RELIABILITY AND VALIDITY OF A LOW LOAD ENDURANCE STRENGTH TEST FOR UPPER AND LOWER EXTREMITIES IN PATIENTS WITH FIBROMYALGIA

Diego Munguía-Izquierdo, PhD, Alejandro Legaz-Arrese, PhD


Objective: To evaluate the reliability, standard error of the mean (SEM), clinical significant change, and known group validity of 2 assessments of endurance strength to low loads in women with fibromyalgia syndrome (FS).

Design: Cross-sectional reliability and comparative study.

Setting: University Pablo de Olavide, Seville, Spain.

Participants: Middle-aged women with FS (n = 95) and healthy women (n = 64) matched for age, weight, and body mass index (BMI) were recruited for the study.

Interventions: Not applicable.

Main Outcome Measures: The endurance strength to low loads tests of the upper and lower extremities and anthropometric measures (BMI) were used for the evaluations. The differences between the readings (tests 1 and 2) and the SDs of the differences, intraclass correlation coefficient (ICC) model (2.1), 95% confidence interval for the ICC, coefficient of repeatability, intrapatient SD, SEM, Wilcoxon signed-rank test, and Bland-Altman plots were used to examine reliability. A Mann-Whitney U test was used to analyze the differences in test values between the patient group and the control group. We hypothesized that patients with FS would have an endurance strength to low loads performance in lower and upper extremities at least twice as low as that of the healthy controls.

Results: Satisfactory test-retest reliability and SEMs were found for the lower extremity, dominant arm, and nondominant arm tests (ICC = 0.973–0.979; P < .001; SEMs = 1.44–1.66 repetitions). The differences in the mean between the test and retest were lower than the SEM for all performed tests, varying from −0.10 to .29 repetitions. No significant differences were found between the test and retest (P > .05 for all). The Bland-Altman plots showed 95% limits of agreement for the lower extremity (4.7 to −4.5), dominant arm (3.8 to −4.4), and nondominant arm (3.9 to −4.1) tests. The endurance strength to low loads test scores for the patients with FS were 4-fold lower than for the controls in all performed tests (P < .001 for all).

Conclusions: The endurance strength to low loads tests showed good reliability and known group validity and can be recommended for evaluating endurance strength to low loads in patients with FS. For individual evaluation, however, an improved score of at least 4 and 5 repetitions for the upper and lower extremities, respectively, was required for the differences to be considered as substantial clinical change. Patients with FS showed impaired endurance strength to low loads performance when compared with the general population.

Key Words: Fibromyalgia; Rehabilitation.

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FIBROMYALGIA SYNDROME (FS) is a chronic musculoskeletal pain disorder characterized by multiple tender points. FS is found primarily in women and is often accompanied by a wide variety of symptoms, such as sleep disturbances, reduced physical work capacity, muscular fatigue, mood disorders, and cognitive disturbances. Patients with FS have difficulty performing activities of daily living, such as climbing stairs, running, carrying objects, and working with their arms in an elevated position. Patients with FS experience a loss in quality of life comparable with that found in other chronic diseases. Consequently, the assessment of functional performance in this population is important for understanding the relationship between functional performance and health and for determining the efficacy of treatment interventions.

Recent studies have shown the clinical value of assessing upper and lower body muscle strength in patients with FS. Several studies have shown that patients with FS have less muscle strength in the upper and lower extremities than healthy subjects. Decreased voluntary muscle strength in patients with FS has been attributed to impaired central drive, symptom severity, low levels of functional capacity, and poor motivation. These aspects may decrease the test scores of patients with FS, especially in maximal tests that require patients to achieve volitional exhaustion. Tests related to functional activities have been suggested to be more reliable measures of FS than laboratory strength measurements. Functional performances of patients with FS have been reported to be significantly decreased compared with the performances of healthy subjects when assessed using standardized functional tests.

Dynamic functional tests are used to describe and monitor health status and treatment effects; consequently, it is important to evaluate them. Knowledge of the test reproducibility is necessary for clinicians in order to evaluate the individual effect of an intervention. However, evaluations of the reliabil-

List of Abbreviations

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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BMI</td>
<td>body mass index</td>
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<tr>
<td>CI</td>
<td>confidence interval</td>
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<tr>
<td>ICC</td>
<td>intraclass correlation coefficient</td>
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<td>FS</td>
<td>fibromyalgia syndrome</td>
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<tr>
<td>SEM</td>
<td>standard error of the mean</td>
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ity of the weight-bearing dynamic functional tests used for the assessment of patients with FS are scarce, and none have exhaustively examined the reliability, standard error of the mean (SEM), clinically significant change, and known group validity of the tests used.

