Original Article

Test-Retest reliability of Biodex Balance SD on physically active old people

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ABSTRACT

Parraca JA, Olivares PR, Carbonell-Baeza A, Aparicio VA, Adsuar JC, Gusi N. Test-Retest reliability of Biodex Balance SD on physically active old people. *J. Hum. Sport Exerc.* Vol. 6, No. 2, pp. 444-451, 2011. The purpose of this study was to determine the reliability of the Biodex Balance System in elderly. Forty-five subjects aged 66±5.5 years old and weight 71.6±9.8 kg were tested on the Biodex Balance System. In order to calculate the reliability, the Fall Risk Test (FRt) and the Postural Stability Test (PSt) were measured on two separate occasions 7 days apart. Every subject completed the Falls Efficacy Scale-International (FES-I) questionnaire the first day of testing. The Fall Risk Index (FRi) showed a good ICC (.80) and a low percentage of variation of method error. The Overall Stability Index (OSi) showed a good and acceptable reliability measured by the ICC (.69) but a percentage of variation of method error near to 25%. FES-I Score was 23.1 (±7.2). The reliability of the BBS using Bland-Altman method showed that systematic errors (mean difference between test-retest) for the balance test developed were nearly zero and the 95% limits of agreement narrow, indicating a good reliability of the measurement. Biodex balance measures were showed reliable and may be useful for measuring the risk of falls and monitoring programs for prevent falls in elderly. This study revealed that fall risk assessment in older people must be incorporated into the evaluation process of the physical functioning. **Key words**: EQUILIBRIUM, ELDERLY, STABILOMETRY.

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INTRODUCTION

Balance disorders are common in elderly (Sturnieks, St George, & Lord, 2008). Balance can be described as the ability to maintain the centre of gravity of the body over the base of support (Pollock, Durward, Rowe, & Paul, 2000) and it is an important risk factor for falls. Balance is affected by the progressive loss of sensorimotor functioning with increasing age (Sturnieks et al., 2008). Falls are the most common cause of accidental injuries in the elderly and frequently result in disability and handicap, emotional distress and increased use of health and social services (Society et al., 2001; Skelton, 2001; Yardley et al., 2007). Fallers shows poorer body balance in the standing position and worse body posture than non-fallers (Ostrowska, Giemza, Wojna, & Skrzek, 2008). There is not a single universally accepted method for measuring balance. In fact, classic balance test in current use are not effective predictors of falls in elderly without significant health problems (Keskin et al., 2008). Therefore, there is a need of simple and reliable outcome measures in physiotherapy assessment and evaluation of recovery and treatment in subjects with falls problems (Kammerlind et al., 2005).

The most frequently used advanced technique to evaluate postural stability is the measurement of the position and displacement of the centre of pressure (COP) using a force plateform (Geldhof et al., 2006). Force platform balance tests provide valid information of postural control that can be used to predict fall risk even among elderly without apparent balance problems or fall history (Melzer, Benjuya, & Kaplanski, 2004; Pajala et al., 2008), however, force plateform can not measures dynamic test.

The Biodex Balance SD (BBS) (Biodex Medical Systems, 1999) is a multi-axial device which objectively measures and records an individual’s ability to stabilize the involved joint under dynamic stress. It uses a circular platform that is free to move in the anterior–posterior and medial–lateral axes simultaneously and it is possible to control the instability degree in 12 levels plus static position. As well BBS has a display to give feedback in real time about the position of the COP during the test. There are many possible variations in the BBS stance protocol: varying degrees of instability of the platform (Aydog, Bal, Aydog, & Cakci, 2006), crossed arms (Aydog et al., 2006) or free arms (Gstottner et al., 2009), one or two-leg stance (Akbari, Karimi, Farahini, & Faghihzadeh, 2006) and open or closed eyes (Ghoseiri, Forogh, Sanjari, & Bavi, 2009). Other studies have found the BBS as a reliable assessment device across multiple test trials in healthy college students (Cachupe, Shifflett, Kahanov, & Wughalter, 2001; Pincivero et al., 1995) and collegiate athletes (Cachupe et al., 2001). Nevertheless, further studies are needed to measure this reliability in elderly and other populations groups (Cachupe et al., 2001; Hinman, 2000).

