A Psychometric Investigation of Fear-Avoidance Model Measures in Patients With Chronic Low Back Pain

The fear-avoidance model of musculoskeletal pain (FAM) has been highlighted as a psychological model of potential importance for rehabilitation. The FAM proposes that during a musculoskeletal pain episode, anxiety, pain-related fear, and pain catastrophizing interact to determine whether an individual will resume normal activities (low psychological distress) or will avoid normal activities due to anticipation of increased pain and/or reinjury (high psychological distress). The FAM suggests that high psychological distress will be associated with poor clinical outcomes, potentially resulting in depressive symptoms, elevated pain intensity, greater physical impairments, and continued disability.

Evidence supporting validity of the FAM can be found in the clinical studies of low back pain (LBP). Longitudinal studies have indicated that elevated FAM measures were predictive of poor outcomes for individuals with LBP. Furthermore, effective FAM treatment strategies have been reported, including patient education, graded exercise, and graded exposure. While portions of the FAM are well supported in the literature, there are unresolved questions and issues affecting its application in clinical settings.

One unresolved issue is related to measurement of FAM constructs in outpatient physical therapy settings, which is the focus of this particular study. The FAM is associated with multiple psychological constructs, and there are several available measurement tools. Examples include the Fear-Avoidance Beliefs Questionnaire (FABQ), Fear of Pain Questionnaire (FPQ), Tampa Scale for Kinesiophobia (TSK), and Pain Catastrophizing Scale (PCS). Typically, psychometric studies incorporate 1 or 2
of these measures in studies of chronic pain,1,7,23,24,26,28,53,57 with investigations using multiple FAM measures underreported in the physical therapy literature. Few studies have investigated multiple FAM measures in the same outpatient physical therapy cohort for stability (test-retest reliability), association with each other (construct redundancy), and association with clinical measures (criterion validity).

FAM measures may be very highly correlated with each other, and the resulting redundancy would suggest that 1 or 2 measures are sufficient to capture constructs of interest. This scenario was recently indicated in a study of patients with LBP that reported very high correlations (r = 0.86) between culturally adapted versions of the TSK and FABQ.7 In our own research involving patients with LBP and shoulder pain, we have seen statistically significant but lower-magnitude correlations between FAM measures (r<0.6),16,18,19 suggesting that separate measurement may be warranted. Another potential scenario is that FAM measures have differing associations with clinical measures, indicating specificity of criterion validity. We have observed this scenario in our own studies. In patients with LBP, fear of pain was associated with first-pulse thermal pain sensitivity, while pain catastrophizing was associated with temporal summation.19 In subjects with shoulder pain, fear of pain was predictive of induced pain sensitivity, while pain catastrophizing was predictive of clinical pain intensity.16

Additional measurement focused studies could assist with clinical implementation of the FAM in physical therapy settings. Therefore, the purpose of this study was to investigate 4 commonly used FAM measures in a cohort of patients with chronic LBP, who were seeking treatment at outpatient physical therapy clinics. The goals of this study were 3-fold. First, we investigated 48-hour test-retest reliability and calculated stability estimates. The novelty for the current study was that the same group of patients would complete 4 FAM measures, whereas prior studies only focused on reliability of 1 or 2 FAM measures.5,7,23,24,26,28,53,57 Second, we investigated construct redundancy by determining the amount of shared variance among the 4 FAM measures. Third, we investigated criterion validity in a multi-variable setting by determining FAM measures’ association with depression, pain intensity, physical impairment, and disability.

**METHODS**

**Overview**

This study was approved by the University of Florida Institutional Review Board, and all subjects provided informed consent before study participation was confirmed. The cohort consisted of patients with chronic LBP, because they would be clinically stable during the 48-hour test-retest period. Subjects considered for this study were recruited during routine clinical visits for physical therapy.

**Subjects**

A sample of convenience was recruited from patients seeking treatment for LBP at University of Florida-affiliated outpatient physical therapy clinics. Inclusion criteria were patients aged between 15 and 60 years who had chronic LBP (greater than 3 months in duration) with or without radiating symptoms. Patients had to have the ability to read and speak English, because numerous self-report questionnaires were used. Exclusion criteria were patients with acute/subacute LBP (less than 3 months in duration), signs of nerve root compression, lumbar spinal stenosis, and postlumbar spine surgery. Patients were also excluded for pregnancy, osteoporosis, and spinal disorders related to metastatic disease, visceral disease, or fracture. Eligible patients completed a standard questionnaire to collect demographic information that included age, sex, employment status, and prior history of LBP.

