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Reliability and Validity of the Falls Efficacy Scale-International (FES-I) in Individuals with Dizziness and Imbalance

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Abstract

Hypothesis—The purpose of this research is to establish the test-retest reliability and convergent validity of the Falls Efficacy Scale-International (FES-I) in people with vestibular disorders.

Background—Individuals with vestibular dysfunction have an increased risk of falling. The FES-I is a measure used to quantify an individual's concern of falling during different tasks.

Methods—A cross-sectional descriptive study was used in order to determine the test-retest reliability and convergent validity of the FES-I. Fifty-three individuals with vestibular or balance dysfunction completed the FES-I twice during an initial evaluation by a neurotologist. Test-retest reliability was assessed using the intraclass correlation coefficient. The convergent validity was measured by correlating the FES-I with the Activities-specific Balance Confidence (ABC) scale, Dizziness Handicap Inventory (DHI), Vestibular Activities and Participation (VAP) scale, 4-item Dynamic Gait Index (DGI-4), and measuring gait speed.

Results—The FES-I demonstrated high test-retest reliability (intraclass correlation coefficient, model 3,1: 0.94; 95% confidence interval, 0.90–0.97) and had concurrent validity with other self-report and physical performance measures (correlation coefficients for the ABC: −0.84; DHI: 0.75; VAP: 0.78, gait speed: −0.55; and DGI-4: −0.55).

Conclusion—The FES-I is a reliable and valid tool for measuring an individual's concern of falling in a sample of people with vestibular disorders.

Keywords

fear of falling; vestibular; inner ear

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Conflicts of Interest
No conflicts of interest were declared.

Introduction

Individuals who experience dizziness, unsteadiness and imbalance have an increased incidence of falls. Among people who visited an emergency room with an unexplained fall, a majority had vestibular symptoms in the past year (1). In data retrieved from the National Health and Nutrition Examination Survey, it was reported that people with vestibular dysfunction who were symptomatic were 12 times more likely to have reported a fall (2). Individuals with vestibular and balance dysfunction also report psychological distress about the possibility of having a fall (3). Gradually, persons with vestibular disorders may become limited in essential daily activities and become restricted in participating within their community (4). As a result, many basic and essential activities may become unsafe and difficult to perform such as running errands, walking alone, driving, and shopping because of fear of falling and avoidance of moving (5–7).

In order to provide patient centered care it is crucial to assess and be aware of an individual's concern of falling. Thus, physical therapists and physicians working with patients with vestibular disorders must have reliable and valid patient self-reports in order to properly determine how concerned a patient is of having a fall. The Falls Efficacy Scale International (FES-I) has been developed and validated to evaluate the concern of falling in older individuals (8–10). The goal of this study aims to build upon prior psychometric testing that has determined that the FES-I is reliable and valid in determining concern of falling in older adults across cultures as well as in persons with and without cognitive impairment (8–11). Recently, the short version of the FES-I has been used in individuals with bilateral vestibular hypofunction, and a moderate to severe fear of falling was found in over 50% of the participants (12). Because of fear of falling among people with vestibular disorders, and the widespread use of the FES-I internationally, our research interest lies in examining the reliability and validity of the FES-I in a sample of adults with vestibular disorders.

Methods

Subjects

A sample of convenience was used. Over as period of 2 months, subjects were recruited during their visit to a neurotologist who specializes in the diagnosis of persons with balance and vestibular dysfunction. Fifty-three subjects, (33 females, 20 males) with a mean age of 54 y (SD 15 y, range 18–79 y) provided informed consent that had been approved by the local Institutional Review Board. The inclusion criterion for this study was a complaint of dizziness or balance dysfunction that required an appointment with the neurotologist. Subjects were excluded if they were unable to ambulate, unable to read English, and anyone under the age of 18 and over the age of 85.

Outcome Measures

Falls Efficacy Scale – International (FES-I)—The FES-I is a 16-item questionnaire of fall-related self-efficacy based on the Falls Efficacy Scale (10 items) (13), but extended by 6 additional items including more difficult functional tasks and social-related aspects of falling (8). The 16 items of the FES-I are rated according to "how concerned you are about the possibility of falling", using the following responses (score in parentheses): not at all (1), somewhat (2), fairly (3), and very concerned (4). Thus, the total score ranges from 16 to 64 points. Higher values indicate less fall-related self-efficacy (and more concern about falling). Test-retest reliability of the FES-I has ranged from 0.79 to 0.96 in older adult populations (8,9,11). Furthermore, validity of the instrument has been demonstrated by

comparison between different subject groups and with different measures (8–10,14). In a previous validity study, the FES-I was significantly associated with ABC (r = −0.68) (14).

