: Potential endocrine mechanisms involved in the development of frailty
IGF-1=insulin-like growth factor 1. DHEAS=dehydroepiandrosterone. GC=glucocorticoid.

The essence of frailty: A systematic review and qualitative synthesis on frailty concepts and definitions

Junius-Walker U, Onder G, Soleymani D, Wiese B, Albaina O, et. al.

European Journal of Internal Medicine

2018 vol. 56 pp. 3-10

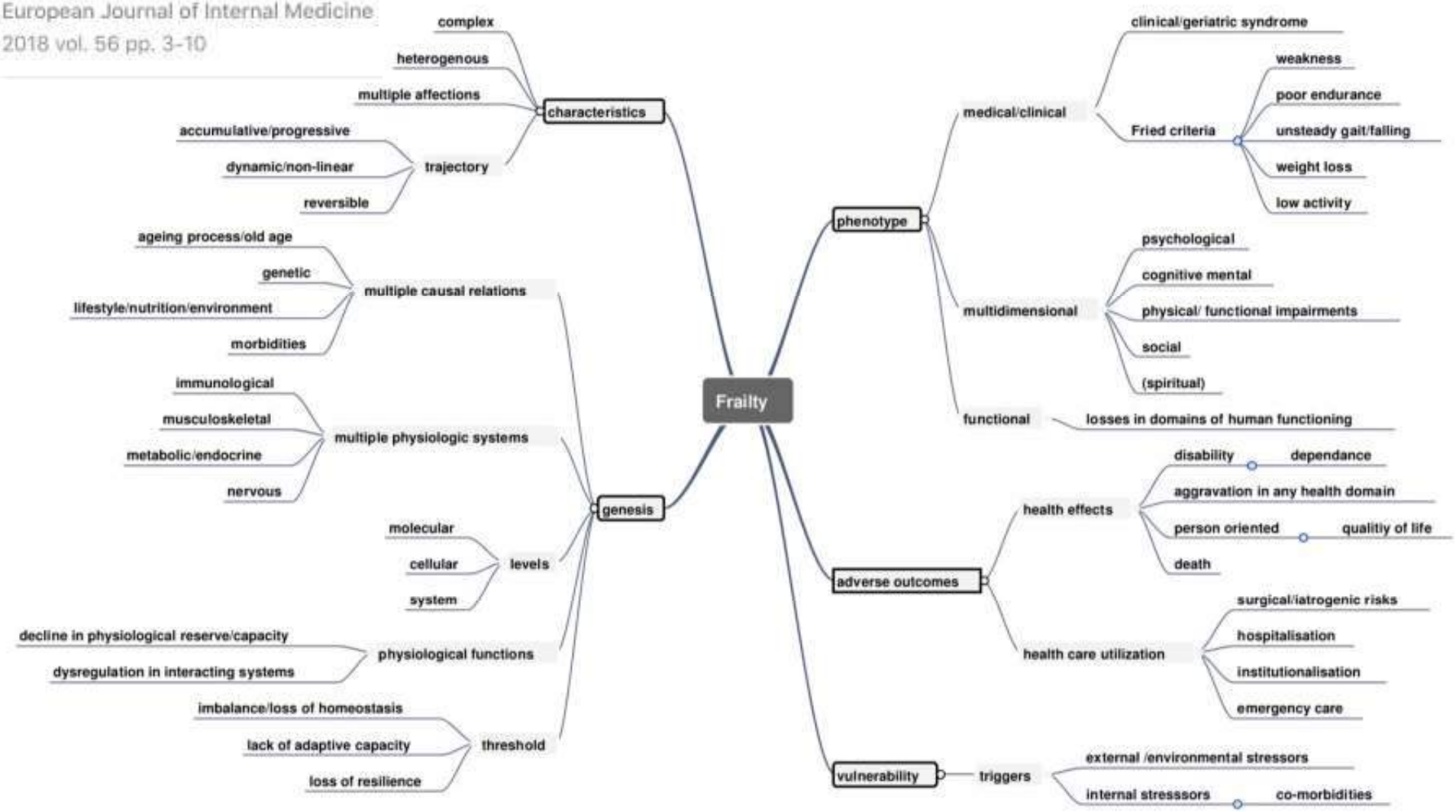


Fig. 3. Core components and their descriptive criteria that define frailty.

