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Factor Analysis for the Newly Adapted Arabic Version of Micheli Function Scale

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Abstract

Background: The Micheli function scale (MFS) is a commonly used self-reported outcome measure in young athletes with low back pain.

Aim of Study: The Aim of this study was to conduct an exploratory factor analysis (EFA) of the newly translated and cross-culturally adapted Micheli function scale-Arabic version (MFS-AR).

Material and Methods: An EFA using the principal component analysis (PCA) method was conducted on a sample of 77 young athletes with low back pain. The Oblique (non-orthogonal) rotation method was used. The Eigenvalue of 1.00 was used as a cutoff point to retain a factor. A scree plot was produced to visually examine the eigenvalues. Item loading on factors with a value greater than 0.4 was considered enough to show a satisfactory inclusion in the structure.

Results: The Kaiser-Meyer-Olkin (KMO) value of 0.852 with Bartlett's test of sphericity (p<0.01) justified the appropriateness of running the factor analysis. The analysis produced a one-factor structure which accounted for 67% of the total variance.

Conclusion: The newly adapted MFS-AR items can be abridged to one factor since items are loaded on a one-factor structure.

Key Words: *Factor analysis – Principal component analysis – Micheli function scale.*

Introduction

LOW back pain (LBP) is a global musculoskeletal problem **[1]**. Low back pain is also a common complaint among athletes, with an even higher prevalence compared with the general population **[2].**

The most common predisposing factor for LBP is a recent increase in the intensity and volume of physical conditioning exercises or sports participation. Several causes should be considered in the differential diagnosis of lower back pain in young athletes **[3]**.

Young patients who are physically active and participate in sports or high-demand activities should ideally be evaluated for symptoms and disability in the context of their sport and level of activity. Patients in this category, in reality, have different expectations and needs than the majority of working and sedentary patients **[4]**.

A short athletic functional scale for young athletes with low back pain was developed in 2012, 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 time (usually 5-10 minutes). This scale allows the determination of the amount of flexion, extension, or jumping limitation along with sports limitation and pain quantification **[4].**

In 2015, Naghdi translated and culturally adapted the Micheli functional scale (MFS), a self-report questionnaire developed to evaluate young athletes with low back pain (LBP) inthe Persian language and examine the reliability and validity of the Persian MFS (PMFS) **[5].** Recently, the same authors of this study also cross-culturally adapted and translated it into Arabic and examined its psychometric properties.

Exploratory factor analysis (EFA) is a widely used statistical method of data reduction. A questionnaire or self-reported outcome measure can be used to better show how multiple items of a questionnaire load or unload on a shortened version of a structure **[6].** Therefore, this study aimed to perform an EFA of the newly cross-culturally adapted Arabic version of the Micheli function scale (MFS-AR). A previous study by the same authors of this one per-

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formed the cross-cultural adaptation and the translation of the MFS.

Material and Methods

This cross-sectional analysis was an extension of the previous study to further examine the properties of the MFS-AR. It is a self-report questionnaire with 5 items. A symptom question, three activity-related questions (extension, flexion, and jumping), and a visual analog scale (VAS) for the degree of pain are included. It was performed on 77 young athletes with low back pain after obtaining their consent to participate.

This study was conducted with different sports teams in sporting club from 2022-2023.

Ethical consideration:

The study has been approved by the ethical committee of the Faculty of Physical Therapy, Cairo University, approval number: P.T.REC/012/004034. The participants signed an informed consent form before the data collection. The procedure reported in the manuscript was performed following the ethical standards of the Helsinki Declaration of 1975 for studies involving human subjects.

Statistical analysis:

For factor analysis, EFA using principal component analysis (PCA) was conducted using the statistical package for social sciences (SPSS) computer program version 27 software for Windows (IBM SPSS Inc., Chicago, IL, USA). The Eigenvalue of 1.00 was set as a cutoff to exclude or include factor (retained if Eigenvalue greater than 1.00). A visual interpretation of the factors was performed by using a scree plot to visually examine the eigenvalues **[7].** The number of dots before which the line breaks or changes from vertical to horizontal is usually the number of the retained factors **[6].**

An oblique (nonorthogonal) rotation method (oblimin) was then conducted to further clarify factor rotation. This was chosen because we hypothesized that pain and function items of the questionnaire would hypothetically be correlated with one another and consequently the produced factors would be correlated with one another. Item loading on a factor with a value greater than 0.4 was considered enough to show a satisfactory inclusion in the structure **[6].**

Results

Subject baseline characteristics are shown in Table (1). For factor analysis, the Kaiser-Meyer-Olkin value was 0.852 with a highly significant Bartlett's test of sphericity ($p<0.001$). This justified the appropriateness of running EFA since the intercorrelation between the questionnaire items is high. The analysis produced a one-factor structure which accounted for 67% of the total variance with loading between 0.748 and 0.861. The cumulative percentage of extraction sums of squared loadings showed that the one-factor structure has the highest factor loading.

Factor 1 explained 67% of the variance, factor 2 explained 12% of the variance, and factor 3 explained 8.7% of the variance. This one factor was retained because the Eigenvalue was greater than 1.00. Items loading on the factor structure are presented in Table (2). The factor correlation matrix shows a low to moderate correlation between the one-factor solutions. The correlation ranged between 0.748 and 0.861 (Table 2).

Table (1): Baseline characteristics of participants (n=77).

