Healthy Aging North Dakota

HEALTH, NUTRITION, AND EXERCISE SCIENCES

Mobility: Handgrip Strength

Ryan McGrath, PhD

Disclosures & Acknowledgements

- No conflicts
- NIH-NIA R15AG072348
- HRSA

About Me

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Objectives

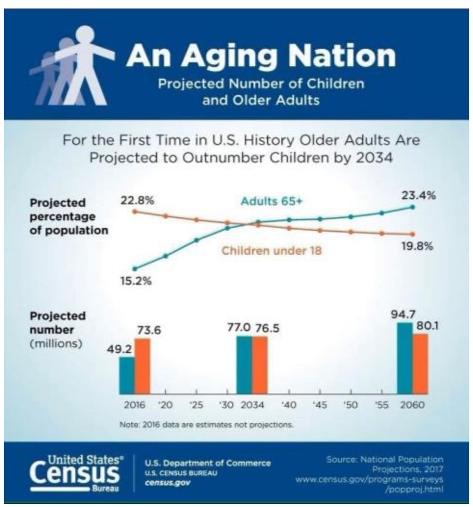
1. Review how handgrip strength is connected with mobility

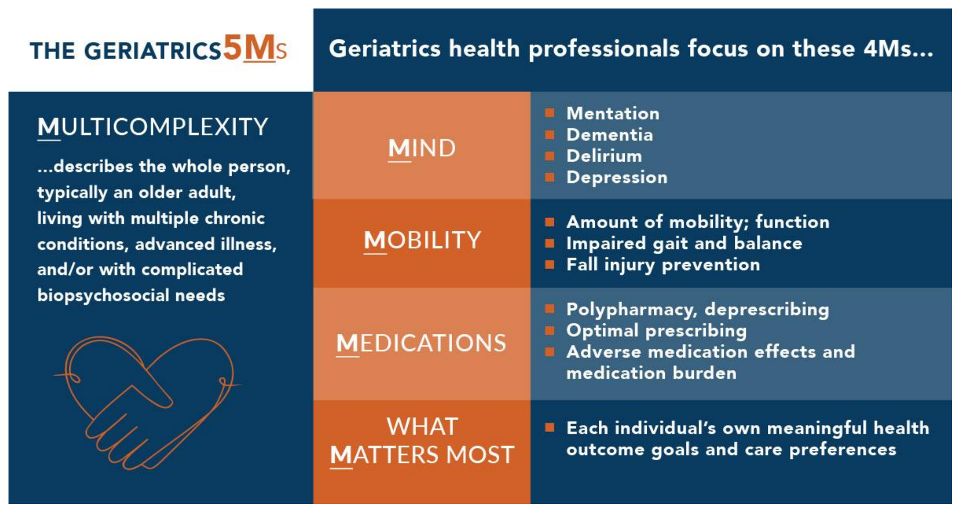
2. Present how to measure handgrip strength

3. Encourage the inclusion of handgrip strength in appropriate classroom and healthcare settings

Mobility: Handgrip Strength

- Rapidly growing older adult demographic
- Healthcare demand for aging and health
  - Need for age-friendly care

