# Validation of a New Instrument for Evaluating Low Back Pain in the Young Athlete

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**Objective:** To validate a back-specific instrument for functional assessment in the young athlete for clinical and research purposes, the Micheli Functional Scale (MFS).

Design: Prospective cohort study, Diagnostic Level II.

Setting: Division of Sports Medicine Clinic, Children's Hospital Boston.

**Participants:** Male and female patients aged 12 to 22 with and without low back pain.

**Interventions:** Patients presenting with back pain were compared with a control group of patients presenting with complaints other than back pain. Both groups were given the modified Oswestry Low Back Pain Disability Questionnaire (ODQ) and MFS.

**Main Outcome Measures:** Micheli Functional Scale and ODQ score correlations.

**Results:** A total of 94 patients were enrolled (44 patients with low back pain and 50 patients without low back pain). Ages ranged from 12 to 22 for both groups, with no differences in age (P = 0.07) or gender (P = 0.50). Patients with back pain had significantly higher ODQ scores (median, 32 points) and MFS scores (median, 47 points) compared with controls (median, 0 points; P < 0.0001). These results held for male and female patients and younger (12-16.99 years) and older (17-22 years) age groups. The Pearson correlation coefficient showed a high positive correlation between MFS scores and ODQ scores (Pearson r = 0.90, P < 0.0001). Cronbach level indicated excellent item reliability on the MFS ( $\alpha = 0.904$ , P < 0.0001).

**Conclusions:** The MFS is a valid instrument for assessing pain and functional levels in the young athlete. This scale considers pain, athletic function, and athletic disability.

Key Words: athletic low back pain, functional assessment, reliability, validity, Micheli Functional Scale

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INTRODUCTION

Clinicians and researchers increasingly recognize the need to consider a disease from the patient's perspective and consequently measure important patient-related factors. Many back-specific instruments have been developed over the last decade. A recent review identified 36 back-specific questionnaires attempting to address patient perceptions of their back trouble.<sup>1</sup> All these questionnaires used a mixture of measurement tools. For example, function was measured by various constructs, such as pain and symptoms of sleep disturbance, psychological dysfunction, physical impairment, and social function. Nine questionnaires solely assessed activities of daily living and none assessed sports-related limitations or dysfunction. Despite the amount of back-specific questionnaires, choosing the "ideal" outcome measure is difficult because each instrument offers advantages and disadvantages depending on the patient and the aspect of functioning measured.

Deyo and Diehl<sup>2</sup> proposed a standardized core set of instruments measuring 5 domains: pain symptoms, back-related function, generic well-being, disability, and satisfaction with care. An expert panel updated these recommendations in 2000.<sup>3</sup> Modified Oswestry Low Back Pain Disability Questionnaire (ODQ) and the Roland-Morris Disability Questionnaire (RMDQ) are the most commonly used outcome measures for back pain.<sup>4,5</sup> The RMDQ is primarily a measure of function, whereas the ODQ incorporates a measure of pain and physical function. Nonetheless, in practice, the differences between these instruments are relatively small. Although they are easy to use, reliable, and valid, the ODQ is sometimes preferred because it assesses the level of pain along with interference with physical activity, which is crucial from the patient's perspective.

Ideally, young patients who are very active and participate in sports or high-demand activities should be evaluated for symptoms and disability in the context of their sport and level of activity. In fact, patients in this population have different expectations and demands than most working and sedentary patients. To our knowledge, there are currently no outcome rating scales that evaluate patients' functional status in relation to sports activity.

Over the past 10 years in our clinic, we have used a short athletic functional scale in the young athlete with low back pain, the Micheli Functional Scale (MFS). This is a back-specific rating scale for youth sports activity levels, which is easily self-administered in a short duration of

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time (usually 5-10 minutes). This scale allows determination of the amount of flexion, extension, or jumping limitation along with sports limitation and pain quantification. The purpose of this study was to determine if this new scale differentiates the athlete with low back pain from ageand gender-matched controls with no back pain. Furthermore, we will measure the correlation between scores obtained from the MFS to those of the ODQ, the gold standard in this study. The modified ODQ is a well-established instrument for back pain but lacks functional evaluation of the young athlete.

