Balance performance of community-dwelling older people

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ABSTRACT

الأهداف: بحث العلاقة بين أربعة من اختبارات التوازن التي كثيراً ما تُستخدم في الفحص السريري، بالإضافة إلى تاريخ السقوط لدى المسنين السعوديين اللذين يعيشون في المجتمع.

الطريقة: أُجريت هذه الدراسة الاسترجاعية في قسم التأهيل الصحي بكلية العلوم الطبية التطبيقية، جامعة الملك سعود، الرياض، المملكة العربية السعودية وذلك خلال الفترة من سبتمبر 2009م إلى يونيو 2010م. شملت هذه الدراسة 48 مسناً ممن تتراوح أعمارهم ما بين 85-60 عاماً، حيث تم اللجوء إلى بطارية الاختبارات المعيارية لقياس الآداء الحركي والتوازن لديهم.

النتائج: أشارت نتائج الدراسة إلى أن المسنين اللذين سبق لهم التعرض للسقوط كان أدائهم في اختبارات التوازن الواردة في البطارية أقل من المسنين اللذين لم يتعرضوا للسقوط، حيث أظهر اختبار الوقوف على ساق واحدة فرقاً واضحاً بين المجموعتين وذلك في حالة فتح العينين (p=0.001)، وفي حالة إغلاقهما (p=0.0001). كما أظهر أداء هذا الاختبار في حالة إغلاق العينين قدرة على توقع السقوط بنسبة 83.2%، وكانت نسبة حساسية الاختبار عالية (79.2%)، ونسبة دقته عالية (87.5%).

خاتمة: أثبتت الدراسة قصور التوازن لدى المسنين السعوديين الذين تعرضوا للسقوط مسبقاً، وقد كان اختبار الوقوف على ساق واحدة في حالة إغلاق العينين من أفضل اختبارات التوازن التي أظهرت العلاقة بين اضطراب التوازن أثناء التقييم وتاريخ السقوط.

Objectives: To investigate the association of 4 common clinical balance tests and history of fall in Saudi community-dwelling older people.

Method: This retrospective study took place in the Rehabilitation Health Sciences Department, College of Applied Medical Sciences, King Saud University. Older people were recruited from Riyadh, Kingdom of Saudi Arabia from September 2009 to June 2010. Four balance performance tests were used. Inclusion criteria for 60-85 year-old participants (n=48) were checked.

Results: Fallers had lower balance performance than non-fallers in the test-battery measures with significance difference for one leg stance test with open (p=0.001) and closed eyes (p=0.0001). One leg stance with closed eyes test showed an overall prediction capability (83.2%), high sensitivity (79.2%), and specificity (87.5%).

Conclusion: This study shows that Saudi community-dwelling older people fallers had compromised balance performance, and that one leg stance test with closed eyes was the best balance test associated with history of fall.

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Falls are the leading accidental cause of death among older people in their homes.[1] Approximately 30% of people over 65 years of age, and living in the community fall each year.[2] In a community based study, it was found that over 50 percent of falls among older people results in at least some minor injury.[3] Serious injuries could occur in up to 10% of falls.[3] Apart from direct injuries resulting from falls, other long-term consequences may include physical decline, disability, fear of falling, and loss of independence, which can have serious effects on older people's health, and quality of life.[4,5] The identification of individuals at risk of falling is not a trivial matter. Many different physiological performance tests are believed to be sensitive to fall risks. Several research groups have investigated combination of tests to produce test batteries addressing fall risk in older people.[6-8] In addition, numerous clinical screening instruments for identifying older people at high risk of falling have been proposed, and these vary in complexity from a single clinical test, to scales involving 10 or more assessments.[9,10] Apparently, fall risks can be assessed by testing balance performance,[11] and a number of balance tests have been shown to predict future falls in older people. These include the following simple tests, which may be used in a busy clinical setting: Sit-to-Stand (STS) test, Timed Up and Go (TUG) test, One-Leg Stance (OLS) test, and Functional Reach (FR) test.[12,13] The purpose of the current study was to investigate the association of 4 common clinical balance tests, and history of fall in Saudi community-dwelling older people.

Methods. The study was designed as a retrospective study with the outcome being fallers versus non-fallers. Participants were recruited from the Rehabilitation Health Sciences (RHS) Department, College of Applied Medical Sciences (CAMS), King Saud University (KSU), Riyadh, Kingdom of Saudi Arabia (KSA) from September 2009 to June 2010 through bulletin board announcement. They were Saudi community-dwelling older people who were able to walk without human assistance, and to follow the instructions given to them. The age range was from 60-85 years. Out of 198 older people, 48 males and females were eligible to participate, and were invited to the study by verbal contacts. There were 2 groups; 24 with- and 24 without history of falling within the previous year. Exclusion causes included knee joint pain due to osteoarthritis and musculoskeletal disorders, especially low back pain. Older people were excluded if they reported any of the following: a) major musculoskeletal disorder; b) significant pain that limited daily functions; c) ear infection within 2 weeks prior to the test; d) dependence on special care to stay in the community; e) known uncorrected visual or vestibular problems; f) cognitive impairment; g) fractures following the falls.