**Measures**

**FAM Measures**

Validated questionnaires commonly used to assess FAM constructs were used in this study. The FABQ was used to quantify fear-avoidance beliefs specific to LBP.61 The FABQ contains 2 scales, a 7-item FABQ work scale (FABQ-W; range, 0-42) and a 4-item FABQ physical activity scale (FABQ-PA; range, 0-24). Higher scores indicate higher levels of fear-avoidance beliefs for both FABQ scales. The FPQ was used to assess fear of pain to specific activities and events.1,40,41 A shortened 9-item version of the FPQ was used (FPQ-9), giving the scale a total range of 9 to 45, with higher scores indicating higher fear of pain. The TSK was used to assess fear of movement (kinesiophobia) and re-injury.22,43,61 We used a validated 11-item version of the TSK (TSK-11), giving the scale a range of 11 to 44, with higher scores indicating higher fear of movement and re-injury.61 The PCS was used to assess the extent of catastrophic cognitions a patient reports due to LBP.58,65 The PCS is a 13-item scale, with a total range of 0 to 52, and higher scores are associated with higher amounts of pain catastrophizing.

**Clinical Measures**

The 4 clinical measures used in this study were consistent with outcome domains recommended for chronic pain clinical trials.10 Depression was assessed as part of the emotional functioning domain.22 Symptoms of depression were assessed with the Patient Health Questionnaire (PHQ-9), a measure that has demonstrated validity in different settings.9,37 The 9 items on this questionnaire come directly from signs and symptoms of major depression. Each item is rated from 0 (not at all) to 3 (nearly every day), giving the scale a potential range of 0 to 27,22 with higher numbers indicating higher depressive symptoms. The total score PHQ-9 score was reported for the purposes of this study. To account for the pain intensity domain, subjects rated their present pain intensity using a numerical rating scale (NRS), ranging from 0 (no pain) to 10 (worst pain imaginable).30

To account for the physical function...
domain, 2 different measures were completed. First, a physical impairment scale (PIS) was performed by a physical therapist to quantify physical impairment due to LBP. The PIS consists of 7 different physical examination procedures performed by the patient, and performance for each procedure is scored as a negative (0) or positive (1) for presence of impairment. The PIS has a total range of 0 to 7, and higher scores indicate higher levels of physical impairment due to LBP. Second, self-report of disability was assessed with the modified Oswestry Disability Questionnaire (ODQ). The modified ODQ has 10 items that assess how LBP affects common daily activities such as sitting, standing, and lifting. The ODQ has a range of 0 (no disability due to back pain) to 100 (completely disabled due to back pain), with higher scores indicating higher disability from LBP.

Sample Size
The goal was to recruit 50 subjects, as this was the minimum number that would allow for planned test-retest and regression analyses. Specifically, 50 subjects allow for adequate stability estimates and multivariate regression models to be built with 5 to 10 predictor variables. If these guidelines are followed, the planned regression models will not be overfit and provide reasonable $R^2$ estimates. This sample size and resulting range of predictor variables was adequate for the maximum number of variables that would be considered in the criterion validity analysis.

Procedures
Patients meeting eligibility criteria and providing informed consent completed questionnaires and then underwent physical examination by a physical therapist (C.V. or G.Z.) to collect the physical impairment data (PIS). Subjects were then given a second set of questionnaires to take home with instructions to complete the packet 48 hours later and return them to the study physical therapist (C.V.) by using the provided, prepaid envelope. The PIS was not completed a second time.

### TABLE 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y (%)</td>
<td>44.3 (18.5)</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td>Male 10 (20%)</td>
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<tr>
<td></td>
<td>Female 43 (80%)</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td>Caucasian 36 (67%)</td>
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<tr>
<td></td>
<td>African American 16 (31%)</td>
</tr>
<tr>
<td></td>
<td>Other 1 (2%)</td>
</tr>
<tr>
<td>Employment status</td>
<td>Employed 30 (56%)</td>
</tr>
<tr>
<td></td>
<td>Not employed 23 (44%)</td>
</tr>
<tr>
<td>FABQ-PA (potential range, 0-24)</td>
<td>13.6 (6.2)</td>
</tr>
<tr>
<td>FABQ-W (potential range, 0-42)</td>
<td>13.9 (2.2)</td>
</tr>
<tr>
<td>FPQ-9 (potential range, 9-45)</td>
<td>22.9 (12)</td>
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<tr>
<td>TSK-11 (potential range, 11-44)</td>
<td>22.6 (6.5)</td>
</tr>
<tr>
<td>PCS (potential range, 0-52)</td>
<td>15.0 (12.4)</td>
</tr>
<tr>
<td>PHQ-9 (potential range, 0-27)</td>
<td>6.3 (5.7)</td>
</tr>
<tr>
<td>NRS (potential range, 0-10)</td>
<td>3.6 (2.4)</td>
</tr>
<tr>
<td>PIS (potential range, 0-7)</td>
<td>3.4 (2.2)</td>
</tr>
<tr>
<td>ODQ (potential range, 0-100)</td>
<td>22 (72)</td>
</tr>
</tbody>
</table>

