



# Identification of stair climbing ability levels in community-dwelling older adults based on the geometric mean of stair ascent and descent speed: The GeMSS classifier



Ruth E. Mayagoitia<sup>a,\*</sup>, John Harding<sup>b</sup>, Sheila Kitchen<sup>a</sup>

<sup>a</sup> Division of Health and Social Care Research, King's College London, Guy's Campus, London SE1 1UL, United Kingdom

<sup>b</sup> Harding Innovation and Design, 50 Hugh Squier Avenue, South Molton, Devon EX36 3DR, United Kingdom

## ARTICLE INFO

### Article history:

Received 20 August 2015

Received in revised form

20 May 2016

Accepted 23 May 2016

### Keywords:

Balance

Strength

Endurance

Timed-up-and-down-stairs

## ABSTRACT

The aim was to develop a quantitative approach to identify three stair-climbing ability levels of older adults: no, somewhat and considerable difficulty. Timed-up-and-go test, six-minute-walk test, and Berg balance scale were used for statistical comparison to a new stair climbing ability classifier based on the geometric mean of stair speeds (GeMSS) in ascent and descent on a flight of eight stairs with a 28° pitch in the housing unit where the participants, 28 (16 women) urban older adults (62–94 years), lived. Ordinal logistic regression revealed the thresholds between the three ability levels for each functional test were more stringent than thresholds found in the literature to classify walking ability levels. Though a small study, the intermediate classifier shows promise of early identification of difficulties with stairs, in order to make timely preventative interventions. Further studies are necessary to obtain scaling factors for stairs with other pitches.

© 2016 Elsevier Ltd. All rights reserved.

## 1. Introduction

Reporting on falls from stairs among the UK population as a whole, [Rois \(2001\)](#) said: “Taking into account the amount of time people spend on stairs, this makes stairs the most dangerous component of any home.” Clearly not all individuals are equally vulnerable to such falls. Older adults, however, are one group at risk. In order to introduce preventative measures at an appropriate time, vulnerable individuals need to be identified so that the level and type of intervention is commensurate with need. One common and relatively inexpensive form of intervention is assistive technology, which can take many forms including walking sticks, grab rails, stairlifts and lifts. Older adults are regularly assessed for such interventions, with a clinician (for example a physical or an occupational therapist) following a variety of procedures including self-report, observation, functional performance tests or proxy reports.

Self-report can be very general and unstructured or incorporate the use of rating scales. [Roorda et al. \(2004\)](#) developed a simple,

self-rated, 15-item, dichotomous instrument aimed at measuring the limitations patients with lower limb disorders have with stair climbing. The authors demonstrated scalability and applicability to a range of lower limb disorders, but it is not clear from the paper how the results of the questionnaire could be used and interpreted for a single patient, as opposed to a group, or for those without obvious lower limb disorders. A further contribution has been the stair self-efficacy test and observational stair score developed and tested by [Hamel and Cavanagh \(2004\)](#), which rely on both participant perceptions of their own competence and the observations of professional staff. Amongst other measures, they used average stair climbing speed (of each ascent and descent) as a direct measure of stair performance and they demonstrated it to be moderately correlated to stair self-efficacy (descent  $r = 0.464$  and ascent  $r = 0.349$ ), with slower speeds linked to lower self-efficacy scores. Their observational score relies on the individual professional judgments of the practitioner. The timed-up-and-down-stairs test ([Zaino et al., 2004](#)) was developed to test children with cerebral palsy, though it has also been used with older populations, such as people with hemiparesis ([Flansbjerg et al., 2005](#); [Bonnyaud et al., 2013](#)) adding the instruction to do the test as quickly and safely as possible. This test asks people to ascend one flight of stairs, turn around and descend back to the starting point. A stopwatch is used

\* Corresponding author. Division of Health and Social Care Research, Shepherd's House, Guy's Campus, King's College London, London SE1 1UL, United Kingdom.

E-mail addresses: [Ruth.Mayagoitia-Hill@kcl.ac.uk](mailto:Ruth.Mayagoitia-Hill@kcl.ac.uk) (R.E. Mayagoitia), [enquiries@energyathomesw.co.uk](mailto:enquiries@energyathomesw.co.uk) (J. Harding), [Sheila.Kitchen@kcl.ac.uk](mailto:Sheila.Kitchen@kcl.ac.uk) (S. Kitchen).

to time ascent and descent separately. It aims to evaluate a composite of functional mobility and balance. Handrails and assistive devices are allowed if necessary. As will be seen, the work presented in this paper builds on the outcomes of this test.

Functional tests are also commonly used to assess mobility problems, though most have been tested in relation to walking rather than stair climbing. A number of these are related to balance, general health and activities of daily living, and some provide well-recognized cut-off scores for risk of falls or prescription of mobility support (Podsiadlo and Richardson, 1991; Bogle Thorbahn and Newton, 1996; Shumway-Cook et al., 2000). However we agree with the review by van Iersel et al. (2003) that states: “Important aspects such as safety on stairs are missing from all scales” or are included in just one or two items such as in the Activities-specific Balance Confidence scale (Powell and Myers, 1995), or the SF-36 health survey (Ware et al., 2000). There is a need, therefore, to develop assessments that provide clear indications of the level of ability of a person while climbing stairs and, ideally, can identify potential difficulties before the person becomes a “faller”.

