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Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

References

1. Tinetti M, Speechley M, Ginter S. Risk factors for falls among elderly persons living within the community. N Engl J Med 1988; 319: 1701–7.
2. Scuffman P, Chaplin S, Legood R. Incidence and costs of unintentional falls in older people in the United Kingdom. J Epidemiol Community Health 2003; 57: 740–4.
3. Logan PA, Coupland CAC, Gladman JRF *et al* Community falls prevention for people who call an emergency ambulance after a fall: randomised controlled trial. BMJ 2010; 340: c2102.
4. Gillespie LD, Robertson MC, Gillespie WJ *et al* Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev 2009; 2: CD007146.
5. Gates S, Fisher JD, Cooke MW, Carter YH, Lamb SE. Multifactorial assessment and targeted intervention for preventing falls and injuries among older people in community and emergency care settings: systematic review and meta-analysis. BMJ 2008; 336: 130–3.
6. NICE. Falls: the assessment and prevention of falls in older people, 2004. www.nice.org.uk/cg21.
7. National Institute for Health and Clinical Excellence. Guide to the methods of technology appraisal. URL: www.nice.org.uk/media/B52/A7/TAMethodsGuideUpdateJune2008.pdf.
8. Logan PA, Murphy A, Drummond AE *et al* The cost of assistive devices for people who have fallen. Br J Occupat Therapy 2007; 70: 475.
9. Sach TH, Whynes DK. Measuring indirect costs: is there a problem? Appl Health Econ Health Policy 2003; 2: 135–9.
10. Davis JC, Robertson MC, Comans T, Scuffham PA. Guidelines for conducting and reporting economic evaluation of fall prevention strategies. Osteoporos Int 2011; 22: 2449–59.
11. Brooks R. EuroQol: the current state of play. Health Policy 1996; 37: 53–72.
12. Dolan P. Modelling valuations for EuroQol health states. Med Care 1997; 35: 1095–108.
13. Briggs AH, Wonderling DE, Mooney CZ. Pulling cost-effectiveness analysis up by its bootstraps: a non-parametric approach to confidence interval estimation. Health Econ 1997; 6: 327–40.
14. Fenwick E, Claxton K, Sculpher MJ. Representing uncertainty: the role of cost-effectiveness acceptability curves. Health Econ 2001; 10: 779–87.
15. Barton GR, Briggs AH, Fenwick EA. Optimal cost-effective decisions: the role of the cost-effectiveness acceptability curve (CEAC), cost effectiveness acceptability frontier (CEAF) and expected value of perfect information (EVPI). Value Health 2008; 11: 886–97.
16. Irvine L, Conroy SP, Sach T *et al* Cost-effectiveness of a day hospital falls prevention programme for screened community-dwelling older people at high risk of falls. Age Ageing 2010; 39: 710–6.
17. Salkeld G, Cumming RG, O'Neill E *et al* The cost effectiveness of a home hazard reduction program to reduce falls among older persons. Aust N Z J Public Health 2000; 24: 265–71.
18. Briggs AH, O'Brien BJ. The death of cost-minization studies? Health Econ 2001; 10: 179–84.

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Is grip strength associated with length of stay in hospitalised older patients admitted for rehabilitation? Findings from the Southampton grip strength study

Helen Clare Roberts[1], Holly Emma Syddall[2], Cyrus Cooper[2], Avan Aihie Sayer[1,2]

[1]Academic Geriatric Medicine, University of Southampton, Southampton, UK
[2]MRC Lifecourse Epidemiology Unit, University of Southampton, Southampton, UK

Address correspondence to: H. C. Roberts. Tel: (+44) 023 8079 4354; Fax: (+44) 023 8079 6965. Email: h.c.roberts@soton.ac.uk

