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Research

Normative scores on the Berg Balance Scale decline after age 70 years in healthy community-dwelling people: a systematic review

Stephen Downs [a], Jodie Marquez [b], Pauline Chiarelli [b]

[a] Transitional Aged Care Service, Bellingen Hospital, Bellingen, Australia; [b] Discipline of Physiotherapy, School of Health Sciences, University of Newcastle, Callaghan, Australia

KEYWORDS

Berg Balance Scale
Normal values
Literature review
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ABSTRACT

Questions: What is the mean Berg Balance Scale score of healthy elderly people living in the community and how does it vary with age? How much variability in Berg Balance Scale scores is present in groups of healthy elderly people and how does this vary with age? **Design:** Systematic review with meta-analysis. **Participants:** Any group of healthy community-dwelling people with a mean age of 70 years or greater that has undergone assessment using the Berg Balance Scale. **Outcome measurement:** Mean and standard deviations of Berg Balance Scale scores within cohorts of elderly people of known mean age. **Results:** The search yielded 17 relevant studies contributing data from a total of 1363 participants. The mean Berg Balance Scale scores ranged from 37 to 55 out of a possible maximum score of 56. The standard deviation of Berg Balance Scale scores varied from 1.0 to 9.2. Although participants aged around 70 years had very close to normal Berg Balance Scale scores, there was a significant decline in balance with age at a rate of 0.7 points on the 56-point Berg Balance Scale per year. There was also a strong association between increasing age and increasing variability in balance (R^2 = 0.56, $p < 0.001$). **Conclusion:** Healthy community-dwelling elderly people have modest balance deficits, as measured by the Berg Balance Scale, although balance scores deteriorate and become more variable with age. **[Downs S, Marquez J, Chiarelli P (2014) Normative scores on the Berg Balance Scale decline after age 70 years in healthy community-dwelling people: a systematic review. *Journal of Physiotherapy* 60: 85–89]**

Introduction

The Australian Institute of Health and Welfare has found that 65-year-old Australians have increasing life expectancy, both of years lived with disability and years lived without disability.[1] With the percentage of Australians aged 85 years and older expected to increase from 2% in 2013 to 3.5% in 2033,[2] the costs of disability in older Australians can be expected to substantially increase unless disability can be prevented and treated more efficiently. Falls are a major contributor to injury with subsequent disability in the elderly, and poor balance is associated with increased risk of injurious falls.[3] The development and implementation of effective and cost-efficient strategies to prevent falls in older people is therefore an urgent challenge for health care. Such strategies require accurate and comprehensive measurement of balance ability.

The Berg Balance Scale was developed in 1989 using health professional and patient interviews, which explored the various methods used to assess balance.[4] Thirty-eight component balance tests were originally selected and then refined through further interviews and trials to 14 items, each scored from 0 to 4, making a possible total score between 0 and 56, with a higher score indicating better balance. Although the Berg Balance Scale was originally developed to measure balance in the elderly, it has since been used to measure balance in a wide variety of patients.

The convergent validity of the Berg Balance Scale has been established across several different domains. Hospital inpatients with a lower Berg balance score have been found to have a significantly higher chance of being discharged to nursing home accommodation.[5] Among community-dwelling veterans, progressively lower Berg Balance Scale scores are associated with increased risk of injurious falls.[3] Responsiveness to change was established in a trial enrolling sedentary older people, where those who exercised improved their Berg Balance Scale scores and reported fewer falls, compared to a control group.[6] The Berg Balance Scale also had greater ability than four other performance measures to predict the onset of difficulty in activities of daily living in older adults.[7]

Normative data are important when interpreting any balance tool, both for clinicians and researchers. Knowledge that a person or a group of people has significantly worse balance than a healthy person of the same age may assist the identification and effective management of balance problems. The effect of interventions to improve balance can be assessed by comparison to normative data

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for balance from healthy elderly people in specific age cohorts. Knowledge of the variability of the Berg Balance Scale in groups of healthy elderly people can be used to interpret individual results and to help establish the sample sizes required for future studies.