### MATERIALS AND METHODS

The study was approved by the Children's Hospital Boston Institutional Review Board. All patients presenting to the Division of Sports Medicine at Children's Hospital Boston, between 12 and 22 years of age, which were not currently taking mind-altering medications were eligible to participate in the study. If the patient presented with back pain, he or she was included in the back pain group. If the patient presented with an issue other than back pain, he or she was included in the control group. After consent, all subjects were asked to complete 2 questionnaires: the modified ODQ<sup>6</sup> and the MFS. The modified ODQ is a 10-item questionnaire designed to measure how back pain affects patients' everyday life. This questionnaire is validated and widely used in orthopedic clinical trials. Components of the ODQ include pain intensity, personal care, activities of daily living, traveling, and changing degree of pain. Each item is scored on a scale of 0 to 5, with 0 being the least amount of symptoms and 5 the most. The total score is calculated by multiplying the sum of the responses by 2 and then dividing the total by the percentage of answered questions.

$$(\text{Score} \times 2) / (\text{\_Sections Answered} \times 10) = \text{\_ODQ}.$$

A score of 0 indicates no disability, 0% to 20% indicates minimal disability, 20% to 40% moderate disability, 40% to 60% severe disability, 60% to 80% crippled, and 80% to 100% bed bound.<sup>4</sup>

The MFS is a 5-item questionnaire (Figure 1). Components include a symptom question, 3 activity-related questions (extension, flexion, and jumping), and a visual analog scale (VAS) for degree of pain. The questionnaire is designed to assess symptoms of back pain and ease or difficulty of performing various sporting activities relative to low back pain. Responses from the symptom question (0-5 points) and the 3 activity questions (extension, 0-4; flexion, 0-3; jumping, 0-3) total 15 points. The visual analog scale is scored on 10 points based off a 10-cm line. Overall score is determined by adding questionnaire responses plus VAS score. This summation may equal a maximum score of 25. This number is then multiplied by 4.  $(Symptoms + Extension + Flexion + Jumping + VAS) \times 4$ 

= \_\_\_\_\_MFS.

The total scores range from 0 to 100. A score of 0 is optimal and indicates the least amount of difficulty.

### **Statistical Analysis**

Low back pain and control study groups were compared using the 2-sample Student t test for age, Fisher exact test for gender, and the nonparametric Mann-Whitney U test for the ODQ and MFS.<sup>7</sup> Because functional scores were not normally distributed as assessed by the Kolmogorov-Smirnov and Lilliefors tests, they are reported in terms of the median, interquartile range (IQR), and full range for all groups. The Pearson correlation coefficient (r) was used to measure the linear association between MFS and ODQ scores with a regression line for describing the best fit.8 Cronbach alpha was used to measure reliability of the 5 items on the MFS.<sup>9</sup> Power analysis indicated that the number of back pain patients and controls overall and within the 2 age categories provided 80% statistical power (2-tailed  $\alpha = 0.05$ ,  $\beta = 0.20$ ) for detecting significant median differences of 20 points between the groups on the MFS using the Mann-Whitney U test to validate the use of the MFS for younger and older athletic patients with suspected lower back pain (version 7.0, nQuery Advisor; Statistical Solutions, Saugus, Massachusetts). Statistical analysis was performed using the SPSS software package (version 18.0; SPSS, Inc, Chicago, Illinois). Two-tailed values of P < 0.05 were considered statistically significant.

### RESULTS

Ninety-four patients were enrolled in this study (44 back pain patients and 50 controls). There were no differences in mean age (P = 0.07) or gender (P = 0.50) between the 2 groups. Both groups on average were 16 to 17 years of age (range, 12-22 years) and had a predominance of female patients (Table 1). Patients with low back pain had significantly higher ODQ scores (median, 32 points; range, 4-70 points) compared with controls (median, 0 points; range, 0-28 points) (P < 0.0001). Similarly, the back pain group had significantly higher MFS scores (median, 47 points; range, 10-82 points) than controls (median, 0 points; range, 0-53 points) (P <0.0001). The Pearson correlation coefficient showed a high positive correlation between MFS and ODQ scores (r = 0.90, P < 0.0001), indicating that patients with high MFS scores also tend to have high ODQ scores and those with low MFS scores tend to have low ODQ scores (Figure 2). Box and whisker plots illustrate significantly higher median scores and IQRs for both ODQ and MFS scores in patients with low back pain than agematched controls (Figure 3).