The study was approved by the Department of RHS, CAMS, KSU, and informed consent was obtained from all participants prior to inclusion in the study.

Four common clinical balance tests were selected for a test-battery to cover different aspects of physical performance related to fall risk. The participants were introduced to each test in the test-battery by a demonstration, and they were allowed to do a pre-test trial. The participants were interviewed regarding age and number of falls. A 'fall' is when a sudden, unintended loss of balance makes a person comes to rest on the ground from an upper level or the same level.[12] This definition was considered when older people were asked to recall the number of their falls, and the accuracy of their recall was assured by their adult relatives. In the TUG test, the participants sat on a chair (height; approximately 46 cm). A line was drawn on the floor 3 meters in front of the chair. The participants were asked to rise from the chair, walk the 3 meters to cross the line, turn around, walk back, and sit down on the chair again. The time for this procedure was recorded, in seconds by a stopwatch. In the OLS test, the participants were asked to stand barefoot on the limb of their choice, with the other limb raised so that the raised foot was near, but not touching the ankle of their stance limb. Subjects were asked to focus on a spot on the wall at eye level in front of them, for the duration of the eye-open test. Prior to raising the limb, subjects were instructed to cross their arms over the chest. The researcher used a digital stopwatch to measure the time (in seconds), the subject was able to stand on one limb. Time commenced when the subject lifted the foot off the floor. Time ended when the subject either: 1) uncrossed his arms, 2) moved the raised foot toward, or away from the standing limb, or touched the floor, 3) moved the weight-bearing foot to maintain his balance, 4) a maximum of 45 seconds had elapsed, or 5) opened eyes on eyes-closed trials. The procedure was repeated 3 times, and each time was recorded on the data collection sheet. The average of the 3 trials was calculated. Subjects performed 3 trials with the eyes-open, and 3 trials with eyes-closed, alternating between the conditions. For example, one trial with eyes-open followed by one trial with eyes-closed equaled one trial set. The order of testing was randomized by a coin. At least 5 minutes of rest were allowed between each trial set to avoid fatigue. In the FR test, the subjects were asked to position themselves close to, but not touching the wall with their feet shoulder-width apart, their arms raised outstretched to 90 degrees of flexion, and hands fisted. The researcher took note of the starting position by determining what number the third metacarpophalangeal (MCP) joint lines up with on a yardstick. Have the subjects reach as forward as possible in a plane parallel with the measuring device, the researcher took note of the end position of the third MCP joint and recorded the difference (in cm) between the starting and ending positions numbers. The test was repeated, and the average difference was calculated. The same procedure was followed for the right and left arms. In the STS test, the subjects were instructed to sit on a chair, keep feet flat on the floor, approximately hip-width apart, the back of legs away from the chair, knees bent at a 90° angle with arms crossed over the chest. Subjects were asked to stand up and sit down 10 times as quickly and safely as possible, and the researcher began timing, by starting the stopwatch. The researcher indicated that any improper technique, for example, not standing all the way up, not sitting all the way back, and so forth, would not be counted. At the tenth repetition, the researcher clicked the stopwatch off, while the participant was in standing position. Two trials were conducted, separated by 3 minutes, and the average time in seconds was calculated.

Data analysis was performed using the Statistical Package for Social Sciences version 13 (SPSS Inc, Chicago, IL, USA). Descriptive statistics means, and standard deviation of participants' age, and cross tabulation with Chi-square of gender and history of fall were carried out. Faller/non-faller was used as the dependent variable. The tests' scores were used as independent variables. To compare group characteristics and tests' scores in the fallers and non-fallers group, the Student's t-tests were used. Logistic regression was used to evaluate the association efficacy of the test-battery and history of fall. Pearson coefficient of correlation was used to examine the correlation between number of falls and tests scores. A 95% confidence interval was assigned, and a $p<0.05$ was considered.

