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Population-based reference values of handgrip strength and functional tests of muscle strength and balance in men aged 70–80 years

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ABSTRACT

With aging, the incidence of falls and fractures increases. There has during the last decades been secular changes in demographics so that the proportion of elderly increases in society. Hence, there is an increasing need for clinicians to be able to make a solid appraisal of the elderly patient's functional capacity, as to identify individuals with an increased risk to fall. If high risk individuals could be targeted fall preventive strategies might be implemented in specific risk cohorts. This would require reference values for muscle strength tests and functional tests, in order to defined high risk individuals performing inferior. From the MrOS Sweden cohort, 999 subjects aged 70–80 years were evaluated. Muscle strength and functional performance was tested by timed-stands test, 6-m and 20-cm narrow walk tests and Jamar handgrip strength test. Normative data is presented. With increasing age, there was a 10–18% successively decline in performance throughout the entire age span. This study provides reference values for handgrip strength and functional muscle tests in 70–80 years old men. The decline in the test values with increasing age, infer the use of age-specific normative data when using these tests both in clinical and research settings.

1. Introduction

Hip fractures constitute a health problem associated with aging (Chang et al., 2004). Often the risk to sustain a fragility fracture is selectively related to the level of bone mineral density, a trait known to diminish with aging and strongly associated with fracture risk (Cummings et al., 1995). But, muscle strength, balance and several functional capacities are also traits that deteriorate with aging and traits that all lead to an increased tendency to fall. As most hip fractures are preceded by a fall (Tinetti et al., 1988; Grisso et al., 1991; Hayes et al., 1993; Greenspan et al., 1994; Kannus et al., 2005), it is therefore of great importance to catch individuals in these ages prone to fall. In the clinical setting there is a need of tests of physical performance in order to predict the risk of falling, especially in patients with low bone mineral density. Most falls occur when a patient is rising from a sitting position or when walking (Lord et al., 2000) Therefore, hypothetically timed-stands test and gait tests seem feasible to use. In addition, the tests are easy to use in a clinical situation. The test was design as a 10-repetition test by Csuka and McCarty (1985), but was later used as a 5-repetition test as suggested by Guralnik et al. (1995). Handgrip strength is another test often used in similar clinical situations, mostly measured by a hydraulic dynamometer This is a valid and reliable tool measuring peak force in healthy subjects (Harkonen et al., 1993), in studies reported to be a good marker for physical health and therefore also a possible tool to predict fall (Proctor et al., 2006; Sasaki et al., 2007; Ribom et al., 2009). But, if the clinician is to make judgements about the normality of a patient's physical performance, age and gender specific reference values are required for comparison. The aim of this study was therefore to establish normal reference values for handgrip strength, timed-stands test, 6-m walking test, and 20-cm narrow walk in 70–80 year old men, the age ranges with an exponentially increase in the risk to sustain fall and fragility fractures.

2. Subjects and method

2.1. Subjects

The MrOS study is a multi-center prospective fracture epidemiology investigation involving elderly men from different sites around the world, including Sweden. To be eligible for the study in Sweden, the subject had to be able to walk without aids and aged 69–81 years. The population-based Swedish cohort, with an attendance rate of 45%, consists of 3014 men

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aged 69–80 years. The Uppsala cohort, used in this report, consists of 999 men aged 70–80 years. The participants were randomly selected from the population registries and invited by mail. At the clinic visit, participants completed standardized questionnaires about medical history, current medication use, lifestyle characteristics and previous fractures. Informed consent was obtained for all subjects and the study was approved by the local ethics committees (Ups 01-057) and conducted in accordance with the guidelines in The Declaration of Helsinki.

2.2. Handgrip measurement

A Jamar® hydraulic hand dynamometer (5030J1), Jackson, MI, USA, with adjustable handgrip was used in the measurement. The participant was sitting in a standard chair with the arm resting on a movable table with the dynamometer in an upright position. Two trials of each hand were performed using the best results in the analysis. Handgrip strength is registered as maximum kilograms of force during a trial. The measurement was not performed if the subject had a current flare-up or pain their wrist or hand or had undergone fusion, arthroplasty, tendon repair, synovectomy, or related surgery of the upper extremity in the past 3 months. In 26 subjects no handgrip measurement was performed; 14 due to pain, arthritis or, surgery of one or both hands or other diseases influencing their ability to perform the test; 2 due to failure of the handgrip dynamometer; 10 no reason is given.