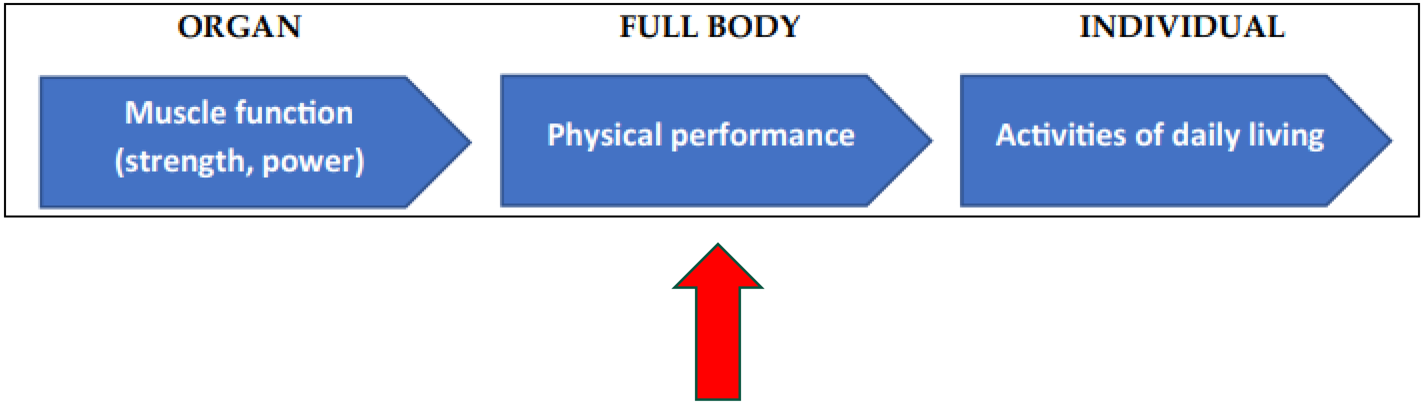




AGS

Mobility: Handgrip Strength

- Mobility assessments
  - Many are within the physical performance classification
    - Gait speed
    - Balance
    - TUG



Beaudart et al. 2019

Mobility: Handgrip Strength

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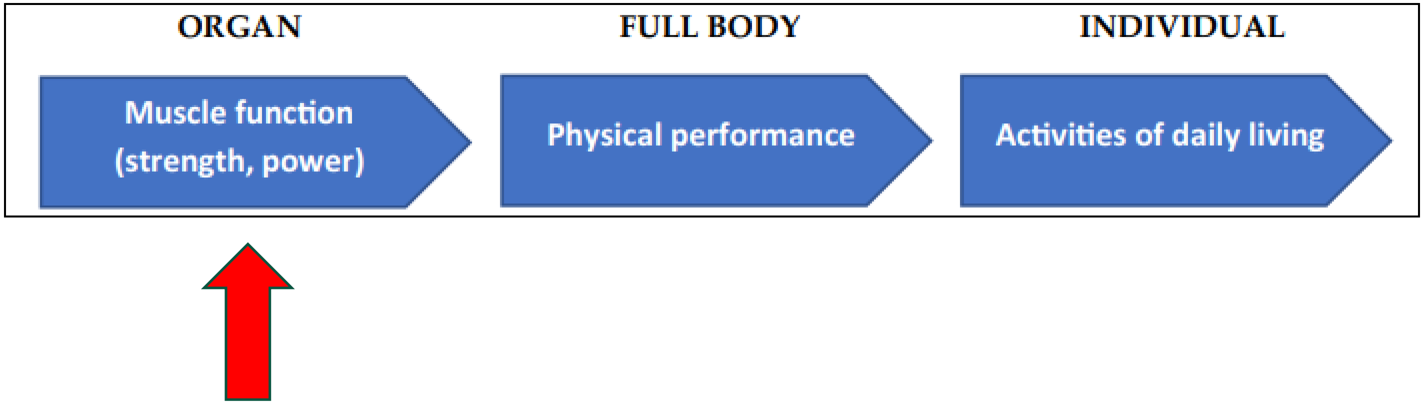


Beaudart et al. 2019

Mobility: Handgrip Strength

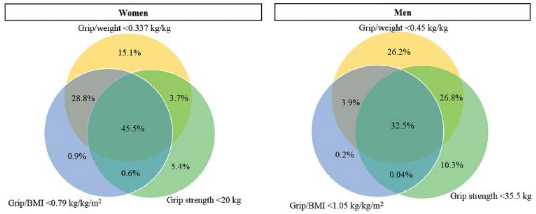
Mobility: Handgrip Strength

- Convenient and reliable
- Easy to use
- Simple to learn
- Private
- Inclusive
- Well used in research
- Lots of data
- Linked to bad stuff

