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Increased Trunk Extension Endurance is Associated with Meaningful Improvement in Balance among Older Adults with Mobility Problems

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Abstract

Objective—To determine if trunk extension endurance changes with training are associated with clinically meaningful improvements in balance among mobility-limited older adults.

Design—Longitudinal data from a randomized clinical trial.

Setting—Outpatient rehabilitation research center.

Participants—Community-dwelling older adults (N=64; mean age 75.9 y) with mobility limitations as defined by a score of 4 to 10 on the Short Physical Performance Battery.

Interventions—16 weeks of progressive resistance training.

Main Outcome Measures—Outcomes were the Berg Balance Scale (BBS) and the Unipedal Stance Test (UST). Predictors included leg strength, leg power, trunk extension endurance and the product of heart rate and blood pressure (RPP) at the final stage of an exercise tolerance test. We performed an analysis of data from participants who completed 16 weeks of training using binary

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Portions of this data were presented in preliminary form at the Association of Academic Physiatrists Annual Meeting in April 2010 in Bonita Springs, FL, and at the American Academy of Physical Medicine and Rehabilitation Annual Assembly in November 2010 in Seattle, WA.

outcomes defined by a clinically meaningful change from baseline to completion of the intervention (CMC) (BBS= 4 units; UST= 5 seconds). The association of predictor variables with balance outcomes was examined separately and together in multivariate adjusted logistic regression models.

Results—Trunk extension endurance in seconds (1.04 [1.00– 1.09]) was independently associated with CMC on the BBS. Trunk extension endurance (1.02 [1.00– 1.03]) was independently associated with CMC on the UST. Other physical attributes were not associated with meaningful change in balance.

Conclusions—Improvements in trunk extension endurance were independently associated with clinically meaningful changes in balance in older adults. Leg strength, leg power, and RPP were not associated with CMC in balance. Poor trunk extension endurance may be a rehabilitative impairment worthy of further study as a modifiable factor linked to balance among older adults.

Keywords

Aged; Core; Impairments; Rehabilitation

Balance problems are associated with falls and fall related injuries among older adults.^{1–3} An important goal of falls research, therefore, is the identification of physical impairments that, when modified, are associated with improvements in balance (and thus a reduction in falls or falls related injuries).⁴ Extensive literature exists examining the effects of resistance training on balance in older adults. Nevertheless, few studies of exercise interventions for balance have examined associations between longitudinal changes in different physical attributes and improvements in balance.⁵ This is important, because the training of certain muscle groups and physical attributes may be effective in improving balance, while training of others may be ineffective.⁵

In a recent cross-sectional study, we reported significant associations between trunk muscle extension endurance and balance performance in older adults.⁶ Trunk muscle extension endurance was more strongly associated with balance measured by the Berg Balance Scale (BBS) than trunk muscle extension strength, trunk muscle flexion strength, trunk muscle flexion endurance, and leg strength. The greater importance of trunk extension endurance as compared to other trunk and limb muscle attributes is a worthwhile finding, because trunk extension endurance training and assessment can be easily performed with simple equipment already available in many gyms. Furthermore, neither trunk extension endurance nor other trunk impairments are targeted in recommended exercise programs for older adults, that emphasize limb muscle strengthening and improvement of aerobic capacity.⁷ Exercises to improve trunk extension endurance may be a feasible and efficacious component of rehabilitative programs to improve balance in older adults. However, no studies to date have examined associations between longitudinal changes in trunk attributes and changes in balance in older adults.

Recent reports have emphasized the importance of framing functional outcomes in terms of clinically meaningful change (CMC).^{8, 9} The advantage of assessing outcomes with CMCs over continuous measures is that they define outcomes in clinical terms, enhancing the translation of research findings into both clinical trials and practice, as well as avoiding emphasis on statistical differences that may not have clinical relevance.⁸ In the present study, we examined associations between changes with training in trunk extension endurance and clinically meaningful changes in balance in older adults participating in a 16-week intervention. The goal of this study was to investigate whether trunk extension endurance changes would be associated with balance improvement, independent of demographic factors and physical attributes. We hypothesized that improvements in trunk

extension endurance would be associated with improvements in balance, even after accounting for other physical attributes related to balance performance changes.