An earlier review[8] searched for the phrase 'Berg Balance Scale' and, despite finding 511 articles, did not identify any published review of normative data of the Berg Balance Scale.

The study questions for the systematic review were:

1. What is the mean Berg Balance Scale score of healthy elderly people living in the community and how does it vary with age?
2. How much variability in Berg Balance Scale scores is present in groups of healthy elderly people and how does this vary with age?

Method

Identification and selection of studies

A literature search was undertaken to locate all relevant published studies. Electronic searches of MEDLINE, CINAHL, Embase, and the Cochrane Library databases from 1980 to September 2012 were conducted using 'Berg Balance Scale' as the search term. No keywords related to intervention type or health condition were used and no methodological filters to identify particular study designs were used. All potentially relevant papers were identified by screening the abstracts and assessed for inclusion. Data were extracted by two authors (SD and PC), with any disagreements adjudicated by a third author (JM).

The a priori criteria for studies to be included in the review are presented in Box 1. Studies were excluded if the participants were hospital inpatients or resided in an aged care facility. Studies in which subjects had health conditions likely to significantly affect their balance were also excluded, as were studies in which healthy elderly subjects with extremes of balance (either minimal or maximal deficits) were excluded, or gait aid users were excluded. Where there were inadequate details of methods or results, an email was sent to the author where possible to seek further information.

Assessment of characteristics of trials

Participants: The inclusion and exclusion criteria and the country in which the data were collected were extracted for each trial. The sample size and the mean age of the participants were also extracted, along with whether the participants were enrolled as an observational cohort, an intervention group, or a control group.

Outcome: Means and standard deviations were extracted for baseline Berg Balance Scale scores. Where variability data were presented as other statistics, these were converted to standard deviations.

Box 1. Inclusion criteria.

Design
- Any study design reporting baseline data on an unselected cohort
- Original research report (ie, not literature review)

Participants
- Community dwelling
- Free of health condition likely to affect balance
- Mean age at least 70 years

Outcomes measures
- Berg Balance Scale mean
- Berg Balance Scale variability

Data analysis

Meta-regression analysis of the mean Berg Balance Scale scores was conducted. Where studies provided participant groups stratified by age, analysis was conducted using subgroups rather than pooled data. In studies where subjects were listed by age decade without provision of the mean age within the data, the mean age was assumed to be the mid-point of the decade. Where studies provided data for treatment and control groups in a trial, the baseline data for each group were included in the analysis separately.

To account for differences in the statistical power of the studies included in the meta-regression analysis, samples with larger numbers and samples with homogenous balance scores are weighted more highly when calculating the overall relationship between age and Berg Balance Scale score. Conversely, small samples and samples with highly variable balance scores were given less weight.

The relationship between the mean age of a sample and the standard deviation of the Berg Balance Scale scores of the sample was investigated using linear regression analysis, with weighting for sample size.

Results

Flow of studies through the review

After duplicates were removed, 859 articles were found containing the term 'Berg Balance Scale' in their abstract, title, or keywords. Hand searches of reference lists revealed one additional relevant paper. Of these, 17 were deemed relevant and included in the analysis. Figure 1 presents the flow of studies through the review and the reasons for exclusion. The main reasons for exclusion from the study were: the participants had significant health conditions or limited mobility; the participants were too young; the participants were hospital inpatients; and the authors reported inadequate details about the participants,