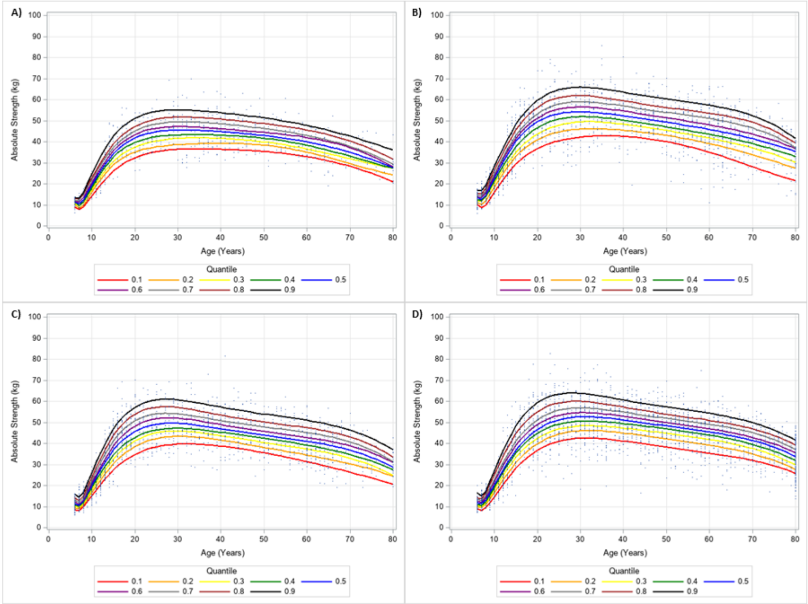
Mobility: Handgrip Strength

Categorical Weakness

- Males: <26-kilograms
- Females: <16-kilograms
- Normalized
  - Body mass (weight)
  - Stature
  - BMI



Percentiles



Alley et al. 2014; McGrath et al. 2020; Patel et al. 2020

Mobility: Handgrip Strength

- Gait speed
- Falls
- Osteoporosis
- AD/ADRD
- Functional limitations
- Discharge
- Time to mortality
- Vital sign

Grip Strength Cutpoints for the Identification of Clinically Relevant Weakness

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Background. Weakness is common and contributes to disability, but no consensus exists regarding a strength cutpoint to identify persons at high risk. This analysis, conducted as part of the Foundation for the National Institutes of Health Sarcopenia Project, sought to identify cutpoints that distinguish weakness associated with mobility impairment, defined as gait speed less than 0.8 m/s.

Methods. In pooled cross-sectional data (9,897 men and 10,950 women), Classification and Regression Tree analysis was used to derive cutpoints for grip strength associated with mobility impairment.

Results. In men, a grip strength of 26–32 kg was classified as "intermediate" and less than 26 kg as "weak"; 11% of men were intermediate and 5% were weak. Compared with men with normal strength, odds ratios for mobility impairment were 3.63 (95% CI: 3.01–4.38) and 7.62 (95% CI 6.13–9.49), respectively. In women, a grip strength of 16–20 kg was classified as "intermediate" and less than 16 kg as "weak"; 25% of women were intermediate and 18% were weak. Compared with women with normal strength, odds ratios for mobility impairment were 2.44 (95% CI 2.20–2.71) and 4.42 (95% CI 3.94–4.97), respectively. Weakness based on these cutpoints was associated with mobility impairment across subgroups based on age, body mass index, height, and disease status. Notably, in women, grip strength divided by body mass index provided better fit relative to grip strength alone, but fit was not sufficiently improved to merit different measures by gender and use of a more complex measure.

Conclusions. Cutpoints for weakness derived from this large, diverse sample of older adults may be useful to identify populations who may benefit from interventions to improve muscle strength and function.

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ORIGINAL ARTICLE

Check for updates

Handgrip strength asymmetry is associated with future falls in older Americans

Ryan McGrath[1] · Brian C. Clark[2,3,4] · Matteo Cesari[5,6] · Carol Johnson[7] · Donald A. Jurivich[7,8]

Received: 3 September 2020 / Accepted: 9 November 2020 / Published online: 27 November 2020

Abstract
Background Examining handgrip strength (HGS) asymmetry could extend the utility of handgrip dynamometers for screening future falls.
Aims We sought to determine the associations of HGS asymmetry on future falls in older Americans.
Methods The analytic sample included 10,446 adults aged at least 65 years from the 2006–2016 waves of the Health and Retirement Study. Falls were self-reported. A handgrip dynamometer measured HGS. The highest HGS on each hand was used for determining HGS asymmetry ratio: (non-dominant HGS/dominant HGS). Those with HGS asymmetry ratio < 1.0 had their ratio inverted to make all HGS asymmetry ratios ≥ 1.0. Participants were categorized into asymmetry groups based on their inverted HGS asymmetry ratio: (1) 0.0–10.0%, (2) 10.1–20.0%, (3) 20.1–30.0%, and (4) > 30.0%. Generalized estimating equations were used for the analyses.
Results Every 0.10 increase in HGS asymmetry ratio was associated with 1.26 (95% confidence interval (CI) 1.07–1.48) greater odds for future falls. Relative to those with HGS asymmetry 0.0-10.0%, participants with HGS asymmetry > 30.0% had 1.15 (CI 1.01–1.33) greater odds for future falls; however, the associations were not significant for those with HGS asymmetry 10.1–20.0% (odds ratio: 1.06; CI 0.98–1.14) and 20.1–30.0% (odds ratio: 1.10; CI 0.99–1.22). Compared to those with HGS asymmetry 0.0–10.0%, participants with HGS asymmetry > 10.0% and > 20.0% had 1.07 (CI 1.01–1.16) and 1.12 (CI 1.02–1.22) greater odds for future falls, respectively.
Discussion Asymmetric HGS, as a possible biomarker of impaired neuromuscular function, may help predict falls.
Conclusions We recommend that HGS asymmetry be considered in HGS protocols and fall risk assessments.