Abbreviations: FABQ-PA, Fear-Avoidance Beliefs Questionnaire physical activity scale; FABQ-W, Fear-Avoidance Beliefs Questionnaire work scale; FPQ-9, Fear of Pain Questionnaire (9-items); NRS, numerical rating scale for pain intensity; ODQ, Oswestry Disability Questionnaire; PCS, Pain Catastrophizing Scale; PHQ-9, Patient Health Questionnaire (9-items); PIS, Physical Impairment Scale; TSK-11, Tampa Scale Kinesiophobia (11 items).

* Values are mean (SD) except where otherwise indicated.

Data Analysis
Descriptive analyses were generated and reported in the appropriate metric for continuous and categorical variables. Test-Retest Reliability
Reliability analyses for the 4 FAM measures included intraclass correlation coefficient (ICC$_{2,1}$) for total questionnaire scores obtained at baseline and 48 hours later. These results were reported with a 95% confidence interval (CI). From these data, the standard error of measurement (SEM) was calculated for each measure using a previously described method: $SD \times \sqrt{1 - (test-retest reliability coefficient)^2}$. The minimal detectable change (MDC$_{95}$) was also calculated using a previously described method ($1.96 \times SEM \times \sqrt{2}$) to provide a responsiveness metric.

Construct Redundancy
Construct redundancy analyses included calculation of Pearson $r$ correlation coefficients among the 4 FAM measures.

Criterion Validity
Criterion validity was assessed by 4 separate multiple regression models. These models tested FAM contributions to recommended pain clinical trial outcome domains, including emotional function, pain intensity, and physical function. The regression models consisted of a hierarchical portion to account for age, sex, and employment status. The regression models included a stepwise portion to determine which specific FAM measure had the strongest statistical association with the dependent variable of interest. Stepwise regression was warranted because we had no a priori hypothesis for FAM measure order of entry, and, as per the purpose of this study, we wanted to create parsimonious models. Variance inflation factor was reported with the final models to provide an esti-
mate of multicollinearity. The 4 separate regression models had depression (PHQ-9), pain intensity (NRS), physical impairment (PIS), and disability (ODQ) as the dependent variables. In each model, age, sex, and employment status were included as covariates in the first block of the model, followed by stepwise consideration of the FAM measures (FABQ-PA, FABQ-W, PCS, FPQ-9, and TSK).

RESULTS

Descriptive statistics for baseline measures of this cohort are reported in Table 1. Eighty-seven percent (46/53) of the subjects completed the 48-hour reliability assessment, with no differences in key variables for those that completed and those that did not complete the reliability follow-up. The data from those completing the 48-hour assessment were used for the reliability analyses, while baseline data for all 53 subjects were used for all other analyses.

Reliability

Reliability results are reported in Table 2, with ICC coefficients ranging from 0.90 to 0.97 for all questionnaires. Stability estimates (eg, SEM and MDCs) are also reported in Table 2 for each questionnaire. The MDC estimates provide a responsiveness metric by indicating how much change is necessary in a particular questionnaire to exceed measurement error.

Construct Redundancy

Pearson correlation coefficients are reported in Table 3. As expected, the FAM measures were significantly correlated with each other, with the only exception being an absence of association between the FPQ-9 and FABQ-W (r = 0.04, P > .05). The variance shared between FAM measures ranged from 9% (FPQ-9 and TSK-11) to 48% (PCS and TSK-11).

Criterion Validity

The final regression model for depression scores is reported in Table 4. In the hierarchical block, age, sex, and employment status accounted for 23% of the variance (P < .01) in depression scores. In the stepwise portion, the PCS contributed an additional 37% (P < .01) variance in depression scores. No other FAM measures contributed to the regression model for depression.

The final regression model for pain intensity ratings is reported in Table 5. In the hierarchical block, age, sex, and employment status accounted for 22% of the variance (P < .01) in pain intensity ratings. In the stepwise portion, the FABQ-PA contributed an additional 23% (P < .01) variance in pain intensity ratings. No other FAM measures contributed to the regression model for pain intensity.