Abstract

Background: identification of patients at risk of prolonged hospital stay allows staff to target interventions, provide informed prognosis and manage healthcare resources. Admission grip strength is associated with discharge outcomes in acute hospital settings.
Objective: to explore the relationship between grip strength and length of stay in older rehabilitation in-patients.
Design: single-centre prospective cohort study.
Setting: community hospital rehabilitation ward.
Subjects: one hundred and ten patients aged 70 years and over.
Methods: data on age, height, weight, body mass index (BMI), co-morbidities, medication, residence, grip strength, physical function, cognitive function, frailty, falls, discharge destination and length of stay were recorded.
Results: higher grip strength was associated with reduced length of stay, characterised by an increased likelihood of discharge to usual residence among male rehabilitation in-patients (hazard ratio 1.09 (95% confidence interval 1.01, 1.17) per kilo increase in grip strength, $P = 0.02$) after adjustment for age and size.
Conclusions: this is the first prospective study to show that stronger grip strength, particularly among male in-patients, is associated with a shorter length of stay in a rehabilitation ward. This is important because it demonstrates that grip strength can be discriminatory among frailer people. Further research into the clinical applications of grip strength measurement in rehabilitation settings is needed.

Keywords: *grip strength, rehabilitation, length of stay, older people*

Introduction

The identification of patients at risk of prolonged hospital stay is a key objective of comprehensive geriatric assessment [1] and allows staff to target appropriate timely interventions, provide informed prognosis and manage healthcare resources effectively. Several screening instruments for the prediction of functional adverse outcomes of hospitalised patients have been trialled, mainly with acute admissions and in the emergency department, but they tend to be complex, time consuming and with insufficient validity [2] for routine clinical practice. The main components of these instruments that are associated with poor outcomes include older age, worse cognitive and physical function [3] and depression [4].

Low grip strength in middle-aged and older community-dwelling adults is associated with subsequent onset of functional limitations [5], disability [6], cognitive decline [7], co-morbidities such as coronary heart disease and stroke [8, 9] and increased all-cause mortality rates [10]. In the acute hospital setting, lower admission grip strength was associated with decreased likelihood of discharge home among older acutely ill medical patients [11] and patients hospitalised with pneumonia [12]. Lower grip strength has also been shown to be associated with longer length of stay among surgical [13] and cancer patients [14] in acute settings, but it is unknown as to whether a similar association exists in rehabilitation settings. This study aimed to prospectively investigate the relationship between grip strength and length of stay in older people admitted for rehabilitation.

Methods

Patients aged 70 years and over who were admitted to the rehabilitation ward of a community hospital were prospectively consecutively recruited within 1 week of admission. They were admitted for mobilisation after an acute medical illness, surgery or fracture. Patients who were unable to provide consent, had difficulties holding the dynamometer or were terminally ill were excluded. After obtaining written informed consent, baseline data on age, weight, body mass index (BMI), current co-morbidities, medication and usual residence were abstracted from the clinical records, and forearm length was measured to estimate height [15]. Grip strength was measured three times in each hand with a Jamar dynamometer (Lafayette Instrument Company, USA) using a standard protocol [16] with the highest score used to characterise maximum grip strength. Questionnaires on physical function (Barthel score) [17], cognitive function (Mini-Mental State Examination (MMSE)) [18], frailty (Strawbridge Frailty Questionnaire) [19] and the number of falls in the last year were administered. At discharge, participants' destination and length of stay were recorded. The study received full approval from the local research ethics committee.

Sample size

The sample size was set at 100 participants, based on a previous study that demonstrated significant associations between grip strength and length of stay in acute medical wards with this sample size [11].