Back pain patients and controls were divided into 2 age subgroups (12-16.99 and 17-22 years) to compare ODQ and MFS scores between low back pain patients and controls for younger and older patients separately (Table 2). Younger low back pain patients had significantly higher ODQ scores than their age-matched controls with medians of 28 and 0 points,

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## **MICHELI FUNCTIONAL SCALE**

Instructions: This survey asks for your assessment of back-pain and functional impairment. For each of the following questions, please mark the ONE appropriate response.

#### (A) Symptoms:

To what degree does pain affect your sports activity? 1.

- No pain
- Pain is not affecting sports activity
- Pain has a slight or minimal effect on sports activity
- Pain has a moderate effect on sports activity
- Pain has a severe effect on sports activity
- Unable to participate in sports activity due to pain

#### **(B)** Activities of daily living:

- 1. To what degree is your pain associated with back extension (bending backwards) and/or upright activities?
  - Able to run full speed and extend without limitations
  - Able to run but extension causes some pain
  - Running and extension cause pain
  - Unable to extend at all
  - Unable to run or extend
- 2. To what degree is your pain associated with sitting and/or flexion (bending forward) activities?
  - Able to sit and flex at Lumbar Spine without limitations
  - Able to sit, but feel some pain with flexion activities
    - Sitting and flexion activities cause pain
  - Unable to sit or do loaded flexion activities
- 3. To what degree is your pain associated with jumping?
  - Able to jump without pain
  - Jumping causes some pain
  - Jumping causes severe pain
  - Unable to jump due to pain

#### **(C)** Visual Analogue Scale for Pain Assessment:

1. If the left extremity of the line indicates no pain, and the right end indicates such severe pain that you are unable to work or go to school, rate the intensity of your pain by marking an X on that part of the line which most corresponds to your experience.

Most Severe Pain

No FIGURE 1. Micheli Functional Scale.

respectively (P < 0.0001). Similarly, for younger patients, MFS scores were significantly higher than controls with medians of 47 and 0 points, respectively (P < 0.0001). Among older patients, the median ODQ score among back pain patients was 32 points (range, 14-56 points) compared with 0 points for controls (range, 0-20 points) (P < 0.0001). The median MFS was 46 points (range, 18-82 points) for back pain patients aged 17 to 22 years compared with median scores of 0 points (range, 0-51 points) for controls (P < 0.0001).

Cronbach level, a psychometric measure of internal reliability, indicated excellent interitem reliability among the 5 items on the MFS ( $\alpha = 0.904$ , P < 0.001). The modified ODQ and MFS scores were also compared between low back pain patients and controls for each gender (Table 3). For each gender, ODQ and MFS scores clearly differentiate back pain from control. Among female patients, median ODQ score was 34 points (range, 4-56 points) for back pain group and 0 points (range, 0-28 points) in the control group (P < 0.0001).

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TABLE 1. Demographics, MFS, and ODQ Scores for the Study Groups

Variable	Control Group (n = 50)	Back Pain Group (n = 44)	Р
Age, y			
Mean $\pm$ SD	$16.2 \pm 2.7$	$17.0 \pm 2.3$	
Range	12-22	12-22	0.07
Gender, n (%)			
Female	33 (66)	32 (73)	
Male	17 (34)	12 (27)	0.50
ODQ			
Median (IQR)	0 (0-7)	32 (22-45)	< 0.0001*
Range	0-28	4-70	
MFS			
Median (IQR)	0 (0-6)	47 (36-62)	< 0.0001*
Range	0-53	10-82	
SD, standard dev *Statistically sign	iation. hificant.		

Similarly, MFS scores were significantly higher among back pain patients, with median of 47 points (range, 10-82 points) and 0 points (range, 0-51 points) for back pain patients and controls, respectively (P < 0.0001). Among male patients, median ODQ score was 28 points (range, 16-70 points) for the back pain group compared with 0 points (range, 0-14 points) for control group (P < 0.0001). The MFS scores were also significantly higher among male back pain patients, with median of 45 points (range, 14-79 points) and 0 points (range, 0-53 points) for back pain patients and controls, respectively (P < 0.0001).

### DISCUSSION

This study evaluated young athletes with low back pain using 2 scales: a gold standard ODO and the new MFS. The main objective was to determine whether these 2 scores were



FIGURE 2. Pearson correlation coefficient showing high correlation between MFS and ODQ.