2.3. Timed-stands test

The test is described in detail previously (Ribom et al., 2009). In summary, a straight-backed chair without arms, with seat height

Table 1
Normative data in Swedish men aged 70–80 years ($n = 999$).

Age groups (years)	70.0–70.9	71.0–71.9	72.0–72.9	73.0–73.9	74.0–74.9	75.0–75.9
Number	92	88	86	91	92	99
Anthropometry						
Height (cm)	175.6 ± 7.8	175.3 ± 6.8	175.0 ± 6.4	174.7 ± 6.1	175.5 ± 6.6	173.2 ± 10.8
Weight (kg)	85.0 ± 13.0	85.5 ± 12.6	82.1 ± 12.3	81.0 ± 12.4	82.0 ± 10.8	78.9 ± 11.0
BMI (kg/m^2)	27.6 ± 4.2	27.8 ± 3.9	26.7 ± 3.4	26.5 ± 3.8	26.6 ± 3.1	26.8 ± 7.7
Clinical tests						
Right hand grip strength (kg)						
	45 ± 8	44 ± 8	42 ± 8	43 ± 7	41 ± 10	41 ± 8
	(29–61)	(28–60)	(26–58)	(29–57)	(21–61)	(25–57)
Left hand grip strength (kg)						
	45 ± 7	43 ± 9	41 ± 8	41 ± 8	40 ± 8	40 ± 8
	(31–59)	(25–61)	(25–57)	(25–57)	(24–56)	(24–56)
Time stand test (s)						
	14.0 ± 4.4	14.3 ± 4.3	14.2 ± 2.7	14.1 ± 3.0	15.5 ± 4.9	14.7 ± 3.9
	(5.2–22.8)	(5.7–22.9)	(8.8–19.6)	(8.1–20.1)	(5.7–25.3)	(6.9–22.5)
6-m walking test (s)						
	4.7 ± 0.8	4.9 ± 1.2	5.0 ± 1	5.0 ± 1.0	5.2 ± 1.2	5.2 ± 1.2
	(3.1–6.3)	(2.5–7.3)	(3.0–7.0)	(3.0–7.0)	(2.8–7.6)	(2.8–7.6)
6-m walking test (steps)						
	9 ± 1	9 ± 2	9 ± 1	9 ± 1	10 ± 2	9 ± 2
	(7–11)	(5–13)	(7–11)	(7–11)	(6–14)	(5–13)
20-cm narrow walk test (s)						
	4.8 ± 0.8	4.8 ± 0.8	5.0 ± 1	5.1 ± 1.2	5.1 ± 1.1	5.2 ± 1.2
	(3.2–6.4)	(3.2–6.4)	(3.0–7.0)	(2.7–7.5)	(2.9–7.3)	(2.8–7.6)
Age groups (years)						
	76.0–76.9	77.0–77.9	78.0–78.9	79.0–80.0	80.0–80.9	70.0–80.9
Number	88	84	91	121	67	999
Anthropometry						
Height (cm)	174.9 ± 6.6	174.1 ± 6.9	174.9 ± 6.5	173.6 ± 5.8	171 ± 5.7	174.4 ± 7.2
Weight (kg)	78.8 ± 11.5	80.0 ± 10.8	79.8 ± 12.1	78.2 ± 11.7	76.3 ± 10.2	80.7 ± 12.0
BMI (kg/m^2)	25.8 ± 3.4	26.3 ± 2.8	26.1 ± 3.8	25.9 ± 3.5	26.1 ± 3.1	26.6 ± 4.2
Clinical tests						
Right hand grip strength (kg)						
	41 ± 8	40 ± 8	41 ± 7	39 ± 7	37 ± 8	41 ± 8
	(25–57)	(24–56)	(27–55)	(25–53)	(21–53)	(25–57)
Left hand grip strength (kg)						
	40 ± 7	39 ± 8	39.0 ± 7	38 ± 6	36 ± 7	40 ± 8
	(26–54)	(23–55)	(25–53)	(26–50)	(22–58)	(24–56)
Time stand test (s)						
	15.0 ± 3.6	15.8 ± 5.2	15.7 ± 5.2	14.7 ± 4.2	15.4 ± 5.7	14.8 ± 4.4
	(7.8–22.2)	(5.4–26.2)	(5.3–26.1)	(6.3–23.1)	(4–26.8)	(6–23.8)
6-m walking test (s)						
	5.3 ± 1.2	5.5 ± 1.6	5.5 ± 1.1	5.4 ± 1.2	5.5 ± 1.2	5.2 ± 1.2
	(2.9–7.7)	(2.3–8.7)	(3.3–7.7)	(3–7.8)	(3.1–7.9)	(2.8–7.6)
6-m walking test (steps)						
	10 ± 2	10 ± 2	9 ± 1	10 ± 2	10 ± 1	9 ± 2
	(6–14)	(6, 14)	(7–11)	(6–14)	(9–11)	(7–11)
20-cm narrow walk test (s)						
	5.4 ± 1.3	5.6 ± 1.7	5.7 ± 1.4	5.4 ± 1.0	5.6 ± 1.0	5.2 ± 1.2
	(2.8–8.0)	(2.2–9)	(2.9–8.5)	(3.4–7.4)	(3.6–7.6)	(2.8–7.6)

