

Hand-Grip Dynamometry Predicts Future Outcomes in Aging Adults

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ABSTRACT

Background and Purpose: One use of clinical measures is the prediction of future outcomes. The purpose of this systematic review was to summarize the literature addressing the value of grip strength as a predictor of important outcomes. **Methods:** Relevant literature was located using 4 bibliographic databases, searching article reference lists, and perusing personal files. **Results:** Forty-five relevant research articles were found. The research involved both healthy subjects and patients; it tended to focus on middle-aged and older adults. The primary outcome addressed was mortality/survival (24 articles), but disability (9 articles), complications and/or increased length of stay (12 articles), and other outcomes were also examined. Low grip strength was shown consistently to be associated with a greater likelihood of premature mortality, the development of disability, and an increased risk of complications or prolonged length of stay after hospitalization or surgery. **Conclusions:** Given its predictive validity and simplicity, dynamometrically measured grip strength should be considered as a vital sign useful for screening middle-aged and older adults.

Key Words: muscles, epidemiologic measures, equipment and supplies, health status indicators

INTRODUCTION

One of the accepted purposes of measurements is the prediction of critical outcomes.¹ Such prediction is important for identifying individuals who are at risk of untoward future events and for determining appropriate targets for risk-reducing efforts.¹ Although muscle strength is an essential component of the physical examination,² it is not routinely used clinically to predict outcomes. A literature review published several years ago intimated that dynamometrically measured grip strength may have value as a predictor of important outcomes.³ That review, however suggestive, was insufficiently comprehensive to justify the routine inclusion of hand grip dynamometry among screening tools. The purpose of this systematic review, therefore, was to establish the adequacy of evidence for supporting the inclusion of hand-grip dynamometry as a predictor of important outcomes.

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METHODS

For this systematic review, which was limited to peer-reviewed journal articles, the four major electronic databases were searched: Medline/PubMed, Cumulative Index of Nursing and Allied Health, EMBASE, and Science Citation Index. The final search was conducted in June 2006. Terms used in the search included: hand, grip, and strength in combination with outcome, mortality, survival, disability, function, complications, hospital, or surgery. The author examined for relevance all identified articles, as well as articles located by examination of reference lists. Additionally, personal files were searched for pertinent articles. Finally, a list of journal articles identified by these means was reviewed by a content expert (Nicaola Massy-Westropp, OT, PhD: University of South Australia) for omissions.

Inclusion of articles was dependent on their: (1) indication that hand-grip dynamometry was used to measure strength and (2) presentation of statistics describing a relationship between grip strength and an outcome other than strength. Articles were excluded if they: (1) were in a language other than English, (2) did not contain original data (eg, reviews), (3) described only cross-sectional relationships, or (4) addressed relationships between changes in grip strength and a relevant outcome.

Journal articles meeting inclusion criteria and not excluded were abstracted. Specifically recorded in a Word table were: the important outcome addressed, key sample characteristics (eg, sex, size and age), dynamometer measurement specifics (eg, dynamometer and measurement used) follow-up/time period, and findings relevant to the relationship between grip strength and outcomes. When findings were adjusted for factors other than grip strength (eg, demographics, health), adjustments were designated.

RESULTS

Altogether, 45 articles were identified and found relevant on the basis of inclusion and exclusion criteria (Table 1). Sixteen of the articles involved mostly healthy community-dwelling subjects.⁴⁻²⁰ Twenty-eight articles included subjects who were described by authors as disabled or having functional limitations^{21,22} hospitalized,²³⁻²⁹ postsurgical,³⁰⁻³⁷ or as having specific health problems such as pneumonia,^{23,25} arthritis,³⁸⁻⁴³ cancer,^{27,30} renal or liver disease,^{35,44-46} coronary artery disease,³¹ or hip fracture.^{47,48}

The majority of studies focused on middle-aged and older adults, though a few also included younger individuals^{33,34} or did not specify age.^{32,37,48} The time between the measurement of grip strength and the determination of outcome was not always indicated specifically, but it ranged from a few days in the case of studies focusing on hospitalization or the postoperative period^{25-37,48}

Table 1. Summary of Studies Examining the Value of Grip Strength as a Predictor of Different Outcomes