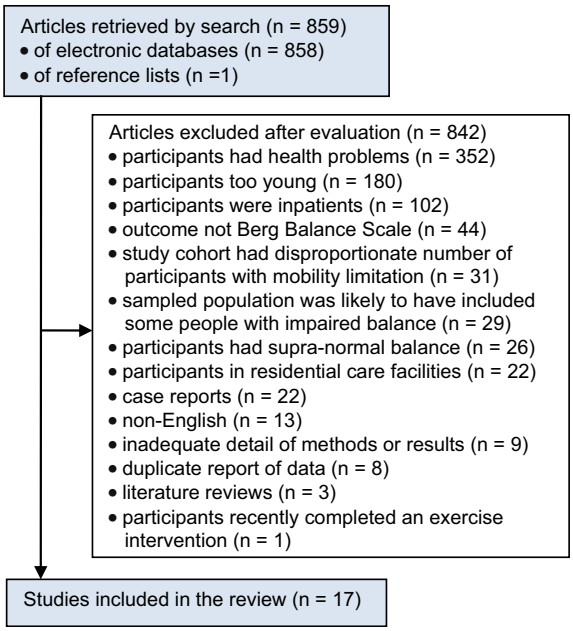

Figure 1. Flow of studies through the review.

Table 1
Summary of included studies (n = 17) and samples (n = 23).

Study	Inclusion criteria	Exclusion criteria	Country	n	Age mean	Cohort	Berg Balance Scale mean (SD)
Bhatt, 2011[9]	Ambulatory, MMSE > 25	Serious musculoskeletal, neurological disorders, osteoporosis	USA	59	71.6	Observational	53.9 (2.2)
Coleman, 2010[10]	Able to follow directions	Stroke, transient ischemic attack, Parkinson's Disease, joint replacement	USA	53	75.4	Intervention	53.0 (4.0)
Daubney, 1999[11]	Aged > 65 y, ambulatory	Any medical condition affecting ability to test BBS	Canada	50	74.8	Observational	49.7 (6.6)
Eyigor, 2009[12]	Aged > 65 y, active, independent	Any health or cognitive problem limiting ability to learn dance	Turkey	19	73.5	Intervention	54.1 (2.2)
				18	71.2	Control	53.6 (2.1)
Hatch, 2003[13]	Able to walk 6.1 m without help and follow commands	Depression, neurological disorder, recent lower limb fracture or surgery	USA	50	81.7	Observational	46.5 (9.5)
Hinman, 2002[14]	Ambulatory, able to follow structured exercise program	Acute neurological or orthopaedic condition, dementia	USA	28	73.1	Intervention	53.1 (2.8)
				30	72.6	Intervention	52.9 (3.7)
				30	70.1	Control	53.6 (4.1)
Jongjit, 2003[15]	Age matched controls	Fracture, major orthopaedic surgery	Thailand	55	75.7	Control	54.1 (3.8)
Li, 2005[6]	Age >70 y, ambulatory but inactive	Cognitive impairment, unable to exercise at moderate intensity	USA	125	76.9	Intervention	45.7 (3.9)
				131	78.0	Control	46.2 (4.5)
Lusardi, 2003[16]	Ambulatory	Symptomatic cardiac, respiratory or neurological disease, depression, major surgery in last 6 months, dementia, cancer, acute illness or injury	USA	19	75.0	Observational	52.7 (2.4)
				33	85.0	Observational	42.0 (9.2)
				17	95.5	Observational	37.2 (9.1)
MacIntyre, 2010[17]	Community-dwelling control subjects	Taking medication known to alter bone metabolism, known medical condition	Canada	11	71.0	Control	55.3 (1.0)
Ozdemir, 2009[18]	Volunteers	Major cardiac, respiratory or neurological disease, musculoskeletal conditions limiting movement	Turkey	30	70.4	Observational	54.5 (3.2)
Pardasaney, 2012[19]	Age > 65 y, can ascend stairs, MMSE > 23	Unstable acute or chronic disease	USA	111	75.9	Observational	51.5 (9.0)
Sihvonen, 2009[20]	Age 60–85 y, control group	Hip fracture, neurological or progressive severe disease	Finland	31	73.4	Observational	52.9 (3.4)
Sun, 2006[21]	Age > 65 y, control group	Surgery to spine or knees, arthritis, cardiac disorder, other condition that might affect Berg Balance Scale testing	Taiwan	50	73.8	Control	53.2 (3.1)
Wang, 2006[22]	Age > 65 y, independent in self care	Hip or knee surgery, unable to follow instructions	Taiwan	268	73.9	Observational	53.3 (4.1)
Wennie Huang, 2010[7]	Age > 60 y, MMSE > 24	Activity of daily living difficulty, terminal health condition, dementia	USA	110	80.3	Observational	49.8 (4.8)
Wrisley, 2010[23]	Age 60–90 y, MMSE > 25, can stand 1 min	Fall in last year, significant neurological, orthopaedic, cardiac or respiratory disease	USA	35	72.9	Observational	52.7 (4.0)

MMSE = Mini Mental Status Examination[24].

methods, or results. The 17 included studies contributed data on 23 study cohorts involving 1363 participants in total.