General observation of older persons climbing stairs shows that speed of descent (DS) and speed of ascent (AS) are affected as people get frailer (Nightingale et al., 2014). From this three potential scenarios arise. Firstly, those who are fit have a faster descent than ascent, as young people do (Roys, 2001; Mian et al., 2007), while, secondly, the frail have a slower, and sometimes much slower, speed of descent than ascent, though both ascent and descent slow down in absolute terms (Novak et al., 2016). The third scenario, that is explored in this paper, is an intermediate stage where the speeds of descent and ascent are about the same, where the person's ability lies somewhere between fit and frail. Thus the three levels of classification for this research project were hypothesised to be in line with these scenarios as having *no*, *somewhat* and *considerable* difficulty with climbing stairs.

The simplest formula for a classifier value would be the ratio of DS to AS. However this definition of the classifier would be incomplete as the absolute speed is also an ability indicator. Therefore the geometric mean of AS and DS was chosen and tested for this paper.

$$\text{GeMSS} = \sqrt{\text{AS} \cdot \text{DS}} \quad (1)$$

where GeMSS (geometric mean of stair speeds) is the classifier value, AS is the ascent speed, DS is the descent speed.

It is essential that the validity of such a classifier be examined. Unfortunately there is no gold standard for measuring stair climbing ability, making it impossible to measure concurrent validity. It was decided therefore to examine convergent validity through testing the relationship between the proposed GeMSS classifier, detailed below, and three well-recognized functional tests that could be performed in the place where the volunteers lived. The Berg balance scale (BBS), six-minute-walk test (SMW), and timed-up-and-go test (TUG) were selected as measures of balance, endurance and strength, respectively, because these are the three essential skills to climb stairs (Andriacchi et al., 1980; McFadyen and Winter 1988; Zachazewski et al., 1993; Hortobágyi et al., 2003). These tests have good reliability and validity (Steffen et al., 2002) and are simple, easy to implement and normally used for mobility assessments of older people.

Speed of movement decreases as people get older (Tomasz, 2005), mainly as the result of changes within the muscles (Klass et al., 2006) that cause an even larger decrease in muscle power during aging, since muscle power depends on both muscle strength and movement velocity (Skelton et al., 1994). Power (which can be expressed as force times velocity) is seen as an important indicator of the ability of older adults to perform activities of daily living,

such as stair climbing (Bean et al., 2003). Ascent speed (AS) and descent speed (DS) are objective measures specific to stair climbing ability that are easy to obtain and were chosen as the main subject of exploration in this paper.

The aim of this study was to develop a simple quantitative method of screening older adults in order to identify their ability level when climbing stairs. The test question was: How does the GeMSS classifier value compare to functional test results to allow classification of stair climbing ability of an elderly adult? In this paper the term “stair climbing” encompasses both ascent and descent. It is planned that the application of the GeMSS can be done with everyday equipment, so the test can be performed in almost any environment, at a very low cost.

## 2. Materials and methods

### 2.1. Participants

Urban, community dwelling, older adults (62–94 years) were approached through the Housing Development Unit of the London Borough of Hammersmith and Fulham and twenty-eight people (16 women) volunteered. Participant characteristics are detailed in Table 1. Each volunteer undertook all the tests on a single day. Data were collected over five testing days in late spring. Upon arrival on the morning of the scheduled test, the volunteers gave their written consent. The King's College London Research Ethics Committee approval number for this project was 04/05–08.

Inclusion criteria were:

- aged 60 and over
- able to ascend and descend an eight-step flight of stairs independently or by using the handrails or the assistance of a device such as a walking stick or crutches
- living in the community or in sheltered accommodation.

Exclusion criteria were:

- known diagnosis of cognitive impairment
- excessive<sup>1</sup> alcohol consumption the night before the tests or any alcohol consumption on the day of testing.

### 2.2. Procedure

Volunteers were recruited by letter and follow-up telephone calls by the staff of the Social Services Offices of the Housing Development Unit of the London Borough of Hammersmith and Fulham. Testing was undertaken in the common room and one of the stairs of one of the sheltered housing units within the Borough. Demographic data were collected first and compliance with inclusion and exclusion criteria confirmed. The functional tests, presented in random order, followed and also served as pre-screening to ensure safety before the stair climbing tests. During stair climbing tests one researcher was at the top and another at the bottom of the stair to ensure safety. The total testing time for each individual was between 30 and 35 min. Refreshments were available and rest periods provided between tests as needed by the volunteers. Individual tests were undertaken as follows, with a specific researcher responsible for carrying out a given test.

<sup>1</sup> Alcohol consumption above the maximum recommended in the Sensible Drinking Report of the Department of Health (1995) of three units for women and four units for men.

Download English Version:

<https://daneshyari.com/en/article/6947731>

Download Persian Version:

<https://daneshyari.com/article/6947731>

[Daneshyari.com](https://daneshyari.com)