Preventive Medicine 119 (2019) 63–69

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Review Article

Should we screen for frailty in primary care settings? A fresh perspective on the frailty evidence base: A narrative review

Rachel C. Ambagtsheer[a,b,*], Justin J. Beilby[a,b], Renuka Visvanathan[a,c], Elsa Dent[b,d], Solomon Yu[a,c], Annette J. Braunack-Mayer[e,f]

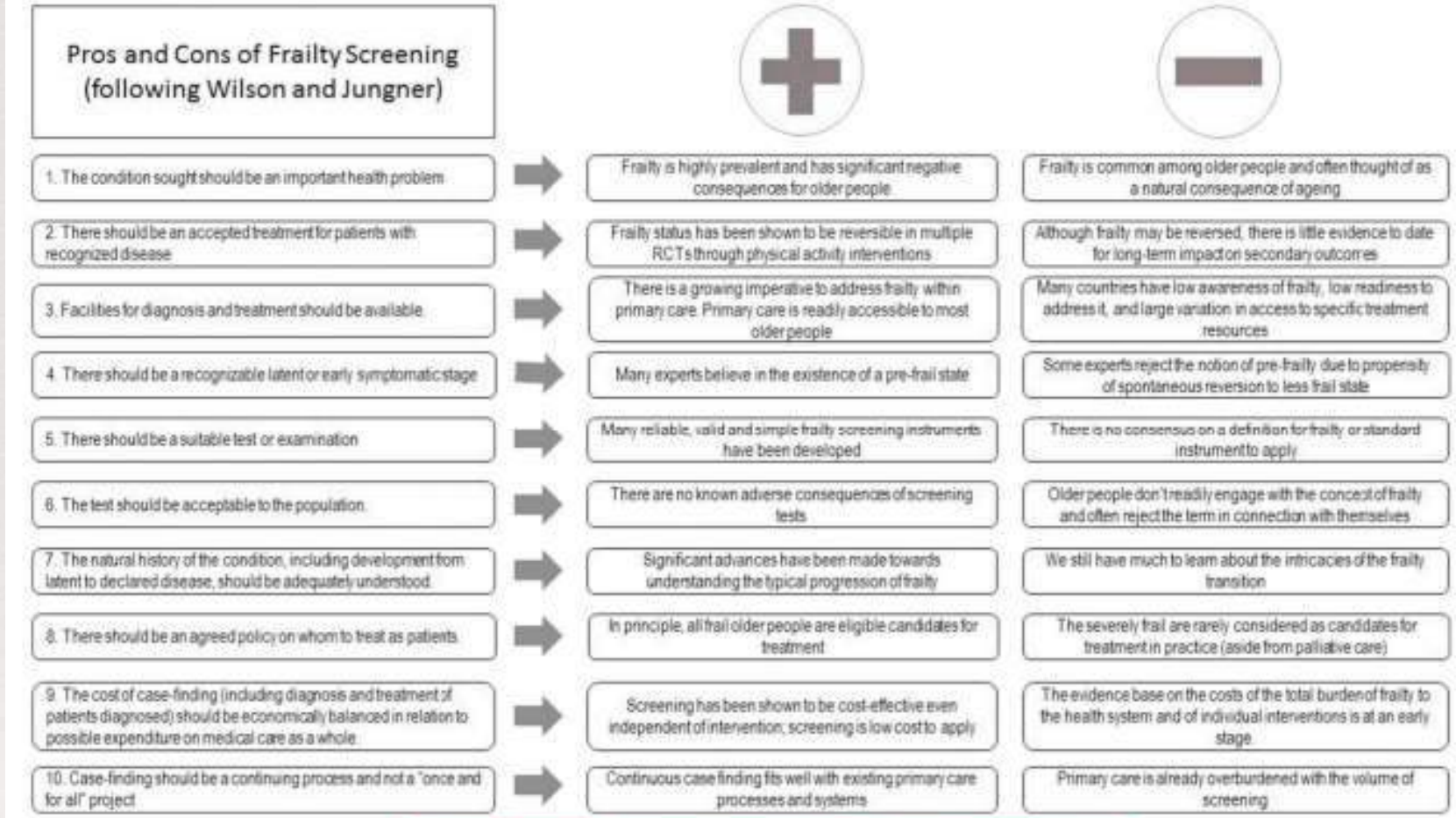


Fig. 1. Pros and cons of frailty screening against the Wilson and Jungner principles.