Therefore, the purpose of this study was to assess the reliability of measures obtained from the BBS in static position (Postural Stability Test) and the predeterminated dynamic test, the Fall Risk Test in physically active old people.

MATERIAL AND METHODS

Participants

The sample was composed by 45 physically active old people (4 men and 41 women). The inclusion criterions were: people older than 60 years old, living in their houses, non-smokers, not drinker alcoholic drinks, practice physical activity regularly (almost 2 days per week), without any clinical history of metabolic or biomechanical diseases that might influence in any way the osseous metabolism or the muscular strength, and have a low punctuation in fear of fall, measured with the Falls Efficacy Scale-International (FES-I) questionnaire (Yardley et al., 2005) (Table 1). All the participants gave their written informed consent according to the updated Declaration of Helsinki and the project protocol was approved by the Biomedical Ethical Committee of the University of Extremadura (Spain).

Measurements

Weight and height were measured using a 780 SECA digital column scale (Germany) and body mass index (BMI) was calculated. For valorating fear of fall was employed a validated instrument: the FES-I questionnaire (Yardley et al., 2005).

Postural stability was measured using a Biodex Balance System SD (BBS) (Biodex, Shirley, NY) which is an instrument designed to measures and trains the postural stability on a static or unstable surfaced. BBS consisted in a circular platform that is free to move in the anterior-posterior and medial lateral axes simultaneously, been able to control the movement degree of the platform with 12 levels. The BSS device is interfaced with dedicated software (Biodex, Version 1.08, Biodex, Inc.) allowing the BSS to measure the degree of tilt in each axis, providing an average sway score. Eight springs located underneath the outer edge of the platform provide the resistance to movement (stability level of the plataform). Resistance levels range from 8 (most stable) to 1 (least stable).

BBS have a display to give feedback in real time about the posture and was calibrated before the measures. The participants stood on the BBS supporting on their two legs and looking the display all time trials. All trials were done without shoes and Foot position was recorded using coordinates on the platform's grid to ensure the same stance and, therefore, consistency on future tests.

In this research were used two of the software protocols: The Fall Risk Test (FRt) and the Postural Stability Test (PSt). In the FRt, the platform is unstable and permits obtain the Fall Risk index (FRi). This test was done with the standard software configuration: three trials of 20 second each one, ten seconds rest between test and a stability level of the platform of 8. In the PSt the platform is static in the anterior–posterior and medial–lateral axes, and permits to obtain the Overall Stability index (Osi). This test consisted on three trials, with 20 seconds of duration each one and one minute between tests. These indexes represent fluctuations around a zero point established prior to testing when the platform is stable (Arnold & Schmitz, 1998).

In order to calculate the test-retest reliability, these measures were performed on two separate occasions 7 days apart. The tests were carried out by 2 experienced testers and each tester measured the same subjects in the test and the re-test day to reduce inter-examiner errors.

Statistical analysis

Test-retest reliability was assessed by the two-way random effect model (absolute agreement definition), average measure ICC ($ICC_{2,2}$ according to Shrout & Fleiss, 1979).

Furthermore, the Bland and Altman method, which includes a scatter plot of the differences between test and retest against their mean, was also used to define the magnitude of disagreement between test and retest values (Bland & Altman, 1986). This method also includes the Limits of Agreement (LOA) (Bland & Altman, 1986), which represent the mean difference between tests and its 95% Confidence Interval (CI). To evaluate changes over time in an individual (e.g., the effect of clinical rehabilitation), the magnitude of the change has to exceed the inherent variability of the outcome. Within this context, the LOA can be used to assess a real change in an individual's performance (i.e., if the difference between two measurements is outside the LOA, there is a true change in performance).