Activities-specific Balance Confidence (ABC) scale—The ABC scale was developed to provide a description of activity difficulty and fear of falling in an older population by expanding the original Falls Efficacy scale (FES) (15). The ABC has 16 items developed through combined efforts of clinicians and older adults. The items include activities with various levels of difficulty that range from walking around the house to walking on icy sidewalks. The scale of the ABC is from 0% (indicating no confidence) to 100% (indicating complete confidence) in performing the task without any difficulty (15). The ABC was found to be internally consistent ($\alpha = 0.96$) and had good test-retest reliability over a 2-week interval (r = 0.92, $p < 0.001$) (15). A strong correlation was found between the ABC and the FES (r = −0.84, $p < 0.001$) and the DHI (r = −0.64, p < 0.0005) demonstrating convergent validity (16,17). Patients with a fall history had lower ABC scores than patients who did not report a fall (18). Similarly, the ABC score was able to distinguish between patients with and without reduced mobility (17).

Dizziness Handicap Inventory (DHI)—The DHI is a 25-item questionnaire that quantifies the impact of dizziness on daily life by evaluating the self-perceived handicap in patients with vestibular disorders (19). The DHI items were developed from interviews of patients with dizziness. Content analysis categorized the DHI items into 3 domains: functional, emotional, and physical aspects of dizziness and disequilibrium. The response scale used in the DHI is “yes/sometimes/no” and is scored as “4/2/0” respectively. Higher scores have been related to greater frequency of falls in people with vestibular dysfunction (19). The DHI was found to have good internal consistency for the total score ($\alpha = 0.89$) and satisfactory internal consistency for the subscales ($\alpha = 0.72–0.85$) (19). The test-retest reliability of the DHI was high (r = 0.97) (19). There is evidence for discriminant validity based on the good relationships between the DHI scores and the number of episodes of dizziness (20).

Vestibular Activities and Participation (VAP) Questionnaire—The VAP is a 34-item self-report measure designed to assess the effect dizziness and imbalance have on an individual’s activities and participation (4,21). The questionnaire asks individuals to rate how much their dizziness and imbalance affects certain activities and participation in their daily life, including, but not limited to, rolling over in bed, running, and cleaning the house (4,21). The scale ranges in number from 0 to 5 and is scored by adding the total and taking the average. Zero corresponds to no difficulty, one is mild difficulty, two is moderate, three is severe, four is unable to do, and five is not applicable. The higher the score, the greater the affect balance and dizziness have on an individual’s activities and participation.

Gait Speed—Gait speed was measured while participants walked at their comfortable speed over 6.1 meters using a walking start. The participant was instructed to “Walk to the other end of the course at your usual speed passing the marked line, just as if you are walking down the street to go to the store”. Test-retest reliability of normal gait speed usually is above 0.90 for different subject populations (22,23). A reduction in gait speed as people age is related to morbidity and mortality (24).

4-Item Dynamic Gait Index (DGI-4)—The original Dynamic Gait Index was developed for use in community-living older people and also has been used for people with balance and vestibular disorders (25,26). The full 8-item DGI is a tool with which the examiner rates an individual’s gait performance on an ordinal scale that ranges from 0 to 3, 0 being severe impairment and 3 being no impairment in completing the motor task. The DGI-4 uses the

first 4 items of the full assessment (27). The psychometric properties of the DGI-4 were comparable or superior to those of the original 8-item DGI (27). The DGI also correlates well with the Activities-specific Balance Confidence Scale in people with vestibular disorders.(28) A score of less than 10 out of 12 on the DGI-4 indicates that the person is at a higher risk for having a fall (27).

Procedure

During their initial visit to the neurotologist, individuals were given the FES-I, ABC, DHI, and VAP to complete in random order. Subjects were instructed to complete the questionnaires based upon how they currently were feeling. The DGI-4 and four gait speed tests were performed over a 6.1 meter (i.e. 20 foot) course. Subjects were permitted to ambulate with an assistive device if they chose to do so. Later, a second FES-I with questions in a different order were given to the participants at least 45 minutes after completing the first FES-I. The second test was administered on the same day because patient status can change quickly depending on the intervention, and subject attrition occurs after the appointment is completed.