Height and weight was estimated by standard equipment; BMI was calculated as usual; hand grip strength by Jamar dynamometer; time stand test and 6.m walking test and 20-cm narrow walk test as functional tests. Data are provided as numbers, mean ± 1 SD and ± 2 SD as range-limits in parentheses to include 95% of the values in the population as this in reference lists usually is described as estimated limits of the normative values.

of 45 cm, was used in this test and placed against a wall for added stability. The participant's feet were placed squarely on the floor in front of them. The participant was seated in a position which allows them to place their feet on the floor with knees flexed to slightly greater than 90° so that their heels were somewhat closer to the chair than the back of the knees. The arms were crossed over the chest and the rise was from full standing position all the way down to sitting. The procedure was demonstrated for the participant before doing it. The participants were before the test asked to rice from the chair with their arms crossed on the chest. Those who could rice without aid then performed the 5 stands. The examiner stood in front of the participant. A successful test was when the participant could perform 5 stands in a row. The test was performed once. 19 individuals could not rice from a chair without aid or could not rice 5 times and 1 subject have missing values, rendering 979 men to be included in this test.

2.4. The 6 m walking test and the 20 cm narrow walking test

The test is described in detail previously (Ribom et al., 2009). In summary, a 6 m walking course was laid out on the floor. In the first test the participants walk 6 m with the participant's usual pace which is measured along with numbers of steps. Steps were counted by counting both right and left steps and included the initial starting step and the step that first touches the floor across the finish line. There was one missing value for the 6-m walking test and two missing values for number of steps. The second test the participants walk the 6 m course within a 20 cm-wide lane. Two scored trials were performed for the narrowed walk. The narrow walked was scored for time if there was no more than two deviations form the path. Timing was started when the first footfall crossed over the starting line (when the participant's foot touched the floor on the first step). The timing was stopped when the first footfall crossed the finish line. Time was recorded in nearest 0.01 s. The 20-cm narrow walk was performed successfully by 899 subjects, 100 failed and had three or more oversteps (95 subjects) or could not perform the test (5 subjects).

The statistical calculations were done using Statistica version 7.0 (StatSoft). Mean ± S.D. was calculated for each variable. The data are presented as mean ± S.D. and within brackets ±2 × S.D. as limits. We do this for the convenience of the reader and the usability of the data in a clinical situation, as the limits ±2 × S.D. from mean are commonly reported when describing normative data in laboratory and medical tests since 95% of the population are then captured.

3. Results

In Table 1 normative data for age, anthropometry and the different tests are presented in all men and specifically for each one year age group. Mean body height, body weight and BMI were in the men 174.4 ± 7.2 cm, 80.7 ± 12.0 kg, 26.6 ± 4.2. In the handgrip measurements mean strength were 41 ± 8 kg in the right hand and 40 ± 8 kg in the left hand. The timed-stands test took on average 14.8 ± 4.4 s to perform and the 6-m and 20-cm narrow walk test took 5.2 ± 1.2 s and 5.2 ± 1.2 s, respectively (Table 1). As shown in Fig. 1, the men did 10–18% successively inferior in absolute values in the tests with increasing age (Fig. 1).

