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Fall risk screening in the elderly: A comparison of the minimal chair height standing ability test and 5-repetition sit-to-stand test

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ABSTRACT

Background: Successfully identifying older adults with a high risk of falling can be complicated, time consuming and not feasible in daily medical practice. This study compared the effectiveness of the Minimal Chair Height Standing Ability Test (MCHSAT) and 5-repetition sit-to-stand tst (5R-STS) as fall risk-screening instruments for the elderly.
Methods: 167 community-dwelling older adults (mean age = 83.6 ± 7.3 years) were interviewed for demographics, fall history, cognition, and mobility status. MCHSAT performance was assessed using a chair whose seat height was modifiable by increments of 5 cm, starting at 47 cm and lowering after each successful attempt. 5R-STS performance was assessed by recording the time it took to rise and sit back down five consecutive times from a chair of 47 cm high. Operating Receiving Characteristic (ROC) curves and Area under the Curve (AUC) were calculated for each test as well as for sub-groups of participants classified based on medical comorbidities (e.g. cardiac disease/stroke, lower limb arthritis).
Results: The MCHSAT and 5R-STS were equally effective fall-risk screening instruments for the overall population (AUC (95% CI) = 0.72 (0.63–0.82) and 0.73(0.64–0.81) respectively). The 5R-STS was more effective than the MCHSAT for participants suffering from lower limb arthritis (AUC (95% CI) = 0.81(0.70–0.92) and 0.71(0.58–0.85) respectively) while the opposite was true for participants with a history of cardiac disease or stroke (AUC (95% CI) = 0.59 (0.44–0.80) and 0.65 (0.47–0.84) respectively).
Conclusion: Due to their simplicity and quick administration time, the MCHSAT and 5R-STS are equally suitable for implementation in clinical settings.

1. Introduction

Due to Canada's unprecedented trend in aging (Stewart, Finlayson, MacWilliam, & Roos, 2002; Doupe et al., 2011), older adults (65 years and older) are the fastest-growing age group in the country (Estabrooks et al., 2013). This trajectory is expected to accelerate over the next three decades and then continue to grow at a slower pace between 2036 and 2056, at which time older adults will represent 27.2 per cent of Canada's population (Statistics Canada, 2007). Based on these predicted demographic population aging trends, researchers have forecasted substantial social and economic pressure on the health care system (Berta, Laporte, Zarnett, Valdmanis, & Anderson, 2006).

Although it is often argued that older adults are largely responsible for depleting health care resources, a large proportion of this "depletion" appears to be associated with falls and fall-related injuries rather than aging itself (Scuffham, Chaplin, & Legood, 2003; Craig et al., 2013; Towne, Ory, & Smith, 2014). The major problem that arises with falling is the risk of a skeletal fracture, and this risk grows exponentially as individuals age and bone mass weakens (Melton, 1996). The area of the human body that is most susceptible to fractures is the hip (Cummings & Melton, 2002). In Canada, the annual economic costs of hip fractures are $1.1 billion (Nikitovic, Wodchis, Krahn, & Cadarette, 2012) and are expected to rise to $2.4 billion by the year 2041 (Wiktorowicz et al., 2001). Furthermore, the psychological implications of falls can be devastating: The prevalence of post-fall anxiety syndrome and function-impairing fear of falling affects 73% of fallers (Perell et al., 2001). The damaging consequences of this fear can result in further costs, due to nursing home placement and often prolonged rehabilitation (Perell et al., 2001).

Accordingly, issues related to falls prevention among the elderly have been gaining increasing attention from researchers and clinicians. Identifying older adults at a high risk of falling and referring them to fall-prevention programmes has proven effective in reducing the rate of falls in various clinical settings (Haines, Bennell, Osborne, & Hill, 2004) (Jensen, Lundin-Olsson, Nyberg, &

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Gustafson, 2002)(Ray et al., 1997). A substantial number of fall-risk screening instruments have been developed over the past three decades (Berg, Wood-Dophinee, Williams, & Gayton, 1989; Duncan, Weiner, Chandler, & Studenski, 1990; Lord & Menz, 2003; Podsiadlo & Richardson, 1991). Unfortunately, few of these screening instruments are included as routine assessments in hospitals, outpatient medical clinics and nursing homes since they are complicated, time consuming and not feasible in daily medical practice (Bongue et al., 2011). Health care professionals need a simple and pragmatic clinical approach to identify older adults with high risk of falling.

The Minimal Chair Height Standing Ability Test (MCHSAT) is a fall-risk screening assessment tool (Schurr, Ho, Sherrington, Pamphlett, & Gale, 2002) that measures the lowest height chair from which a person can rise to standing unassisted. Studies have shown that decreased MCHSAT performance is an important risk marker for falls in older adults (Kwan, Lin, Chen, Close, & Lord, 2011; Reider, Naylor, & Gaul, 2014). The 5-repetition sit-to-stand test (5R-STS) is the most commonly used method to measure functional strength in older individuals (Bohannon, 2002) and it is sometimes used by physical therapists as a screening instrument for identifying fall risk (Lord, Murray, Chapman, Munro, & Tiedemann, 2002). The test involves measuring the fastest time it takes to stand from a seated position five times (Bohannon, 1995).

