Grip strength and its determinants among older people in different healthcare settings

HELEN C. ROBERTS1, HOLLY EMMA SYDDALL2, JONATHAN SPARKES1, JAN RITCHIE3, JOE BUTCHART3, ALASTAIR KERR4, CYRUS COOPER2, AVAN AIHIE SAYE1,2

1Academic Geriatric Medicine, University of Southampton, Mailpoint 807 Southampton General Hospital Tremona Road, Shirley, Southampton, Hants So16 6YD, UK
2MRC Lifecourse Epidemiology Unit, University of Southampton, Southampton, Hants, UK
3Medicine for Older People, University Hospital Southampton NHS Foundation Trust, Southampton, Hants, UK
4Older People’s Unit, Royal United Hospital, Bath, UK

Address correspondence to: H. Roberts. Tel: (+44) 2380 794354; Fax: (+44) 2380 796965. Email: hcr@soton.ac.uk

Abstract

Background: low muscle strength is central to geriatric syndromes including sarcopenia and frailty. It is well described in community-dwelling older people, but the epidemiology of grip strength of older people in rehabilitation or long-term care has been little explored.

Objective: to describe grip strength of older people in rehabilitation and nursing home settings.

Design: cross-sectional epidemiological study.

Setting: three healthcare settings in one town.

Subjects: hundred and one inpatients on a rehabilitation ward, 47 community rehabilitation referrals and 100 nursing home residents.

Methods: grip strength, age, height, weight, body mass index, number of co-morbidities and medications, Barthel score, Mini-Mental State Examination (MMSE), nutritional status and number of falls in the last year were recorded.

Results: grip strength differed substantially between healthcare settings for both men and women (P < 0.0001). Nursing home residents had the lowest age-adjusted mean grip strength and community rehabilitation referrals the highest. Broadly higher grip strength was associated in univariate analyses with younger age, greater height and weight, fewer comorbidities, higher Barthel score, higher MMSE score, better nutritional status and fewer falls. However, after mutual adjustment for these factors, the difference in grip strength between settings remained significant. The Barthel score was the characteristic most strongly associated with grip strength.

Conclusions: older people in rehabilitation and care home settings had lower grip strength than reported for those living at home. Furthermore grip strength varied widely between healthcare settings independent of known major influences. Further research is required to ascertain whether grip strength may help identify people at risk of adverse health outcomes within these settings.

Keywords: grip strength, older people, healthcare setting, rehabilitation, nursing home

Introduction

Characterisation of muscle strength is important because loss of strength is central to a number of major geriatric syndromes including sarcopenia [1], frailty [2], mobility impairment [3] and falls [4]. Low muscle strength is also associated with poor future health. Among community-dwelling adults, it has been found to be predictive of increased future functional limitations and disability [5–7], increased fracture risk [8, 9], development of chronic diseases [10, 11], higher risk of cognitive decline [8, 12] and increased all-cause mortality [13], particularly for those aged over 60 years.

Grip strength is recommended as a ‘good simple measure’ of muscle strength [14], with the caveat that grip strength should be measured with a well-studied model of dynamometer in standard conditions and with known reference populations. The Jamar dynamometer is the most widely used with established reliability and reproducibility [15], and standardised protocols have been described [16]. However, grip strength values such as the widely reported
‘consolidated norms’ developed by Bohannon et al. [17] from a meta-analysis of 12 studies from five countries are derived from community-dwelling adults, and no studies report grip strength values for patients in rehabilitation healthcare settings or residents in care homes although Roberts et al. [18] have reported that relatively lower grip strength was associated with a longer length of stay within an inpatient rehabilitation setting.

The aim of this study was to describe grip strength, and its cross-sectional associations with clinical characteristics, among older men and women undergoing inpatient rehabilitation, community-based rehabilitation and resident in nursing homes.

Methods

Participants

This cross-sectional epidemiological study was conducted in one town in England. Patients aged 70 years and over were prospectively recruited from inpatient rehabilitation at the community hospital, referrals to the community rehabilitation team for physiotherapy, and residents of five local nursing homes (one registered for general nursing care, one for dementia care, three dual registered). Exclusion criteria included inability to give written informed consent or hold the dynamometer, terminal phase of illness (on/about to be started on the Liverpool Care pathway for the dying), and researcher unable to review participants within 1 week of admission to hospital or 4 weeks of community referral. The study was approved by the local Research Ethics Committee.

