Reliability, validity, and sensitivity to change of Turkish Activities-specific Balance Confidence Scale in patients with unilateral peripheral vestibular disease

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The aim of this study is to evaluate the internal consistency, test–retest reliability, construct validity, and sensitivity to change of the Activities-specific Balance Confidence Scale (ABC) in people with peripheral vestibular disorder. Thirty-three patients with unilateral peripheral vestibular disease were included in the study. Patients were also evaluated with the Visual Analog Scale, the Romberg test (eyes open, closed), the tandem Romberg test (eyes open, closed), standing on foam (eyes open, closed), static posturography, Five Times Sit to Stand test, Timed Up to Go test, gait speed, Dynamic Gait Index, Functional Gait Assessment, and Dizziness Handicap Inventory. To assess sensitivity to change, 27 patients were involved in a 4-week customized vestibular rehabilitation program and then reassessed at the end of 4 weeks. The individual item intraclass correlation coefficient ranged from 0.67 to 0.92 and Crohnbach α ranged from 0.67 to 0.93. The Crohnbach α value for whole scale was determined as 0.95. Although the Dizziness Handicap Inventory showed significant correlation with the Turkish ABC Scale ($r=0.51-0.54$, $P<0.05$), no such a correlation was observed between the Turkish ABC Scale and the other parameters assessed ($P>0.05$). Both Turkish ABC Scale and the other parameters assessed showed significant improvement after 4-week customized exercise program ($P<0.05$). The Turkish ABC Scale is a culturally relevant, reliable, and sensitive to change tool for measuring self-perceived balance confidence in unilateral peripheral vestibular disease.

Ziel der vorliegenden Studie ist die Evaluierung der internen Konsistenz, der Test-Retest-Reliabilität, der Konstruktvalidität und der Änderungssensitivität der aktivitätsspezifischen Balance Confidence-Skala (ABC) bei Patienten mit peripher-vestibulärer Störung. In die Studie wurden insgesamt 33 Patienten mit unilateraler peripher-vestibulärer Störung eingeschlossen. Die Patienten wurden auch anhand der folgenden Tests evaluiert: visuelle Analogskala, Romberg-Test (Augen offen/geschlossen), Tandem-Romberg-Test (Augen offen/geschlossen), Standversuche auf Schaumstoff (Augen offen/geschlossen), statische Posturographie, Five Times Sit to Stand Test, Timed Up to Go Test (Zeitmessung bei Aufstehen und Gehen), Ganggeschwindigkeit, Dynamic Gait Index, Functional Gait Assessment (FGA) und Dizziness Handicap Inventory (DHI). Zur Beurteilung der Änderungssensitivität wurden 27 Patienten in ein 4-wöchiges maßgeschneidertes vestibuläres Reha-Programm eingeschlossen und nach Abschluss der vier Wochen erneut beurteilt. Der Intraclass-Korrelationskoeffizient (ICC) für einzelne Aspekte lag bei 0.67 bis 0.92, Cronbach α bei 0.67 bis 0.93. Der Cronbach α-Wert für die gesamte Skala wurde mit 0.95 ermittelt. Obwohl der Dizziness Handicap Inventory keine signifikante Korrelation mit der türkischen ABC-Skala aufwies ($r=0.51–0.54$, $P<0.05$), wurde keine derartige Korrelation zwischen der türkischen ABC-Skala und den anderen Beurteilungsparametern beobachtet ($P>0.05$). Sowohl die türkische ABC-Skala und die anderen beurteilten Parameter wiesen nach einer 4-wöchigen maßgeschneiderten Bewegungstherapie eine signifikante Verbesserung auf ($P<0.05$). Die türkische ABC-Skala ist ein kulturell relevantes, zuverlässiges und änderungssensitives Instrument zur Erfassung der selbstempfundenen Balancefähigkeit bei einer unilateralen peripher-vestibulären Störung.