Methods

This study was a secondary analysis of data collected as part of a single-blinded randomized controlled trial evaluating the benefits of two forms of exercise among community-dwelling, mobility limited older adults¹⁰. Although the parent study was conducted at two outpatient rehabilitation centers in the greater Boston area (Hebrew SeniorLife, Roslindale, MA; Spaulding Outpatient Center, Cambridge MA), the trunk measures utilized in this study were collected as part of an investigation conducted only at the Spaulding Outpatient Center. Therefore, only individuals recruited at the Spaulding Outpatient Center were included in this investigation. The Institutional Review Board of Spaulding Rehabilitation Hospital approved the conduct of this study.

Recruitment and Screening Process

The details of the recruitment process are provided elsewhere¹⁰. In brief, participants were solicited via advertising in newspapers, direct mailings, and referrals from primary care providers. Telephone screenings identified 265 potentially eligible participants, who attended an initial screening assessment. Participants were community-dwelling older adults (age ≥ 65) who demonstrated some mobility limitations as defined by a Short Physical Performance Battery (SPPB) score between 4 and 10, but who were able to climb a flight of stairs independently or while using an assistive device (e.g., cane). Exclusion criteria were unstable acute or chronic disease, a score of less than 23 on the Folstein Mini-Mental State Examination¹¹, a neuromusculoskeletal impairment limiting participation in further performance testing, current participation in a resistance training program, or a submaximal treadmill exercise tolerance test demonstrating unstable cardiovascular disease.

After providing informed consent, participants underwent a comprehensive history and physical examination conducted by a physiatrist specializing in geriatric rehabilitation (JFB). After eliminating individuals for exclusion criteria ($n=99$) and accounting for those who chose not to participate ($n=28$), 138 participants were randomized to one of two exercise programs as part of the parent study. Trunk endurance testing was only performed at the Spaulding Outpatient Center and therefore only those participants ($N=70$) were eligible for inclusion in this analysis. Within the intervention study, one group participated in an exercise program known as InVEST (Increased Velocity Exercise Specific to Task) training. This mode of training provided a series of progressive resistance training exercises using a weighted vest. These exercises were designed to emphasize improvements in leg power and functional mobility¹⁰. The other exercise group conducted a strength training program for the upper and lower limbs using free weights as advocated by the National Institute on Aging.¹² Only those participants who completed the full 16 weeks of training in either training group were included in this secondary analysis ($n=64$). There were no material differences in sociodemographic or health characteristics between participants who completed the full 16 weeks of training and those who did not (data not shown).

Physical attributes

Four physical attributes were examined as predictors of balance performance: leg strength, leg power, aerobic capacity, and trunk extension endurance. These attributes were measured both at baseline and at completion of training. Baseline assessments were conducted within 2 weeks of the screening assessment. Follow-up assessments were conducted 16 weeks after the baseline assessment. All physical attribute measures were conducted by a research staff member blinded to group assignment. Testing of all physical attributes including trunk

extension endurance was well tolerated by the study participants, without the occurrence of associated injuries or adverse events during testing at the start and conclusion of the study period.

Lower limb strength and leg power were measured using computerized pneumatic strength training equipment (Keiser Sports Health Equipment Inc., Fresno, CA). Participants were tested on a seated double leg press machine. Seat positions were recorded and replicated at each testing session. Muscle strength was measured at each evaluation using the one repetition maximum (1RM), and leg power was measured at 70% 1RM, as previously described⁴. Reliability for strength and power testing using these methods is excellent (1RM ICC=.97; power ICC= .85).¹³

The RPP is the product of heart rate and systolic blood pressure (RPP). We performed a treadmill exercise tolerance test (ETT) on all participants. We did not perform a direct measurement of oxygen consumption during ETT testing and therefore changes in RPP served as a surrogate of changes in aerobic capacity. The RPP would be expected to decrease, at a given power output or exercise intensity, with improved cardiovascular conditioning.

To measure trunk extension endurance, each subject lay prone on a specialized apparatus that permitted support of the subject's lower body at a fixed position 45 degrees from horizontal, and support of subject's torso in the horizontal position, with the subject's trunk flexed. At rest, participants were able to rest their arms and upper body on the torso portion of the table, with feet anchored by a foot plate. During testing, participants extended their trunk to a spine neutral position while keeping their arms folded across their chest, maintaining their head and trunk position in line with the lower body. In this way when viewed from the side, the subject's head, trunk and legs were in a straight line positioned 45 degrees from vertical. Participants were asked to maintain this position, unsupported, for as long as possible. The test was terminated when the subject could no longer maintain the unsupported position, and this time was recorded in seconds. This method of testing has been extensively described previously, and was found to have excellent reliability (ICC=.88-.91).⁶