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70 60 Functional Score 50 47 P < 0.0001 40 32 P < 0.0001 30 20 10 0 **Control Group** Control Group Back Pain Back Pain **Oswestry Score** Micheli Score

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FIGURE 3. Box and whisker plots showing higher MFS and ODQ median scores and IQRs in the back pain group.

able to differentiate young athletes with low back pain from controls. Both scores realized a high statistical significance, and this is demonstrated in Table 1.

The age range of 12 to 22 years is a rather broad range during the maturation of the young athlete. The pubertal growth spurt occurs during the age of 9 to 13 in girls and 10 to 17 in boys.<sup>10</sup> It is during the growth spurt that lumbar lordosis increases and the prevalence of low back pain increases.<sup>11,12</sup> Therefore, we stratified the groups from 12 through 16.99 and 17 to 22 years. This allowed us to differentiate the athlete during the time of growth from the more mature athlete. With this stratification, both the younger and the more mature athlete again demonstrated significantly higher scores on both the MFS and ODQ scores than controls. The MFS differentiated low back pain patients from controls when evaluating all patients and a high level of differentiation was also found when considering younger and older subgroups and male and female patients separately. This indicates excellent generalizability of the MFS. The high correlation between scores obtained on the MFS and those on the ODQ demonstrate validity with the gold standard (Figure 2).

The MFS demonstrated excellent correlation with the ODQ gold standard and significantly identified back pain in both younger and older patients and among female and male patients, indicating a valid and widely applicable clinical tool. Furthermore, Cronbach alpha for the 5 items on the MFS showed excellent interitem reliability ( $\alpha = 0.904$ ) and thus excellent internal consistency in measuring low back pain. However, a larger prospective study is needed to better quantify the MFS levels with sports disability.

There are several limitations to this study. For example, in the younger age group, there was an unequal distribution of back pain and controls. Furthermore, there was a disproportionate amount of male and female patients with low back pain in the study. There were only 12 male patients with low back pain. This may be explained by the large portion of dancers and figure skaters in this clinic population. Nonetheless, it questions the external validity of this subgroup. Another limitation is the

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Score	Ages (12–16.99 y)			Ages (17–22 y)		
	Control (n = 30)	Back Pain (n = 17)	Р	Control $(n = 20)$	Back Pain (n = 27)	Р
ODQ						
Median (IQR)	0 (0-7)	28 (19-38)	< 0.0001*	0 (0-7)	32 (24-48)	< 0.0001*
Range	0–20	4-70		0–28	14–56	
MFS						
Median, IQR	0 (0-6)	47 (32–64)	< 0.0001*	0 (0-8)	46 (37-60)	< 0.0001*
Range	0-53	10-79		0-51	18-82	

TABLE 3. ODQ and MFS Scores for Back Pain and Control Groups Stratified by Gender

Score	Female Patients			Male Patients		
	Control (n = 33)	Back Pain (n = 32)	Р	Control (n = 17)	Back Pain (n = 12)	Р
ODQ						
Median (IQR)	0 (0-8)	34 (22–48)	< 0.0001*	0 (0–3)	28 (19-37)	< 0.0001*
Range	0-28	4–56		0-14	16-70	
MFS						
Median (IQR)	0 (0–10)	47 (36-60)	< 0.0001*	0 (0–2)	45 (31–71)	< 0.0001*
Range	0-51	10-82		0-53	14-79	

lack of correlating levels of the MFS scores into levels of sports disability as minimal, moderate, and severe. Further studies should look at a larger spectrum of athletes in this age group and quantify levels of sports disability with the MFS. Such information may be helpful in return to play criteria.

### CONCLUSIONS

The advantage of the MFS as a tool in evaluating low back pain in the young athlete is that it represents a brief and reliable measure of pain and athletic function, without including items that are more relevant to the adult working population. Furthermore, the score offers some insight to the clinician, with the pain description aggravating maneuvers of jumping, flexion, or extension.<sup>13</sup> This may give some anatomic clue to the anatomy of the pain generator. The MFS is a new tool that will allow an accurate evaluation of young athlete's back pain and function and can be used for a broad range of ages from 12 to 22 years and for both male and female patients. As a research tool, it will offer better validation of treatment options for back pain in the young athlete.

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