The standard error of measurement (SEM) (Weir, 2005) and the 95% CI of ICC values were also calculated for all dependent variables. The use of the 95% CI shows how closely the measurements agree on different occasions, and the SEM indicates the precision of measurements.

All analyses were performed using the Statistical Package for Social Sciences (SPSS, version 16.0 for Windows; SPSS Inc., Chicago, IL), and the level of significance was set at 0.05.

RESULTS

The characteristics of the subjects are provided in Table 1.

Table 1. *Sample characteristics*

Age group	All	< 65	65-70	>70
N	45	18	13	14
Age (years)	66 (5.5)	60 (3.0)	67 (1.4)	72 (1.3)
Weight (Kg)	71.6 (9.8)	70.8 (6.9)	68.9 (13.2)	74.9 (8.6)
Height (cm)	155 (6)	155 (5)	155 (8)	154 (5)
BMI (Kg/m^2)	29.71 (3.69)	29.26 (3.03)	28.37 (4.50)	31.42 (3.10)
FES-I Score	23.1 (7.2)	24.3 (9.0)	21.7 (6.7)	22.8 (4.7)

BMI: body mass index; FES-I: Falls Efficacy Scale-International questionnaire.

** Values expressed as mean (SD).*

A summary of the study results obtained for the Fri and OSi is presented in Table 2. FRi showed a good ICC (.80) and a low percentage of variation of method error. The OSi showed a good and acceptable reliability measure by the ICC (.69) but a percentage of variation of method error near to 25%.

Table 2. *Reliability index of Biodex Balance System SD on physically active old people.*

	Mean Test1 (SD)	Mean Test2 (SD)	ICC	SEM	ME	CVme (%)	Absolute limits (95%)
FRi	1.44 (.46)	1.13 (.47)	.80	0.36	0.14	11.01	0.31 (-.24 to .85)
OSi	0.56 (.22)	0.50 (.19)	.69	0.19	0.14	26.68	0.05 (-.33 to .44)

FRi: Fall Risk index; OSi: Overall Stability index; SEM: Standard error of measurement;

ME: method error; CVme: Coefficient of variation of method error.

Figure 1 shows the differences between test and retest plotted against their mean for each subject with 95% CI and 95% LOA. The systematic errors (mean difference between test-retest) for analyzed test were nearly zero and the 95% limits of agreement narrow, indicating a good reliability of the measurement.