Outcome measures

Balance was measured using the Berg Balance Scale (BBS) and the Unipedal Stance Time (UST). All outcome measures were conducted by a research staff member blinded to group assignment. The BBS has demonstrated reliability and validity as a measure of dynamic balance, and is perhaps the most well-established balance measurement scale in the literature.¹⁴⁻¹⁶ It is also recognized as a more general physical performance measure being predictive of the onset of ADL difficulty.¹⁷ The BBS includes 14 tasks that are scored on a scale of 0 (unable to perform) to 4 (normal performance), with a maximum score of 56. The BBS includes normal functional activities such as sitting, standing, and leaning over.¹ The UST is a reliable and valid test of balance while standing that is a predictor of falls in older adults.^{2, 3, 18} The UST measures the length of time that a person is able to maintain balance while standing on one leg up to a maximum of 30 seconds. Stance times are measured to the nearest 0.01 second using a stopwatch. Unipedal stance is a component of the BBS, but on its own represents a simple, clinically feasible balance test.

For both the BBS and the UST, we identified CMCs, based upon a review of the literature and used these increments of change as a binary outcome. We defined a CMC for our primary outcome of the BBS as a change of 4 points. This threshold has previously been identified to produce 95% confidence that a true change has occurred when baseline scores are between 45-56, as in our study sample.¹⁹ Although CMCs have not yet been

empirically defined for the UST, for the purposes of this study, we defined a CMC for the UST as 5 seconds. We defined a CMC in UST based on the work of Vellas et al, in which a threshold of 5 seconds or lower was associated with falls among frail elders³, and a recent report by Richardson et al, that identified 10 seconds as another important threshold of performance.²⁰ Considering these prior reports, our prior clinical experience using this measure and the distribution of our data, 5 seconds was determined to represent a CMC.

Adjustment variables

Baseline adjustment variables considered for inclusion in our models were age, gender, body mass index (BMI) and number of active medical conditions. The examining physician recorded the total number of active medical conditions for each subject at the baseline evaluation. Active medical conditions were defined as: (1) any condition for which a participant was currently receiving treatment, or (2) a condition requiring medical treatment within the past year. Medical records were requested from participants' primary care physicians to corroborate these findings. In addition, in order to account for changes in participant weight over the study period, we examined changes between the baseline and 16-week assessment. Weight was measured in kilograms using a calibrated scale.

Statistical Analysis

We characterized the sample using means and standard deviations for continuous variables, and frequencies and proportions for categorical variables. We calculated change scores for the balance and attribute measures and body weight between the baseline and 16-week assessments. We examined the distributions of the baseline variables, and change scores for the attribute measures and body weight, using descriptive statistics and graphic plots. Based on this characterization of the variables, RPP changes were divided into quintiles based on the number of participants in order to make the odd ratios more interpretable. Cut points for the quintiles were RPP values of 576, -632, -1890 and -3620. All physical attribute measures were treated as continuous variables. Lower limb strength and power were normalized for body weight in kilograms. Simple correlations were determined between the attribute measures using Spearman correlation coefficients. Recognizing our limited sample size, we utilized an analytic approach to include the covariates and change scores that were most strongly associated with the outcomes of interest, or were felt *a priori* to have clinical importance, in parsimonious multivariate models. First, we examined associations between each predictor variable with each balance outcome measure in separate logistic regression models that included baseline health and demographic variables described above and the change score for the attribute measure. We then created two multivariate logistic regression models, one for each balance outcome (CMC in BBS and UST) that included all the attributes whose coefficients had a p-value $\leq .25$ in the separate models. Finally, each multivariate model was evaluated controlling for baseline values of the outcome. If statistically relevant, the baseline value was retained in the final model. An alpha level of .05 was used to determine statistical significance. In order to account for the weak magnitude correlation between leg strength and trunk extension endurance, we performed a secondary analysis examining the effect of adding the predictor of leg strength to both final multivariate models for the outcomes of BBS and UST. In addition, we performed secondary analyses excluding participants who were already within one CMC of the maximum possible score for the BBS or the UST, in order to account for those participants who may have been limited by a 'ceiling effect' for balance improvement. All analyses were performed using SAS software, version 9.2 (SAS Institute., Cary, NC).

