

[Orthopaedic Surgery]

Is the Marx Activity Scale Reliable in Patients Younger Than 18 Years?

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Background: There is no baseline activity scale yet validated in pediatric patients. The Marx and Tegner scales have been validated in adult patients only. The Tegner scale involves questions not pertinent to children, such as their work activity. The Marx scale is simple, and all its questions can be related to athletic activities.

Hypothesis: The Marx scale is reliable for use in a pediatric population.

Study Design: Cohort study.

Level of Evidence: Level 2.

Methods: Patients younger than 18 years were given the Marx activity scale in clinic and again 3 weeks later. The patients were divided into 3 groups, of at least 50 patients each, based on presenting diagnosis: knee injury, lower extremity (non-knee) injury, and upper extremity injury. Test-retest reliability was determined for the overall scores and the individual questions. Differences in scores were also compared based on age (<14 vs ≥14 years).

Results: A total of 162 patients (mean age, 14.4 years; range, 8-17 years) were included. The Marx scale had a high intraclass correlation coefficient (ICC) overall as well as for each of its 4 questions. Both older and younger patients had ICCs >0.80, though the older group generally had higher scores. The mean score was 13.55 (out of 16), and 50.6% scored the maximum; only 1.9% scored the minimum. Mean scores for the knee, lower extremity, and upper extremity groups were 13.71 (SD, 3.70), 13.22 (SD, 4.18), and 13.68 (SD, 3.33), respectively ($P > 0.05$). There also was no difference in total score based on age ($P = 0.88$).

Conclusion: The Marx activity scale is reliable in patients younger than 18 years with injuries to the knee and lower extremities, though the scale was less reliable in patients younger than 14 years. There is a significant ceiling effect present, which limits its overall usefulness.

Clinical Relevance: Although there is no other current substitute, the Marx activity scale is not an ideal measurement of younger patients' baseline activity levels.

Keywords: activity scale; pediatric; sports; knee

Patient-reported outcomes measures have become an important component of determining patient outcomes after sports-related injuries treated both surgically and nonsurgically.^{2,4,5,8,9,13,15,16,18,20-22,24,25,28} An important component of patient-reported outcomes measures is the baseline activity level of a patient, which is in effect a functional measure of musculoskeletal health. It is important to be able to quantify a patient's activity level so it can be evaluated within a context of other patients for both research needs and for comparison with population normative data when treating injuries.

Commonly used activity rating scales have only been validated in adults and include the Marx and Tegner activity scales.^{19,27} The Marx activity scale has been previously validated in a sports medicine clinic in adult patients and subsequently has been used in many published studies. Some of these reported results in pediatric patients are as part of a mixed patient population that also included adults.^{5,9,15,25} This scale has not been previously validated in a pediatric population. Other knee rating systems incorporate an activity scale within the subjective portion of the score. Both the Tegner activity scale and the

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Lysholm activity subset question factor in work-related activities, making their adaptation to a pediatric population difficult.^{17,26} There has been 1 validated pediatric sports activity scale intended to measure current (though not baseline) patient activity level based in part off of the Marx scale, though it has yet to be used in the published orthopaedic surgery literature.⁶

There are other existing pediatric orthopaedic rating scales, though they are typically targeted at a patient's current activity level as opposed to baseline uninjured function.^{11,12,23,27} Some of those have targeted pediatric patients with baseline functional disabilities as opposed to physically healthy children who sustain an injury.²³ Additionally, some of these scales can be time consuming and can be specific to an activity or joint.^{11,12,27} Last, there are outcome tools adapted for pediatric patients such as the pediatric International Knee Documentation Committee (pedi-IKDC) form, though these are instruments that measure current subjective and objective knee function as opposed to baseline subjective knee activity level.¹² This makes them difficult to apply to a busy outpatient sports medicine orthopaedic clinic. Given its simplicity (only 4 questions), easy readability (grade 4), sports participation focus, and prior use in the sports medicine literature, the Marx activity scale would be an ideal activity scale for pediatric sports medicine.