Gender distribution	66% females, 34% males
Medication received	25% not received,17% analgesics, 11% muscle relaxants, 22% NSAIDs, 5% analgesics and muscle relaxants
Surgical intervention	97% non-surgical, 3% surgical

Abbreviations:
NSAIDs = Non-steroidal anti-inflammatory drugs.

Table (2): Component matrix. Rotation method: Oblimin with Kaiser normalization (reporting only items with high loading on each factor)

Item 2	.861
Item 5	.856
Item 4	.849
Item 3	.775
Item 1	.748

Discussion

Understanding the psychometric properties of new outcome measures is an essential component in analyzing the usefulness of their usage **[6,8,9]**. Factor analysis was performed to explore if the questionnaire items can be meaningfully clustered into smaller factors and to investigate the loading of the items on the factors.

The choice of the rotation method in the PCA is to simplify and clarify the questionnaire items and to show how they load on the produced structure. The oblique (nonorthogonal) method of rotation such as "direct oblimin" and "Promax" is best when the items are somehow correlated. On the other

hand, an orthogonal method of rotation such as "varimax" should be used when the items do not seem to be correlated [6]. Since the items of the MFS are pain and function, the choice of a nonorthogonal (oblique) rotation method was prioritized.

Using an oblique rotation method, an author recommended that data should be examined in the structure rather than the pattern matrix since the structure matrix shows the item-factor correlation and can be easily interpreted [10]. Another author [6], recommend reporting the pattern matrix over the structure matrix since it shows the factor loading of each item with each factor structure which is considered the actual regression coefficient and indicates how much variance is explained by each item in the factor. In the current study, we reported the values of the pattern matrix as we felt it accurately defines the relationship between the item loading and the factor structure.

The result of this work should be interpreted with caution since a small sample size would not efficiently produce an accurate factor analysis. The larger the sample size, the more accurate representation of the factor analysis would be. While Fabrigar et al. [11] and MacCallum et al. [12] reported that the sample size for factor analysis should be based on the nature of the data; the more the data have high commonalities in the analysis, the smaller the sample size needed. The commonalities are considered high when the value is 0.8 or greater (which rarely occurs). In the cross-cultural adaptation of self-reported outcome measure, however, the best-reported method for sample size calculation would be the subject-to-item ratio. Some studies report that the needed sample should be 10 subjects per questionnaire item [6], other reports 20, 5, or 2 subjects per item [13,14]. In factor analysis studies, "the more is better" [6].

As a rule, a factor with fewer than 5 items with a score of less than 0.5 is considered a weak factor structure [6]. In the current analysis, the three produced factors have more than 5 items with a score higher than 0.5 which substantiated the model produced by the analysis. The one-factor structure is considered solid according to this interpretation.

It is also important to highlight that the nature of factor analysis is exploratory and not inferential. Factor analysis is designed to explore data of a given item questionnaire. It should not be interpreted in the sense of testing hypotheses. It, therefore, should not be used to infer substantive conclusions relative to testing hypotheses. In the same sense, it is subjected to errors if the procedure is not conducted correctly if missing data is present if the sample size is extremely small, and/or if the correct extraction and/or rotation method is not used. If a decisive conclusion is an aim, then other forms of analysis such as confirmatory factor analysis (CFA) should be used. The CFA is more helpful in testing an already established instrument and provides more decisive conclusions [6].

Limitation:

1- Errors can occur if the procedure is not followed correctly, if incomplete data is provided, the sample size is too small, and/or an appropriate extraction and/or rotation method is not utilized.

2- Factor analysis is designed to examine data of a certain item questionnaire rather than get significant conclusions about testing hypotheses. It is not used to infer substantive conclusions about testing hypotheses.

3- Other types of analysis, such as confirmatory factor analysis (CFA), should be utilized. CFA is more useful in evaluating an already established instrument and delivers more conclusive results.

Conclusion:

This study extracted a one-factor structure for the Arabic version of the Micheli function scale. The "function" items of the questionnaire loaded heavily on factor 1 with less representation of the "pain" items of the questionnaire in the factor structure. The result of this study should be interpreted with caution since a small sample size may produce a less accurate conclusion of the factor analysis.

Recommendations:

It is recommended that future studies:

- More studies are required with a larger sample size.
- Confirmatory factor analysis (CFA), should be utilized as other types of analysis, this is more useful in analyzing an existing instrument.

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Conflict of interest:

The authors declare that they have no competing interests.

Author contribution:

The authors contributed equally to the study.

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تحليل عامل للنسخة العربية المعدلة حديثًا لمقياس ميشيلى الوظيفى

الهدف من البحث: كان الغرض من هذه الدراسة هو إجراء تحليل عامل استكشافي (EFA) لمقياس ميشيلى الوظيفى المترجم حديثًا والمتكيف عبر الثقافات – النسخة العربية (MFS–AR).

طريقة البحث: تم إجراء EFA باستخدام طريقة تحليل المكونات الرئيسية (PCA) على عينة من ٧٧ رياضيًا شابًا يعانون من آلام أسفل الظهر. تم استخدام طريقة الدوران المائلة (غير المتعامدة).

نتائج البحث: بررت قيمة Kaiser–Meyer–Olkin (KMO) البالغة ٠,٨٥٢ مع اختبار Bartlett للكروية (p <٠,٠١) ملاءمة تشغيل تحليل العوامل. أنتج التحليل بنية ذات عامل واحد تمثل ٦٧٪ من التباين الكلى.

الاستنتاجات: يمكن اختصار عناصر MFS–AR المعدلة حديثًا إلى عامل واحد حيث يتم تحميل العناصر على هيكل أحادي العامل.