In a previous study, 2 tests were designed to assess the endurance strength to low loads endurance strength to low loads of the upper and lower extremities of patients with FS. That study conducted an incomplete analysis of the reliability of the endurance strength to low loads tests; it did not examine the individual level of reliability and SEM, and its results could have been affected by the small sample size. However, according to the Standards for the selection of health Measurement Instruments checklist used to evaluate the methodologic quality of the measurement properties, this study is considered fair. The aim of the present study was to rigorously evaluate the reliability SEM, and clinically significant changes of the endurance strength to low loads tests of the upper and lower extremities in a sample group of patients with FS. In addition, the endurance strength to low loads performances of the patients with FS were compared with those of a group of healthy women matched for age, weight, and body mass index (BMI) to assess the known group validity of the tests.

**METHODS**

**Study Population**

*Participants.* We contacted a local association of patients with FS in Seville (Spain), and an invitation to participate in the study was sent to all women aged 18 to 60 years (n = 250). Ninety-five potentially eligible subjects responded and sought more information. All gave their written informed consent after receiving detailed information in a meeting about the study aims and procedures. The exclusion criteria included a history of morbid obesity, known cardiopulmonary diseases, uncontrolled endocrine or allergic disturbances, severe trauma within the last 6 months, orthopedic or musculoskeletal limitations that precluded ambulation, frequent migraines, inflammatory rheumatic disease, and severe psychiatric illness according to the criteria of the Diagnostic and Statistical Manual of Mental Disorders, 4th edition. In addition, subjects with other diseases that prevented physical loading and subjects who were pregnant were also excluded. The Spanish version of the revised Physical Activity Readiness Questionnaire was also administered to identify people at risk for adverse events while exercising. In addition, all patients were instructed to refrain from consuming any food or performing any exercise for 3 hours before testing.

*Control group.* For comparison of the endurance strength to low loads performance between patients with FS and healthy subjects, 64 healthy women volunteers, matched to the patients according to age, weight, and BMI, were invited to participate in the study. To match for age, weight, and BMI, each patient with FS tried to recruit a healthy woman of similar age (±5y), weight (±5kg), and height (±5cm), and consequently similar BMI. The same exclusion criteria were used, and all of the healthy subjects gave written consent. No significant differences were seen between the FS and control groups with respect to demographic and clinical characteristics (table 1).

*Study design.* The research protocol was reviewed and approved by the Committee on Biomedical Ethics of the University Pablo de Olavide. Test-retest reliability was evaluated for the endurance strength to low loads tests of the upper and lower extremities in the patients with FS. Two measurement sessions, separated by a 1-week interval, were performed during appointments that took place at the university to estimate the reliability of the endurance strength to low loads tests of the upper and lower extremities in a sample of patients with FS. We selected a 1-week interval between tests to obtain stability in the patients with respect to pain, muscle strength, and endurance. Because patients with FS often describe exacerbation of pain after physical activity, the participants were asked not to exercise, undergo any treatments, or change their medications during the week of the study. For the study validation, 1 measurement session in the control group was sufficient to make comparisons with the first measurement session in the FS patient group.

During the first appointment, the sociodemographic, anthropometric, and personal medical records of the healthy women and the FS patients were examined by a trained rheumatologist, and an FS diagnosis was confirmed per the American College of Rheumatology classification criteria. In addition, the healthy women and patients were familiarized with all of the testing procedures. They then completed the tests in random order and were blinded to the results. During the second appointment, the patients completed the same tests in the same order.

The endurance strength to low loads performance of the FS patients was assessed for all of the tests on 2 separate occasions by 2 independent and well-trained physical therapists who had several years of experience in the rehabilitation of patients with FS; they were blinded to the results.

**Instruments**

*Endurance strength to low loads measures.* The endurance strength to low loads tests of each subject’s upper and lower extremities were evaluated according to the 2 previously and properly designed tests. The total administration time of the tests was approximately 5 to 10 minutes per patient.