The main properties of the studies of healthy elderly are presented in Table 1. In cases where studies contain more than one group of subjects, the groups are listed individually.

The meta-regression analysis of mean age compared to mean Berg Balance Scale score in community-dwelling healthy elderly is presented in Figure 2. Each circle represents an individual sample, with the diameter of the circle representing the weight given to that sample because of its variability and sample size. The analysis shows the deterioration of Berg Balance Scale score with increasing age (R^2 = 0.81, $p < 0.001$). The Berg Balance Scale score of healthy people aged 70 years and older can be estimated by the formula: Berg Balance Scale score$_{(\text{over 70 years})}$ = 107.7 − (age in years * 0.75).

Linear regression analysis found a strong relationship between increasing age and increasing variability of Berg Balance Scale scores (R^2 = 56%, $p < 0.001$). This analysis is presented in Figure 3. The standard deviation of the Berg Balance Scale in groups of healthy people aged 70 years and older can be estimated by the formula: standard deviation of the Berg Balance Scale score$_{(\text{over 70 years})}$ = (age in years * 0.328) – 20.5.

Discussion

The results of the meta-regression of mean Berg Balance Scale scores suggests that a 70-year-old community-dwelling person without health conditions likely to significantly affect their balance is likely to have a Berg Balance Scale score close to the maximum possible value of 56. The estimate of the decline in Berg Balance Scale with age beyond 70 years was fairly strongly supported by a large pooled sample of data (1363 participants). Interpretation of this decline in Berg Balance Scale with age should, however, acknowledge that only three studies (four samples, 210 participants) had participants with a mean age over 80 years, and that the statistical power of these studies were weakened by large standard deviations.

These findings are broadly comparable to normative measures of mobility and balance using tools other than the Berg Balance

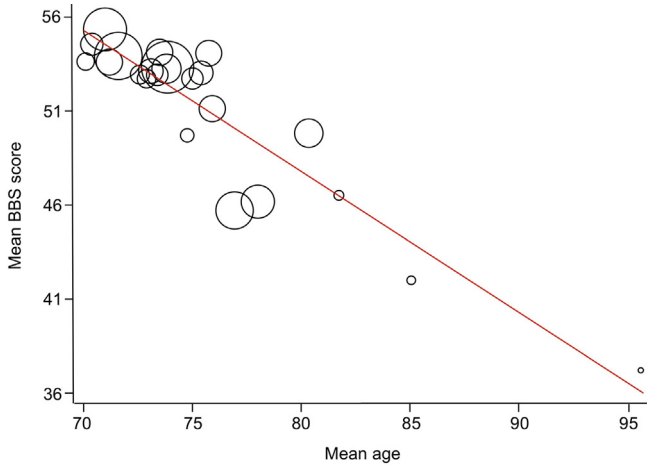

Figure 2. Relationship between mean age and mean Berg Balance Scale (BBS) score in healthy, community-dwelling elderly people.