Statistical methods

Data were doubly entered and analysed using Stata, version 11. Men and women were examined separately throughout. Baseline characteristics, discharge destination and length of stay were described using means and standard deviations

(SD), medians and interquartile ranges (IQR) and frequency and percentage distributions. Cross-sectional associations between grip strength and other baseline characteristics were explored using regression analysis and analysis of variance. Weight and height were positively correlated (Pearson's correlation coefficient for men $r = 0.27$, $P = 0.12$; women $r = 0.42$, $P = 0.001$); to avoid multi-colinearity problems in subsequent adjusted survival analysis models, a standardised residual of weight adjusted for height was derived. Length of stay until discharge to usual residence was censored for 26% of the study participants because of discharge to a new care home (17%), a hospital transfer (8%) or death (1%). Accordingly, Cox's proportional hazard's models (which account for censoring of observations) were used to explore the associations between baseline characteristics and likelihood of discharge to usual residence. Firstly, univariate analyses were conducted for each baseline characteristic in turn in relation to discharge to usual residence. Secondly, analyses were repeated with adjustment for age and size (characteristics recognized *a priori* as important correlates of grip strength). Thirdly, analyses were repeated with adjustment for age, size and additionally those characteristics most strongly associated with grip strength in the age- and size-adjusted model.

Table 1. Participants' characteristics and discharge destination

	Male ($N = 37$)	Female ($N = 64$)
Age (years)[a]	82.6 (5.6)	84.9 (6.2)
Height (cm)[a]	170.9 (3.5)	157.9 (4.0)
Weight (kg)[a]	70.1 (11.9)	57.9 (15.7)
Maximum grip (kg)[a]	21.7 (7.7)	13.6 (5.0)
Barthel score[b]	62 (31, 78)	69.5 (48, 83)
Number of co-morbidities[b]	4 (3, 5)	4 (3, 5)
Number of medications[b]	8 (7, 10)	8 (6, 11)
MMSE[b]	24 (21, 26)	25 (20, 27)
Frail on Strawbridge score[c]	20 (57)	30 (50)
Falls in past year[c]: None; 1; 2 or more	8 (22); 11 (31); 17 (47)	16 (25); 19 (30); 28 (45)
Discharge destination		
Usual residence[c]	29 (78.4)	46 (71.9)
New care home[c]	5 (13.5)	12 (18.8)
Hospital transfer[c]	3 (8.1)	5 (7.8)
Death[c]	0 (0.0)	1 (1.6)

SD, standard deviation; IQR, interquartile range; MMSE, mini-mental state examination.
[a]Mean (SD).
[b]Median (IQR).
[c]Number (%).

Results

One hundred and one participants were recruited from 161 consecutive admissions between February and December 2008. Sixty patients (mean age 84.6 years) were not included for the following reasons: 12 too unwell; 12 severely confused; 4 refused; 11 discharged or transferred before review; 21 could not be seen by the researcher within one week of admission. In the morning participants were all assessed by themselves on the ward: the median delay between admission and data collection was 4 days (IQR 2–6, range 1–7). This variation in time to data collection was not thought to impact on the grip strength values since grip strength assessed twice at least 2 weeks apart among a sub-sample of 20 rehabilitation in-patients (who had demonstrated clinical improvement) had shown a mean difference (95% confidence interval (CI)) in the two grip strength readings of only −0.3 kg (−1.7, 1.07) $P = 0.65$. Thus, grip strength demonstrated little change during a short period of rehabilitation in this group of participants.

The participants comprised 37 men (mean age 82.6 years, range 73.0–92.6) and 64 women (mean age 84.9 years, range 70.3–99.4). Participants' baseline characteristics are described in Table 1. The median length of stay was 26 days (range 2–98 days) and 74.3% of participants were discharged to their usual residence. There was no statistically significant gender difference in the pattern of discharge, although with a hazard ratio (HR) for discharge to usual residence of 0.91 (95% CI 0.38, 2.15; $P = 0.82$) for women compared with men, women were 9% less likely to be discharged to their usual residence than men.

Table 2 shows the associations between discharge to usual residence and baseline variables among the male participants in unadjusted and adjusted analyses. In univariate unadjusted analyses, the key baseline variables associated with increased likelihood of discharge to usual residence were shorter stature and higher Barthel score. A 1 kg increase in grip strength was associated with a 5% greater likelihood of discharge to usual residence but this was not statistically significant (HR per kilo increase in grip strength, 1.05; 95% CI 0.99; 1.11, $P = 0.14$).