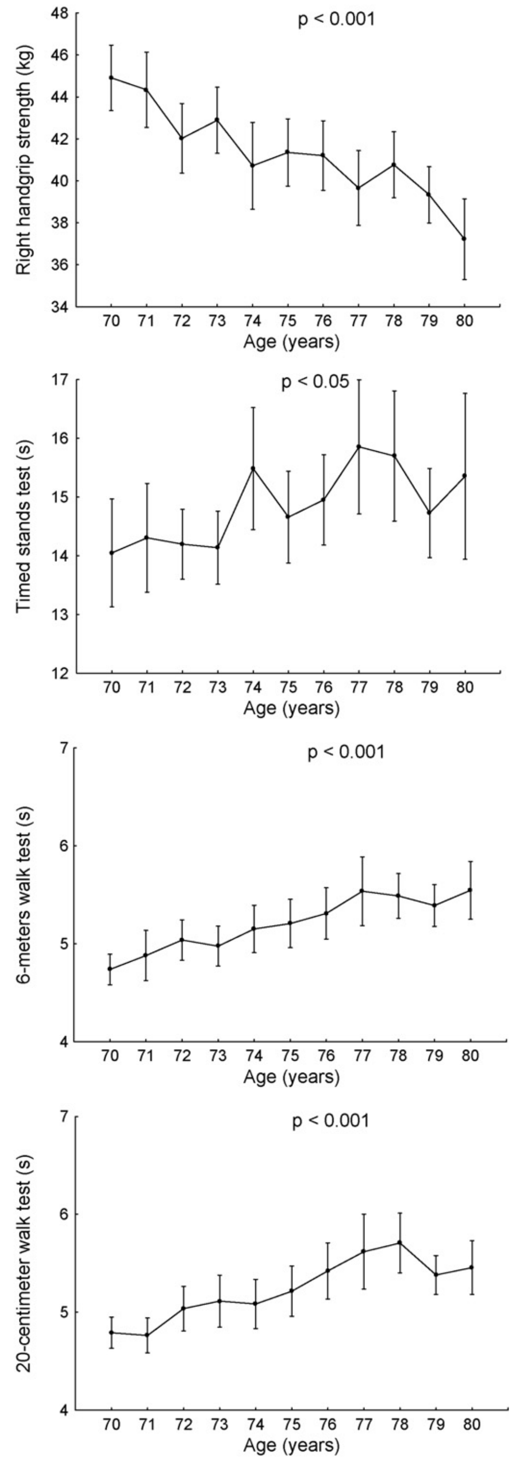

Fig. 1. The age-dependent decline in handgrip strength, timed-stands test, 6-m walking test and 20-cm narrow walk test, year by year.

4. Discussion

This study presents normative data for handgrip strength test and clinically usable functional performance tests in a population-based cohort of men aged 70–80 years. The men in our study performed better in handgrip strength measures than in several other reports, some including volunteers and some randomly selected subjects, reporting hand grip strength to vary between 31 and 38 kg in the right hand and 28.2 and 35 kg in the left hand, in mean within the same ages. (Budziareck et al., 2008; Günther et al., 2008; Luna-Heredia et al., 2005; Schlüssel et al., 2008). This might be explained by the larger size of the subjects in the present study compared to above quoted studies, who included men from Brazil and Spain, whom inhabitants are shorter than Scandinavians (Budziareck et al., 2008; Luna-Heredia et al., 2005). Finding German values being closest to our values

(Günther et al., 2008; Schlüssel et al., 2008), at least do not opposes this hypothesis.

Timed-stands test is one commonly used way of measuring physical performance. Our results show that in the age-span between 70 and 80 the mean time for a five repetitions stand up varied between 14 and 16 s. This is somewhat slower than in a comparable study by Guralnik et al. (1995), where quartiles for the length of time required for the measure was used. The difference in results could be explained by the fact that the subjects selected in that study where those who had not reported any disability and whereas the study participants in our report were population-based selected.

Another issue is if the tests referred to above, are of clinical relevance. Several studies support this when finding inferior values in all tests in fallers compared to non-fallers. Some of the tests, as hand grip strength, could even discriminate multiple fallers form single fallers, and fallers with fractures from fallers without (Ribom et al., 2009). That is, the tests seem to capture high risk individuals for falls and fractures in men in these ages. This increases the relevance of publishing normative data for clinical use.

5. Conclusion

This study provides reference values for handgrip strength and functional muscle tests in 70–80 years old men. As there is a decline in all the test-results with increasing age, this infers the use of age-specific normative data when using these tests both in the clinical and the research situation.

Conflict of interest statement

None.

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