El objetivo de este estudio es evaluar la consistencia interna, la fiabilidad prueba-reprueba, la validez conceptual y la sensibilidad a los cambios según la Escala de Confianza del Equilibrio Específica de Actividades (CEEA) en personas con trastornos vestibulares periféricos. En el estudio se incluyeron 33 pacientes con enfermedad vestibular periférica unilateral. Los pacientes se evaluaron además mediante la Escala Visual Análoga, la prueba de Romberg (ojos abiertos/cerrados), la prueba de Romberg en tándem (ojos abiertos/cerrados), bipedestación sobre goma espuma (ojos abiertos/cerrados), posturografía estática, la prueba de sentarse y pararse cinco veces, la prueba del tiempo que toma levantarse y empezar a andar (*Timed Up To Go*, TUG), la velocidad de la marcha, el Índice Dinámico de la Marcha, la Valoración Funcional de la Marcha y el Inventario de Discapacidad por Mareo. Para evaluar la sensibilidad al cambio, 27 pacientes participaron en un programa personalizado de rehabilitación vestibular de 4 semanas de duración, a quienes se reevaluó al final del período de 4 semanas. El coeficiente de correlación intraclase entre las características evaluadas fue de entre 0.67 y 0.92, y el α de Cronbach fue de entre 0.67 y 0.93. El valor del α de Cronbach para toda la escala fue de 0.95. Aunque se observó una correlación importante entre el Inventario de Discapacidad por Mareo y la versión turca de

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la escala CEEA ($r=0.51-0.54$, $P<0.05$), no se observó tal correlación entre la versión turca de la escala CEEA y otros parámetros evaluados ($P<0.05$). Tanto la versión turca de la escala CEEA como otros parámetros evaluados mostraron mejorías importantes tras el programa de ejercicio personalizado de 4 semanas de duración ($P<0.05$). La versión turca de la escala CEEA es una herramienta con relevancia cultural, fiable y sensible a los cambios útil para medir la confianza percibida en relación con el equilibrio en pacientes con enfermedad vestibular periférica unilateral.

Cette étude avait pour objectifd'évaluer la cohérence interne, la répétabilité des tests, la fiabilité du concept et la sensibilité au changement de l'échelle de confiance de l'équilibre (Balance Confidence Scale-ABC) associée aux activités chez les individus souffrant de troubles vestibulaires périphériques. Trente-trois patients atteints de maladie vestibulaire périphérique unilatérale ont été inclus dans l'étude. Les patients ont également été évalués par le biais de l'échelle analogique visuelle, du test de Romberg (yeux ouverts ou fermés), du test Romberg en tandem (yeux ouverts ou fermés), debout sur de la mousse (yeux ouverts ou fermés), de la posturographie statique, du test « Five Times Sit to Stand ', du test « Timed Up to Go ', de la vitesse de marche, de l'indice de marche dynamique (Dynamic Gait Index), de l'évaluation de marche fonctionnelle (Functional Assessment Gait) et de l'inventaire de handicap dû à l'étourdissement (Dizziness Handicap Inventory). Pour évaluer la sensibilité au changement, 27 patients ont participé à un programme de rééducation vestibulaire personnalisé de quatre semaines, puis ont été réévalués à la fin des 4 semaines. Les coefficients de corrélation interclasses des éléments individuels s'étendaient de 0.67 à 0.92 et l'α de Crohnbach variait de 0.67 à 0.93. L'α de Crohnbach pour l'ensemble de l'échelle a été déterminé comme étant 0.95. Bien que l'inventaire de handicap dû à l'étourdissement ait affiché une corrélation significative avec l'échelle ABC turque ($r=0.51$-0.54, $P<0.05$), aucune corrélation n'a été observée entre l'échelle ABC turque et les autres paramètres évalués ($P>0.05$). L'échelle ABC turque et les autres paramètres évalués ont affiché des améliorations significatives après le programme de 4 semaines d'exercices personnalisés ($P<0.05$). L'échelle ABC turque constitue un outil culturellement pertinent, fiable et sensible pour mesurer la confiance perçue dans l'équilibre chez les patients atteints de maladie vestibulaire périphérique unilatérale. *International Journal of Rehabilitation Research* **33:12–18 © 2010 Wolters Kluwer Health | Lippincott Williams & Wilkins.**