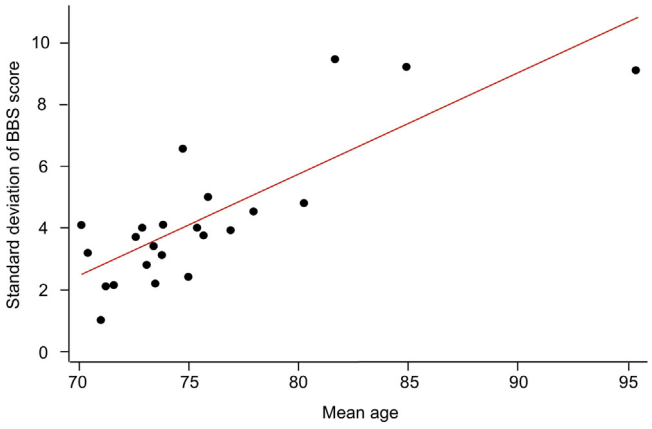

Figure 3. Relationship between standard deviation of the Berg Balance Scale (BBS) score and mean age.

Scale, which also show deterioration with age.[25] The normal values of the Berg Balance Scale suggest a ceiling effect in people younger than 70 years of age. Because of limited data from participants over 80 years old, further study is warranted to explore the relationship between the Berg Balance Scale and age among healthy, community-dwelling people aged 80 years or more.

This review found variation in the relationship between average Berg Balance Scale and age in healthy, community-dwelling elderly people. Several factors might explain this variability. Studies measuring the balance of healthy, community-dwelling elderly included in this review had similar, but not identical, eligibility criteria. Two outliers in the meta-regression, with lower Berg Balance Scale scores than expected for their age, were the treatment and control groups from a study that included only healthy sedentary elderly,[6] suggesting that sedentary elderly might have poorer balance than active elderly.

Two other outliers in the meta-regression, with higher Berg Balance Scale than expected for age, were cohorts from studies that included only participants without a history of hip or knee joint replacement surgery.[10,15] We can speculate that patients with a history of hip or knee replacement differ from other subjects for several reasons: they are more likely to have a history of arthritis; reduced physical activity following surgery might affect the long-term balance of some people; surgery might involve loss of proprioception at the affected joint; and patients with a history of hip replacement may be more likely to have a history of falls. For these reasons, the finding that studies excluding patients with history of hip or knee replacement find a higher Berg Balance Scale than studies including such patients is unsurprising.

With the exception of the outliers discussed above, all the samples included in this review reported mean Berg Balance Scale scores within 2.3 points of the line of best fit. Given that the Berg Balance Scale is scored from 0 to 58, this suggests that there is relatively little heterogeneity within the studies considered by this review. Random sampling error appears to explain at least some of this heterogeneity, particularly among studies with a small sample size and high variability (displayed in figure as a small circle). The small amount of heterogeneity also suggests that the balance of healthy, community-dwelling elderly, as measured by the Berg Balance Scale, is similar in all countries where studies included in the review have been conducted.

This review provides an important perspective on the normal values of the Berg Balance Scale. It demonstrates that with increasing age, Berg Balance Scale scores of healthy, community-dwelling people become more variable. Some people retain good balance, with very high Berg Balance Scale scores into very old age, while some demonstrate very large deficits in balance. The increasing standard deviation of the Berg Balance Scale scores with age suggests that trials involving very old but otherwise unselected participants will require larger sample sizes to allow for the greater variability compared to trials in younger participants. Alternatively, at the expense of external validity and ease of recruitment, researchers could select very old participants with a specific degree of balance deficit.

Clinicians accustomed to working with balance-impaired people may easily underestimate normal balance values of healthy elderly on the basis of their experience with balance-impaired people and fail to set adequate treatment goals for their patients to attain optimal balance. These pooled normative data will help to identify the usual balance performance of healthy, community-dwelling people aged 70 years or more.

What is already known on this topic: The Berg Balance Scale scores balance from 0 (very poor) to 56 (normal) and is widely used in many clinical populations. It has well-established, favourable clinimetric properties.
What this study adds: Normative data from community-dwelling people aged around 70 years indicates a normal Berg Balance Scale score. With each subsequent year, however, mean scores decrease by about 0.7 points, and variability in the scores increases.

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Competing interests: Nil.
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Correspondence: Stephen Downs, Transitional Aged Care Service, Bellingen Hospital, Bellingen 2454, Australia. Email: Stephen.downs@ncahs.health.nsw.gov.au

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