Large variations in walking, standing up from a chair, and balance in women and men over 85 years: an observational study

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Questions: What is the physical ability of very old people? Is physical ability affected by age or sex? Is it affected by type of housing, level of independence in activities of daily living, cognition, or nutrition? **Design:** A population-based cross-sectional observational study. **Participants:** Half the 85-year-old population, and the total population aged 90 and ≥ 95 (range 95–103) in Umeå, Sweden who were measured in the Umeå 85+ Study (n = 238). **Outcome measures:** Usual and fastest gait speed (m/s) over 2.4 metres, three consecutive chair stands (s), the Berg Balance Scale, and ability to perform the measures (yes/no). **Results:** The median (10^{th} to 90^{th} percentile) usual gait speed was 0.49 m/s (0.23–0.75), time to perform the chair stands test was 12.6 seconds (8.5–20.2), and the Berg Balance Scale score was 45 (0–54). Men had greater physical ability than women. An age-related decline in physical ability was seen in women, but not in men. The Berg Balance Scale showed no floor or ceiling effects, but gait speed and chair stands resulted in a floor effect, especially for women. **Conclusion:** There were large variations in physical ability in these very old people. These data provide valuable reference values of physical ability in the oldest age groups for commonly-used clinical measures. **[von Heideken Wågert P, Gustafson Y, Lundin-Olsson L (2009) Large variations in walking, standing up from a chair and balance in women and men over 85 years: an observational study. *Australian Journal of Physiotherapy* 55: 39–45]**

Key words: Aged, 80 and over; population-based; reference values; physical activity; geriatric assessment

Introduction

With increasing age, a person's physical ability, including gait speed, muscle strength, and balance, generally declines (Odenheimer et al 1994, Wolfson 2001). However, the ageing process is entirely individual and it is impossible to know how much of the impairment is related to age, inactivity, or disease (Odenheimer et al 1994). Generally, gait speed is considered to be rather stable until approximately age 65, and muscle strength to age 50. Thereafter, both abilities decline 1–2% per year (Wolfson 2001). The reduced gait speed is characterised by shorter step length and increased double support time. Balance in older age includes difficulty in compensating for trips or pushes, the need for a larger base of support, a reduced ability to stand on one leg and to maintain one's balance with a limited sensory input, as well as increased postural sway (Wolfson 2001). Leg strength and the ability to maintain balance in different positions is a basic requirement for standing, transferring, and walking, all of which are important for independent living (Sakari-Rantala et al 1995). In addition, the severity of impairments predicts activity limitations (Guralnik et al 1995), hospital care (Penninx et al 2000), nursing home admission, and mortality (Guralnik et al 1994).

A large number of standardised instruments for measuring the physical ability of older people are used in both research and clinical practice as tools in the decision-making process (American Physical Therapy Association 2001, Finch et al 2002). In hospitals and residential care facilities, staff tend to work with older people with disease and impairment and seldom encounter healthy older people. This might have an impact on staff frame of reference, and may lead to an underestimation of the rehabilitation potential of older people. There are a number of studies in which the physical ability of very old people has been investigated (Bootsma-van der Wiel et al 2002, Cress et al 1995, Friedman et al 1989, Guralnik et al 1994, Jones et al 1999, Nybo et al 2001, Ostchega et al 2000, Parker et al 1994, Steffen et al 2002, Thapa et al 1994). However, only three studies have used population-based samples, ie, including participants from a total population living in all kinds of housing (Bootsma-van der Wiel et al 2002, Nybo et al 2001, Parker et al 1994), and none presents reference values in terms of age and sex. The available data for physical ability in the oldest age groups are difficult to use as a basis for comparison and goal setting in clinical practice; there is a need for reference values with which to compare clinical measures of physical ability among very old people. Some commonly-used measures that are suitable for those living both independently and institutionally are gait speed, chair stands and the Berg Balance Scale (Berg et al 1989).