Keywords Aging · Functional laterality · Geriatrics · Geriatric assessment · Muscle strength dynamometer

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Table 2. Results from the logistic regression models for the association between muscle strength and osteoporosis.*

	Males		Females	
	Odds ratio†	95% CI	Odds ratio†	95% CI
Handgrip strength	0.94	0.94–0.94	0.90	0.90–0.90
Age	1.05	1.05–1.05	1.06	1.06–1.06
Body mass index	0.93	0.93–0.94	0.89	0.89–0.89
Ethnicity (reference: non-Hispanic black)				
Non-Hispanic Asian	6.62	6.51–6.72	6.42	6.37–6.48
Hispanic	2.56	2.52–2.60	2.19	2.17–2.21
Non-Hispanic white	3.26	3.22–3.31	3.97	3.94–4.00
Supplementation (reference: no supplement)	1.77	1.76–1.78	0.50	0.50–0.50
Mean dietary calcium	1.00	1.00–1.00	1.00	1.00–1.00
Mean dietary vitamin D	0.98	0.98–0.98	0.98	0.98–0.98

*95% CI = 95% confidence intervals; Supplement, takes calcium and vitamin D supplement.
†All odds ratios were $p < 0.0001$.

McGrath et al. 2017

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Table 2. Association Between Decreased Handgrip Strength and Mild Cognitive Impairment.

	Odds Ratio	95% Confidence Interval
Handgrip Strength (5-Kilogram Decrease)	1.16	1.10, 1.23

Table 3. Association Between Decreased Handgrip Strength and Severe Cognitive Impairment.

	Odds Ratio	95% Confidence Interval
Handgrip Strength (5-Kilogram Decrease)	1.06	1.03, 1.09

Table 4. Association Between Decreased Handgrip Strength and Cognitive Impairment Progression.

	Odds Ratio	95% Confidence Interval
Handgrip Strength (5-Kilogram Decrease)	1.14	1.09, 1.19

McGrath et al. 2019

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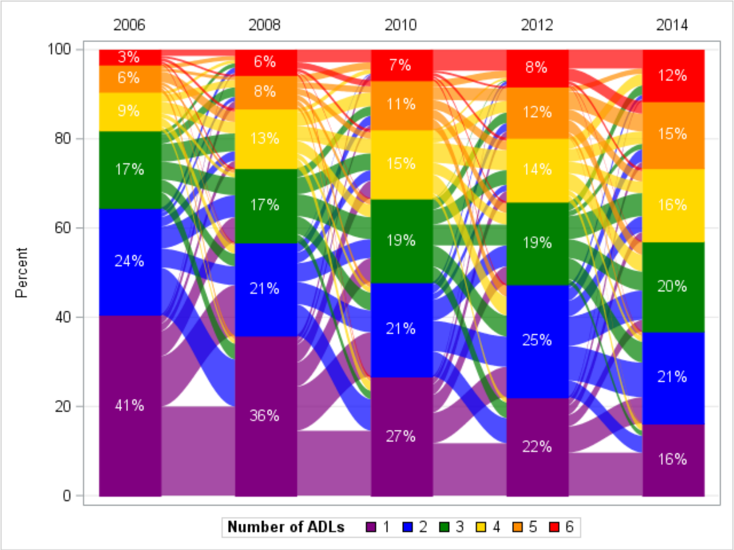

McGrath et al. 2018

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Original Communication

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Handgrip Strength at Admission and Time to Discharge in Medical and Surgical Inpatients

Joana Mendes, MSc[1,2]; Ana Azevedo, MD, PhD[1,2]; and Teresa F. Amaral, PhD[3,4]