Data collection

Participants’ demographic details, dates of admission or referral, current weight and body mass index (BMI), co-morbidities and current medications were abstracted from their clinical records. Grip strength was measured three times with each hand using a Jamar hand dynamometer (Promedics, UK) according to a standard protocol with standardised encouragement [15]. Maximum grip strength was recorded to the nearest 1 kg. Height was calculated from forearm length (cm) [19] since many participants were unable to stand. All inpatients and nursing home residents had current weights in their records and the community referrals were weighed to the nearest 0.1 kg on standing scales such that their BMI could be calculated. Physical function was assessed using the 100 point Barthel Score (maximum score 100, higher scores representing greater independence) [20]. The number of self-reported falls in the last year was recorded and corroborated with medical records or care staff where possible to improve the reliability of these data. The Mini-Mental State Examination (MMSE) was used to assess cognitive function (maximum score 30 points representing intact cognition, <24 points representing impaired cognition) [21]. The ‘malnutrition universal screening tool’ (‘MUST’) score [22] was assessed for each participant.

Statistical analyses

The database was created by double entry, and cleaned and prepared for use with the Stata statistical software package (StataCorp, Texas, 2010). Descriptive statistics (number, percentage) were used to report participant recruitment rates and reasons for exclusion in each healthcare setting. Participants’ characteristics, including age, anthropometry, numbers of co-morbidities and medications, grip strength, Barthel score, MMSE score, ‘MUST’ score and falls, were described using summary statistics: means and standard deviations (SD), medians and inter-quartile ranges (IQR) and number (percentage) were presented for each healthcare setting. The ‘MUST’ score was re-coded from five categories [score of 0 representing low risk of malnutrition, 1 (modest risk), 2 (high risk), 3 and 4 representing extremely high risk] to three categories (score 0, 1 and 2–4) since a score of 2 or more is used clinically to denote a high risk of malnutrition and very few participants scored >2. There was a large range in the number of falls (0–352) in the last year, although only 28 people had fallen more than five times. The number of falls was, therefore, recoded into three categories: none, one and two or more falls, since clinically two or more falls denotes a higher risk of further falls.

The men were taller and heavier than the women in each healthcare setting and since body size is associated with grip strength data were presented by gender and setting throughout. Men and women were compared within each setting using the two-sample t-test, The Mann–Whitney test and Fisher’s exact test as appropriate. Men or women were compared between healthcare settings using ANOVA, the Kruskal–Wallis test and Fisher’s exact test.

Maximum grip strength was described using means (SD) and percentiles for men and women separately in each setting with and without adjustment for age. The mean maximum grip strength for men and women was compared within each setting using the two-sample t-test, and between setting study settings using ANOVA. The associations of maximum grip with participants’ clinical characteristics—the number of co-morbidities and medications, the Barthel, MMSE and MUST scores and the number of falls during the last year—were analysed individually for men and women separately in each setting using linear regression analysis. Participants’ height and weight were strongly correlated and so a standardised residual of weight adjusted for height (‘weight-for-height’) was derived for inclusion in regression analysis. Thus results were presented adjusted for age, height and weight-for-height, using regression estimates with confidence intervals, and statistical significance was indicated using P-values.

Results

Recruitment

Of 137, 101 eligible rehabilitation inpatients (37 men, 64 women; 41% admitted from acute hospital, 59% from
Grip strength in different healthcare settings

Men were significantly taller than women within each setting ($P < 0.0001$), and heavier (except among the community rehabilitation referrals). Age and body size also varied between settings with the community rehabilitation referrals being the youngest and heaviest (Table 1). There was a median of four co-morbidities for men and women in all three settings. There was a similar prevalence of hypertension and stroke in all settings: falls and fracture were common among the inpatients, and osteoarthritis and joint replacement among the community rehabilitation patients. Poor mobility and dementia were common among the nursing home residents. However, there was a significant difference in the number of medications for both men and women across settings, with inpatients taking the most (median of eight). The Barthel and MMSE scores were both highest among the community referrals and lowest among nursing home residents, with a significant difference for both men and women between settings ($P = 0.0001$).

There was no significant difference in ‘MUST’ scores between men and women within each setting, but there was a difference between the settings for women ($P = 0.001$) with the poorest nutritional scores among the female inpatients. Men and women within each setting experienced similar numbers of falls, but again there was a significant difference between settings with nursing home residents experiencing the fewest falls.