The very old, aged 80 years and over (United Nations 2001), is the fastest growing age group of older people today. By the middle of the 21^{st} century the proportion of this age group, out of the population aged 60 years and over, will have nearly doubled in many parts of the world (United Nations 2001). The prevalence of disease and impairment of body structure and function increases with advanced age; consequently, the demand for healthcare and services among very old people, as well as for rehabilitation, will be higher in the future. There is evidence that exercise for old people results in benefits in gait, balance, and leg strength (Gardner et al 2000). However, it is important that information about the range of physical ability in very old people is available so that appropriate goals can be set during rehabilitation. Therefore, the research questions for this study were:

1. What is the physical ability of very old people?
2. Is physical ability affected by age or sex?
3. Is it affected by type of housing, level of independence in activities of daily living, cognition or nutrition?

Method

Design

This observational study is part of the Umeå 85+ Study, which is described in detail elsewhere (von Heideken Wågert et al 2006). The data for this analysis were the baseline data from the Umeå 85+ Study producing a cross-sectional design. Participants were divided into male and female, and into three age groups: 85 years old, 90 years old, and ≥ 95 years old. Data were collected on their physical ability (and on factors that may affect physical ability) during home visits, and from next of kin, caregivers, and medical charts. Four people performed the physical ability measures: one registered physiotherapist, one registered nurse, and two medical students (late in their education). They followed a strict protocol with detailed instructions and performed several measures together to enhance inter-rater agreement.

Participants

A random sample of half the population born in 1915 (85 year olds), and the total population born in 1910 (90 years old), and 1905 or earlier (≥ 95 years old, range 95–103), living in the municipality of Umeå, Sweden on 1 January 2000, were selected for participation (n = 348). All people from these upper age groups, regardless of housing, were asked to participate. The 85 year olds were randomly selected from a list from the National Tax Board in which all citizens are listed along with their civil registration number, address, and marital status.

Characteristics of the participants were collected in order to describe the participants and to predict physical ability in preplanned groups. A structured interview concerning the participants' actual living conditions was conducted. Housing was classified as independent if participants lived in a house or apartment with or without help from homecare services. Institutional housing included residential care, skilled nursing homes, and group dwellings for people with dementia, all with 24-hour access to staff in the same building. Independence in activities of daily living was assessed with the Staircase Activities of Daily Living (Sonn 1996), which is a further development of the Katz Index of activities of daily living (Katz et al 1963). The scale measures both personal and instrumental activities of daily living, which includes cleaning, grocery shopping, transport and cooking. In addition, the participants reported how frequently they walked outdoors independently of others, and whether they had fallen in the preceding year.

Reading vision was rated as unimpaired if the participant could read, with or without glasses, a word printed in 3 mm capital letters at reading distance. Hearing was rated as unimpaired if the participant, with or without a hearing aid, could hear someone speaking in a normal voice from a distance of one metre.

Nutrition was assessed using the Mini Nutritional Assessment (Guigoz et al 1994), a screening instrument for nutritional status which is valid for use in very old people or residents in institutional care (Guigoz et al 1994, Vellas et al 1999). The maximum score of 30 indicates very good nutritional status, scores of 23.5–17 indicate a risk of malnutrition, and below 17 malnutrition (Vellas et al 1999). Perceived health in comparison to their peers was rated using the self-rated health question from the Mini Nutritional Assessment. Cognition was screened using the Mini-Mental State Examination (Folstein et al 1975), which has a maximum score of 30. A score below 24 indicates impaired cognition (Tombaugh and McIntyre 1992).

Current health status was collected from the participants, next of kin, and caregivers, and from medical charts at the hospital, general practitioners and/or the institutional care facility. Prescribed drugs were recorded. A specialist in geriatric medicine evaluated all diagnostic documentation, drug interventions, and assessments, for completion of the final diagnoses according to the same criteria for all participants, as previously described (von Heideken Wågert et al 2006).

Outcome measures

Three aspects of physical ability were measured: walking, standing up from a chair, and balance. The ability and time to walk 2.4 metres (8 feet) were measured at both usual and fastest speed (Guralnik et al 1994). Participants used their walking aid and the footwear they normally used indoors. The distance was marked on the floor with red tape and the participant stood just behind the starting line before the test. A static (standing) start rather than a dynamic (walking) start has been found to be more commonly used in studies (Graham et al 2008). A digital stopwatch was started when the participant began to walk, and stopped when the first foot crossed the finishing line. The participants were asked to walk the distance safely past the finishing line, twice at their usual speed, and once as fast as they could. A mean was calculated for usual gait speed from the two trials. Ability to walk was reported dichotomously as yes or no, while gait speed was reported in m/s.