Data Analysis

Reliability—Test-retest reliability of the two initial administrations of the FES-I was determined using intraclass correlation coefficient, model 3,1 (ICC 3,1). Standard error of the measurement (SEM) and the minimal detectable change (MDC_{95}) were calculated by the following formulas. The MDC_{95} can be interpreted as the magnitude of change needed to conclude that a real change occurred with 95% confidence (29).

$$SEM = SD * \sqrt{(1 - ICC)}$$

$$MDC_{95} = 1.96 * \sqrt{2} * SEM$$

Convergent Validity—First, potential associations between FES-I and age and gender were examined to determine if these demographic factors needed to be accounted for as confounding variables. Then convergent validity was established by computing the Pearson correlation coefficient between the FES-I and the other functional and self-reported disability measures described earlier: ABC, DHI, VAP, average of 4 gait speed measurements, and DGI-4. The false discovery rate method was used to correct for the multiple comparisons, using a family wise error rate of $\alpha = 0.05$ for the 15 correlations (30). Exploratory factor analysis using principal component extraction with varimax rotation was used to examine the amount of overlap in the conceptual foundation of the measures.

Results

Table 1 presents the clinical test findings and treatment recommendations. Twenty-nine subjects had clinically significant evidence of a peripheral vestibular disorder, as documented by abnormal cervical vestibular evoked myogenic potentials (cVEMP, tone bursts at 500Hz) or caloric test (30 °C and 44 °C using water with closed-loop irrigation) results. Fourteen subjects had bilateral vestibular dysfunction (9 bilateral cVEMP abnormalities, 3 bilateral caloric abnormalities, 1 bilateral cVEMP and caloric abnormality, and 1 unilateral cVEMP abnormality on one side, unilateral caloric abnormality on the other side). A majority of subjects (n = 38; 72%) were referred for vestibular physical therapy for

treatment. Table 2 displays the descriptive statistics for the outcome measures. The average FES-I score of 31 indicates that on average this sample of people with vestibular disorders were somewhat concerned about falling during the various activities. Similarly, the ABC demonstrated that the subjects had a lack of confidence about maintaining their balance. Despite these moderately negative perceptions about balance and falling, they reported only mild restriction in their activities and participation, as measured with the VAP. The median DGI-4 score was 10, indicating that about half of the sample had a higher risk for falling.

The ICC for the FES-I was 0.94 (95% CI: 0.90–0.97; SEM 3.0; MDC_{95}: 8.2). No significant association was found between FES-I and age (Pearson r = 0.18, p = 0.20) or gender (t_{51} = −0.48, p = 0. 63). Table 3 reports the correlation coefficients for the convergent validity between the FES-I and the ABC, DHI, VAP, and gait performance measures. The FES-I showed statistically significant correlations with the three self-report measurements as well as both gait measurements. The highest correlation was with the ABC, followed by the two other self-report measures (DHI and VAP). The FES-I had a lower correlation with the gait performance measures, although they were still statistically significant. The factor analysis of the six measures generated a two-factor solution that accounted for 86% of the variance in the measures. The primary factor weighted heavily on the self-report measures, and the second factor weighted on the gait performance measures.

Discussion

The aim of this study was to determine if the FES-I is a reliable and valid self-report of fear of falling in a sample of people with dizziness and imbalance. The FES-I has excellent test-retest reliability, and demonstrates convergent validity with other self-report and performance measures used in persons with vestibular disorders.

The current sample of subjects with complaints of dizziness and imbalance, with a mean age of 54 years, was younger than in most of the other studies, which validated the FES-I for use in older adult populations that were restricted to ages greater than 60 years (8,31). Despite having a younger age group in this study, we found that concerns about falling were evident. The mean FES-I value of 31 in the current study was several (3 to 5) points lower than previous studies, which examined the influence of dizziness on FES-I scores in the older adult population (8,32). The difference in scores between the current study and the studies that used older subjects may be due to a combination of inherent error in the measurement and a modest age effect indicated by higher scores in older subjects. Although there was no association between age and FES-I in the current study, previous studies of geriatric subjects have found a significant increase (worsening) in scores for the older cohort (e.g. 80 y and older) compared with the younger cohort subjects (e.g. 70 – 79 y) (8,9).