	Evidence	Outcomes analysed	Certainty of evidence
All community-dwelling older adults (primary care)			
Identify frailty or pre-frailty through screening and case identification in primary care	Four systematic reviews[58-61]	Accurate identification of frailty or pre-frailty	Low
Community-dwelling older adults living with frailty (interventions targeting the management of frailty in home or community settings)			
Prescribe physical activity programmes (resistance-based training, aerobic training, or balance or coordination training)	Three systematic reviews[62-64] (excluded: reviews on frailty prevention or with merged frailty and pre-frailty groups[65-67])	Physical performance (SPPB); gait speed; muscle strength; mobility	Very low for all four outcomes
Prescribe multicomponent physical activity programmes	Three systematic reviews[62-64] (excluded: reviews on frailty prevention or with merged frailty and pre-frailty groups [65-67])	Disability; falls; balance; muscle strength	Very low for all four outcomes
Provide community-based group physical activity classes	Systematic review of six trials of mild frailty or pre-frailty,[68] and one systematic overview with one relevant trial[69]	Physical function; muscle strength; balance	Very low for all three outcomes
Protein or protein-energy, micronutrient supplementation	Systematic review of three nutritional trials,[66]* and one systematic overview with one relevant trial[69]	Frailty; physical performance; strength (leg or grip); gait speed; physical activity	Low for all five outcomes
Provide individually tailored management of clinical conditions	Systematic review of three trials of frailty[66]	Frailty; ADL	Low for both outcomes
Provide advice on health behaviour improvement	Systematic review of six education trials[70]	Physical function	Low
Ensure practical social support	Systematic review of 13 trials on enabling health-behaviour change[70]	Physical function	Very low
Modify home environment for health behaviour change	Systematic review of five trials[70]	Physical function; health behaviour	Very low for both outcomes
Older adults with frailty in hospital (hospital care)			
Ensure targeted care delivery through CGA intervention (CGA done in emergency department, short stay unit, or clinical decision unit)	Systematic mapping review of eight studies covering CGA intervention for older people with frailty[111]*	Physical function; readmission; emergency department readmission	Very low for all outcomes
Review medications using implicit criteria	One systematic mapping review[111]*	Prevention of emergency department readmission	Very low
Ensure patient is placed on a frailty-specific care pathway	One systematic mapping review[111]*	Prevention of emergency department readmission	Low

All intervention strategies listed in this table have been reviewed for effectiveness in recent systematic and structured reviews; intervention strategies without systematic review appraisal were not included. Reviews were only listed if their included studies defined frailty using objective measurement, regardless of whether they had the word frail in their title. All strategies and outcomes listed have been found to be superior to usual care; strategies and outcomes not showing consistent or substantial evidence of benefits compared with usual care have not been included. Certainty of evidence was defined according to GRADE criteria[71] as applied by the authors: high (further research is very unlikely to change our confidence in the estimate of effect and there are no suspected biases); moderate (further research will likely change our confidence in the estimate of effect and may change the estimate); low (further research is very likely to have an important impact on confidence in the estimate of effect, and is likely to change the estimate); very low (any estimate of effect is uncertain). The search for relevant reviews was based on a quasi-systematic review, and thus the list of interventions might not be exhaustive. CGA=Comprehensive Geriatric Assessment. ADL=activities of daily living. IADL=instrumental activities of daily living. SPPB=Short Physical Performance Battery test. *Although these systematic reviews combined results from older adults in general and those with frailty, this table shows trial results for those with frailty only.