Sample (n): initial age	Follow-up/ time period	Measurement and Findings	Study
Mortality			
Individuals without disability (2292): 70-79 yr	Mean 4.9 yr	Right grip strength (measured with Jamar dynamometer) “strongly related to mortality.” Hazard ratio = 1.45 (unadjusted) and 1.42 (adjusted) per 10.7 kg grip strength.	Newman et al (2006) ⁴
Health-promotion center visitors (4056): ≥40 yr	Mean 6.1 yr	Less than standard grip strength (mean of left & right, measured with undesignated dynamometer) predictive of death in men (relative risk = 1.92) but not in women (relative risk = .84)	Fujita et al (1995) ⁵
Healthy men (1071): mean 50.1 yr	40 yr	Total grip strength (left + right, measured with Smedley dynamometer) significantly higher (t-test) for survivors overall (p<.001) and for men ≥ 60 yr (p<.001) but not for men < 60 yr (p=.06).	Metter et al (2002) ⁶
Noninstitutionalized Mexican-Americans (2488): ≥65 yr	5 yr	Maximum right grip strength (measured with Jamar dynamometer) associated with death. Adjusted hazard ratio for lowest quartile compared to highest quartile = 2.47 for men and 2.89 for women.	Al Snih et al (2002) ⁷
Patients hospitalized for pneumonia (153): 66-98 yr	1 yr	Maximum grip strength of stronger hand (measured with Jamar dynamometer) related to death. Pearson correlation = -.272 (p<.001). Adjusted odds ratio = .969 per lb of grip strength.	Bohannon et al (2004) ²³
Patients hospitalized for pneumonia (191): mean 72.5 yr	30 d	Maximum grip strength of stronger hand (measured with Jamar dynamometer) related to death. Pearson correlation = .285 (p<.001). Adjusted odds ratio = .370 for grip strength > 10 kg.	Vecchiarino et al (2004) ²⁴
Older women with disability (919): ≥ 65 yr	5 yr	Maximum grip strength of stronger hand (measured with Jamar dynamometer) a “powerful predictor of cause specific and total mortality.” Relative risk for lowest tertile compared to highest tertile = 3.21 (unadjusted) and 2.04-2.24 (adjusted) for cardiovascular disease mortality and 2.40 (unadjusted) and 1.68-1.80 (adjusted) for all-cause mortality.	Rantanen et al (2003) ²¹
Women with rheumatoid arthritis (75): mean 54.7 yr	15 yr	Mean grip strength of left and right hands (measured with modified sphygmomanometer) associated with death . If strength ≤82 mm Hg: relative risk (unadjusted)= 7.0 (5 y), 3.9 (10 y), 3.0 (15 y), relative risk (adjusted)= 8.4 (5 y), 4.5 (10 y), 3.2 (15 y). If strength ≤ 100 mm Hg, significantly greater risk of death (15 y) for women but not men.	Pincus et al (1994) ³⁸
Healthy men (6040): 45-68 yr	30 yr	Maximum grip strength of stronger (measured with Smedley dynamometer) hand associated with long-term mortality risk. Depending on body mass index, relative risk for lowest tertile = 1.21 – 1.44 (unadjusted) and 1.25 – 1.39 (adjusted).	Rantanen et al (2000) ⁸
Patients undergoing surgery for cancer (95): 42-88 yr	Postoperative	Maximum grip strength of nondominant hand (measured with “single spring” dynamometer) predictive of mortality. If < 85% standard strength, sensitivity = 100%, specificity = 73.3%.	Kalfarentzos et al (1989) ³⁰
Community-dwelling women (7250): ≥ 75 yr	Mean 3.8 yr	Maximum grip strength of dominant hand (measured with Martin Vigorimeter) associated with mortality. Hazard ratio for lowest tertile compared to highest tertile = 1.47 (unadjusted) and 1.34 (adjusted) for IADL, diabetes, cognition, smoking, self-reported health, obesity, inability to walk outdoors, and hospitalization during last year for all-cause mortality.	Rolland et al (2006) ⁹