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### Table 1: Demographic and Clinical Characteristics of the FS Group (n = 95) and the Control Group (n = 61)

<table>
<thead>
<tr>
<th>Variables</th>
<th>FS Group</th>
<th>Control Group</th>
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<tbody>
<tr>
<td><strong>Age, y</strong></td>
<td>49 (45–54)</td>
<td>48 (42–55)</td>
</tr>
<tr>
<td><strong>BMI, kg/m²</strong></td>
<td>27 (25–31)</td>
<td>29 (25–33)</td>
</tr>
<tr>
<td><strong>Duration of symptoms, y</strong></td>
<td>15 (12–22)</td>
<td>ND</td>
</tr>
<tr>
<td><strong>Tender point count, 1–18</strong></td>
<td>18 (16–18)</td>
<td>ND</td>
</tr>
<tr>
<td><strong>Sex (women)</strong></td>
<td>95 (100)</td>
<td>61 (100)</td>
</tr>
<tr>
<td><strong>Ethnicity (white)</strong></td>
<td>95 (100)</td>
<td>61 (100)</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housewife</td>
<td>55 (58)</td>
<td>32 (52)</td>
</tr>
<tr>
<td>Operatives</td>
<td>17 (18)</td>
<td>12 (20)</td>
</tr>
<tr>
<td>Office or store worker</td>
<td>14 (14)</td>
<td>10 (16)</td>
</tr>
<tr>
<td>Manager</td>
<td>10 (10)</td>
<td>7 (12)</td>
</tr>
<tr>
<td><strong>Highest education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No schooling</td>
<td>6 (6)</td>
<td>3 (5)</td>
</tr>
<tr>
<td>Elementary school</td>
<td>53 (56)</td>
<td>32 (52)</td>
</tr>
<tr>
<td>High school</td>
<td>22 (23)</td>
<td>18 (30)</td>
</tr>
<tr>
<td>College/university</td>
<td>14 (15)</td>
<td>8 (13)</td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>25 (26)</td>
<td>11 (18)</td>
</tr>
<tr>
<td>Married</td>
<td>56 (59)</td>
<td>42 (69)</td>
</tr>
<tr>
<td>Widowed</td>
<td>3 (3)</td>
<td>3 (5)</td>
</tr>
<tr>
<td>Divorced or separated</td>
<td>11 (12)</td>
<td>5 (8)</td>
</tr>
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</table>

**NOTE.** Values are the median (25th–75th percentiles) unless otherwise indicated or n (%).

Abbreviation: ND, no data.
The endurance strength to low loads test for the lower extremities was administered by using a 43-cm high ordinary folding chair without arms. The chair, with rubber tips on the legs, was placed against a wall to prevent it from moving during the test. The test began with the participant seated in the middle of the chair with the back straight. The feet were approximately shoulder-width apart and were placed on the floor at an angle slightly back from the knees, with 1 foot slightly in front of the other to help maintain balance when standing. The arms were extended parallel to the trunk with the elbow and shoulder in 0° of flexion/extension, and each hand held a dumbbell weighing 2.5 kg. On receiving a signal from a metronome, the participant rose to a full standing position (body erect and straight), and at the next signal of the metronome, the participant returned back to the initial seated position, maintaining arm extension. The pace of the metronome was 60 beats per minute and 90° of movement per second. The score was measured as the total number of stands executed correctly until the participant could not keep up with the pace of the metronome.

The endurance strength to low loads test for the upper extremities was administered by using the same chair used for the lower extremities test. The test began with the participant seated in the middle of the chair, leaning back completely, extending the arm parallel to the trunk with the elbow and shoulder in 0° of flexion/extension, and holding a dumbbell weighing 2.5 kg. At the signal of the metronome, the participant curled the weight through a full range of elbow flexion. At the next signal of the metronome, the participant returned to the initial position, keeping the back straight. The pace of the metronome was 60 beats per minute and 120° of movement per second. The score was measured as the total number of curls executed correctly until the participant could not keep up with the pace of the metronome. This test was repeated for the other arm.

**Anthropometric measures.** All anthropometric measurements were performed by the same operator, according to the Anthropometric Standardization Reference Manual. Weight was measured to the nearest 100 g, and height was measured to the nearest 0.1 cm, using an electronic balance with an incorporated stadiometer, with the subjects in their underwear. The BMI was calculated as body mass (kg) divided by height (m²).