Table 2 shows that adjustment for age, height and weight-for-height strengthened the association between grip strength and discharge to usual residence (HR 1.09; 95% CI 1.01, 1.17; $P = 0.02$) and also the association between the number of co-morbidities and discharge to usual residence (HR for discharge to usual residence per extra co-morbidity 0.62; 95% CI 0.42, 0.92; $P = 0.02$). Additional adjustment for Barthel score and number of co-morbidities attenuated the association between grip strength and discharge to usual residence. The association between co-morbidities and discharge to usual residence was little altered in the fully adjusted model.

Table 3 shows the associations between discharge to usual residence and baseline variables among the female participants. In univariate analyses, higher Barthel score and MMSE, and lower Strawbridge frailty score and fewer falls were associated with increased likelihood of discharge to usual residence; these associations were strengthened by adjustment for age and size. However, only older age, MMSE and falls were associated with discharge to usual residence in the fully adjusted model.

Table 2. Univariate associations between baseline variables and discharge to usual residence for male participants

Men ($n = 37$)	Univariate analyses[a]			Adjusted for age and size[b]			Fully adjusted[c]		
	HR	(95% CI)	*P*	HR	(95% CI)	*P*	HR	(95% CI)	*P*
Age (years)	0.96	(0.90, 1.04)	0.33	1.01	(0.93, 1.09)	0.90	1.03	(0.96, 1.11)	0.40
Height (cm)	0.83	(0.73, 0.95)	0.01	0.82	(0.71, 0.95)	0.01	0.72	(0.59, 0.87)	0.00
Weight for height (SD score)	1.00	(0.97, 1.04)	0.88	1.00	(0.97, 1.04)	0.85	1.02	(0.98, 1.07)	0.32
Barthel score	1.02	(1.00, 1.04)	0.01	1.03	(1.01, 1.05)	0.00	1.03	(1.00, 1.05)	0.03
Maximum grip (kg)	1.05	(0.99, 1.11)	0.14	1.09	(1.01, 1.17)	0.02	1.02	(0.92, 1.12)	0.75
Co-morbidities (number)	0.75	(0.53, 1.05)	0.09	0.62	(0.42, 0.92)	0.02	0.65	(0.44, 0.95)	0.03
Medications (number)	1.08	(0.96, 1.22)	0.18	1.02	(0.89, 1.15)	0.82	1.07	(0.93, 1.23)	0.36
MMSE	1.09	(1.00, 1.18)	0.05	1.07	(0.97, 1.17)	0.16	1.06	(0.9, 1.16)	0.26
Strawbridge frailty	1.17	(0.53, 2.56)	0.70	1.27	(0.54, 3.02)	0.59	1.28	(0.48, 3.43)	0.62
Falls in last year (number)	1.54	(0.93, 2.56)	0.09	1.30	(0.73, 2.30)	0.37	1.20	(0.65, 2.21)	0.56

HR, hazard ratio; CI, confidence interval; SD, standard deviation; MMSE, mini-mental state examination.
P values for association estimated using Cox's proportional hazards models.
[a]Univariate unadjusted associations between discharge to usual residence and each characteristic in the table in turn.
[b]Associations between discharge to usual residence and each characteristic in the table in turn after adjustment for age, height and weight-for-height.
[c]Associations between discharge to usual residence and each characteristic in the table in turn after adjustment for age, height, weight-for-height and factors predictive of outcome in age and size adjusted model, i.e. Barthel score, grip strength and number of co-morbidities.