Table 1. Description of participants’ characteristics by setting

<table>
<thead>
<tr>
<th></th>
<th>Hospital rehabilitation inpatients</th>
<th>Community rehabilitation referrals</th>
<th>Nursing home residents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male ($n = 37$)</td>
<td>Female ($n = 64$)</td>
<td>Male ($n = 24$)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>82.6 (5.6)</td>
<td>84.9 (6.2)</td>
<td>79.2 (5.5)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td></td>
<td></td>
<td>$P = 0.07$</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>170.9 (3.5)</td>
<td>157.9 (4.0)</td>
<td>173.3 (4.7)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td>$P &lt; 0.0001$</td>
<td></td>
<td>$P &lt; 0.0001$</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>70.1 (11.9)</td>
<td>57.9 (15.7)</td>
<td>79.5 (13.6)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td></td>
<td></td>
<td>$P = 0.33$</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>24.0 (3.9)</td>
<td>23.1 (5.8)</td>
<td>26.5 (4.2)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td></td>
<td></td>
<td>$P = 0.20$</td>
</tr>
<tr>
<td>Number of comorbidities*</td>
<td>4 (3, 5)</td>
<td>3 (3, 5)</td>
<td>4 (3, 5)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td></td>
<td></td>
<td>$P = 0.37$</td>
</tr>
<tr>
<td>Number of medications*</td>
<td>8 (7, 10)</td>
<td>8 (6, 11)</td>
<td>6 (3.5, 7.5)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td></td>
<td></td>
<td>$P = 0.77$</td>
</tr>
<tr>
<td>Barthel score*</td>
<td>62 (31, 78)</td>
<td>69.5 (48, 83)</td>
<td>99.5 (92, 100)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td></td>
<td></td>
<td>$P = 0.12$</td>
</tr>
<tr>
<td>MMSE*</td>
<td>24 (21, 26)</td>
<td>25 (20, 27)</td>
<td>28 (24, 30)</td>
</tr>
<tr>
<td>$P$-value**</td>
<td></td>
<td></td>
<td>$P = 0.94$</td>
</tr>
<tr>
<td>MUST score*</td>
<td></td>
<td></td>
<td>$P = 0.17$</td>
</tr>
<tr>
<td>Falls in past year*</td>
<td>0 21 (68)</td>
<td>28 (47)</td>
<td>20 (87)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$P = 1.00$</td>
</tr>
<tr>
<td></td>
<td>1 4 (13)</td>
<td>11 (18)</td>
<td>1 (4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$P = 0.96$</td>
</tr>
<tr>
<td></td>
<td>2 or more 17 (47)</td>
<td>28 (44)</td>
<td>12 (50)</td>
</tr>
</tbody>
</table>

Weight and BMI missing for three male and one female inpatients, and one male community referral; MMSE missing for one male community referral, MUST missing for six male and four female inpatients and one male community referral, falls missing for one male and one female inpatient.

*Median (inter-quartile range, IQR).

**Number (percentage, %).

SD, standard deviation; $n$, number; cm, centimetres; kg, kilograms; BMI, body mass index; m, metre; MMSE, Mini-Mental State Examination; MUST, Malnutrition Universal Screening Tool.

*P-value for differences between settings by gender calculated using ANOVA, Kruskal–Wallis test and Fisher’s exact test.

**P-value for differences between genders within settings calculated using two-sample t-test, Mann–Whitney rank-sum test and Fisher’s exact test.

Downloaded from https://academic.oup.com/ageing/article-abstract/43/2/241/10581 by guest on 13 March 2019
wide variation in grip strength within each setting as demonstrated by the percentiles (Table 2). In general, higher grip strength was associated in univariate analyses with younger age, increased height and weight, fewer co-morbidities, higher Barthel score, higher MMSE score, lower ‘MUST’ score and fewer falls. After mutual adjustment for all of these factors in a multivariate analysis, the Barthel score was most strongly associated with grip strength and was the only factor significantly associated with grip strength in each setting for both men and women.

For both men and women, there was a substantial difference in mean maximum grip strength between settings (P < 0.0001) as shown in Table 2 and Figure 1. Even after adjustment for age, nursing home residents had the lowest mean age-adjusted maximum grip strength [men 18.9 kg (SD 9.5); women 8.4 kg (SD 5.0)] and community referrals the highest [men 30.6 kg (SD 7.4); women 17.7 kg (SD 7.6)]. The difference in grip strength values between the healthcare settings was so substantial that they remained significant (P < 0.0001 for both men and women) after univariate adjustment in turn for the following factors: age, height, weight, BMI, number of co-morbidities and medications, Barthel score, MMSE, ‘MUST’ score and falls category. The difference in grip strength values between settings remained significant after mutual adjustment for all these factors (P = 0.008 men; P < 0.001 women).