**Statistical Analyses**

The descriptive statistics and validity analysis were calculated based on data for the entire sample, the FS patient group (n=95) and control group (n=61). The reliability analysis was based on a listwise deletion of cases to include only those patients with FS who had complete measures on 2 different occasions (n=86). Demographic, clinical, and functional variables were analyzed by comparing the results from the listwise deleted sample (n=86) and the original sample of patients (n=95) with the Mann-Whitney U test.

The test-retest reliability of the endurance strength to low loads tests was assessed using the differences observed between the readings (tests 1 and 2), the SDs of the differences, the intraclass correlation coefficient (ICC) model 2,1,20 the 95% confidence interval (CI) for the ICC, the coefficient of repeatability, the intrapatient SD, and the SEM.21 The SEM was reported in conjunction with the ICCs using the formula: SEM = SD \sqrt{1– ICC}.22 ICCs of <.49, .50–.74, and >.75 represented poor, moderate, and good reliability, respectively.23 Regarding the number of patients required to obtain a certain CI around an ICC, a minimum sample size of 50 patients was needed to obtain a CI from 0.7 to 0.9 around an ICC of 0.8.24 Because the variables were not normally distributed, nonparametric tests were used. The Wilcoxon signed-rank test was selected to analyze the systematic differences in the variables between the 2 appointments. In addition, based on the Bland-Altman plots, the differences between tests 1 and 2 against the mean for each of the tests, including the 95% limits of agreement,27 were used to determine the agreement between the recorded values at the individual level.

The known group validity of the endurance strength to low loads tests was analyzed by comparing the results from the FS and healthy participants with the Mann-Whitney U test. Results from the first endurance strength to low loads tests in the FS patient group were compared with results from 1 test in the control group. Given that the patients with FS are likely to reduce their daily life physical activities and thus display a reduced muscular endurance and strength26 and that the fatigue and pain characteristics of FS might negatively affect endurance and strength performance,27 we hypothesized that patients with FS would have an endurance strength to low loads performance in lower and upper extremities at least twice as low as that in healthy controls, as seen in a previous study.8 Finally, a bilateral performance comparison between the dominant and the nondominant arms and a performance comparison between the upper and lower extremities were made. All tests were 2-tailed, and a significance level of 5% was established.

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**Fig 1. Flowchart of the study.**
RESULTS

Sample Characteristics

Of the 95 women with FS and 64 healthy women who agreed to participate in this study, 86 (91%) volunteer patients who were diagnosed with FS and 61 (95%) healthy women matched according to age, weight, and BMI fully completed the study and were included in the reliability and validity analysis, respectively. Using the Spanish version of the revised Physical Activity Readiness Questionnaire, none of the participants were identified as being at risk for adverse events while exercising, and all patients confirmed their compliance with the instructions regarding medications, exercise, and treatments during the study period. None of the participants reported any problems related to the tests, but 9 women (9%) from the FS patient group were excluded from the reliability analysis because they did not attend the second measurement session. No differences were observed between the listwise deleted sample (n=86) and the original sample (n=95) in any demographic, clinical, and functional variable (P varies from .849 to .972).

In addition, 3 women (5%) from the control group were excluded from the validity analysis because they did not attend the assessments. Three patients did not attend due to transportation problems, and 6 patients with FS and 3 healthy women did not attend due to employment commitments. Figure 1 displays the flowchart of the study.

Table 1 summarizes the demographic and clinical characteristics of the patients with FS and the control group. No differences were observed between the control women and the FS patients in any demographic or clinical variable. The age of the participants ranged from 22 to 60 years, and the median ages of the patients with FS and the control women were 49 (25th–75th percentiles, 45–54y) and 48 years (25th–75th percentiles, 42–53y), respectively. All of the participants were women, white, and born in Spain. Most of the participants were married, were housewives, and reported an elementary level of education or higher.

Test-Retest Reliability

For all of the endurance strength to low loads tests, the mean differences, SDs of the differences, intrapatient SDs, ICC model 2,1 results, 95% CIs for the ICCs, coefficients of repeatability, SDs of the differences, and intrapatient SDs are presented in table 2. The ICC model 2,1 and SEM results were satisfactory for the lower extremity (.979; P<.001 and 1.44, respectively), dominant arm (.978; P<.001 and 1.44, respectively), and nondominant arm (.973; P<.001 and 1.66, respectively) tests. The differences in the mean between the test and retest were lower than the SEM for all performed tests, varying from −1.10 to 2.30 repetitions. The coefficient of repeatability was less than 2 SDs for the lower extremity, dominant arm, and nondominant arm tests (4.48, 4.03, and 3.88, respectively).