Abstract

Background and Objective: Handgrip strength is a relevant marker of functional status and is also a component of nutrition assessment. The simplicity of this measurement supports its usefulness as a tool to predict who will likely take longer to hospital discharge. The aim of this study was to quantify the association between sex-specific handgrip strength at hospital admission and time to discharge alive. We intended to include a group of diverse diagnoses and to compare medical and surgical wards, taking into account the potential confounders' effect of patients' characteristics and severity of disease. *Subjects and Methods*: Prospective study in 2 public acute-care general hospitals in Porto, Portugal, in 2004. Handgrip strength was evaluated using a handgrip dynamometer in a probability sample of 425 patients from medical and surgical wards. The association between baseline handgrip strength and time to discharge was evaluated using survival analysis with discharge alive as the outcome and deaths and transfers being censored. *Results*: In medical wards, women with high admission handgrip strength had a very short hospital stay (all had been discharged by the sixth day), and among men, patients with low handgrip strength had a particularly longer stay (approximately 50% were discharged after 15 days of hospitalization). In surgical wards, an increasing length of stay with decreasing handgrip strength quartiles was also observed in both sexes. *Conclusions*: Lower handgrip strength at hospital admission was associated with a longer time in the hospital, in patients of both sexes, in medical and surgical wards. Although this association was explained in part by age, height, education level, cognitive status, and disease severity, its direction remained unchanged regardless of the aforementioned factors. (*JPEN J Parenter Enteral Nutr*. 2014;38:481-488)

Keywords

diagnosis-related groups; hand strength; length of stay; nutrition status; patient discharge; prognosis

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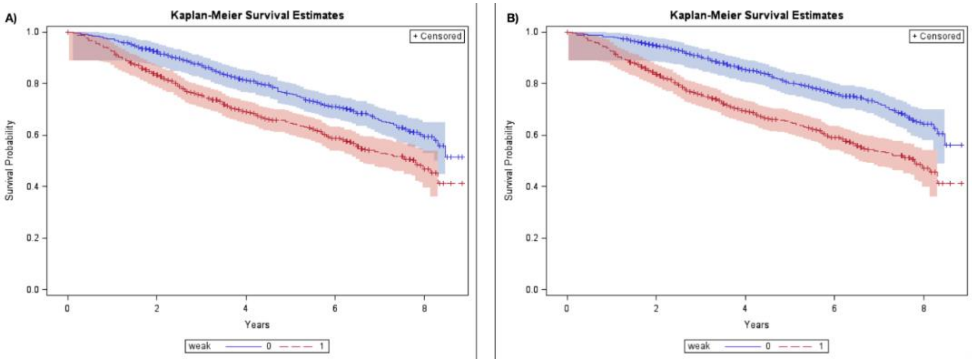

McGrath et al. 2020

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Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study

*Darryl P Leong, Koon K Teo, Sumathy Rangarajan, Patricio Lopez-Jaramillo, Alvaro Avezum Jr, Andres Orlandini, Pamela Seron, Suad H Ahmed, Annika Rosengren, Roya Kelishadi, Omar Rahman, Sumathi Swaminathan, Romaina Iqbal, Rajeev Gupta, Scott A Lear, Aytekin Oguz, Khalid Yusoff, Katarzyna Zatonska, Jephat Chifamba, Ehimario Igumbor, Viswanathan Mohan, Ranjit Mohan Anjana, Hongqiu Gu, Wei Li, Salim Yusuf, on behalf of the Prospective Urban Rural Epidemiology (PURE) Study investigators**

Summary

Background Reduced muscular strength, as measured by grip strength, has been associated with an increased risk of all-cause and cardiovascular mortality. Grip strength is appealing as a simple, quick, and inexpensive means of stratifying an individual's risk of cardiovascular death. However, the prognostic value of grip strength with respect to the number and range of populations and confounders is unknown. The aim of this study was to assess the independent prognostic importance of grip strength measurement in socioculturally and economically diverse countries.