The within-day test-retest reliability between the two test administrations of the FES-I was 0.94. This is consistent with Yardley et al. who determined the one week test-retest reliability to be 0.96 (8). Estimates of test-retest reliability given 4 weeks apart in Germany and the Netherlands were 0.79 and 0.82, respectively (9). It is possible that the lower reliability scores in the Kempen et al. study were related to the longer time between test administrations, when change in the subject's health status may have occurred. It is also possible that reliability may be related to age, as the subjects from Germany and the Netherlands were older (i.e. 70 years and older) than our sample and the Yardley et al., sample. Another factor that affects test-retest reliability is the presence of cognitive impairment (11). The one-week test-retest reliability of the FES-I is considerably lower in subjects with cognitive impairment, defined as having a Mini Mental State Examination score of less than 23, especially when the FES-I is given as a self-report (ICC = 0.58) compared with an interview (ICC = 0.74). In particular, it appears that people with cognitive

impairment under-report concern for falling when they provide a self-report compared with when they are interviewed.

The correlations between the FES-I, the self-report scores, and gait performance measures were significant, demonstrating that concern of falling is related to the concepts of balance confidence, dizziness handicap, participation in society, and walking performance in people with vestibular disorders. Furthermore, it appears that the FES-I was more highly correlated with the self-report measures than with the gait performance measures. The exploratory factor analysis of the six measures confirmed this observation, suggesting that an individual's perceptions of their health status, whether it is balance confidence, concern of falling, dizziness handicap or participation, are highly related. Furthermore, these perceptions are distinct from their physical performance.

Since the FES-I has excellent short-term reliability in persons with vestibular disorders, future studies should examine the reliability over a slightly longer term, such as one week. After ensuring this longer term reliability during a period when the individual's condition would not be expected to change, the responsiveness to change of the FES-I could be assessed over a two-or three month period. Future research should also determine the effect of different interventions such as vestibular physical therapy on change in FES-I scores. In addition, an attempt to quantify the prevalence of falls in relation with FES-I scores in a population of people with dizziness and imbalance would be valuable.

A limitation of the study is that the performance measures were both based on walking ability. Measures of gait speed and DGI-4 were more strongly correlated with the FES-I than the other self-report measures. Thus, the FES-I may provide a more accurate assessment of an individual's gait performance than the ABC, DHI and VAP.

Conclusions

The FES-I could be used as a quick screening tool to assess an individual's self-reported fear of falling in persons with balance and vestibular disorders. Poor scores on the FES-I could facilitate conversations with patients as to why they are afraid of falling as well as guide medical, rehabilitative, and psychological treatment. In individuals with vestibular disorders, the minimal detectable change was 8.2 points. Clinicians could use a change of 8.2 in the FES-I to determine if an intervention either positively or negatively affected a patient's perceived fall risk.

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Table 1

Clinical test results and treatment recommendations.

Vestibular function test results	Abnormal Calorics: 43% Abnormal cVEMPs: 48% Abnormal rotational chair: 54% Abnormal positional: 22% Bilateral dysfunction: 26%
Treatment recommendations	Physical therapy: 73% Canalith repositioning maneuver: 13% Change diet: 13%

cVEMP: cervical Vestibular Evoked Myogenic Potential

Abnormal caloric test: > 24% asymmetry or total eye speed < 20 deg/sec

Abnormal VEMP test: asymmetry > 29% or absent response

Abnormal rotational chair test: reduced gain, phase lead, or directional preponderance

Abnormal positional test: slow phase velocity > 4 deg/sec (> 6 deg/sec for age >65)

Table 2

Mean (SD) scores on the self-report and gait performance measures.

Outcome Measure	Mean (SD)
Falls Efficacy Scale – International (FES-I)	31 (12)
Activity-specific Balance Confidence (ABC)	64 (26)
Dizziness Handicap Inventory (DHI)	47 (24)
Vestibular Activities and Participation Scale (VAP)	1.2 (0.8)
Gait speed (m/s)	1.01 (0.25)
Dynamic Gait Index – 4 item (DGI-4)	9 (3)

Table 3

Convergent validity (Pearson Correlation) of the Falls Efficacy Scale-International (FES-I) with the Activities-specific Balance Confidence (ABC) scale, the Dizziness Handicap Inventory (DHI), Vestibular Activities and Participation (VAP) scale, gait speed, and the 4-item Dynamic Gait Index (DGI-4) in persons with dizziness or balance disorders. All correlations were significant using the False Discovery Rate procedure to correct for 15 correlations, familywise $\alpha = 0.05$ (30).

Measure	ABC	DHI	VAP	Gait Speed	DGI-4
FES-I	−0.84	0.75	0.78	−0.55	−0.55
ABC		−0.79	−0.73	0.41	0.47
DHI			0.83	−0.35	−0.37
VAP				−0.33	−0.37
Gait Speed					0.70