No systematic differences were observed for assessments that were completed on 2 different occasions for the lower extremity (P=.674), dominant arm (P=.286), and nondominant arm (P=.589) tests (table 3). These results show that the patients were stable with respect to muscle endurance over the 1-week interval selected between tests. Figure 2 shows the Bland-Altman plots and the limits of agreement for the lower extremity (4.7 to −4.5), dominant arm (3.8 to −4.4), and nondominant arm (3.9 to −4.1) tests.

Known Group Validity and Endurance Strength to Low Loads Level

The endurance strength to low loads performances for the patients with FS were significantly decreased in comparison with those for the healthy subjects in all of the tests (P<.001 for all) (see table 3). The patients with FS obtained an endurance strength to low loads performance score that was 4.2, 3.9, and 4.1 times lower than that of healthy women for the lower extremity, dominant arm, and nondominant arm tests, respectively. Figure 3 shows the entire distribution of scores for the lower extremity, dominant arm, and nondominant arm tests.

Significant differences were observed among the test scores for the dominant arm, nondominant arm, and lower extremities for patients with FS and for the healthy subjects (P<.001 for all). The bilateral comparison of the upper extremity test demonstrated a significant 24% difference performance between the dominant and nondominant upper extremities for the patients with FS and a significant 20% difference for the healthy controls. The comparison between the upper and lower extremity tests demonstrated a significant 26% difference between the upper and lower extremities for the patients with FS and a significant 30% difference for the healthy controls.

DISCUSSION

The purpose of this study was to examine the utility of 2 previously designed tests7 used to assess the endurance strength to low loads of the upper and lower limbs in patients with FS. The utility of the tests depends on the reliability of the test in the selected group, as well as knowledge of the known group validity. The present study showed good reliability and
The ICCs were very high. The SEMs provided a low index of error that can be expected for the endurance strength to low loads tests; namely, approximately 1 and 2 repetitions of measurement error were found for the upper and lower extremities, respectively. The limits of agreement were approximately 4 and 5 repetitions for the upper and lower extremities, respectively. Thus, in our setting, an improved endurance strength to low loads score of at least 4 and 5 repetitions for the upper and lower extremities, respectively, was required to be 95% certain of a true improvement in the individual.

The endurance strength to low loads tests also proved valid for our sample group of patients with FS. The significant differences in the endurance strength to low loads test values between the groups for all the performed tests provide some evidence of known group validity for the tests. The endurance strength to low loads test scores for the patients with FS were 4.2 and 4.0 times lower than those for the healthy women for the lower and upper limbs, respectively \((P<.001\) for all). The differences in the number of repetitions between the patients with FS and the healthy women were large and homogeneous \((74\%–76\%\) lower in FS than in healthy women) in all tests. These differences are similar to those reported in the only previous study that used the same tests. The results of the present study are in line with previous studies reporting lower muscular endurance in patients with FS compared with healthy subjects. However, when interpreting these results, it is unknown group validity for the endurance strength to low loads tests in patients with FS. The ICCs were very high. The SEMs provided a low index of error that can be expected for the endurance strength to low loads tests; namely, approximately 1 and 2 repetitions of measurement error were found for the upper and lower extremities, respectively. The limits of agree-
important to keep in mind that our sample were women, white, and mostly middle-aged. Therefore, generalizing these findings to other populations entails some risks.

To analyze the repeatability of the endurance strength to low loads tests, the coefficient of repeatability, SEM, and intrapatient SD were calculated. The results of these analyses are presented in the same units as those used for the tests (repetitions). An intrapatient SD × 2.77 is assumed to provide a range within which 95% of the repeated measurements are found.29 The intrapatient SD × 2.77 of the lower extremity, dominant arm, and nondominant arm tests was 2.6, 2.4, and 2.4 repetitions, respectively, which is acceptable for these tests. An examination of the Bland-Altman plots (see fig 2) and the coefficients of repeatability suggested that the tests were fairly repeatable, regardless of the number of repetitions that were performed.