Table 1. Continued

Patients with hip fracture (248): mean 78.4 yr	3.5 yr	Grip strength (measured with Harpenden dynamometer) associate with death. Compared to controls, relative risk for patients in lower half of distribution = 2.30 (adjusted) for age and sex.	Meyer et al (2000) ⁴⁷
Community residents (1464): ≥ 70 yr	6 yr	Maximum grip strength of dominant hand (measured with undesignated dynamometer) associated with death. Compared to individuals of the 81-100 percentile group, respective incident rate ratios for 1-20, 21-40, & 41-60 percentile groups = 1.86, 1.52, 1.53 (unadjusted); 3.66, 2.42, 1.77 (adjusted for demographics); 2.81, 2.06, 1.56 (adjusted for demographics and health).	Anstey et al (2001) ¹⁰
Patients undergoing coronary artery bypass grafting (200): 26% > 70 yr	3 mo	Maximum grip strength of the stronger hand (measured with undesignated dynamometer) was significantly more likely (X ² test, p<.05) to be deficient in patients who died.	Cook et al (2001) ³¹
Community residents (487): 62-90 yr	5 yr	Maximum grip strength of the right hand (measured with modified sphygmomanometer, corrected for age) was significantly higher (p<.01) for individuals who survived.	Milne & Maule (1984) ¹¹
Patients with rheumatoid arthritis (75): mean 54.7 yr	9 yr	Mean grip strength of two hands (measured with modified sphygmomanometer) less (but not significantly) in those who died. Relative risk of death 1.36 for those with grip strength ≤ 60 mm Hg rather than ≥ 61 mm Hg.	Pincus et al (1987) ³⁹
Patients with rheumatoid arthritis (206): mean 56.6 yr	5 yr	Grip strength (measured with undesignated dynamometer) significantly less (t-test, p<=.03) in patients who died.	Callahan et al (1997) ⁴⁰
Patients with end-stage renal disease (206): mean 52.0 yr	Mean 37 mo	Maximum grip strength of stronger hand (measured with undesignated dynamometer) related to survival of all subjects and of men but not women. Survival for all subjects significantly longer (Kaplan-Meier, p<.01) if grip strength > median.	Stenvinkel et al (2002) ⁴⁴
Patients on peritoneal dialysis (233): mean 55.0 yr	Mean 30 mo	Maximum grip strength of nondominant hand (measured with Smedley dynamometer) related to survival. Strength significantly greater for survivors. Greater hand grip strength adjusted for demographics, health and nutrition was followed by lower all-cause (hazards ratio .95) and cardiovascular (hazards ratio .94) mortality.	Wang et al (2005) ⁴⁵
Patients with rheumatoid arthritis (1018): mean 51.8 yr	15 yr	Grip strength (measured with undesignated dynamometer) > 200 associated with greater survival (79%) at 15 years than grip strength < 200 (55%).	Mitchell et al (1986) ⁴²
Female patients admitted to geriatric ward (82): mean 82.0 yr	Mean 14 days	Maximum grip strength of each hand (measured with Harpenden dynamometer) related to survival. Strength significantly greater in survivors (Wilcoxon test, p<.01). Strength ≥ 5 kg most sensitive and specific cut-off point.	Phillips (1986) ²⁹
Patients with rheumatoid arthritis (75): mean 54.7 yr	9 yr	Mean grip strength of right hand (measured with modified sphygmomanometer) not significantly different (T test, p=.059) between groups that died versus survived.	Pincus et al (1984) ⁴³
Community residents (422): 69-71 yr	10 yr	Grip strength of stronger hand (measured with undesignated dynamometer) associated with mortality. In women the relative risk (.62) was significant. In men the relative risk (.84) was not significant. In multivariate analysis grip strength did not add to the explanation of mortality for men or women.	Shibata et al (1992) ¹⁹
Community residents (466): 75 & 80 yr	4 yr	Grip strength of the dominant hand (measured with undesignated dynamometer) predictive of death. Odds ratio for death = 1.86 for individuals with < mean strength.	Laukkanen et al (1995) ²⁰