Results. Out of 198 older people proposed to participate in the study, 48 were eligible (24.2%). The study population of older people had a mean age of 66.5 ± 6.3 years, and the proportion of males was 39.6%. Fallers were older (67.04 years) than non-fallers (65.9 years), but without significant difference (p=0.558) (**Table 1**). There were 37.5% fallers, and 41.6% non-fallers in males. On the other hand, females were 62.5% fallers, and 58.3% non-fallers. Chi-square test showed no significant difference in gender distribution among fallers and non-fallers (p=0.768) (**Table 1**). The fallers group experienced varied numbers of fall in the previous year (1-5 times). Most fallers (79.2%) had fallen once (41.7%), or twice (37.5%). Fallers showed non-significant lower balance tests scores than non-fallers except for OLS test, which showed significant lower fallers' scores with open- (p=0.001) and closed eyes conditions (p=0.0001) (**Figure 1**). The OLS with closed eyes condition was the best investigated clinical balance test, which showed association with history of fall in the studied Saudi community-dwelling older people (p=0.009) (**Table 2**). The best overall prediction rate was 83.2% of fallers (sensitivity; 79.2%), and non-fallers (specificity; 87.5%). Pearson coefficient of correlation showed no statistically significant correlation between the number of falls and the tests scores (**Table 3**).

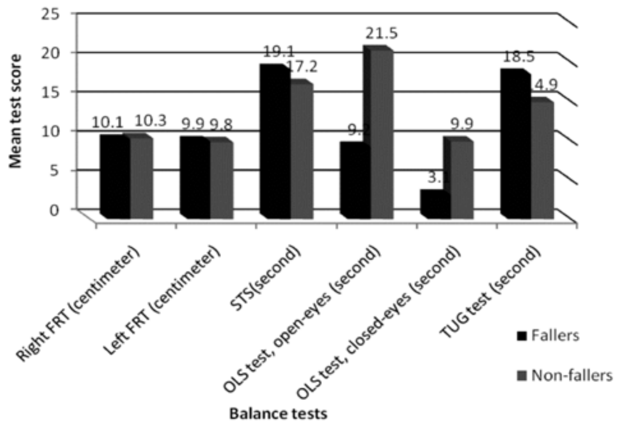

Figure 1 - Independent t-test comparison of fallers and non-falling groups' mean balance tests' scores. FRT - functional reach test, STS - sit-to-stand, OLS - one-leg stance, TUG - timed up and go

Table 2 - Logistic regression of test-battery scores association with fall history.

Independent variable	B	SE	*P*-value
Right functional reach test (cm)	-0.048	0.242	0.884
Left functional reach test (cm)	-0.063	0.271	0.817
Sit-to-stand test (sec)	0.186	0.127	0.142
One-leg stance test, open-eyes (sec)	0.064	0.058	0.268
One-leg stance test, closed-eyes (sec)	0.625	0.240	0.009
Time up and go test (sec)	-0.220	0.110	0.050
Constant	-2.852	2.440	0.243

B - regression coefficient, SE - standard error

Table 3 - Pearson coefficient correlation (r) of test-battery scores and number of falls of older people fallers (n = 24).

Independent variable	r	*P*-value
Right functional reach test (cm)	-0.093	0.695
Left functional reach test (cm)	-0.012	0.960
Sit-to-stand test (sec)	0.106	0.657
One-leg stance test, open-eyes (sec)	-0.188	0.427
One-leg stance test, closed-eyes (sec)	-0.066	0.781
Time up and go test (sec)	0.421	0.064

Table 1 - Demographic characteristic of fallers, and non-falling older people.

Older people groups	Age, year mean ± SD	Gender		Total
		Male	Female	
		n (%)		
Fallers, n=24	67.04 ± 7.3	9 (37.5)	15 (62.5)	**24 (100)**
Non-fallers, n=24	65.9 ± 5.3	10 (41.6)	14 (58.3)	**24 (100)**
Total, n=48	**66.5 ± 6.3**	**19 (39.6)**	**29 (60.4)**	**48 (100)**
P-value	0.558	0.768		

SD - standard deviation

Discussion. Injuries resulting from falls in older people are a major public-health concern, and the problem is going to worsen, since the rates of such injuries seem to be rising in many areas, as is the number of older people in both the developed and developing world.[14] Numerous studies have been conducted on risk factors for falls, and the best predictors appear to be abnormalities of balance,[15] but it was observed that screening tools have been developed for use in various populations, including hospitalized older adults, adults in residential care, and community-dwelling older people.[9,10] It is for this reason why in the current study, a balance test-battery related to falls was designed to address fall risk in a Saudi community-dwelling older people population.