Table 3. Univariate associations between baseline variables and discharge to usual residence for female participants

Women ($n = 64$)	Univariate analyses[a]			Adjusted for age and size[b]			Fully adjusted[c]		
	HR	(95% CI)	*P*	HR	(95% CI)	*P*	HR	(95% CI)	*P*
Age (years)	1.03	(0.98, 1.08)	0.23	1.03	(0.98, 1.08)	0.22	1.08	(1.02, 1.14)	0.01
Height (cm)	1.04	(0.96, 1.13)	0.31	1.05	(0.96, 1.14)	0.26	1.03	(0.94, 1.13)	0.58
Weight for height (SD score)	1.01	(0.99, 1.03)	0.44	1.01	(0.98, 1.03)	0.51	1.00	(0.97, 1.03)	0.95
Barthel score	1.02	(1.01, 1.04)	0.00	1.03	(1.01, 1.04)	0.00	1.01	(0.99, 1.03)	0.31
Maximum grip (kg)	1.03	(0.98, 1.08)	0.25	1.03	(0.98, 1.09)	0.25	0.95	(0.88, 1.03)	0.22
Co-morbidities (number)	0.86	(0.70, 1.05)	0.14	0.85	(0.70, 1.04)	0.12	0.89	(0.72, 1.11)	0.31
Medications (number)	0.95	(0.87, 1.04)	0.29	0.95	(0.87, 1.05)	0.31	0.96	(0.86, 1.07)	0.44
MMSE	1.13	(1.05, 1.20)	0.00	1.18	(1.09, 1.28)	0.00	1.15	(1.04, 1.27)	0.01
Strawbridge frailty	0.49	(0.26, 0.90)	0.02	0.39	(0.21, 0.76)	0.01	0.54	(0.25, 1.13)	0.10
Falls in last year (number)	0.52	(0.36, 0.75)	0.00	0.48	(0.32, 0.71)	0.00	0.44	(0.28, 0.69)	0.00

HR, hazard ratio; CI, confidence interval; SD, standard deviation; MMSE, mini-mental state examination.
P values for association estimated using Cox's proportional hazards models.
[a]Univariate unadjusted associations between discharge to usual residence and each characteristic in the table in turn.
[b]Associations between discharge to usual residence and each characteristic in the table in turn after adjustment for age, height and weight-for-height.
[c]Associations between discharge to usual residence and each characteristic in the table in turn after adjustment for age, height, weight-for-height and also factors predictive of outcome in age- and size-adjusted models, i.e. Barthel score, MMSE, frailty and falls.

Discussion

This is the first prospective study to demonstrate that higher grip strength is associated with reduced length of stay among older male patients in a community hospital rehabilitation ward. One previous retrospective study of younger rehabilitation in-patients with a mean age of 58 years similarly found a correlation between admission grip strength and length of stay [20]. Our findings are consistent with those from studies conducted in acute hospital settings among medical, surgical and cancer patients, where low grip strength has been associated with longer lengths of stay and also increased complication rates [21] as well as mortality rates [22]. Kerr *et al.* [11] studying acute older medical in-patients demonstrated a 3% increase in the likelihood of discharge to usual residence for every additional 1 kg in grip strength adjusted for age and gender (HR 1.03; 95% CI 1.00, 1.07; $P = 0.05$). A Portuguese study of hospitalised acute patients similarly found that each additional 1 kg of grip strength was associated with a 4% reduction of risk of having a longer-than-average length of stay [23].

The association between grip strength and length of stay may have a number of alternative explanations such as a relationship with functional status [24]. This would be supported by the attenuation of the association between grip strength and discharge to usual residence by the Barthel score and number of co-morbidities in this study. Length of stay is also subject to external influences such as the availability of health and social care, as well as personal choice. These are not related to grip strength and so the effect of these external influences would have been to reduce the likelihood of detecting an association

between grip strength and discharge home. Among the female participants a greater proportion (18.8%) were discharged to a new care home compared to the men (13.5%), and although this was not statistically significant it may have contributed to a longer length of stay and thus the gender difference in association seen in this study. There are known associations between individual co-morbidities such as osteoporosis and type 2 diabetes and these may have also contributed as differences between men and women could not be taken into account with the small number of participants in this study. Only one participant died in this study, so it was not possible to evaluate the association between grip strength and mortality.