Methods The Prospective Urban-Rural Epidemiology (PURE) study is a large, longitudinal population study done in 17 countries of varying incomes and sociocultural settings. We enrolled an unbiased sample of households, which were eligible if at least one household member was aged 35–70 years and if household members intended to stay at that address for another 4 years. Participants were assessed for grip strength, measured using a Jamar dynamometer. During a median follow-up of 4·0 years (IQR 2·9–5·1), we assessed all-cause mortality, cardiovascular mortality, non-cardiovascular mortality, myocardial infarction, stroke, diabetes, cancer, pneumonia, hospital admission for pneumonia or chronic obstructive pulmonary disease (COPD), hospital admission for any respiratory disease (including COPD, asthma, tuberculosis, and pneumonia), injury due to fall, and fracture. Study outcomes were adjudicated using source documents by a local investigator, and a subset were adjudicated centrally.

Findings Between January, 2003, and December, 2009, a total of 142 861 participants were enrolled in the PURE study, of whom 139 691 with known vital status were included in the analysis. During a median follow-up of 4·0 years (IQR 2·9–5·1), 3379 (2%) of 139 691 participants died. After adjustment, the association between grip strength and each outcome, with the exceptions of cancer and hospital admission due to respiratory illness, was similar across country-income strata. Grip strength was inversely associated with all-cause mortality (hazard ratio per 5 kg reduction in grip strength 1·16, 95% CI 1·13–1·20; p<0·0001), cardiovascular mortality (1·17, 1·11–1·24; p<0·0001), non-cardiovascular mortality (1·17, 1·12–1·21; p<0·0001), myocardial infarction (1·07, 1·02–1·11; p=0·002), and stroke (1·09, 1·05–1·15; p<0·0001). Grip strength was a stronger predictor of all-cause and cardiovascular mortality than systolic blood pressure. We found no significant association between grip strength and incident diabetes, risk of hospital admission for pneumonia or COPD, injury from fall, or fracture. In high-income countries, the risk of cancer and grip strength were positively associated (0·916, 0·880–0·953; p<0·0001), but this association was not found in middle-income and low-income countries.

Interpretation This study suggests that measurement of grip strength is a simple, inexpensive risk-stratifying method for all-cause death, cardiovascular death, and cardiovascular disease. Further research is needed to identify determinants of muscular strength and to test whether improvement in strength reduces mortality and cardiovascular disease.

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Clinical Interventions in Aging

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REVIEW

Grip Strength: An Indispensable Biomarker For Older Adults

This article was published in the following Dove Press journal:
Clinical Interventions in Aging

Richard W Bohannon

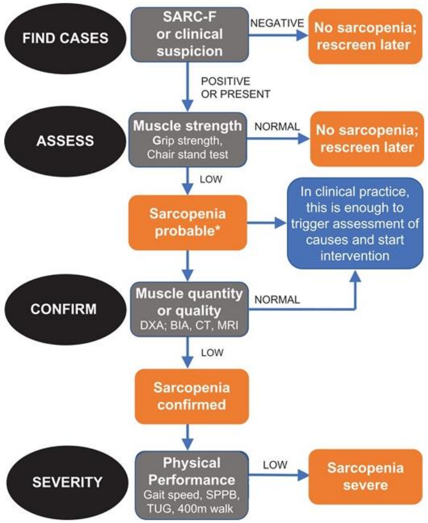
Department of Physical Therapy, Campbell University, Lillington, NC, USA

Abstract: Grip strength has been proposed as a biomarker. Supporting this proposition, evidence is provided herein that shows grip strength is largely consistent as an explanator of concurrent overall strength, upper limb function, bone mineral density, fractures, falls, malnutrition, cognitive impairment, depression, sleep problems, diabetes, multimorbidity, and quality of life. Evidence is also provided for a predictive link between grip strength and all-cause and disease-specific mortality, future function, bone mineral density, fractures, cognition and depression, and problems associated with hospitalization. Consequently, the routine use of grip strength can be recommended as a stand-alone measurement or as a component of a small battery of measurements for identifying older adults at risk of poor health status.

Keywords: biomarker, muscle strength, health outcomes, epidemiology, mortality, rehabilitation, aging

Mobility: Handgrip Strength

- Weakness is part of frailty evaluations (representing different physiological systems; ability to cope with acute or chronic stressors)
  - Unintentional weight loss (10 lbs. in past year)
  - Self-reported exhaustion
  - Weakness (grip strength)
  - Slow walking speed
  - Low physical activity