Results

Participant characteristics, trunk and limb measures, and physical performance measures for the study sample are presented in Table 1. The study sample was predominantly female (67.2%). Participants had a mean age of 75.9 ± 7.3 years, BMI of 27.6 ± 5.1 , and 6.1 ± 2.6 active medical conditions. Reflecting the random assignment, there were no significant differences between the two training regimen groups for any baseline characteristic or change scores.

In examining correlations between changes in physical attributes at the beginning and end of the study, a significant correlation was found only for the association of trunk extension endurance change with leg strength change ($r=0.32$; $p=0.02$). All other correlations were of a weak magnitude.

Trunk extension endurance change (in seconds) showed an association with meaningful improvement in BBS of borderline significance (β [SE] = 0.009 [0.005]; $p=.06$). Also, baseline BBS score was significantly and negatively associated with improvements in BBS (β [SE] = -0.16 [0.06]; $p<.01$). That is, individuals with better balance had less improvement in BBS scores over the 16 weeks of follow-up. Other predictor variables, including baseline values for physical attributes, were not significantly associated with the BBS outcome. Table 2 presents the results of our final multivariate logistic regression model for the outcome of BBS. When age, gender, baseline BBS, and trunk extension endurance change were included in a multivariate model, trunk extension endurance change was significantly and independently associated with a clinically meaningful change on the BBS. An increase in trunk extension endurance of one second was associated with 1.04 times the odds of clinical improvement in balance. Greater balance ability at baseline (higher BBS) was associated with less balance improvement. Additional analyses controlling for mode of training did not reveal an association between training group and balance, and did not alter the findings (data not shown). The final model demonstrated a c -statistic of 0.91, indicating an excellent fit of the model for predicting a CMC on the BBS, based on the included variables.

Trunk extension endurance change (in seconds) with training was significantly associated with meaningful improvement in UST (β [SE] = 0.017 [0.007]; $p=.01$). Leg power change (W/kg) showed a trend towards an association with UST (β [SE] = -0.22 [0.15]; $p=.14$). Other predictor variables, including baseline values for physical attributes, were not significantly associated with the outcome. Table 2 presents the results of our final multivariate logistic regression model for the outcome of UST. When age, gender, leg power change, and trunk extension endurance change were included in a multivariate model, only trunk extension endurance change was significantly and independently associated with a clinically meaningful change on the UST. An increase in trunk extension endurance of one second was associated with 1.02 times the odds of clinical improvement in balance. Additional analyses controlling for mode of training did not reveal any association between training group and balance, and did not alter the findings (data not shown). The final model demonstrated a c -statistic of 0.75, indicating a moderate fit of the model for predicting a CMC on the UST, based on the included variables.

In secondary analyses to account for weak correlations between leg strength and trunk extension endurance, leg strength was not a statistically significant predictor, and did not produce any substantive improvement in model fit, for either balance outcome (data not shown). Furthermore, exclusion of individuals who were within one CMC of the maximum possible score for either balance outcome did not materially alter our findings from the primary analyses.

Discussion

Improvements in trunk extension endurance were independently associated with clinically meaningful changes in balance in this study of older adults. A one-second increase in trunk extension endurance was associated with a >4% increase in the odds of meaningful change on the BBS. The mean improvement in trunk extension endurance over the 16-week duration of this study was 35 seconds, which corresponds to more than a doubling of the odds of meaningful balance improvement. Similar significant associations were found between change in trunk extension endurance and UST, although these were of a smaller magnitude. This suggests that trunk extension endurance may have relatively greater importance to a functional balance measure than a measure of balance while standing. Similar improvements in balance were noted irrespective of mode of training. In contrast, improvements in leg strength, leg power, and aerobic capacity were not associated with meaningful changes in balance.

No prior studies have examined relationships between longitudinal changes in trunk muscle attributes and balance in older adults after training. Suri et al. demonstrated cross-sectional associations between trunk extension endurance and balance, exceeding that of trunk muscle extension strength, trunk muscle flexion strength, trunk muscle flexion endurance, and lower limb strength. The current study demonstrates further that, when trunk muscle endurance improves with training, so does balance performance. The maintenance of balance requires neuromuscular control involving minute changes that occur continuously in order to maintain the center of gravity over the base of support²¹. Trunk extension endurance may be especially important in older adults due to the changes of kyphosis which are common with age²², or due to other physiologic changes which may predispose to leaning forward, thus requiring involvement of the trunk extensors to maintain upright posture²³. Although kyphosis was not measured in the current study, future investigations of the mechanisms by which trunk extension endurance is associated with balance may yield important information, which can lead to improved interventions targeted at balance.