There are some limitations to our study. It included patients admitted for rehabilitation from one locality and all participants were Caucasian. Further research is therefore required to assess the generalisability of the findings to ethnically diverse populations. The exclusion of patients who were too unwell or confused to consent to take part in the study may have excluded some with lower grip strength, while those excluded because they were discharged too quickly may have had higher grip strength. However, the patients excluded were of a similar age to those who took part in the study and the study was designed to minimise selection bias through a single researcher screening all admissions. Furthermore, the single assessor measured grip strength using a standard protocol with a calibrated dynamometer that was regularly reassessed for accuracy.

The measurement of grip strength is attractive for use in clinical practice because it is both simple and quick to perform and is acceptable to patients [25, 26]. Grip strength is the only measure recommended by the European Working Group on Sarcopenia in Older People for the measurement of muscle strength, as a 'good simple measure'. It has been shown to correlate highly with leg strength and calf cross-sectional area, and to have a stronger association with poor mobility and future clinical outcomes than low muscle mass [27]. However, this recommendation comes with the caveat that grip strength should be measured in standard conditions with a well-studied model of dynamometer and with known reference populations. Importantly, grip strength should be measured with the patient in a sitting position and independent mobility is not required. Thus, it has the potential to be used with frailer people in a wide range of healthcare settings.

In conclusion, stronger grip strength was associated with reduced length of stay among older male patients in a community hospital rehabilitation ward. This is the first prospective study to demonstrate this association in a rehabilitation setting. It is important to recognise that grip strength can be discriminatory even among frailer people and identify those at increased risk of poor outcomes. Further research into the clinical applications of grip strength in rehabilitation and other healthcare settings is needed.

Key points

- This is the first prospective study to demonstrate that admission grip strength is associated with length of stay in a rehabilitation ward.
- Early identification of patients at risk of adverse outcomes of hospital care allows timely and focused interventions.
- Grip strength measurement is simple, cheap and acceptable to older patients.

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Conflicts of interest

None declared.

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References

1. Wells JL, Seabrook JA, Stolee P *et al*. State of the art in geriatric rehabilitation. Part I: review of frailty and comprehensive geriatric assessment. Arch Phys Med Rehabil 2003; 84: 890–7.
2. De Saint-Hubert M, Schoevaerdts D, Cornette P *et al*. Predicting functional adverse outcomes in hospitalized older patients: a systematic review of screening tools. J Nutr Health Aging 2010; 14: 394–9.
3. Sager MA, Rudberg MA, Jalaluddin M *et al*. Hospital admission risk profile (HARP): identifying older patients at risk for functional decline following acute medical illness and hospitalization. J Am Geriatr Soc 1996; 44: 251–7.
4. Hoogerduijn JG, Schuurmans MJ, Duijnstee MS *et al*. A systematic review of predictors and screening instruments to identify older hospitalized patients at risk for functional decline. J Clin Nurs 2007; 16: 46–57.
5. Wennie Huang WN, Perera S, VanSwearingen J *et al*. Performance measures predict onset of activity of daily living difficulty in community-dwelling older adults. J Am Geriatr Soc 2010; 58: 844–52.
6. Rantanen T, Guralnik JM, Foley D *et al*. Midlife hand grip strength as a predictor of old age disability. JAMA 1999; 281: 558–60.
7. Cooper R, Kuh D, Cooper C *et al*. Objective measures of physical capability and subsequent health: a systematic review. Age Ageing 2011; 40: 14–23.
8. Silventoinen K, Magnusson PK, Tynelius P *et al*. Association of body size and muscle strength with incidence of coronary heart disease and cerebrovascular diseases: a population-based cohort study of one million Swedish men. Int J Epidemiol 2009; 38: 110–8.
9. Rantanen T, Masaki K, Foley D *et al*. Grip strength changes over 27 yr in Japanese-American men. J Appl Physiol 1998; 85: 2047–53.