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Introduction

Peripheral vestibular disease is known to induce balance problems and increase the risk of falls (Herdman *et al.*, 2000; Whitney *et al.*, 2000). Falls in people with vestibular disorders may lead to significant consequences (Pothula *et al.*, 2004). Fear of falling can become incapacitating; people who perceive themselves at risk of falling are prone to inactivity which itself can lead to problems of debilitation, increased handicap, and disability (Legters, 2002). Thus, prompt diagnosis and treatment is essential to relieve the symptoms and reduce the risk of falls in patients with vestibular disorder. Studies have shown that balance and disability is improved by vestibular rehabilitation (Horak *et al.*, 1992; Hillier and Hollohan, 2007). Several tools, such as the Berg Balance Scale, the Four Square Step test, the Five Times Sit To Stand (FTSTS) test, the Timed Up to Go (TUG) test, and the Dynamic Gait Index (DGI), can be used to assess falls in patients with peripheral vestibular disease (Whitney *et al.*, 2004a; Macias *et al.*, 2005; Meretta *et al.*, 2006; Whitney *et al.*, 2007). The Activities-specific Balance Confidence (ABC) Scale is an assessment tool for peripheral vestibular disease that was developed to assess subjective balance confidence in community-dwelling elderly who are usually ambulatory (Powell and Myers, 1995). The reliability and validity of the ABC Scale in Germany, China, and Britain have been assessed by several studies (Parry *et al.*, 2001; Mak *et al.*, 2007; Schott, 2008), but had not yet been assessed in Turkey. Therefore, the aim of our study was to develop a Turkish version of the ABC Scale and assess its reliability, validity, and sensitivity to change in patients with unilateral peripheral vestibular dysfunction.

Materials and methods

All patients were reviewed by a board of consulting physicians from Ear, Nose and Throat, Neurology and Physical Medicine, and Rehabilitation Departments, known as the Dizziness Council, which assembled once a week to evaluate every patient with vertigo, dizziness, and balance problems. Patients who were eligible for the study and were also appropriate for vestibular rehabilitation were recruited for the study. Among these, patients who were diagnosed as having peripheral vestibular dys-

function through neurological and otological examinations and vestibular function tests (electronystagmography, bithermal caloric test, ocular motor testing, and positional testing) performed by a neuro-otologist or neurologist between January 2007 and July 2008 were included in the study.

Patients with any problem that could interfere with rehabilitation (such as ambulatory problems or restricted cervical movement which was defined as flexion, extension, lateral flexion, or rotation of less than 30°; a disorder affecting visual and somatosensorial system; or cognitive, orthopedic or neurological disorders) were excluded from the study. Patients with fluctuating and intermittent vertigo, benign paroxysmal positional vertigo, or symptoms lasting less than 2 months were also excluded. All vestibular suppressing medications taken by patients were stopped 1 week before the start of the study.

The ABC Scale was translated into Turkish by three Turkish doctors (one each from Physical Therapy and Rehabilitation, Ear Nose Throat, and Neurology Departments) who were proficient in English. The translation aimed to best reflect the meaning of English items. The Turkish ABC Scale was then separately translated from Turkish back into English by two official linguists (one a native English speaker who also speaks Turkish and one a teacher of English literature who has lived in England for 15 years and had a very good command of English) who were uninformed about the original version. Finally, they gathered to discuss and decide for the translations. The final version was compared with the original English version and they appeared to be identical. The Turkish version was delivered to 10 elderly patients. They were asked whether they could understand all items of the Turkish ABC Scale. None of the patients in this initial group reported a problem with any item of the ABC Scale.

Initially, 45 patients completed the ABC Scale. Duration of disease, concomitant diseases, migraines, social status, educational level, hearing capacity, use of spectacles, and falls within last 6 months were recorded either by face-to-face interview or from patient charts. These patients were also evaluated by the Visual Analog Scale (VAS) for imbalance, the Romberg test (eyes open, closed), the tandem Romberg test (eyes open, closed), standing on foam (eyes open, closed), FTSTS test, TUG test, gait speed, DGI, Functional Gait Assessment (FGA), Dizziness Handicap Inventory (DHI), and static posturography (Tetrax Interactive Balance System, Tetrax, Ramat Gan, and Sunlight Medical, Tel-Aviv, Israel).

Twelve of the 45 patients did not continue in the study owing to either transportation problems or loss of interest. Therefore, 1 week after the first assessment, the ABC Scale was given to 33 patients to check for test–retest reliability. The one-week interval was chosen to minimize the effects of time on memory and due the possibility of substantial changes in vestibular condition, which could interfere with the results of the study.