The ability and time to stand up from a chair was measured in three self-paced, consecutive chair stands, a modified version of Thapa et al (1994). Participants were asked to stand up to a fully upright position and then sit down again three times at a self-paced speed with their arms folded over the chest. A digital stopwatch was started when the buttocks initially lifted from the chair and stopped when the buttocks touched the chair for the third time. There was no maximum time for the test. The chairs used were from the participants' homes; they were hard, straight-backed chairs without armrests, mostly kitchen chairs, about 45 cm high. Ability to stand up was reported dichotomously as yes or no, while time to stand up was reported in seconds.

Balance was measured using the Swedish translation (Jensen et al 1998) of the Berg Balance Scale (Berg et al 1989). The scale consists of 14 static and dynamic balance tasks commonly encountered in everyday life, eg, sitting, standing, turning, and reaching. Each task is scored 0 to 4, where zero represents an inability to perform the task and four the ability to perform the task safely and independently. The maximum score is 56, indicating good balance for an older person (the ability to stand on one leg for 10 seconds), whereas the minimum score of zero indicates an inability to sit without support for 10 seconds.

Table 1. Characteristics of the 238 participants.

Characteristic	Women			Men		
	85 years old (n = 67)	90 years old (n = 62)	≥ 95 years old (n = 50)	85 years old (n = 26)	90 years old (n = 21)	≥ 95 years-old (n = 12)
Sociodemographics, n (%)						
Independent housing	59 (88)	30 (48)	11 (22)	22 (85)	14 (67)	4 (33)
Married	3 (5)	1 (2)	3 (6)	14 (54)	4 (19)	3 (25)
Mobility and ADL, n (%)						
Independent in P-ADL	49 (73)	27 (44)	10 (20)	19 (73)	15 (71)	5 (42)
Independent in all ADL	22 (33)	7 (11)	2 (4)	8 (31)	6 (29)	2 (17)
Independent in bathing	50 (75)	27 (44)	10 (20)	20 (77)	15 (71)	5 (42)
Independent in transfer	62 (93)	48 (77)	24 (48)	24 (92)	20 (95)	11 (92)
Independent walking outdoors	51 (76)	27 (44)	10 (20)	20 (77)	15 (71)	6 (50)
Fall/s the preceding year	24 (36)	32 (52)	29 (58)	9 (35)	8 (38)	7 (58)
Current health status, n (%)						
Hypertension	51 (76)	35 (57)	14 (28)	16 (62)	7 (33)	2 (17)
Arthrosis	19 (28)	22 (36)	11 (22)	8 (31)	7 (33)	0
Dementia	11 (16)	19 (31)	25 (50)	6 (23)	3 (14)	3 (25)
Depression	11 (16)	22 (36)	14 (28)	4 (15)	5 (24)	2 (17)
Previous hip fracture	15 (22)	19 (31)	20 (40)	1 (4)	1 (5)	2 (17)
Heart failure	7 (10)	20 (32)	16 (32)	6 (23)	3 (14)	4 (33)
Previous stroke	11 (16)	18 (29)	8 (16)	8 (31)	5 (24)	3 (25)
Chronic lung disease	6 (9)	10 (16)	5 (10)	5 (19)	3 (14)	3 (25)
Diabetes	7 (10)	7 (11)	4 (8)	4 (15)	3 (14)	3 (25)
Vision, hearing, and health, n (%)						
Reading vision	57 (85)	44 (71)	22 (44)	25 (96)	17 (81)	10 (83)
Hearing	50 (75)	36 (58)	20 (40)	18 (69)	14 (67)	5 (42)
Better health than age peers[a]	30 (46)	22 (40)	16 (50)	17 (65)	9 (43)	7 (58)
Drugs, nutrition, and cognition, med (10^{th} to 90^{th} percentile)						
Number of prescribed drugs	5 2–11	8 3–14	7 3–13	5 1–11	5 1–12	6 0–14
MNA *(0 to 30)*[b]	25.5 20–28	22.5 13.5–26.5	19.0 10–27	27.0 20–28	25.0 19–27	25.0 21–29
MMSE *(0 to 30)*[c]	26 18–29	23 2–30	17 0–28	26 16–29	25 16–29	22 5–29