10. Cooper R, Kuh D, Hardy R. Objectively measured physical capability levels and mortality: systematic review and meta-analysis. BMJ 2010; 341: c4467.
11. Kerr A, Syddall HE, Cooper C *et al*. Does admission grip strength predict length of stay in hospitalised older patients? Age Ageing 2006; 35: 82–4.
12. Vecchiarino P, Bohannon RW, Ferullo J *et al*. Short-term outcomes and their predictors for patients hospitalized with community-acquired pneumonia. Heart Lung 2004; 33: 301–7.
13. Mahalakshmi VN, Ananthakrishnan N, Kate V *et al*. Handgrip strength and endurance as a predictor of postoperative morbidity in surgical patients: can it serve as a simple bedside test. Int Surg 2004; 89: 115–21.
14. Guo CB, Zhang W, Ma DQ *et al*. Hand grip strength: an indicator of nutritional state and the mix of postoperative complications in patients with oral and maxillofacial cancers. Br J Oral Maxillofac Surg 1996; 34: 325–7.
15. Haboubi NY, Hudson PR, Pathy MS. Measurement of height in the elderly. J Am Geriatr Soc 1990; 38: 1008–10.
16. Roberts HC, Denison HJ, Martin HJ *et al*. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age Ageing 2011; 40: 423–9.
17. Mahoney FI, Barthel DW. Functional evaluation the Barthel Index. MD State Med J 1965; 14: 61–5.
18. Folstein MF, Folstein SE, McHugh PR. 'Mini-mental state'. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975; 12: 189–98.
19. Strawbridge WJ, Shema SJ, Balfour JL *et al*. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998; 53: S9–16.
20. McAniff CM, Bohannon RW. Validity of grip strength dynamometry in acute rehabilitation. J Phys Ther Sci 2002; 14: 41–6.
21. Alvares-da-Silva MR, Reverbel da ST. Comparison between handgrip strength, subjective global assessment, and prognostic nutritional index in assessing malnutrition and predicting clinical outcome in cirrhotic outpatients. Nutrition 2005; 21: 113–7.
22. Bohannon RW, Maljanian R, Ferullo J. Mortality and readmission of the elderly one year after hospitalization for pneumonia. Aging Clin Exp Res 2004; 16: 22–5.
23. Matos LC, Tavares MM, Amaral TF. Handgrip strength as a hospital admission nutritional risk screening method. Eur J Clin Nutr 2007; 61: 1128–35.
24. Humphreys J, de la Maza P, Hirsch S *et al*. Muscle strength as a predictor of loss of functional status in hospitalized patients. Nutrition 2002; 18: 616–20.
25. Cruz-Jentoft AJ, Baeyens JP, Bauer JM *et al*. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing 2010; 39: 412–23.
26. Roberts HC, Sparkes J, Syddall H *et al*. Is measuring grip strength acceptable to older people? The Southampton Grip Strength Study. J Aging Res Clin Pract 2012; 1: 135–40.
27. Lauretani F, Russo CR, Bandinelli S *et al*. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol 2003; 95: 1851–60.

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Duloxetine for the management of pain in older adults with knee osteoarthritis: randomised placebo-controlled trial

SUZAN ABOU-RAYA[1], ANNA ABOU-RAYA[2], MADIHAH HELMII[3]

[1]Geriatric Unit, Internal Medicine Department, University of Alexandria, Alexandria, Egypt
[2]Rheumatology Unit, Internal Medicine Department, University of Alexandria, Alexandria, Egypt
[3]Biochemistry, Medical Research Institute, University of Alexandria, Alexandria, Egypt

Address correspondence to: S. Abou-Raya. Tel: (203) 5924601; fax: (203) 5924035. Email: suzanraya@yahoo.com

Abstract

Background: pain is the leading symptom of osteoarthritis (OA) and is often chronic in nature, leading to significant morbidity and decreased quality of life. Duloxetine, a selective serotonin norepinephrine reuptake inhibitor has been