A 4-week customized vestibular rehabilitation program was then administered to participants to evaluate responsiveness (sensitivity to change). Six of the 33 patients were excluded, as they could not complete the rehabilitation program. The ABC questionnaire was given to 27 patients once they completed the rehabilitation program and the other assessments that were performed at the first visit [VAS for imbalance, Romberg (eyes open, closed), tandem Romberg (eyes open, closed), standing on a foam (eyes open, closed), FTSTS test, TUG test, gait speed, DGI, FGA, DHI and static posturography] were repeated. Methods used for patient evaluation are described below.

Activities-specific Balance Confidence Scale

The ABC comprises 16 questions that ask people to rate how confident they are in maintaining their balance while performing specific tasks (Powell and Myers, 1995). Scores range from 0 to 100, with 100 as the best score.

Visual Analog Scale

A 10 cm VAS was used to assess the severity of imbalance. A vertically oriented 10 cm line was used for VAS, where 'no imbalance' corresponds to the bottom of the line and 'the worst imbalance that they could imagine' corresponds to the top of the line.

The Romberg test

Patients stood with feet close to each other for 30 s, first with eyes open and then with eyes closed. The time in seconds was noted (Ringsberg *et al.*, 1998)

Tandem Romberg test

Participants stood with one foot just in front of the other (heel to toe) for 30 s, first with eyes open and then with eyes closed. The time in seconds was noted.

Standing on foam

Participants were asked to stand on a 12 cm thick medium density foam pad measuring 45 × 45 cm (NeuroCom International Inc., Clackamas, Oregon USA), first with eyes open and then with eyes closed. The time in seconds was noted.

Static posturography

Postural control was measured using the Tetrax Interactive Balance System (Tetrax, Ramat Gan, and Sunlight Medical). This method of posturography assessment uses vertical pressure fluctuations on four independent force plates while standing in an upright position on either soft

(foam rubber) or solid (hard floor) support. There is one force place beneath each heel and forefoot of the participant. Intensity of sway is measured by Fourier transformation across a spectrum of sway frequencies ranging from 0.01 to 3.00 Hz. Standard examination protocol includes standing for 32 s in each of the following eight positions: (i) head straight, eyes open, support solid; (ii) head straight, eyes closed, support solid; (iii) head straight, eyes open, support soft; (iv) head straight, eyes closed, support soft; (v) head turned to the right, eyes closed, support solid; (vi) head turned to the left, eyes closed, support solid; (vii) head up, eyes closed, support solid; and (viii) head down, eyes closed, support solid. Tetrax evaluates the eight positions and calculates a value called the falling index. The falling index is expressed as a numeric value between 0 and 100, determined by stability of patient, Fourier conversion, and synchronization results. '0' denotes no risk of fall whereas '100' denotes a high risk of fall (Kohen-Raz, 1991; Turner, 1998).

Five Times Sit To Stand test

This test was performed by moving five times from a sitting position on a 43 cm high chair to a standing position as quickly as possible with arms folded. The time in seconds was noted (Lord *et al.*, 2002; Whitney *et al.*, 2004b).

Timed Up To Go test

Patients were asked to stand from a chair with armrest, walk for 3 m, and return to the sitting position at a comfortable pace. The time in seconds was noted (Whitney *et al.*, 2004a).

Gait speed test

Patients were asked to walk at their normal speed on a 6 m long pathway. The time in seconds was noted.

Dynamic Gait Index

The DGI consists of eight walking items including walking on level surfaces, with a quick pivot turn, at different speeds, with head movements (pitch and yaw), over and around objects, and up and down steps (Shumway-Cook and Wollacott, 1995; Wrisley *et al.*, 2003). Each item was scored on an ordinal scale (range 0–3) based on established descriptors. The maximum total score is 24.

Functional Gait Assessment

The FGA is a 10 item gait test that comprises seven of the eight items from the original DGI and three additional items, including 'gait with narrow base of support', 'ambulating backward', and 'gait with eyes closed' (Wrisley *et al.*, 2004).