Table 2: **Single strategies superior to usual care for management of frailty, by target population**

	Intervention	Result
Kusatsu, Japan	A focused effort over 10 years to screen for frailty in primary care, with those identified as pre-frail or frail referred to a group community programme involving physical activity, nutrition, and social participation[51]	Substantial functional improvements in the population[51]
Hong Kong	The Hong Kong Jockey Club CADENZA project implemented a community frailty prevention project that has had a strong response rate,[52] the project has been running for over 9 years and involves the integration of health and social care, provision of caregiver support, and community group classes involving physical activity[53]	Not yet evaluated in the academic literature
Canada	The Seniors' Community Hub[37] builds capacity in primary care to address the health and social needs of older adults with frailty, including encompassing the needs of the older person with frailty in terms of their intrinsic capacity and frailty levels	Improvements in quality of life and functional maintenance or improvements in people with frailty[53]
UK	The NHS General Practice contract for 2017–18 requires practices to identify adults aged 65 years and older with severe or moderate frailty according to an eFI based on routine primary care coding; this identification is paired with a clinical review incorporating medication and falls reviews, and activation of a care summary record[32]	Effects on clinical outcomes have yet to be evaluated, and might help to clarify whether the eFI is generalisable to primary care in terms of acceptability, feasibility, interpretation, and implementation[54]
Singapore	The Ministry of Health has implemented a Silver Generation Ambassadors programme, which integrates health and social services to support seniors, specifically targeting older adults with frailty[54]	Not yet evaluated in the academic literature

NHS=National Health Service. eFI=Electronic Frailty Index.

Table 3: Selected examples of frailty-specific interventions that focus on health-system targets, by location

Age and Ageing 2019; **48:** 16–31
doi: 10.1093/ageing/afy169
Published electronically 24 September 2018

© The Author(s) 2018. Published by Oxford University Press on behalf of the British Geriatrics Society. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

GUIDELINES

Sarcopenia: revised European consensus on definition and diagnosis

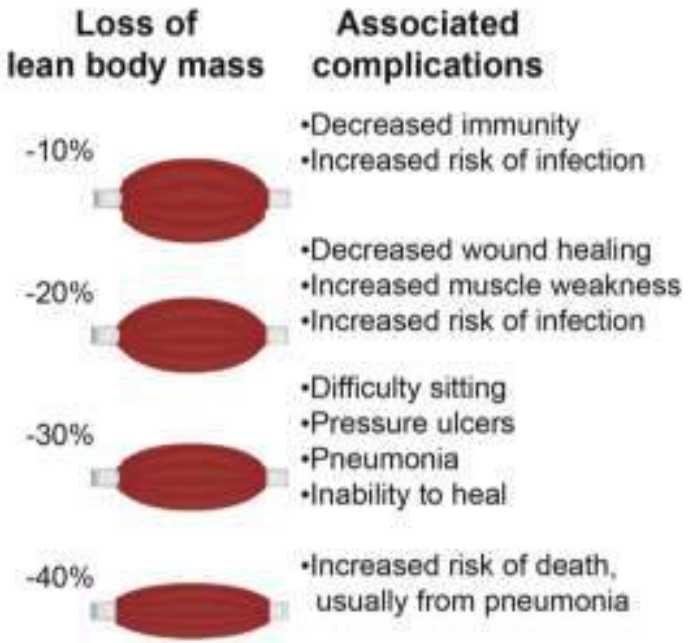


Fig. 3. Complications of lean body mass (muscle) loss.

Table 1. 2018 operational definition of sarcopenia

Probable sarcopenia is identified by Criterion 1.
Diagnosis is confirmed by additional documentation of Criterion 2.
If Criteria 1, 2 and 3 are all met, sarcopenia is considered severe.
(1) Low muscle strength
(2) Low muscle quantity or quality
(3) Low physical performance

Figure 2 Representative chart of components of body composition measured by dual X-ray absorptiometry (DXA) and D_3-creatine dilution. DXA provides a direct measure of bone and fat mass, but not muscle mass. In subjects where both DXA estimates of lean mass and muscle mass by D_3-Cr dilution. While each component of body composition varies by age, sex, and medical condition, muscle mass is about 50% of lean mass. The non-muscle components of lean mass is termed residual lean mass.[37,42]