Cruz-Jentoft et al. 2019; Fried et al. 2001

Mobility: Handgrip Strength

- Measuring handgrip strength

Table 3 Recent HGS protocols proposed

	ASHT protocol – 2015 [26]	Southampton protocol – 2011 [27]
Posture	Subject seated in a chair without arm rests, with feet fully resting on the floor, hips as far back in the chair as possible, and the hips and knees positioned at approximately 90°	Subject seated (same chair for every measurement)
Arm position		Forearms rested on the arms of the chair
-Shoulder	Adducted and neutrally rotated	–
-Elbow	Flexed to 90°, the forearm should be in midprone (neutral)	–
-Wrist	Between 15 and 30° of extension (dorsiflexion) and 0–15° of ulnar deviation	Just over the end of the arm of the chair, in a neutral position, thumb facing upwards
Trials	Three trials	Three trials on each side, alternating sides (start with the right hand)
Dynamometer		
-Model	Jamar dynamometer	Jamar hydraulic hand dynamometer
-Calibration	Yes	–
-Handle position	2nd	Thumb is round one side of the handle and the four fingers are around the other side
Acquisition time	At least 3 s	–
Rest time	At least 15 s	–
Instructions	"This test will tell me your maximum grip strength. When I say go, grip as hard as you can until I say stop. Before each trial, I will ask you 'Are you ready?' and then tell you 'Go'. Stop immediately if you experience any unusual pain or discomfort at any point during testing. Do you have any questions? Are you ready? Go!". "Harder... harder... harder...Relax"	'I want you to squeeze as hard as you can for as long as you can until I say stop. Squeeze, squeeze, squeeze, stop' (when the needle stops rising)
HGS analysis	Mean of three trials	Maximal grip score from all six trials

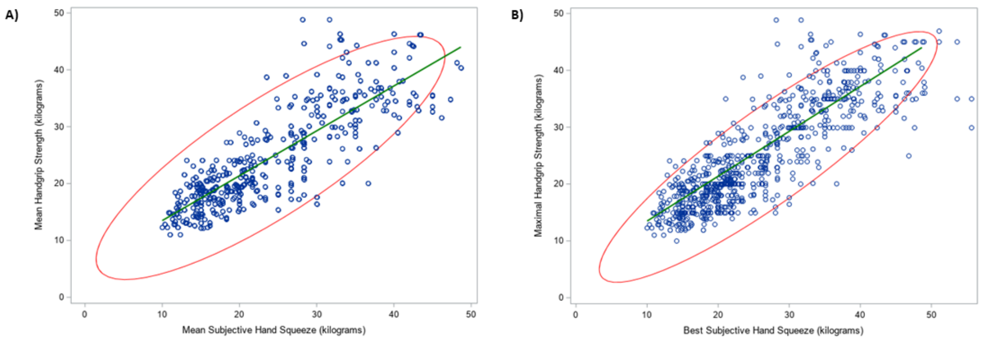
Sousa-Santos & Amaral 2017

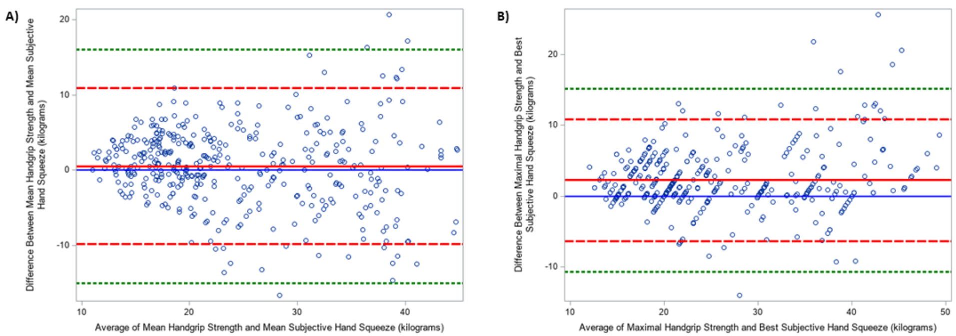
Mobility: Handgrip Strength

- Measuring handgrip strength
  - Chair with back and arm rests (for body placement)
  - Feet flat
  - Explain and demo
  - Adjust to hand size
  - Start on right hand
  - Encouragement!
  - Record
  - Alternate for 2-3 trials
  - Highest recorded measure is included