Dizziness Handicap Inventory

The DHI is a multidimensional self-assessment scale that quantifies the level of disability and handicap in three subscales: physical, emotional, and functional. It is possible to use both the total score and the scores of the three subscales separately. Scores range from 0 to 100, where a score of 100 indicates a high level of disability and handicap from symptoms of dizziness (Jacobson and Newman, 1990; Whitney *et al.*, 2004a).

Exercise program

An individualized exercise program was developed by a physical medicine and rehabilitation specialist considering the specific history, physical examination, and diagnostic tests of the patients. This program consisted of training and exercise components. Functions of the balance system, causes of dizziness, and rationale and contraindications for performing the exercises were explained during the training component. Patients were actively involved in adapting the exercise program to their symptoms, capabilities, and lifestyle. The exercises were personalized by the physical medicine and rehabilitation specialist according to their symptoms and the functional disability of the patient. The treatments included one or more of the following elements: balance and gait training, activities to promote the use of varied sensory inputs for maintaining balance (especially somatosensation), and activities to improve vestibular adaptation for those with remaining vestibular function. Patients with little to no vestibular function were taught to substitute vision and somatosensation for their lost vestibular function. During the training period in the hospital, compliance was monitored by a physician. Home exercises were monitored with a chart that was completed every day by the patient. Study was approved by the local ethics committee of our institution and informed consent forms were obtained from all of the patients who participated.

Statistical analysis

Data were entered in the Statistical Package for the Social Sciences (SPSS) package, Version 16.0 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were used to characterize the sample. The intraclass correlation coefficient (ICC) was used to assess item-specific test–retest reliability of the ABC Scale. For consistency of the whole scale, reliability analysis was performed, Crohnbach α coefficients were calculated, and item total correlation was assessed. Correlation between subdivisions of scales and other parameters determined were assessed by Spearman correlation analysis. The Wilcoxon test was used to determine the effectiveness of the treatment. A P value of less than 0.05 was considered as statistically significant.

Results

The study included 33 patients with unilateral peripheral vestibular dysfunction. Demographic and clinical characteristics of the patients are presented in Table 1.

The individual item ICC ranged from 0.67 to 0.92 and Crohnbach α ranged from 0.67 to 0.93. The Crohnbach α value of the whole scale was determined as 0.95 (Table 2).

To assess the validity of the ABC Scale, it was compared with VAS imbalance, Romberg (eyes open, closed), tandem Romberg (eyes open, closed), standing on foam (eyes open, closed), FTSTS, TUG, gait speed, DGI, FGA, DHI, and static posturograpy (Tetrax Interactive Balance System, falling index). The ABC Scale showed a statistically significant correlation with the DHI (total, emotional, functional, physical; $r=0.62$–0.53, $P<0.05$), but no such correlation was observed between the Turkish ABC Scale and other parameters assessed ($P>0.05$, Table 3).

Twenty-seven patients completed the vestibular rehabilitation program. The Turkish ABC Scale and other parameters assessed all showed significant improvement after the vestibular rehabilitation program ($P<0.05$) (Table 4).

Table 1 Demographic and clinical data of patients

	$n=33$
Age (year, mean ± SD)	50.09 ± 14.06
Sex (*n*, male/female)	11/22
Marital status (married, %)	81.8
Education (primary school, %)	60.6
Concomitant disease (%)	
Hypertension	57.6
Psychiatric disease	12.1
History of migraine (present, %)	15.2
Hearing problem (present, %)	93.9
Use of spectacles (present, %)	81.8
History of fall within last 6 months (present, %)	48.5
Duration of the disease (month, mean ± SD)	40.21 ± 42.93

Table 2 Internal consistency and test–retest reliability of the Turkish ABC Scale

ABC questions	ICC	Crohnbach α
1st question	0.86	0.82
2nd question	0.88	0.87
3rd question	0.83	0.82
4th question	0.84	0.83
5th question	0.92	0.91
6th question	0.78	0.78
7th question	0.72	0.72
8th question	0.71	0.70
9th question	0.72	0.73
10th question	0.93	0.93
11th question	0.78	0.78
12th question	0.84	0.84
13th question	0.78	0.78
14th question	0.77	0.76
15th question	0.68	0.67
16th question	0.89	0.89
Total		0.95

ABC, Activities-specific Balance Confidence Scale; ICC, intraclass correlation coefficient.