Our observation that changes in leg strength were not associated with balance is consistent with prior studies which have failed to find balance improvements after lower extremity resistance training.^{24–26} On the other hand, the lack of an association with leg strength may be explained by our small sample size. Velocity of movement is a separate and important factor in balance, and a determinant of muscle power that is distinct from strength. Our findings that changes in muscle power were not associated with balance must be viewed in the context of some longitudinal studies of muscle power training that have shown improvements in balance.^{25, 27} The lack of an association with leg power seen in our study may also be attributable to our small sample size, or to the fact that lower extremity attributes were assessed at proximal lower limb joints in our study, and did not include distal sites such as the ankle that may be vital to balance.²⁸ Though we recognize that changes in strength or power might be significant if we had been able to evaluate the whole InVEST cohort, the primary purpose of this investigation was to evaluate the relevance of trunk extension endurance and not leg strength or power.

Aerobic capacity, as reflected by the RPP, was not associated with balance improvement in our study. Some authors have suggested that aerobic training through walking may consume time which could be better spent on exercises more likely to yield improvements in balance²⁹. This contention may, in part, be supported by our findings. Regardless, the current study suggests that exercises targeted to improve trunk extension endurance may have potential utility. Future studies of balance and fall prevention should consider the full spectrum of physical attributes that when modified lead to CMC. This can allow us to

develop more efficient and efficacious rehabilitative programs that are parsimonious in the burden they place upon patients.

Study limitations

Some limitations pertain to this study. First, we examined participants from one clinical site in a randomized trial comparing two exercise interventions. Individuals in both groups performed exercises that were similar to the balance tasks that comprise the BBS. The observed changes in our outcome measures may be in part a consequence of task-specific training and not necessarily due to the four physical attributes examined here. Nevertheless, these results provide valuable data that will allow further examination of the relationship between trunk extension endurance and balance. Second, our small sample size precluded the inclusion of multiple adjustment variables in the same statistical models, and prevented us from categorizing predictor attributes in a way that may have been more clinically meaningful. The limited sample size may also have been inadequate to detect some associations, and therefore may explain some of the null findings noted in the study. Future studies may wish to identify clinically meaningful cut points for TEE with reference to important clinical outcomes. Third, we did not measure changes in muscle attributes at the ankle, a site which may be important to balance. Lastly, this was not a population based sample but a rather homogenous cohort of mobility limited volunteers for a randomized trial. We cannot generalize our findings to all mobility-limited older adults living in the community. Nonetheless, our analyses allow us to observe patterns of changes in physical attributes and balance performance that would not be likely to occur in an aged cohort without some form of intervention.

The current study is the first to examine associations between changes in trunk muscle attributes and balance in older adults. Our finding that improvement in trunk extension endurance was independently associated with clinically meaningful changes in balance suggests that poor trunk extension endurance may be a rehabilitative impairment worthy of further examination. Further research is needed to examine how trunk extension endurance can be most effectively trained, and whether this training leads to balance improvements in experimental settings such as randomized trials.

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LIST OF ABBREVIATIONS

BBS	Berg Balance Scale
CMC	clinically meaningful change
1RM	one repetition maximum
ICC	intraclass correlation coefficient
RPP	rate pressure product (product of heart rate and systolic blood pressure)
ETT	exercise tolerance test
ADL	activity of daily living

UST	Unipedal Stance Time
BMI	body mass index
W	watt
kg	kilogram
NA	not applicable

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Table 1
 Characteristics of Participants Completing 16 weeks of Training in the InVEST Study (n=64)