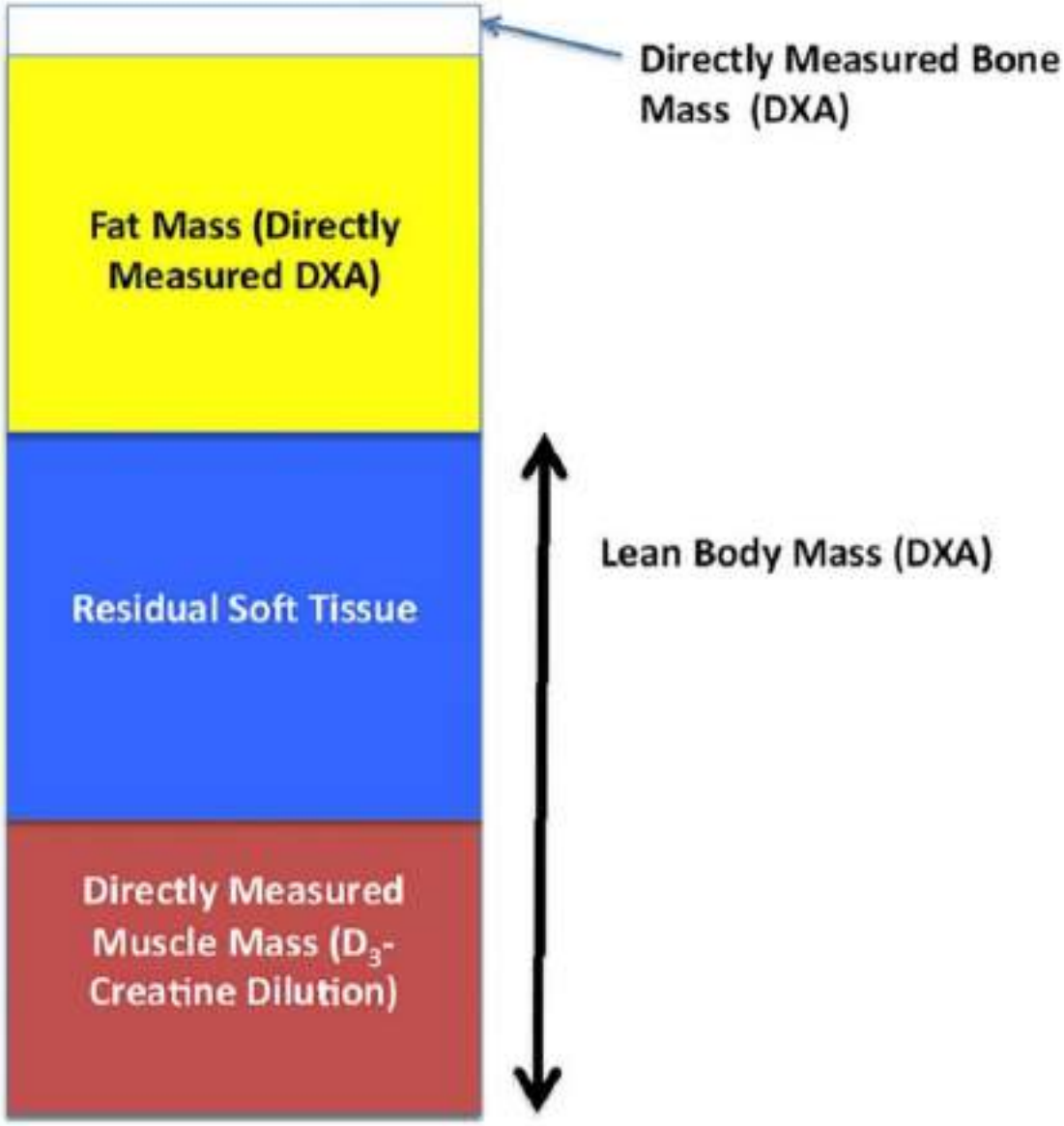


Table 2. Choosing tools for sarcopenia case finding and for measurement of muscle strength, muscle mass and physical performance in clinical practice and in research