Discussion

The participants differed significantly between the three healthcare settings in many respects, notably age, height, weight, BMI, number of medications, Barthel score, MMSE, ‘MUST’ score and number of falls in the last year. Importantly, grip strength also differed significantly between the healthcare settings for both men and women with lower average values among nursing home residents and higher average values among community rehabilitation referrals. Grip strength was associated with the Barthel score in particular, but the differences in grip strength between settings remained significant after adjustment for other co-variates. Although the nursing home residents had the lowest MMSE scores, they nevertheless appeared to understand at the time how to grip the dynamometer and to attempt to squeeze as hard as possible. In fact maximum grip strength was only significantly associated with MMSE among the female inpatients (please see Supplementary data, available at Age and Ageing online, Appendix Table S1). The substantial differences in grip strength between the participants from the different healthcare settings included in this study were not surprising given the heterogeneity of the older people taking part. However, there was also a wide variation in grip strength among people within each healthcare setting.

Three studies in North America have described grip strength in rehabilitation and care home settings and they also report low grip strength values. A retrospective study of 188 patients (mean age 58 years, range 18–87) undergoing acute rehabilitation found that 76% had grip strength lower than age-adjusted reference values in both hands [22, 23] and overall the group’s mean grip strength was 37% lower in the left hand and 43% lower in the right hand. A similar retrospective notes review of 41 consecutive patients (mean age 74 years) receiving domiciliary rehabilitation for stroke disease, cancer, osteoarthritis and fractures reported a reduction in grip strength with mean values 25% lower than age-adjusted normative values for both left and right

Table 2. Maximum grip strength by setting

<table>
<thead>
<tr>
<th>Grip strength (kg)</th>
<th>Hospital rehabilitation inpatients</th>
<th>Community rehabilitation referrals</th>
<th>Nursing home residents</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male (n = 37)</td>
<td>Female (n = 64)</td>
<td>Male (n = 24)</td>
<td>Female (n = 23)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>21.7 (7.7)</td>
<td>13.6 (5.0)</td>
<td>31.1 (6.4)</td>
<td>19.6 (6.9)</td>
</tr>
<tr>
<td>P-value</td>
<td>P &lt; 0.0001**</td>
<td>P &lt; 0.0001**</td>
<td>P &lt; 0.0001**</td>
<td></td>
</tr>
<tr>
<td>Percentiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st</td>
<td>6</td>
<td>2</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>5th</td>
<td>7</td>
<td>6</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>10th</td>
<td>12</td>
<td>8</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>20th</td>
<td>14</td>
<td>10</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>25th</td>
<td>17</td>
<td>11</td>
<td>26.5</td>
<td>15</td>
</tr>
<tr>
<td>50th (median)</td>
<td>22</td>
<td>14</td>
<td>32</td>
<td>20</td>
</tr>
<tr>
<td>75th</td>
<td>27</td>
<td>16</td>
<td>35.5</td>
<td>24</td>
</tr>
<tr>
<td>90th</td>
<td>31</td>
<td>19</td>
<td>39</td>
<td>28</td>
</tr>
<tr>
<td>95th</td>
<td>37</td>
<td>21</td>
<td>39</td>
<td>30</td>
</tr>
<tr>
<td>99th</td>
<td>39</td>
<td>31</td>
<td>43</td>
<td>36</td>
</tr>
<tr>
<td>Mean (SD)*</td>
<td>21.7 (7.5)</td>
<td>13.5 (4.8)</td>
<td>29.3 (6.6)</td>
<td>17.8 (7.2)</td>
</tr>
</tbody>
</table>

kg, kilograms; n, number; SD, standard deviation.
*Mean grip strength adjusted for age.
**P-value for differences between settings by gender calculated using ANOVA.
***P-value for differences between gender within settings calculated using the two-sample t-test.
****P-value for differences between settings adjusted for age calculated using ANOVA.
whereas it was achieved in the other settings in a shorter time
due to lower recruitment. Despite recruiting over a period of 18 months,
a lower recruitment rate was achieved among the community
care settings. This study adds valuable data on participants in UK health-
care settings (74% inpatients and 90% nursing home residents). Thus,
 better grip strength was particularly associated with a higher Barthel score, as a measure of physical function, in each setting.

Key points
- This is the first study to describe the epidemiology of grip strength of older people in different healthcare settings within one locality in the UK.
- Older people in rehabilitation and care home settings had lower grip strength than those living at home.
- The variation in grip strength between healthcare settings was independent of known major determinants of grip strength.
- Better grip strength was particularly associated with a higher Barthel score, as a measure of physical function, in each setting.
H. C. Roberts et al.

Acknowledgements

The authors wish to thank the participants and the staff in each healthcare setting.

Conflicts of interest

None declared.

Funding

This work was supported by the University of Southampton and BUPA Giving (grant 60).

Supplementary data

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

References


Received 20 February 2013; accepted in revised form 4 June 2013