The purpose of this study was to determine whether the Marx activity scale is reliable in patients younger than 18 years with knee and other lower extremity injuries. We hypothesized that the Marx scale would be reliable when used in the pediatric population.

METHODS

This study was approved by our university's institutional review board prior to initiation. Participants and their parents or legal guardians gave consent. Patients were identified in our pediatric sports medicine outpatient clinic. Inclusion criteria were patients 17 years of age and younger being seen for an injury in our clinic that involved the lower extremity or upper extremity. Patients who were 18 years or older, as well as patients with neck or spine injuries, were excluded. Patients with a documented history of developmental delay were also excluded. No patient or parent refused participation in the study. Patients were read aloud the Marx activity scale while also given the scale to read. Any questions regarding the meaning of the questionnaire were answered to ensure patient comprehension. Parents were allowed to be present during the questioning and were allowed to assist with questionnaire interpretation. Parents were not allowed to assist in the actual answering of any questions. Patients were then given the same questionnaire again 3 weeks later for test-retest reliability testing in clinic at a follow-up visit or were contacted by phone at that time if they were not planning a return visit.^{1,14} They were blinded to the results given the first time they answered the activity scale.

The Marx activity scale consists of 4 questions regarding the frequency (<1 time/mo, 1 time/mo, 1 time/wk, 2 or 3 times/wk,

≥4 times/wk) each of running (question 1), cutting (question 2), decelerating (question 3), and pivoting (question 4) in the past year. Patients must pick 1 of the 5 options given regarding the frequency of participation in each of these 4 activities, and the questions were scored 0 to 4. The scale was totaled out of a possible maximum score of 16. A higher score indicates a higher level of activity.

Patients were divided into 3 groups: knee injuries, non-knee lower extremity injuries, and upper extremity injuries. Recruitment continued until all 3 groups had achieved a minimum of 50 patients with initial and 3-week follow-up data. A pre hoc power analysis assuming less than a 2-point difference in the measures indicated a sample size of 50 per group was needed.²² The patients were also divided into 2 groups based on age (14 years and up and <14 years) to see whether there was a difference based on age. Fourteen years was used as a rough estimate of entering high school and is a marker for more advanced education, which may lead to better survey comprehension as well as differing levels of sports participation. Descriptive frequencies were calculated for all questions. Injury types were compared using analysis of variance. Total scores overall and among the age groups were compared using a Student *t* test and within each group using a paired Student *t* test. Test-retest reliability was performed for patients as a whole as well as for each individual injury group, and intraclass correlation coefficients (ICCs) were calculated. A Cronbach alpha score of more than 80% was considered to be good test-retest reliability. Statistical analysis was performed using SPSS 20.0 (IBM Corp).

RESULTS

There were 162 patients overall in the 3 groups. There were 98 boys and 64 girls (mean age, 14.4 years; range, 8-17 years). There were 62 patients in the knee injury group (39 boys, 23 girls; mean age, 14.6 years; range, 8-17 years), 50 patients in the lower extremity injury group (25 boys, 25 girls; mean age, 14.4 years; range, 9-17 years), and 50 patients in the upper extremity injury group (34 boys, 16 girls; mean age, 14.2 years; range, 9-17 years). There was no difference in age between groups ($P = 0.44$). There were 110 patients in the ≥14 years group and 52 patients in the <14 years group.

Overall mean total score was 13.55 (SD, 3.73), and mean scores for the knee, lower extremity, and upper extremity groups were 13.71 (SD, 3.70), 13.22 (SD, 4.18), and 13.68 (SD, 3.33), respectively ($P > 0.05$). There also was no difference in total scores based on age ($P = 0.88$).