Table 3 Construct validity: correlation of Turkish ABC Scale with VAS imbalance, FTSTS, TUG, gait speed, DGI, FGA, Romberg (eyes open, closed), tandem Romberg (eyes open, closed), standing on a foam (eyes open, closed) and DHI

	ABC (*r*)
VAS (imbalance)	−0.31
TUG (s)	−0.16
FTSTS (s)	−0.12
Gait speed (m/s)	0.07
DGI	0.18
FGA	0.06
Romberg (eyes open, s)	0.01
Romberg (eyes closed, s)	0.11
Tandem Romberg (eyes open, s)	0.29
Tandem Romberg (eyes closed, s)	0.25
Foam (eyes open, s)	0.16
Foam (eyes closed, s)	0.13
Falling index	−0.13
DHI total	−0.54*
DHI emotional	−0.52*
DHI functional	−0.51*
DHI physical	−0.51*

ABC, Activities-specific Balance Confidence Scale; DGI, Dynamic Gait Index; DHI, Dizziness Handicap Inventory; FGA, Functional Gait Assessment; FTSTS, Five Times Sit to Stand test; TUG, Timed Up to Go test; VAS, Visual Analog Scale. *$P<0.01$.

Table 4 The ABC scores at baseline and after customized exercise program

$n=27$	Baseline median (minimum–maximum)	Follow-up median (minimum–maximum)	*P*
ABC	66.88 (14–93)	78.75 (0–100)	0.002
VAS (imbalance)	40.00 (0–80)	30.00 (0–60)	0.000
TUG (s)	9.13 (6.69–20.31)	8.07 (5.8–16.7)	0.001
FTSTS (s)	9.97 (7.16–15.91)	8.95 (6.03–12.16)	0.003
Gait speed (m/s)	0.90 (0.4–2.0)	0.86 (0.72–1.62)	0.025
DGI	20.00 (6–24)	23.00 (13–24)	0.000
FGA	23.00 (6–29)	28.00 (15–30)	0.000
Romberg (eyes open, s)	30.00 (5–30)	30.00 (30–30)	0.317
Romberg (eyes closed, s)	30.00 (2–30)	30.00 (30–30)	0.180
Tandem Romberg (eyes open, s)	30.00 (0–30)	30.00 (0–30)	0.018
Tandem Romberg (eyes closed, s)	2.81 (0–30)	7.09 (0–30)	0.002
Foam (eyes open, s)	28.44 ± 4.96	30.00 ± 0.00	0.180
Foam (eyes closed, s)	17.91 ± 11.42	27.53 ± 7.84	0.002
Falling index	52.00 (0–100)	22.00 (2–100)	0.001
DHI total	56.00 (4–86)	30.00 (0–82)	0.000
DHI emotional	12.00 (0–28)	4.00 (0–26)	0.013
DHI functional	24.00 (0–36)	12.00 (0–34)	0.023
DHI physical	18.00 (2–36)	12.00 (0–38)	0.019

ABC, Activities-specific Balance Confidence Scale; DGI, dynamic gait index; DHI, Dizziness Handicap Inventory; FGA, Functional Gait Assessment; FTSTS, Five Times Sit to Stand test; TUG, Timed Up to Go test; VAS, Visual Analog Scale.

Discussion

The results of this study show that the Turkish ABC Scale provides sufficient reliability and responsiveness in patients with unilateral peripheral vestibular disease.

In the original study by Powell and Myers (1995), the ABC Scale showed high internal consistency (Crohnbach $\alpha=0.96$) in community-dwelling older people. Similarly,

Crohnbach α values for the Chinese, British, and German translations of the scale performed on community-dwelling older people ranged from 0.91 to 0.98 (Parry *et al.*, 2001; Mak *et al.*, 2007; Schott, 2008). The ABC Scale also showed high internal consistency in patients with lower limb amputation and Parkinson's disease (Crohnbach $\alpha=0.95$) (Miller *et al.*, 2003; Steffen and Seney, 2008). Similar to the previous studies, the Crohnbach α of the Turkish ABC Scale was determined to be 0.95 for patients with peripheral vestibular disease. In addition, the Crohnbach α of individual items in the Chinese Scale ranged between 0.71 and 0.88, where the Crohnbach α of Turkish version ranged from 0.67 to 0.93. Considering these results, we can conclude that the Turkish ABC Scale has a high internal consistency.