Mobility: Handgrip Strength

- Subjective assessments



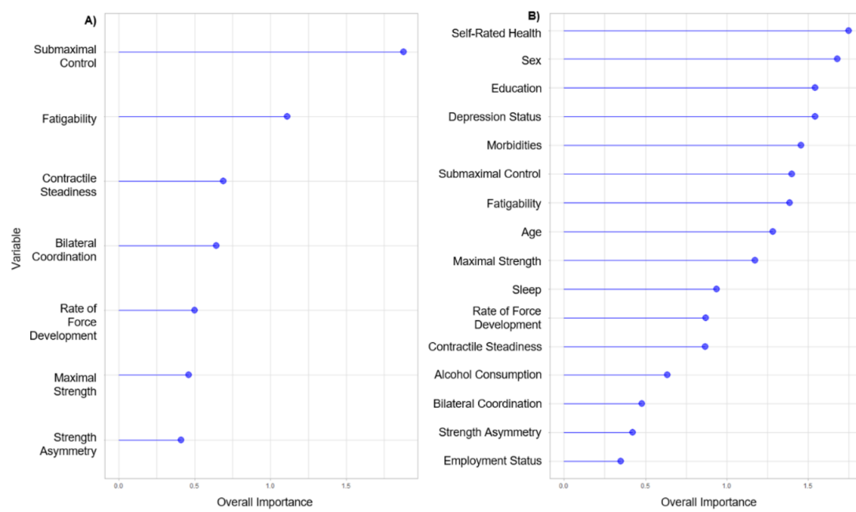


Kieser et al. 2024

Mobility: Handgrip Strength

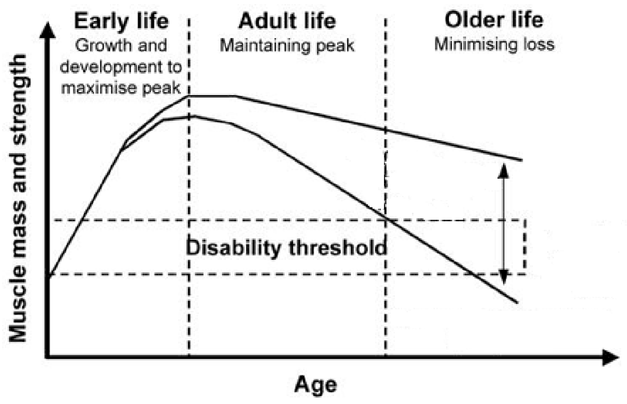
- Asymmetry
- Electronic handgrip dynamometry and accelerometry
  - Test-retest reliability

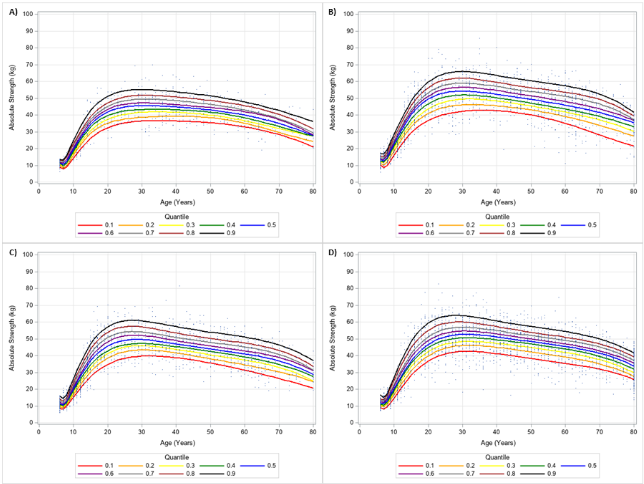
	Cognitively Intact (n=52)	Cognitive Impairment (n=74)
Maximal Strength	19.6±7.3	17.9±6.7
Strength Asymmetry	10.7±6.8	12.1±10.1
Submaximal Control	4.8±3.4	6.9±5.8*
Rate of Force Development	47.5±26.2	42.2±24.2
Bilateral Coordination	8.2±6.7	9.6±10.5
Fatigability	29.9±8.9	31.1±9.3
Contractile Steadiness	14.3±12.2	15.2±11.2



Mobility: Handgrip Strength

- Use in classrooms and healthcare provider settings?
- Important marker of aging
- Screening and continued observation could be important





McGrath et al. 2020; WHO 2000

Thank You!

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Case Examples

- You are measuring handgrip strength on an older patient that has a body mass index classification that is considered normal.
  - Would you consider collecting raw handgrip strength or normalizing to a body size metric (which metric)?

Case Examples

- You are working with an older patient that is considered categorically weak using handgrip strength cut-points.
  - How might you discuss weakness status with this patient?