Table 1. Continued

Disability			
Nondisabled men (138): 71-91 yr	4 yr	Maximum grip strength of dominant hand (measured with Martin Vigorimeter) predictive of incident disability. Relative risk (adjusted) was significant for all men (.97) and men ≥ 77 y (.96), but not for men ≤ 76 y (.99)	Giampaoli et al (1999) ¹²
Nondisabled women (3406): ≥ 67 yr	4 yr	Mean grip strength of left and right hands (measured with Preston dynamometer) significantly less (t-test, $p < .0001$) in women developing incident disability.	Sarkisian et al (2001) ¹³
Healthy men (3218): 45-68 yr	25 yr	Maximum grip strength (measured with Smedley dynamometer) related to functional limitations. Odds ratio (adjusted) for lowest tertile compared to highest tertile = 1.35-2.90 depending on the limitation and adjustments.	Rantanen et al (1999) ¹⁴
Disabled women (884): mean 78.7 yr	3 yr	Maximum grip strength of dominant hand (measured with undesignated dynamometer) related to incident progressive disability of the upper limb. Relative risk (adjusted) = .67 per 5.9 kg. Strength was not related to incident catastrophic disability of the upper limb or progressive or catastrophic ADL or mobility incident disability (relative risk = .84- .94).	Onder et al (2005) ²²
Hospitalized patients (50): mean 55 yr	Median 10 d	Maximum grip strength of each hand (measured with Therapeutics Instruments dynamometer) main predictor of functional decline during admission. Strength of each side significantly different between patients who did and didn't decline. Regression analysis showed left grip strength to explain decline in function: partial correlation = .476.	Humphreys et al (2002) ²⁵
Patients admitted for acute rehabilitation (82): mean 58 yr	Mean 17.4 d	Maximum grip strength of each hand (measured with Jamar dynamometer) correlated positively and significantly with self-care independence at discharge ($r_s = .360$ & $.382$).	McAniff & Bohannon (2002) ²⁶
Patients with rheumatoid arthritis (64): mean 46.5 yr	Mean 15.2 yr	Grip strength (measured with undesignated dynamometer) in conjunction with 3 other variables correctly predicted (discriminant analysis) poor function in 73% of patients.	Corbett et al (1993) ⁴¹
Rural community-dwelling Japanese (736): ≥ 65 yr	6 yr	Low grip strength (measured with undesignated dynamometer) adjusted for age, sex, and number of chronic conditions associated with onset of functional dependence. Hazard ratio for lowest quartile of grip strength 2.51 for patients 65-74 years and 2,21 for patients ≥ 75 years.	Shinakai et al (2000) ¹⁵
Rural, noninstitutionalized Japanese (748): ≥ 65 yr	6 yr	Maximum grip strength of dominant hand (measured with undesignated dynamometer) predictive of onset of BADL and IADL disability. Adjusted hazards ratio for each quartile decrease in grip strength was 1.22 for onset of BADL dependence and 1.33 for onset of IADL dependence.	Shinkai et al (2003) ¹⁶
Complications, Resource Utilization, Discharge Disposition, Other			
Patients hospitalized with cancer (127): mean 54 yr	Postoperative	Maximum grip strength of nondominant hand (measured with undesignated dynamometer) predictive of length of stay (t-test, $p = .002$) and complications (X^2 test, $p < .004$). If $< 85\%$ control, length of stay significantly longer and significantly greater proportion developed complications.	Guo et al (1996) ²⁷
Patients undergoing surgery (205): not stated	Mean 16.6 d	Maximum grip strength of nondominant hand (measured with "single spring" dynamometer) "most sensitive single parameter" predicting postoperative complications. Proportion with complications significantly higher if grip $< 85\%$ standard. Sensitivity = 64%, specificity = 71%.	Hunt et al (1985) ³²