Variable	Clinical practice	Research studies	Video for practical instruction, reference
Case finding	SARC-F questionnaire Ishii screening tool	SARC-F	Malmstrom *et al.* (2016) [12] Ishii *et al.* (2014) [40]
Skeletal muscle strength	Grip strength	Grip strength	Roberts *et al.* (2011) [41]
	Chair stand test (chair rise test)	Chair stand test (5-times sit-to-stand)	American Academy of Orthotists & Prosthetists https://www.youtube.com/watch?v=_jPI-IuRJ5A
Skeletal muscle mass orSkeletal muscle quality	Appendicular skeletal muscle mass (ASMM) by Dual-energy X-ray absorptiometry (DXA)*	ASMM by DXA	Schweitzer (2015) [42] Mitsiopoulos (1998) [43]
	Whole-body skeletal muscle mass (SMM) or ASMM predicted by Bioelectrical impedance analysis (BIA)*	Whole-body SMM or ASMM by Magnetic Resonance Imaging (MRI, total body protocol)	Shen (2004) [44] Sergi (2017) [45] Maden-Wilkinson (2013) [46] Heymsfield (1990) [47] Kim (2002) [48] Yamada (2017) [49]
		Mid-thigh muscle cross-sectional area by Computed Tomography (CT) or MRI	Lee (2004) [50]
	Lumbar muscle cross-sectional area by CT or MRI	Lumbar muscle cross-sectional area by CT or MRI	Van der Werf (2018) [51] Derstine (2018) [52]
		Muscle quality by mid-thigh or total body muscle quality by muscle biopsy, CT, MRI or Magnetic resonance Spectroscopy (MRS)	Goodpaster (2000) [53] Reinders (2016) [54] Grimm (2018) [55] Distefano (2018) [56] Ruan (2007) [57]
Physical performance	Gait speed	Gait speed	NIH Toolbox 4 Meter Walk Gait Speed Test https://www.nia.nih.gov/research/labs/leps/short-physical-performance-battery-appls https://www.youtube.com/watch?v=xLScK_NXUN0
	Short physical performance battery (SPPB)	SPPB	Short Physical Performance Battery Protocol https://research.ndorms.ox.ac.uk/prove/documents/assessors/outcomeMeasures/SPPB_Protocol.pdf NIH Toolbox https://www.nia.nih.gov/research/labs/leps/short-physical-performance-battery-appls
	Timed-up-and-go test (TUG)	TUG	Mathias (1986) [40]
	400-meter walk or long-distance corridor walk (400-m walk)	400-m walk	Newman (2006) [41]

*Sometimes divided by height^2 or BMI to adjust for body size.

Age and Ageing 2019; **48:** 16–31
doi: 10.1093/ageing/afy169
Published electronically 24 September 2018

© The Author(s) 2018. Published by Oxford University Press on behalf of the British Geriatrics Society. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

GUIDELINES

Sarcopenia: revised European consensus on definition and diagnosis

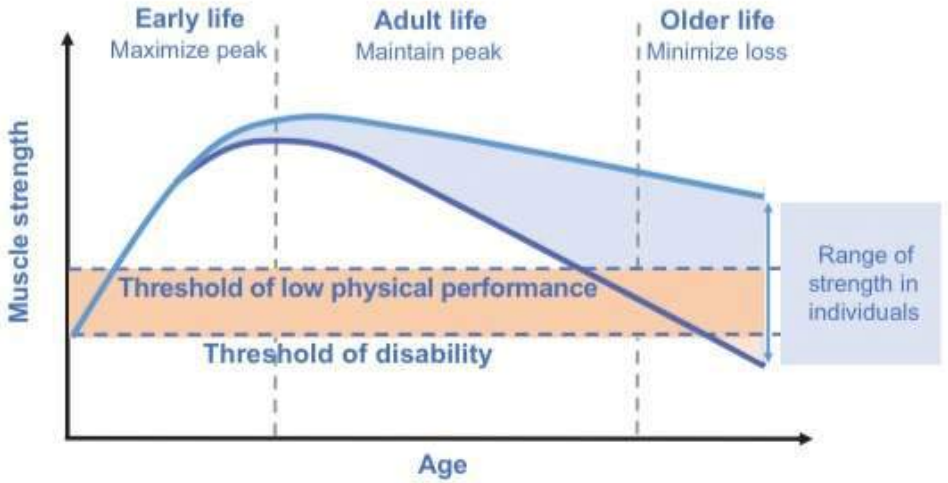


Figure 3. Muscle strength and the life course. To prevent or delay sarcopenia development, maximise muscle in youth and young adulthood, maintain muscle in middle age and minimise loss in older age