Due to their simplicity and quick administration time the MCHSAT and 5R-STS would be suitable for implementation in various health care settings. Thus, the primary objective of this study was to compare the advantages and disadvantages of using the MCHSAT and 5R-STS tests as fall risk-screening instruments within the elderly community.

2. Methods

2.1. Participants and recruitment

A total of 168 male and female volunteers were recruited. The number of study participants required ($n = 162$) was calculated (G*Power 3.1.3 for Windows) using a one-tailed hypothesis, a medium effect size of 0.52, and an error probability of 0.05 (Kwan et al., 2011).

Details of the recruitment procedures have been described elsewhere (Reider et al., 2014). Briefly, participants were recruited from independent living facilities, assisted living facilities and senior community centers in Victoria, British Columbia, Canada. Criteria for participation included being 65 years or older, the ability to walk independently, and a Mini-Mental Score Examination (MMSE) score higher than 19 (Folstein, 1983). Prior to participation, all participants provided written informed consent following approval by the institutional Human Ethics Research Board.

2.2. Experimental design

All data for each participant were collected over a single 45 min testing session. A sub-sample of participants ($n = 45$) were randomly selected to determine if the order in which the MCHSAT and 5R-STS were performed affected the subsequent performance. Twenty-one individuals (mean age ± SD, 83.5 ± 7.9; 17 women) were randomly assigned to begin testing with the MCHSAT while 24 individuals (mean age ± SD, 81.5 ± 9.5; 18 women) were randomly assigned to perform the 5R-STS first. Each test was separated by 3 min of rest. The remaining 122 participants completed the MCHSAT first.

2.2.1. Baseline assessment

The initial assessment included a written questionnaire that focused on demographic characteristics and personal medical history. To obtain information on medical conditions, participants were asked: "*Have you suffered, or do you now suffer from any of the following* (*Lower limb arthritis,hip fracture, hip replacement, diabetes, hypertension, cardiac disease, stroke, cancer, Parkinson's disease, respiratory problems*)?" If the answer was yes, subjects were asked to provide additional information regarding the year of diagnosis and treatment. In addition, all participants completed the Instrumental Activities of Daily Living (IADL) questionnaire (Lawton & Brody, 1969) and the MMSE (Folstein, 1983).

2.2.2. Physical characteristics

Subjects were measured for weight (to the nearest 0.05 kg) using an electronic scale (WANDA, model WD2003, Zhejiang, China) and height (to the nearest 0.5 cm) using a wall-mounted measuring tape (Mastercraft, 1in. × 25 ft./7.5 m). Additionally, participant shank length was measured from the fibular head to the lateral malleolus (Reider et al., 2014). MCHSAT and 5R-STS performances were adjusted for shank length by using the following equation (Kwan et al., 2011):

$$\text{Adjusted MCHSAT/5R{-}STS} = \frac{\text{MCHSAT/5R{-}STS} \times \text{Mean shanklength (gender)}}{\text{Participant's shanklength}}$$

2.2.3. Fall history and consequences

Interviewers were instructed to define a fall as an event in which: "*you suddenly find yourself on the ground, without intending to get there, after you were in either a lying, sitting or standing position*" (Cwikel, Fried, Biderman, & Galinsky, 1998) To account for the possibility of social desirability bias, the phrase "*We all fall from time to time . . .* " was mentioned by the interviewer before commencing the fall-history questionnaire (Cwikel et al., 1998). To document the incidence of past falls, participants were asked: "*In the past 1 year, have you fallen? If yes, how many times?*" Those participants who reported having 1 or more falls in the past year were classified as "fallers". Identified fallers were asked to provide supplementary information regarding the severity and consequences of their fall(s) (e.g. hip fractures, wrist fractures) as well as details regarding the setting (e.g. shower, bedroom) and situation (e.g. cleaning, getting dressed) in which the fall occurred.

2.2.4. MCHSAT performance

The MCHSAT chair was built specifically for the study and designed with a starting height of 47 cm and a moveable seat which could be lowered by increments of 5 cm (47 cm, 42 cm, 37 cm, etc.) (Kwan et al., 2011). The main structure of the chair was aluminum; this material was chosen as aluminum frames are lighter than steel frames, and thus easier to transport (Reider et al., 2014). The seat surface was wood. The total cost for this prototype chair was CAD $250. Both the intra-rater (0.83) and inter-rater (0.9) reliability of the MCHSAT have been found to be high (Kwan et al., 2011; Schurr et al., 2002).Subjects were asked to sit on the chair, feet flat on the floor and hip-width apart, toes aligned directly under knees and arms folded across chest. Participants were given three attempts at each height reached (47 cm, 42 cm, 37 cm, etc.) and 1–2 min of rest between attempts. The chair was lowered 5 cm if the subject was able to rise successfully from the seat. A successful attempt was recorded if participants kept their arms across their chest throughout the entire movement, and did not use the back of their legs against the chair to assist themselves. If the subject was unsuccessful after three attempts, the testing procedure was finished and final seat height recorded. When a