There was good test-retest reliability for all patients' summed scores and for each of the individual questions (see Table 1 in Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>). There was good test-retest reliability for the ≥14 years group for the summed scores and for each individual question. The <14 years group had lower ICC scores overall, though there was still good test-retest reliability for the summed scores and for questions 2 through 4. Question 1 had poor test-retest reliability.

For each group, total scores had good test-retest reliability, as did each individual question (see Table 2 in Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>).

There was a large ceiling effect noted as overall more than half the patients had maximum scores of 16 (50.6%). Overall, 75% of patients chose the maximum score (4 points) for question 1, 65% for question 2, 65% for question 3, and 62% for question 4 (see Figure 1 in Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>). The percentage of patients in each subgroup with the maximum score of 16 were 53.2% in the knee group, 48.0% in the lower extremity group, and 50.0% in the upper extremity group. There was no floor effect as overall, only 1.9% of patients scored a minimum of 0, and the percentages of patients scoring 0 in the knee, lower extremity, and upper extremity groups were 1.6%, 4.0%, and 0.0%, respectively.

DISCUSSION

The Marx activity scale is a statistically reliable activity scale in pediatric patients under the age of 18 years. Test-retest data confirmed its reliability for all questions in the scale except 1 in the ≥ 14 years subgroup. Furthermore, the scale was reliable for not only knee injuries, as it had been originally intended; it was reliable for patients with any lower extremity injury.

We do have concerns regarding it being less reliable in the younger than 14-year-old population. We do not have a direct answer as to why the Marx scale would be less reliable in younger patients, though it is possible that they have less comprehension of the questions and what they refer to. We also have concerns with its prominent ceiling effect due to most patients choosing the maximum score for the majority of the scale's 4 questions. This is likely due to the frequency of which teenagers play sports, such as in physical education class at school, unorganized athletic activities, and organized sports leagues. This high ceiling effect limits the Marx activity scale's usefulness in this younger patient population.

There are a few existing pediatric orthopaedic activity scales. These include the pediatric International Knee Document Committee (pedi-IKDC), the Child Health Questionnaire (CHQ) and Gross Motor Function Classification, Family Nutrition and Physical Activity (FNPA) Screening Tool, and the Physical Activity Questionnaire (PAQ).^{3,10-12,23} Unfortunately, none of these specifically measure a patient's sports activity, and none of them measures a patient's baseline preinjury activity status. The pedi-IKDC, similar to the adult version of the IKDC, is a longer subjective questionnaire that incorporates some reporting of activity level, though a patient's activity is not able to be independently reported from within the score.¹²

Recently, the Hospital for Special Surgery Pediatric Functional Activity Brief Scale (HSS Pedi-FABS) was validated in healthy children as a current, though not baseline, activity scale. It has been subsequently used to predict physical fitness testing performance.^{6,7} The HSS Pedi-FABS is very similar to the Marx activity scale, though there are some differences. The first 4

questions on the HSS Pedi-FABS are identical to those on the Marx activity scale. There are additional questions regarding the duration and endurance of the patient as well as level of competitive sports and supervised sports participation. They found no ceiling effect for their overall scale compared with a substantial one for the Marx activity scale present in our study.⁶

There are limitations to our study. First, although the Marx activity scale is written at a grade 4 reading level, we cannot be certain the patients fully understood the questions. For example, the younger patients had poorer test-retest reliability, especially regarding their frequency of running (question 1). Also, many of the items have similar wording, for example, asking in different questions for the frequency of pivoting and of cutting in sports. Another limitation was that the follow-up survey was completed over the phone for many of the patients who were not seen again in clinic 3 weeks later. This may have biased their answers. Another potential source of bias was parents and family being present in the examination rooms while the patients responded to the survey. They were not allowed to answer for the patients though they were allowed to help interpret the questions.

CONCLUSION

The Marx activity scale is statistically reliable for use in patients younger than 18 years with injuries of the knee and lower extremities, though the scale was less reliable in patients younger than 14 years. There is a significant ceiling effect present, which limits its overall usefulness.

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