When comparing the group of fallers with non-fallers, no statistically significant difference was seen in the fall related balance performance as scored by the test-battery. Indeed, worse scores for fallers were observed. The only exception for that was OLS test with its both open and closed eyes conditions as fallers, showed significant lower scores than non-fallers. This indicated that not all older people with a reduction in balance ability reported a fall over a one-year period. This statement was agreed by Kumar et al.[16] In addition, there was no difference in the demographic characters between fallers and non-fallers. Results showed no significant difference in gender distribution among the 2 groups, and the older age of fallers was not significant. More interestingly, among the fallers group, the number of falls showed no correlation with the test-battery scores. This could be due to the fact that most of the fallers (79.2%) fortunately, had fallen once (10 fallers), or twice (9 fallers), while only one (4.2%) had fallen 3 times, 2 (8.3%) had fallen 4 times, and 2 fallers (8.3%) had fallen 5 times. This small percentage (20.8%) of fallers who fell more than twice could not establish a correlation difference in the test's scores between them, and fallers who fell once or twice. However, when the association of history of fall with balance tests was investigated, it was found that out of the 4 studied balance tests, OLS with closed eyes was the best test showing association with high sensitivity and specificity. In addition, it can be said that Saudi community-dwelling fallers had significant lower scores of open and closed eyes OLS test, but from the association point of view, the OLS test with closed eyes condition was the best test to associate with history of fall. This is due to the relationship between errors in visual perception and falling status, and in older people, problems can arise with interpretation of any type of sensory input including visual, auditory, and positional inputs, but impairments in visual perception are the most widely recognized.[17] This explained falls association with decreased closed eyes OLS test as when older people close their eyes, they loss vision support, and face their pure balance abilities. Fair association between TUG test, and history of fall was also detected (p=0.05). In the study of Kumar et al,[16] they could identify individuals with poor balance, but they could not predict fallers by the test-battery, which includes TUG test. Laessoe et al[11] reported that OLS and TUG tests are not capable to predict falls, and they found no difference between the fallers and non-fallers' test-battery scores. Morris et al[12] reported that the STS test is a non-predictable test, although the TUG test is capable to predict falls, however, they used a 5-meter TUG test, while in the current study, a 3-meter TUG test was used, and they apply the test in different population (in older women with vertebral fracture). A study by Lin et al[18] suggested that the FR test had almost no discriminatory ability between fallers and non-fallers.

The reliability and validity of the used balance tests could not be the source of variation in their predictability to falls among the studies as their psychometric characters are well-documented. Lin et al[18] agreed with that, as their study exhibited excellent test-retest reliability and discriminate validity of OLS, TUG, and FR tests, and in spite of that, they recorded poor responsiveness to fall status. They used intraclass correlation (r) coefficients to measure the intra-rater reliability and inter-rater reliability for the above-mentioned balance tests, and they found that the intraclass r for intra- and inter-rater reliability were excellent for all balance measures, with a range of 0.93-0.99.[18] Wolinsky et al[19] reported a 0.6 intraclass correlations coefficients for OLS test. More recently, Curb et al[20] found good reliability for OLS (0.69) in a sample of 203 aged 35-71 years old, and without significant functional impairments. They also found high reliability for STS test (0.84). Variation among the studies could be explained by the difference in the studied populations. This gives emphasis on the importance of selecting matching population when decisions regarding the fall risk is to be taken. Gates et al[21] had the same opinion as they stated that the tools developed for one population may be less accurate when used in a different setting. Laessoe et al[11] agreed that the reported prediction rates vary a great deal, and they excused that to the characteristics of older people populations included in the different studies. They also adopted the belief in the influence of environmental factors, and difficulty in daily tasks performed on fall risks in community-dwelling older people, and stated that the physiological balance capacity can be addressed by tests related to balance and fall risks, however, falling is a complex phenomenon of a multi-factorial nature with associations to a fall-risky lifestyle. Kumar et al[16] added that it remains a challenge to identify individuals at increased risk of falling, and that falling is a complex phenomenon of multi-factorial origin. It could be said that balance performance is one factor, but fall risk has been related to a number of factors such as age, history of fall, muscle weakness, gait deficit, balance deficit, use of assistive device, visual impairment, mobility impairment, fear of falling, cognitive impairment, depression, psychotropic/cardiovascular medications, sedentary behavior, number of medications, nutritional deficits, urinary incontinence, arthritis, home hazards, and footwear.[22]

The study was designed as a retrospective rather than a prospective study, which would be a more preferable design when the predictability of balance tests is aimed. Riyadh is the capital of KSA, but restricting the study to this large city is another limiting factor that could interfere with the generalization of the study results on KSA. Not considering the level of physical activity, co-morbidity, and the effects of drugs is a further limitation.

In conclusion, among the studied balance performance tests, OLS with eyes closed was the best test associated with the fall history in Saudi dwelling-community older people population. Falling is a complex phenomenon of multi-factorial origin and its prediction is a challenging task. The results from this study support the view that fall risk cannot be predicted by solely assessing balance performance. More comprehensive study is required including, in addition to the balance performance, medical condition, level of activity, and cognitive status of older people.

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