Table 1. Continued

Patients with hip fracture (76): not stated	Postoperative	Maximum grip of nondominant hand (measured with Clinifeed/Roussel dynamometer) predictive of complications for patients ≥ 80 yr but not for patients < 80 yr. Proportion ≥ 80 yr with complications significantly higher if strength < 15 kg. Sensitivity = 90%, specificity = 48%.	Davies et al (1984) ⁴⁸
Patients undergoing surgery for cancer (95): 42-88 yr	Postoperative	Maximum grip strength of nondominant hand (measured with "single spring" dynamometer) predictive of complications. If $< 85\%$ standard strength, sensitivity = 77.8%, specificity = 86.1%.	Kalfarentzos et al (1989) ³⁰
Patients undergoing elective abdominal surgery (100): 13-70 yr	Postoperative	Maximum grip strength of the nondominant hand (measured with "single spring" dynamometer) predicted complications and length of stay. If strength $\leq 85\%$ control mean, significantly more likely to have major complications (sensitivity = 64.4%) and minor complications. Length of stay significantly longer.	Mahalakshmi et al (2004) ³³
Patients undergoing major abdominal surgery (102): 16-81 yr	Postoperative	Maximum grip strength of nondominant hand (measured with undesignated dynamometer) normalized against control values most sensitive test for predicting complications. If strength $< 85\%$ normal, complications significantly more likely.	Klidjian et al (1980) ³⁴
Patients hospitalized with pneumonia (191): mean 72.5 yr	30 d	Maximum grip strength of stronger hand (measured with Jamar dynamometer) correlated with length of stay ($r = -.269$, $p < .001$) and discharge home ($r = .545$, $p < .001$) but not with readmission ($r = -.135$, $p = .067$). Logistic regression shows grip strength related to discharge home but not length of stay or readmission. Adjusted odds ratio for discharge home = 4.670 for grip strength > 10 kg.	Vecchiarino et al (2004) ²⁴
Patients receiving liver transplant (53): mean 50 yr	Postoperative	Mean grip strength of each hand (measured with Jamar dynamometer) associated with prolonged ICU length of stay. Strength significantly less for patients staying ≥ 4 days vs < 4 days (t-test, $p=.01$). Strength not associated (t-test) with total hospital length of stay, development of infection, blood use, acute cellular rejection or global resource utilization.	Figueiredo et al (2000) ³⁵
Hospitalized elders (120): 75-101 yr	Median 9 d	Maximum grip strength of stronger hand (measured with Jamar dynamometer) "associated with increased likelihood of discharge to usual residence." Hazard ratio (adjusted) = 1.03 per kg. Likelihood for returning home increased by 25% if strength > 18 kg for women and 31 kg for men.	Kerr et al (2006) ²⁸
Patients undergoing coronary artery bypass grafting (200): 26% > 70 yr	Postoperative	Maximum grip strength of the stronger hand (measured with undesignated dynamometer) was more likely to be deficient, but not significantly (X^2 , $p>.05$) in patients who had greater lengths of stay or more complications.	Cook et al (2001) ³¹
Patients undergoing elective surgery (84): mean 54 yr	Postoperative	Grip strength of dominant hand (measured with MyGripper dynamometer) correlated significantly ($r= .352$, $p=.014$) with postoperative fatigue.	Schroeder & Hill (1993) ³⁶
Patients undergoing major surgery (90): not stated	Postoperative	Grip strength of nondominant hand (measured with Duffield dynamometer) associated with complications. Strength $< 85\%$ had a 74% sensitivity and 51% specificity for predicting complications.	Webb et al (1989) ³⁷
Patients admitted for acute rehabilitation (82): mean 58 yr	Mean 17.4 d	Maximum grip strength of each hand (measured with Jamar dynamometer) correlated negatively and significantly with length of stay ($r_s = -.277$ & $-.352$).	McAniff & Bohannon (2002) ²⁶

Table 1. Continued

Patients with cirrhosis (50): mean 52.5 yr	1 yr	Grip strength (measured with Kratos ZM dynamometer) was “the only technique that predicted a significant increase in major complications.”	Álvares-da-Silva et al (2005) ⁴⁶
Postmenopausal women (43): mean 42- 52 yr	Up to 14 yr	Grip strength of nondominant hand (measured with RKK grip dynamometer) was not correlated significantly with bone loss at the spine ($p = .310$) or hip ($p = .078$).	Reeve et al (1999) ¹⁷
Healthy postmenopausal women (672): mean 59.1 yr	Mean 5.3 yr	Maximum grip strength (measured with Martin Vigorimeter) significantly less in left ($p < .0001$) and right ($p = .0004$) hands of women who experienced fractures. Adjusted odds ratio of fracture 2.05 for women with left grip strength $\leq .60$ bar.	Albrand et al (2003) ¹⁸

to 15 or more years in several studies of initially healthy men^{6,8,25} or patients with rheumatoid arthritis.^{38,41,43} The specific dynamometer employed was not always stated. Among dynamometers designated, the Jamar was used most often.^{4,7,21,23,24,26,28,35} The grip strength measure used in the studies varied. In a few cases it was not specified,^{5,14,15,41,42,47} but more often the measurement used was the strength of the right hand,^{4,7,11,43} stronger hand,^{20,21,23,24,28,31,44} non-dominant hand,^{17,27,30,32-34,37,45,48} dominant hand,^{9,10,12,16,22,36} or both hands.^{13,18,25,26,29,36,38,39} Mortality/survival was the most commonly measured outcome.^{4-11,21,23,24,30,31,38-40,42-45,47} However, disability,^{12-16,22,25,26,41} complications and increased length of stay,^{26,27,30-34,37,46} and other outcomes^{17,18,24,28,35,36} were also measured.