The final regression model for physical impairment is reported in Table 6. In the
hierarchical block, age, sex, and employment status accounted for 31% of the variance ($P<.01$) in physical impairment. In the stepwise portion, the FABQ-W contributed an additional 13% ($P<.01$) variance in physical impairment scores. No other FAM measures contributed to the regression model for physical impairment.

The final regression model for disability, reported in TABLE 7. In the hierarchical block, age, sex, and employment status accounted for 32% of the variance ($P<.01$) in disability scores. In the stepwise portion, the FABQ-PA and FABQ-W contributed additional 23% ($P<.01$) and 8% ($P<.01$) variance in disability scores, respectively. No other FAM measures contributed to the regression model for disability.

**TABLE 5**  
Prediction of Pain Intensity With Fear-Avoidance Model Measures*  
<table>
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<tr>
<th>Beta</th>
<th>$P$-Value</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.20</td>
<td>.09</td>
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<tr>
<td>Sex†</td>
<td>-.02</td>
<td>.89</td>
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<tr>
<td>Employment status‡</td>
<td>-.22</td>
<td>.06</td>
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<tr>
<td>FABQ-PA</td>
<td>.51</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

*Final model for pain intensity ratings (NRS): $R^2 = 0.45$, adjusted $R^2 = 0.40$, $P<.01$.  
† Sex coding: 0 = male, 1 = female.  
‡ Employment status coding: 0 = employed, 1 = unemployed.

**TABLE 6**  
Prediction of Physical Impairment With Fear-Avoidance Model Measures*  
<table>
<thead>
<tr>
<th>Beta</th>
<th>$P$-Value</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.35</td>
<td>&lt;.01</td>
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<tr>
<td>Sex†</td>
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<td>.23</td>
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<tr>
<td>Employment status‡</td>
<td>-.03</td>
<td>.79</td>
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<tr>
<td>FABQ-W</td>
<td>.43</td>
<td>&lt;.01</td>
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*Final model for physical impairment scale scores (PIS): $R^2 = 0.44$, adjusted $R^2 = 0.40$, $P<.01$.  
† Sex coding: 0 = male, 1 = female.  
‡ Employment status coding: 0 = employed, 1 = unemployed.

**TABLE 7**  
Prediction of Disability With Fear-Avoidance Model Measures*  
<table>
<thead>
<tr>
<th>Beta</th>
<th>$P$-Value</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.32</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Sex†</td>
<td>-.03</td>
<td>.72</td>
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<tr>
<td>Employment status‡</td>
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<td>.57</td>
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<tr>
<td>FABQ-PA</td>
<td>.36</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>FABQ-W</td>
<td>.38</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

*Final model for disability scores (ODQ): $R^2 = 0.63$, adjusted $R^2 = 0.59$, $P<.01$.  
† Sex coding: 0 = male, 1 = female.  
‡ Employment status coding: 0 = employed, 1 = unemployed.

DISCUSSION

This study investigated test-retest reliability, construct redundancy, and criterion validity of commonly used FAM measures. A novel aspect of this study was that 4 FAM measures were used in the same cohort of patients with chronic LBP seeking outpatient physical therapy treatment. Our results suggested that FAM measures had similar levels of test-retest stability and shared low to moderate amounts of variance with each other. Multivariate models, including age, sex, and employment status were used to investigate criterion validity. In these models, the PCS contributed additional variance to depression, the FABQ-PA contributed additional variance to pain intensity, and the FABQ-W contributed additional variance to physical impairment. Both the FABQ-PA and FABQ-W contributed additional variance to self-report of disability.

It was an expected finding that the selected FAM measures demonstrated high levels of test-retest reliability, because we used previously validated measures. Collectively, these results suggest that use of a particular FAM measure in clinical settings should not be solely based on reliability estimates, as they were all similarly high (all ICCs, >0.89). Our data were somewhat unique in that stability was calculated in the same cohort of patients and included estimates of measurement error (SEM and MDC). Prior reliability studies focused on 1 or 2 measures and used different patient cohorts, making direct comparisons between FAM measures difficult. The previously cited studies also tended to focus on reporting factor structure and reliability coefficients, which do not provide a direct metric for measurement error. Measurement error estimates were included in the study from Grotle et al, who reported higher MDCs for the FABQ-PA (9 points) and FABQ-W (12 points) than we reported in the current study. Differences in these measurement error estimates could be because our cohort
these constructs by clinical measurement may be dependent on the specific questionnaire used.