[a] Missing cases: 85 year old women (n = 2), 90 year old women (n = 7), ≥ 95 year old women (n = 18); [b] Missing cases: 85 year old women (n = 2), ≥ 95 year old women (n = 1), 85 year old men (n = 2); [c] Missing cases: 90 year old women (n = 2), ≥ 95 year old women (n = 2). ADL = Activities of Daily Living; P-ADL = Personal ADL; MNA = Mini Nutritional Assessment; MMSE = Mini-Mental State Examination

Table 2. Number (%) of participants able to perform the physical ability measures by sex and age and the significance (*p* value*) of age.

Physical ability	Women				Men			
	85 years old (n = 67)	90 years old (n = 62)	≥ 95 years old (n = 50)	Sig	85 years old (n = 26)	90 years old (n = 21)	≥ 95 years old (n = 12)	Sig
Usual gait speed	61 (91)	45 (73)	23 (46)	< 0.001	23 (88)	20 (95)	12 (100)	0.15
Fastest gait speed	59 (88)	41 (66)	14 (28)	< 0.001	22 (85)	20 (95)	9 (75)	0.78
Three chair stands	59 (88)	29 (47)	7 (14)	< 0.001	19 (73)	17 (81)	6 (50)	0.28
Berg Balance Scale	62 (93)	54 (87)	37 (74)	0.001	25 (96)	21 (100)	11 (92)	0.74

**p* value refers to linear-by-linear association (Chi-square).

Table 3. Median (10th and 90th percentile) physical ability for women and men by age and the significance of age (*p* value[a]).

Physical ability	Women				Men			
	85 years old (n = 67)	90 years old (n = 62)	≥ 95 years old (n = 50)	Sig	85 years old (n = 26)	90 years old (n = 21)	≥ 95 years old (n = 12)	Sig
Usual gait speed (*m/s*)	0.52 (0.31–0.77)	0.41 (0.18–0.69)	0.41 (0.21–0.64)	0.007[b]	0.47 (0.22–.74)	0.51 (0.27–1.02)	0.54 (0.19–0.81)	0.47
Fastest gait speed (*m/s*)	0.77 (0.44–1.14)	0.75 (0.35–1.03)	0.69 (0.46–1.06)	0.09	0.76 (0.45–1.35)	0.81 (0.39–1.33)	0.92 (0.20–1.41)	0.86
Three chair stands *(s)*	12.8 (8.7–19.0)	11.9 (9.0–20.9)	18.5 (10.3–24.7)	0.38	11.5 (6.5–23.1)	11.9 (8.3–26.3)	12.2 (2.8–16.0)	0.80
Berg Balance Scale *(0 to 56)*	48 (38–54)	40 (3–53)	4 (0–45)	< 0.001[c]	47 (8–55)	49 (9–54)	43 (5–53)	0.28

[a]*p* values refer to the Kruskal-Wallis analysis; [b]Post-hoc analyses with adjusted α-value showed significant differences between 85 year olds and both 90 and ≥ 95 year olds.; [c]Post-hoc analyses with adjusted α-value showed significant differences between all three age groups.

Data analysis

Baseline characteristics of participants are presented as number (%) of participants as well as median (10th and 90th percentile). Due to a skewed distribution of data, physical ability was compared between groups using the Kruskal-Wallis test and the Mann-Whitney U test (also for post hoc analyses) for continuous and ordinal data. The Chi-square test was used for dichotomous data and to analyse linear-by-linear association. A $p < 0.05$ was regarded as statistically significant. Bonferroni adjustments were used to correct for multiple comparisons, which resulted in a significant limit of < 0.016 to attain a nominal estimate of < 0.05 to avoid Type I error. When presenting descriptive data and interpreting results for the total sample and *all* women and *all* men respectively, data were weighted by counting every 85 year old twice. This weighting was carried out because of the sampling procedure in order to achieve a more correct interpretation of the results.