In the original study by Powell and Myers (1995), test–retest reliability of the ABC Scale in community-dwelling older people was high (ICC=0.92). Similarly, the ICC values of the items in the Chinese, German, and British translations of the scale performed on community-dwelling older people ranged from 0.73 to 0.98 (Parry *et al.*, 2001; Mak *et al.*, 2007; Schott, 2008). Individual item test–retest coefficient of scale in lower limb amputation has been shown to vary between 0.53 and 0.87 (Miller *et al.*, 2003). Consistent with these studies, the individual item test–retest coefficient in our study was found to range from 0.67 to 0.92, which proved its test–retest reliability.

In the original study by Powell and Myers (1995), the ABC Scale and the DHI showed convergent validity ($r=-0.64$). The ABC Scale showed significant correlation with 2 min walk test ($r=0.72$) and TUG test ($r=-0.70$) in patients with lower limb amputation (Miller *et al.*, 2003). Our study also shows significant correlation between the ABC Scale and the DHI ($r=-0.62$). The lack of significant correlation with other tests may be explained by close to normal data and scores in most of the patients. As dizziness and imbalance may coexist in patients with peripheral vestibular disease (Horak *et al.*, 1992; Mira, 2008), the ABC Scale alone may be insufficient to evaluate these patients. We believe that revalidation studies for diseases with balance problems (bilateral vestibular disorder or central vestibular disorder) are needed to elucidate this confusion.

To our knowledge, the sensitivity to change of the ABC Scale has not been evaluated in any other study. In our study, patients received 4 weeks of customized vestibular rehabilitation and the sensitivity to change of the scale was evaluated during rehabilitation. According to the results, both the ABC Scale and the other parameters showed significant improvement in the patients after vestibular rehabilitation.

Strong aspects of our study include the absence of assessment concerning validity and reliability of the ABC Scale in vestibular rehabilitation (even though it is commonly used for vestibular rehabilitation) (Meretta *et al.*, 2006; Danilov *et al.*, 2007) and being the first study to evaluate the sensitivity to change of the scale with a customized vestibular rehabilitation.

One limitation of our study is the small number of patients. As we included only patients with unilateral vestibular disease that could receive rehabilitation, defining this number of patients as small may not be appropriate. Nevertheless, a control group could provide additional benefits for assessing correlation and sensitivity to change. Addressing these limitations in future studies would be beneficial.

Although objective tests which assess balance function disorders are beneficial and informative, they do not reflect the patient's social and functional restrictions. The ABC Inventory, one of the balance scales, is an easy way of showing an individual's perceived confidence during daily activities. The ABC Scale will be useful as a screening tool in clinical and research work for determining appropriate fall prevention in patients with peripheral vestibular disease. The ABC Scale is also beneficial for assessing the patient's response to treatment. The DHI, in contrast, was developed for individuals with dizziness and measures how dizziness affects an individual's quality of life. The ABC Scale is a measure of disability and the DHI is a focused measure of handicap. Both the ABC and DHI Scales help identify the impact vestibular disease has on an individual's daily activities. In this respect, the Turkish ABC inventory can be recommended for use in evaluating disability of Turkish people with peripheral vestibular disease.

In conclusion, the Turkish ABC Scale is a culturally relevant, reliable, and sensitive to change tool for measuring self-perceived balance in unilateral peripheral vestibular disease.

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References

Danilov YP, Tyler ME, Skinner KL, Hogle RA, Bach-y-Rita P (2007). Efficacy of electrotactile vestibular substitution in patients with peripheral and central vestibular loss. *J Vestib Res* **17**:119–130.

Herdman SJ, Blatt P, Schubert MC, Tusa RJ (2000). Falls in patients with vestibular deficits. *Am J Otol* **21**:847–851.

Hillier SL, Hollohan V (2007). Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. *Cochrane Database Syst Rev* **4**:CD005397.

Horak FB, Jones-Rycewicz C, Black FO, Shumway-Cook A (1992). Effects of vestibular rehabilitation on dizziness and imbalance. *Otolaryngol Head Neck Surg* **106**:175–180.