Low grip strength was a consistent predictor of death and high grip strength was a consistent predictor of survival in studies with diverse samples of subjects. Sixteen of 23 studies provided unqualified support for the use of grip strength as a predictor of mortality/survival.^{4,7-11,21,23,24,29-31,40,42,45,47} Two studies did not demonstrate grip strength to be predictive of survival; both involved patients with rheumatoid arthritis.^{39,43} Two studies reported grip strength to be predictive for men but not women^{5,44} and 2 studies reported grip strength to be predictive for women but not for men.^{19,38} One study reported grip strength of men greater than 60 years to be predictive but grip strength of men less than 60 years not to be predictive.⁶

All studies examining the relationship of grip strength with future disability demonstrated that low grip strength was accompanied by a greater likelihood of functional limitations.^{12-16,22,25,26,41} However, in 1 study the risk of disability was not increased for a subset of subjects less than 77 years.¹² In another study only progressive disability of the upper limb was predicted; catastrophic disability of the upper limb, progressive or catastrophic disability of activities of daily living, and mobility were not predicted by grip weakness.²²

The findings of most studies examining the association of grip strength with complications and length of stay were unambiguous. That is, lower grip strength was followed by an increased likelihood of complications or increased length of stay.^{26-28,30,32-34,36,37,46} Álvares-da-Silva reported grip strength to be “the only technique that predicted a significant increase in major complications” among patients with cirrhosis.⁴⁶ Hunt et al described grip strength as the “most sensitive single parameter” predicting postoperative complications.³² The results of 3 studies were divided. Davies et al determined that low grip strength was predictive of complications but only for the subset composed of patients at least 80 years of age.⁴⁸ Vecchiarino et al found low grip strength to be associated with a

longer length of stay, but only in bivariate analysis.²⁴ Figueriredo et al observed that low grip strength was associated with a longer length of stay in the intensive care unit but not in the hospital overall.³⁵ For patients undergoing coronary artery bypass grafting, Kerr et al noted greater lengths of stay and more complications in patients whose grip strength was less, but the differences were not significant.³⁰ Discharge home²⁶ or to usual residence³⁰ has been shown to be more likely for patients who have greater grip strength. Although bone loss may not be greater for patients with lower grip strength,¹⁷ fractures are more likely.¹⁸

DISCUSSION

This systematic review was conducted to summarize the evidence for using grip strength to predict important outcomes. The evidence gathered from diverse samples of individuals, employing several dynamometers, and using different strength measures supports the value of grip strength as a predictor of mortality, disability, complications, and increased length of stay. In several studies, grip strength was the only significant predictor, the best predictor, or a predictor of comparable or higher value than traditional laboratory or clinical measures. Even when grip strength was adjusted for potentially confounding variables, it was a consistent predictor of important outcomes.

Why might grip strength be such a robust predictor? A causal relationship between grip strength and the outcomes studied is unlikely, except perhaps for disability. It is more probable that grip strength reflects other variables that are potentially causal. As most studies revealing the predictive value of grip strength involved older subjects or a subset of older subjects, several candidate variables come to mind. Chief among the variables is frailty. Decreased strength, most often grip strength, has been prescribed as an important sign of frailty.⁴⁹⁻⁵² Syddall et al even proffered grip strength as a “single marker of frailty.”⁵² Two other variables, sometimes included among markers of frailty as well, are nutritional status and vitality.^{49,51,53} Grip strength has been shown to be a legitimate indicator of nutritional status^{37,45} that may in some populations predict outcomes better than traditional nutritional markers such as weight to height ratios, weight loss, limb circumference, or serum albumin.³⁴ Davies described grip strength as “a crude but effective will to live meter.”⁴⁸

Although the evidence of this systematic review is strong, the evidence it consolidates has several limitations. First, a single individual performed all searches and abstracting. Consequently, the reliability of the coalesced evidence cannot be confirmed. Second,

studies were not vetted for quality. While quality is important, this was not a consolidation of intervention studies such that inclusion could be limited to randomized controlled trials. The author did not want to arbitrarily exclude observational studies as they provide information relevant to the focus of the review. Third, while the diversity of samples, dynamometers, and measures studied supports the robustness of grip strength as a predictor, it also precludes the application of cut-point scores with known sensitivity and specificity across the population as a whole. Future research, therefore, should investigate a very large population-based sample using a commercially available dynamometer and a single measurement (eg, best grip of the strongest side).

In conclusion, broader utilization of grip strength is supportable because of its predictive validity. Additional support resides in its measurement properties,^{54,55} simplicity, portability, and affordability. Like different physical performance measures examined by Studenski et al, grip strength should be considered as one “vital sign” useful for screening “older adults in clinical settings.”⁵⁶

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