Results

Participants

Twenty-nine people out of the 348 (8%) died before they could be asked to participate. The deceased did not differ regarding age or sex from the remaining 319. During recruitment, 81 of 319 (25%) declined to participate, either personally or through their next of kin. These 81 people were more likely to be married ($p = 0.007$), but there were no differences in age, sex, or housing. The final sample comprised 238 participants, 75% of the 319 who were asked to participate. The characteristics of the participants are shown in Table 1.

Effect of age and sex on physical ability

The number (%) of participants able to walk, stand up from a chair, and balance is presented in Table 2 by age and sex. In women, there was a significant age-related linear trend showing that larger proportions of the younger participants were able to walk, stand up from a chair, and balance (all $p < 0.001$) than the older participants. For example, 59 (88%) of the 85 year olds but only 7 (14%) of ≥ 95 year olds could stand up. No such age-related trend was seen among men. There were no differences between the 85 year old men and women. In contrast, among both 90 and ≥ 95 year olds, significantly more men than women were able to walk and stand up from a chair ($p < 0.001$ to 0.03). Two hundred and ten (88%) participants could be rated on the Berg Balance Scale. Twelve (5%) participants could not be rated because of difficulty understanding instructions rather than difficulty balancing.

Across all participants, the median (10th to 90th percentile) usual gait speed was 0.49 m/s (0.23–0.75), fastest gait speed 0.77 m/s (0.43–1.20), time to perform the chair stands test 12.6 seconds (8.5–20.2), and the Berg Balance Scale score 45 (0–54). The 85 year old women walked significantly faster at their usual speed and scored significantly better on the Berg Balance Scale than both the two older female age groups. However, there was no difference between the age groups for fastest gait speed or time to stand up three times

Table 4. Number (%) of participants able to perform the physical ability measures and median (10th and 90th percentile) balance performance by different characteristics and significance (*p* value) of these characteristics.

Characteristic	Women (n = 179)			Men (n = 59)		
	Usual gait speed	Three chair stands	Berg Balance Scale	Usual gait speed	Three chair stands	Berg Balance Scale
Housing						
Independent, n = 100 f, 40 m	92 (92)	79 (79)	48 (33–54)	38 (95)	32 (80)	49 (15–55)
Institutional, n = 79 f, 19 m	37 (47)	16 (20)	10 (0–46)	17 (90)	10 (53)	37 (5–48)
Significance	< 0.001	< 0.001	< 0.001	0.430	0.030	<0.001
Instrumental ADL						
Independent, n = 32 f, 16 m	30 (94)	28 (88)	52 (44–56)	16 (100)	15 (94)	53 (46–55)
Dependent, n = 146 f, 43 m	98 (67)	66 (45)	39 (0–51)	39 (91)	27 (63)	44 (6–51)
Significance	0.002	< 0.001	< 0.001	0.206	0.020	<0.001
MMSE						
≥ 24, n = 87 f, 35 m	80 (92)	63 (73)	49 (23–54)	34 (97)	28 (80)	49 (35–55)
≤ 23, n = 88 f, 24 m	47 (53)	32 (36)	31 (0–49)	21 (88)	14 (58)	38 (5–51)
Significance	< 0.001	< 0.001	< 0.001	0.148	0.071	0.003
MNA						
≥ 24, n = 81 f, 39 m	77 (95)	60 (74)	48 (26–54)	39 (100)	31 (80)	49 (15–55)
≤ 23.5, n = 95 f, 18 m	51 (54)	34 (36)	31 (0–51)	15 (83)	10 (56)	38 (4–49)
Significance	< 0.001	< 0.001	< 0.001	0.009	0.062	0.001

ADL = Activities of Daily Living; MMSE = Mini-Mental State Examination; MNA = Mini Nutritional Assessment

(Table 3). In terms of differences between men and women, 90 year old men walked significantly faster than 90 year old women at their usual speed ($p = 0.04$). Likewise, the ≥ 95 year old men scored significantly better on the Berg Balance Scale than ≥ 95 year old women ($p = 0.006$) (Table 3).