The multivariate regression analyses involving chronic pain outcome domains provided novel information on criterion validity for FAM measures in outpatient physical therapy settings. In these analyses, we included age, sex, and employment status as covariates, then allowed for stepwise consideration of FAM measures. Stepwise regression was used because we had no a priori hypotheses about specific questionnaires and wanted to create parsimonious models to guide clinical recommendations. The first model investigated emotional functioning, measured by depression in this study. The PCS contributed additional variance after considering age, sex, and employment status. Pain catastrophizing has been linked to depression both theoretically and empirically, so its association with depression was expected. It was somewhat surprising that none of the fear-of-pain measures contributed to depression, given that depression and anxiety are known to be very highly correlated.

The other regression models investigated pain intensity, physical impairment, and self-report of disability. In these analyses, the FABQ was consistently the only FAM measure entered into the multivariate regression model after age, sex, and employment status were considered. Specifically, the FABQ-PA contributed additional variance in pain intensity and disability, while the FABQ-W contributed additional variance to physical impairment and disability. The association of fear of pain with pain and disability is not a novel finding in itself. However, it is a novel finding that neither the other fear measures (TSK-11 and FPQ-9) nor the pain-catastrophizing measure (PCS) contributed to these regression models.

These analyses have potential implications for those measuring FAM constructs in outpatient physical therapy settings. There are many measurement options available to assess FAM constructs, and our results indicated that these measures performed in a similar fashion in test-retest reliability. That is, all of the selected FAM measures had stability estimates consistent with use in clinical settings for patients with chronic LBP. Furthermore, all FAM measures were susceptible to varying extent of construct redundancy with each other. The lone exception to the construct redundancy trend was for the FPQ-9, a measure that is not often used clinically, based on our experiences. Therefore, our clinical recommendations are derived from the criterion validity analyses. These results suggested that assessment of the FAM for patients with chronic LBP should include the PCS and the FABQ. Specifically, the PCS should be used for those interested in determining the fear-avoidance influence on emotional functioning, while the FABQ should be used for determining the fear-avoidance on pain intensity and physical function.

Several limitations should be considered when interpreting the results of this study. First, the validity analyses were cross-sectional, and our data cannot be used to make conclusions about the predictive validity of these measures. Future studies that incorporate longitudinal designs will determine which FAM measures are predictive of outcomes of interest. Second, this study recruited patients who were already considered to have chronic LBP, so these data cannot be used to make conclusions about the development of chronic LBP. Future studies that incorporate an inception cohort of patients with acute LBP will determine if elevated pain-related fear and pain catastrophizing are precursors to the development of chronic LBP. Third, this study had a relatively small sample size. The sample size was sufficient to investigate our stated purposes. However, there is a chance of type II error with our sample size and it should be noted that we are potentially underestimating the influence of the other FAM measures. Type II error does not seem to be a con-
cern with our models for depression and disability, as the variance explained was 60% and 63%, respectively. However, the models for pain intensity and physical impairment had only 45% and 44% variance explained, respectively. We acknowledge that these regression models in particular may have included other FAM measures if a larger sample was recruited. Future prospective studies with larger sample sizes will be able to draw more definitive conclusions about measurement of pain intensity and physical impairment. Fourth, the associations reported in this study are specific to the clinical measures used in this study, and the same influences cannot be assumed for other measures of depression, pain intensity, physical impairment, or disability. Fifth, while we included 4 commonly used FAM measures in this study, this was not a comprehensive investigation of FAM measures. Most notably, we did not include the Pain Anxiety Symptoms Scale.69 We also did not include recently proposed measures that assess fear related to specific activities, such as the Fear of Daily Activities Questionnaire72 and the Photograph Series of Daily Activities short electronic version.73

CONCLUSION

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his study recruited subjects with chronic LBP who were seeking outpatient physical therapy interventions, to investigate test-retest reliability, construct redundancy, and criterion validity for 4 commonly used FAM measures. The results suggest that FAM measures had similar levels of stability and shared varying amounts of variance with each other. Multivariate models controlled for age, sex, and employment status indicated that only the PCS contributed additional variance to depression. The FABQ contributed additional variance to pain intensity, physical impairment, and disability in the multivariate models. Therefore, these data suggest that the PCS and FABQ should be used to assess FAM constructs for patients with chronic LBP seeking outpatient physical therapy.

KEY POINTS

FINDINGS: Four commonly used FAM measures had similar test-retest stability estimates and shared low to moderate amounts of variance with each other. The PCS was associated with depression, and the FABQ was associated with pain intensity, physical impairment, and disability.

IMPLICATIONS: Assessment of FAM constructs for patients with chronic LBP in physical therapy settings should include the PCS for emotional function and the FABQ for pain intensity and physical functioning.

CAUTION: The results of the present study cannot be used to make clinical decisions about the predictive validity of any of these FAM measures.

ACKNOWLEDGEMENTS: Giorgio Zeppieri, Jr assisted with data collection.

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