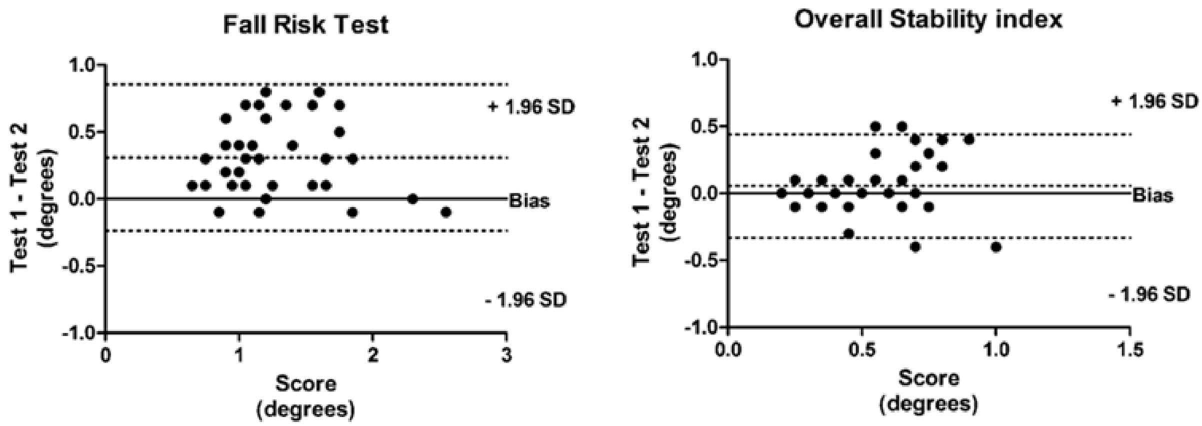

Figure 1. *Bland-Altman Plot of fall risk index and overall stability index scores in elderly people. The central dotted line represents the mean differences between the second trial (T2) and the first trial (T1); the upper and lower dotted lines represent the upper and lower 95% limits of agreement (mean differences ± 1.96 standard deviations of the differences), respectively.*

DISCUSSION AND CONCLUSIONS

The present study examined the test-retest reliability of the BBS in physically elderly. Biodex balance measures showed reliable and may be useful for measuring the risk of falls and monitoring programs for prevent falls in elderly.

To our knowledge, only two studies of reliability with BBS have been developed in elderly: the studies of Hinman et al. (2000) and Baldwin et al. (2004). The ICC obtained in static OSi test for Hinman study was of 0.79, slightly higher than our result (0.69). In the study of Baldwin for three visits, the reliability test was exactly the same to our results (0.69), and 0.76 for two visits. However, in the study of Hinman et al. (2000), the methodology employed in the balance test protocol was of 30 seconds and both test at the same time, in an interval of 30-60 seconds in the re-test trial. Moreover, Hinman developed the test wearing hard-soled shoes or soft-soled shoes while in our study the test was always without shoes. In our protocol, the total test time was 20 seconds and in different evaluation times (one week of distance), with a level of stability in the BBS of eight (the same protocol used in the study of Baldwin et al. (2004)). It has been stablished that the mentioned methodology of evaluation is the most operative and recommended by the scientific community. Furthermore, Hinman only analyzes the reliability by relative index like the I.C.C but not with absolute index such is recommended by recent studies (Moe-Nilssen, Nordin, & Lundin-Olsson, 2008). In the present study are shown various of the main absolute reliability index, mainly limits of agreements expressed by Bland-Alman plots (Bland & Altman, 1986). Bland-Altman method showed that systematic errors (mean difference between test-retest) for the balance test developed in this study with BBS were nearly zero and the 95% limits of agreement narrow, indicating a good reliability of the measurement (Figure 1).

Reliability estimates obtained in this study for the OSi measures (Table 2) was higher than the reported by Pincivero et al. (1995) and lower to the study of Cachupe et al., (2001) (0.84-0.95) in colleages subjects.

Respecting to the limits of agreement of Baldwin et al., (2004) for OSi values, its were more spread out (-0.67 to 1.14) than our limits of agreement (-0.33 to 0.44) as it is shown in Figure 1. The SEM in our study was also better compared with the previous study (Cachupe et al., 2001).

The main finding of this study was the high reliability of the FRi in this population. Due to this fact, this index could be used to measure changes in balance in physically active old people with an error of measurement of only 11%. Generalizability of the findings from this study is limited due to the small sample size employed. However, the estimated reliability observed for this two measures suggests that at least among elderly people, BBS measures of dynamic balance at a spring resistance in the level eight are reliable. Furthermore, this article may serve as a basis for the evaluation of balance in elderly for futures interventions programs (as could be the actually improving balance program developed by our team), aimed at correcting the deficits found in balance to reduce the incidence of falls in elderly. There is good evidence that appropriate exercise can improve balance and reduce falls in older people (Sturnieks et al., 2008). This study revealed that fall risk assessment in older people must be incorporated into the evaluation process of the physical functioning in the mentioned exercise programs.

In conclusion Biodex balance measures have been found to be reliable. Biodex Balance may be useful for the measurement of the risk of falls and for demonstrating the progress of old people in exercise programs oriented to the improve of balance for falls prevention.

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