Effect of housing, independence in activities of daily living, cognition, and nutrition on physical ability

The number (%) of participants able to walk, stand up from a chair and the median (10th to 90th percentile) scores on the Berg Balance Scale are presented in Table 4 according to type of housing and level of independence in activities of daily living, cognition and nutrition. The majority of women who lived in independent housing, or were independent in instrumental activities of daily living, or had a high cognitive level or a good nutritional status, were able to walk and stand up from a chair. Scores on the Berg Balance Scale were higher for both women and men who lived in independent housing, or were independent in instrumental activities of daily living, or had high cognition or good nutrition (Table 4).

Discussion

Measuring physical ability in a population-based sample including all people of advanced age requires instruments that are easy to administer and which challenge high as well as low performers. Ceiling and floor effects are important factors to consider. The floor effect found in the present sample for gait speed and chair stands limits their value for use in some groups of very old people. In the present study, we approached this problem by presenting the results both as the proportion able to perform the measures as well as their median performance. Three repetitions of standing up from a chair was chosen instead of the more common five repetitions (Guralnik et al 1994) in order not to tire the participants and therefore to minimise missing data. Number of completed chair stands during 30 seconds could be used (Jones et al 1999) so that all participants could obtain a score of the same unit. However, it may not be sensitive to changes over time, especially among the low performers.

In older people, there are large variations in health status, and when presenting data about physical ability it is, therefore, important to define the population to which these values refer. If only healthy very old people had been included in the present study, it would have resulted in a very small group which was non-representative for the age group in total. Including all people in certain age groups is in accord with the definition of 'reference values' as a Medical Subject Heading (MeSH) term — 'the range of frequency distribution of a measurement in a population that has not been selected for the presence of disease or abnormality' (National Library of Medicine 2008).

The few population-based studies of physical ability in very old people and the different methods of measurement, administration of measures, and presentations of data make it difficult to compare the results between the studies. However, the usual gait speed of the 90 year-old men and women in the present study was slower, and a higher proportion of very old men could walk than in a previous study (Nybo et al 2001). In previous studies, participants living in independent dwellings as well as in institutions were similar to participants in the present study in terms of their ability to walk (Guralnik et al 1994), and their usual gait speed (Ostchega et al 2000, Thapa et al 1994). The only other study using the Berg Balance Scale in very old people (Steffen et al 2002), reported higher scores, but included both younger and healthier participants. In line with the present study, it has previously been shown that old people with lower Mini-Mental State Examination scores have lower physical ability (Bootsma-van der Wiel et al 2002, Cress et al 1995, Friedman et al 1989) and that a larger proportion of those independent in activities of daily living can walk and stand up from a chair (Nybo et al 2001).

One explanation of why older men have a higher physical ability than women might be that older women with severe impairments have a longer survival time than men (Ferrucci et al 1996). Since results similar to ours have been reported in other studies, we have reason to think that the physical ability of the sample in the present study accurately reflects very old populations, at least in industrialised countries.

The present study has some limitations because of the cross-sectional design. In addition, when divided into six groups on the basis of age and sex, some groups became very small, particularly for the timed performances. Thus, these results are somewhat uncertain and interpretations should be made with caution. The strengths of the study were the population-based sample, and that participants were asked to participate regardless of housing, cognitive level, or the presence of disease. The present study also reports whether the participants could walk, stand up, and balance, as well as their performance. Another strength was that there were only four investigators who performed all physical ability tests, and they followed a strict protocol during the home visits to enhance the reliability of the data.

This study provides valuable reference values for commonly-used clinical measures of physical ability in the oldest age groups. There were large variations in physical ability in these very old people. An age-related decline in physical ability was seen in women but not in men, and men had greater physical ability than women. This information is of importance to both policy makers and clinicians. ■

Ethics: The Ethics Committee of the Medical Faculty of Umeå University (Dnr 99-326) approved this study. Informed consent was gained from all participants before data collection began.

Competing interests: None declared.

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