Characteristic	All participants			InVEST Group			NIA Group		
	Mean (S.D.) or Frequency (%)	Range	Mean (S.D.) or Frequency (%)	Range	Mean (S.D.) or Frequency (%)	Range	Mean (S.D.) or Frequency (%)	Range	
Female Gender	43 (67.2 %)	NA	22 (68.8%)	NA	21 (65.6%)	NA	21 (65.6%)	NA	
Age (years)	75.7 (7.1)	65–94	76.0 (7.2)	65.0–94.0	75.3 (7.0)	65.0–94.0	75.3 (7.0)	65.0–92.0	
BMI (ht/kg ²)	27.6 (5.1)	19.8–41.5	27.9 (5.4)	20.6–41.5	27.3 (4.8)	20.6–41.5	27.3 (4.8)	19.8–38.8	
Number of Active Medical Conditions	6.1 (2.6)	2–14	6.5 (2.3)	2–12	5.7 (2.8)	2–12	5.7 (2.8)	2–14	
Baseline BBS (0–28)	49.1 (5.0)	36–56	49.2 (4.8)	36–56	49.1 (5.3)	36–56	49.1 (5.3)	37–56	
CMC in BBS	17 (26.6%)	NA	7 (21.9%)	NA	10 (31.3%)	NA	10 (31.3%)	NA	
Baseline UST (sec.)	11.8 (10.8)	0.83–30.0	11.0 (9.5)	1.12–30.0	12.5 (12.1)	1.12–30.0	12.5 (12.1)	0.83–30.0	
CMC in UST*	23 (44.2%)	NA	11 (44.0%)	NA	12 (44.4%)	NA	12 (44.4%)	NA	
Trunk Extension Endurance (sec.)	87.6 (63.6)	3.0–240.0	92.8 (74.6)	3.0–240.0	75.0 (56.1)	3.0–240.0	75.0 (56.1)	3.7–240.0	
Δ Trunk Extension Endurance (sec.)	34.6 (68.1)	–78.5 – +219.2	34.6 (63.2)	–57.0 – +219.2	34.5 (73.7)	–57.0 – +219.2	34.5 (73.7)	–78.5 – +192.7	
Leg Press Strength (Newtons/kg)	26.0 (7.6)	11.5–44.0	25.1 (8.5)	11.5–44.0	25.8 (6.5)	11.5–44.0	25.8 (6.5)	12.0–36.5	
Δ Leg Press Strength (Newtons/kg)	4.5 (5.8)	–14.3 – +22.2	4.2 (5.5)	–14.3 – +15.1	4.8 (6.1)	–14.3 – +15.1	4.8 (6.1)	–6.3 – +22.2	
Leg Power (W/kg)	8.6 (3.4)	2.4–16.4	8.2 (3.2)	3.8–15.9	8.9 (3.6)	3.8–15.9	8.9 (3.6)	2.4–16.4	
Δ Leg Power (W/kg)	0.24 (2.2)	–8.7 – +5.5	0.48 (1.4)	–2.5 – +3.3	0.02 (2.8)	–2.5 – +3.3	0.02 (2.8)	–8.7 – +5.5	
Rate-Pressure Product (HR* SBP)	21415 (5103)	10304–32340	20396 (5584)	10304–32340	22434 (4427)	10304–32340	22434 (4427)	12600–29294	
Δ Rate-Pressure Product (HR* SBP)	–1748 (3404)	–12838 – +7172	–2123 (3464)	–12838 – +4998	–1411 (3374)	–12838 – +4998	–1411 (3374)	–9210 – +7172	

Note: Group comparisons all with $p > 0.05$

BMI: Body Mass Index

BBS: Berg Balance Scale

CMC: Clinically Meaningful Change

UST: Unipedal Stance Time

Δ: Change

NA: not applicable

* 12 participants were missing values for either baseline or follow-up assessment of Unipedal Stance Time

Table 2

Multivariate Logistic Regression Analysis of Associations between Predictor Variables and Balance Outcomes

Clinically Meaningful Change in Berg Balance Scale			
Variable	Crude OR (95% CI) [*]	Adjusted OR (95% CI) [*]	c statistic
Age	0.99 (0.91–1.07)	0.82 (0.64–1.05)	0.91
Female gender	0.86 (0.27–2.8)	3.3 (0.21–52.6)	
Baseline BBS	0.85 (0.76–0.95)	0.52 (0.29–0.93)	
Δ Trunk extension Endurance (sec)	1.01 (1.00–1.02)	1.04 (1.00–1.09)	
Clinically Meaningful Change in Unipedal Stance Time			
Variable	Crude OR (95% CI) [*]	Adjusted OR (95% CI) [*]	c statistic
Age	0.96 (0.87–1.05)	0.98 (0.87–1.10)	0.75
Female gender	0.50 (0.15–1.6)	0.48 (0.10–2.36)	
Δ Leg power (W/kg)	0.80 (0.60–1.08)	0.75 (0.52–1.08)	
Δ Trunk extension Endurance (sec)	1.01 (1.00–1.02)	1.02 (1.00–1.03)	

OR: Odds Ratio

Δ: Change

Sec: seconds

W: Watts

kg: kilogram

* Crude ORs from separate univariate logistic regression models including a single predictor variable and the balance outcome; adjusted ORs from a multivariate logistic regression model including all four predictor variables simultaneously.