The satisfactory ICC values demonstrated in the present study were equal to or greater than those determined for other functional tests commonly employed in FS patients.12,13 The well-defined assessment protocol with standardized instructions and equipment reduced variations in measurement, which could have contributed to the excellent reliability of our study. In general, the ability of the patients with FS to perform the tests was good. The patients experienced no problems in performing the tests. In addition to satisfactory execution and easy administration, another advantage of the endurance strength to low loads tests is their short duration, which can promote a high response rate.

Although physical dysfunction is a major limitation among FS patients, its assessment in daily clinical practice is limited by the availability of scientific instruments, notably isokinetic dynamometers,13 fitness machines,10 and ergometers.31 Two of the few tests measuring physical fitness that are applicable in daily clinical practice and are used in patients with FS are the 6-minute walk test32,33 and the chair-stand test.33,34 However, neither test is well suited to assess upper limb function.

The chair-stand test55 aims to have the patient complete as many full stands as possible within 30 seconds. This test probably results in a large level of anaerobic metabolism. Obtaining a better score in this test, for example, after a therapeutic intervention, is only possible by increasing the exercise intensity by performing each repetition at a higher speed. The contribution of aerobic and anaerobic metabolism in the endurance strength to low loads tests is dependent on the number of repetitions performed by each patient. A better score in the endurance strength to low loads test is only possible by increasing the exercise duration by performing more repetitions. This practice inevitably results in a greater degree of aerobic metabolism, which is predominant in most daily activities. These reflections suggest that the endurance strength to low loads tests may be more appropriate than time-limited tests in assessing the degree of physical fitness needed for the activities of daily living in a clinical population. However, based on current data, this is only a hypothesis that should be raised in future studies, for example, comparing the reliability, validity, functional, and metabolic performance, and the influence of the pacing strategy and motivation between the chair-stand test and the lower extremity endurance strength to load tests and between the arm curl test16 and the upper extremity endurance strength to load tests.

**Study Limitations and Research Avenues**

The present study has several limitations, such as the absence of a control for several responses characteristic of FS, such as symptom severity and fluctuation, perceived pain, and exertion immediately after tests; pain vigilance; kinesiophobia; and catastrophizing. A potential limitation is the possibility that patients with significant muscular atrophy in their arms may have complained of upper limb fatigue before lower limb fatigue during the lower limb test. Another limitation of these tests is the high levels of motivation required to submit the patients to an endurance strength to low loads test until they achieve volitional exhaustion. An additional potential limitation is the lack of power resulting from the nonparametric tests used. The relative power of nonparametric tests is weaker than their parametric counterparts (under their assumptions) because the former make fewer assumptions. However, with a moderate to large sample size, like our sample, the power of nonparametric tests becomes similar to that of the equivalent parametric tests. Another limitation is the listwise deletion used for missing values in the reliability analysis. The main limitations of listwise deletion are sample size reduction and possible bias of parameter estimations. However, no differences were observed between the listwise deleted sample (n = 86) and the original sample (n = 95) in any demographic, clinical, and functional variable.

In addition, the sample is of convenience. This includes the limitations of all nonprobability samples, including less reliability, less representativeness, and unknown levels of sampling error. The study was restricted in terms of age, sex, disease severity, and size. As such, these patients do not represent the larger population of community-dwelling individuals of all ages and disease severities who suffer from FS. The relative restrictions of our sample group limit the generalizability of the results and render the results mainly indicative.

Further studies to address other aspects of the measurement properties involving randomly recruited, consecutive patients with FS are needed. In addition, more studies to determine the clinical significance of these tests are needed. The endurance strength to low loads tests could also be analyzed in other clinical and healthy populations by adapting the dumbbell weights. There is a need to develop standardized, reliable, and valid tests for use in rehabilitation.

**CONCLUSIONS**

The endurance strength to low loads tests evaluated in the present study possess excellent reliability for use in patients with FS and are quick and easy to administer and interpret. For individual evaluation over time or after intervention, the improvement of the score has to be 4 and 5 repetitions for the individual evaluation over time or after intervention, the improvement of the score has to be 4 and 5 repetitions for the improvement to be considered as a significant improvement. The scores demonstrate the expected differences between the known groups. The patients with FS showed impaired endurance strength to low loads performance when compared with the general population.

**References**


Supplier
a. Seca 780; SECA Hammer Steindamm 9-25 22089, Hamburg, Germany.