Jacobson GP, Newman CW (1990). The development of the Dizziness Handicap Inventory. *Arch Otolaryngol Head Neck Surg* **116**:424–427.

Kohen-Raz R (1991). Application of tetra-ataxiametric posturography in clinical and developmental diagnosis. *Percept Mot Skills* **73**:635–656.

Legters K (2002). Fear of falling. *Phys Ther* **82**:264–272.

Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A (2002). Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. *J Gerontol A Biol Sci Med Sci* **57**:M539–M543.

Macias JD, Massingale S, Gerkin RD (2005). Efficacy of vestibular rehabilitation therapy in reducing falls. *Otolaryngol Head Neck Surg* **133**: 323–325.

Mak MK, Lau AL, Law FS, Cheung CC, Wong IS (2007). Validation of the Chinese translated Activities-Specific Balance Confidence scale. *Arch Phys Med Rehabil* **88**:496–503.

Meretta BM, Whitney SL, Marchetti GF, Sparto PJ, Muirhead RJ (2006). The five times sit to stand test: responsiveness to change and concurrent validity in adults undergoing vestibular rehabilitation. *J Vestib Res* **16**:233–243.

Miller WC, Deathe AB, Speechley M (2003). Psychometric properties of the Activities-specific Balance Confidence Scale among individuals with a lower-limb amputation. *Arch Phys Med Rehabil* **84**:656–661.

Mira E (2008). Improving the quality of life in patients with vestibular disorders: the role of medical treatments and physical rehabilitation. *Int J Clin Pract* **62**:109–114.

Parry SW, Steen N, Galloway SR, Kenny RA, Bond J (2001). Falls and confidence related quality of life outcome measures in an older British cohort. *Postgrad Med J* **77**:103–108.

Pothula VB, Chew F, Lesser TH, Sharma AK (2004). Falls and vestibular impairment. *Clin Otolaryngol Allied Sci* **29**:179–182.

Powell LE, Myers AM (1995). The Activities-specific Balance Confidence (ABC) Scale. *J Gerontol A Biol Sci Med Sci* **50**:M28–M34.

Ringsberg KAM, Gardsell P, Johnell O, Jósson B, Obrant KJ, Sernbo I (1998). Balance and gait performance in an urban and a rural population. *J Am Geriatr Soc* **46**:65–70.

Schott N (2008). German adaptation of the Activities-specific Balance Confidence (ABC) scale for the assessment of falls-related self-efficacy. *Z Gerontol Geriatr* **41**:475–485.

Shumway-Cook A, Woollacott M (1995). *Motor control: theory and practical applications*. Baltimore: Williams & Wilkins.

Steffen T, Seney M (2008). Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the unified Parkinson disease rating scale in people with parkinsonism. *Phys Ther* **88**:733–746.

Turner M (1998). *Evaluation of the Tetrax Interactive Balance System and Equitest using normal subjects. Faculty of Engineering and Applied Science Institute of Sound and Vibration Research*. Southhampton: University of Southampton.

Whitney SL, Hudak MT, Marchetti GF (2000). The dynamic gait index relates to self-reported fall history in individuals with vestibular dysfunction. *J Vestib Res* **10**:99–105.

Whitney SL, Marchetti GF, Schade A, Wrisley DM (2004a). The sensitivity and specificity of the Timed Up & Go and the Dynamic Gait Index for self-reported falls in persons with vestibular disorders. *J Vestib Res* **14**:397–409.

Whitney SL, Wrisley DM, Brown KE, Furman JM (2004b). Is perception of handicap related to functional performance in persons with vestibular dysfunction? *Otol Neurotol* **25**:139–143.

Whitney SL, Marchetti GF, Morris LO, Sparto PJ (2007). The reliability and validity of the Four Square Step Test for people with balance deficits secondary to a vestibular disorder. *Arch Phys Med Rehabil* **88**:99–104.

Wrisley DM, Walker ML, Echternach JL, Strasnick B (2003). Reliability of the dynamic gait index in people with vestibular disorders. *Arch Phys Med Rehabil* **84**:1528–1533.

Wrisley DM, Marchetti GF, Kuharsky DK, Whitney SL (2004). Reliability, internal consistency, and validity of data obtained with the functional gait assessment. *Phys Ther* **84**:906–918.