The Pediatric Pain Screening Tool (PPST) can Rapidly Identify Elevated Pain and Psychosocial Symptomatology in Treatment-Seeking Youth with Acute Musculoskeletal Pain

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Abstract: This cross-sectional study examines the utility of the Pediatric Pain Screening Tool (PPST) for rapidly assessing pain and psychosocial symptomatology in treatment-seeking youth with acute musculoskeletal pain. Participants were 166 youth (10-18 years, 53.6% female) participating in one of two larger cohort studies of youth with acute musculoskeletal pain. Youth completed the PPST and measures of pain, pain-related fear, pain catastrophizing, pain-related disability, and sleep quality. Participants were categorized into PPST risk groups using published cut-offs. ANOVA and chi-square examined associations between PPST risk groups and self-report measures; receiver operating characteristic (ROC) analyses examined associations among PPST scores and clinical reference cut-offs. The PPST classified 28.3% of youth as high, 23.5% as moderate, and 48.2% as low-risk. Females were more likely to be high-risk. ANOVAs revealed differences in clinical factors by PPST risk group particularly differences among youth labeled high versus low-risk. ROC analyses showed the PPST is effective in discriminating “cases” versus “non-cases” on pain-related disability, pain-fear and catastrophizing. Results reveal the PPST is effective for rapidly screening youth with acute pain for pain and psychosocial symptomatology. An important next step will be to examine the validity of the PPST in predicting recovery outcomes of acute pain samples.

Perspective: This article presents the Pediatric Pain Screening Tool (PPST) as a measure for rapidly screening youth with acute pain and psychosocial symptomatology. The tool categorizes youth into low, moderate or high-risk groups and discriminates among those with versus without clinically significant levels of disability, pain-related fear and catastrophizing.

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Key Words: acute pain, pediatric, musculoskeletal, screening, risk.

Acute musculoskeletal pain is common during childhood and adolescence. While many youth with acute pain recover from symptoms, data suggest 30% develop persistent musculoskeletal pain. Given data showing factors such as sleep disturbances, depressive symptoms, and pain-related fear are associated with pain-related disability and quality of life in the acute pain period, screening for elevated pain and psychosocial symptomatology in the acute care setting is important. While preventive interventions for youth with acute musculoskeletal pain have not been developed, data gathered in the acute care setting can inform provider anticipatory guidance (e.g., education about known associations among pain, mood and sleep; recommendations for activity engagement, use of evidence-based biobehavioral pain management strategies). Moreover, if screening reveals clinically significant symptoms or elevated risk, recommendations for closer follow-up or referrals for additional psychosocial assessment can be given.
The Pediatric Pain Screening Tool (PPST) was developed to efficiently assess physical and psychosocial symptomatology in youth with chronic pain. Physical and psychosocial domains assessed include sleep, pain-related disability, school attendance, pain-related anxiety, and depression. Adapted from Keele’s Start Back Screening Tool, the brief 9-item PPST classifies youth into low, moderate or high-risk groups, with greater endorsement of items leading to higher risk classification. A validation study in youth with chronic pain revealed PPST risk classification was concurrently associated with pain-related disability, pain anxiety, pain-related fear, anxiety and depression. Moreover, PPST scores predicted pain outcomes over time, with youth classified at baseline as either moderate or high-risk having greater disability and more psychological symptoms 4 months later.

Recently the utility of the PPST screener was examined in pediatric headache and sickle cell populations. In youth with headache, Heathcote and colleagues found PPST scores effectively discriminated youth with high versus low levels of disability and emotional distress (pain catastrophizing, fear of pain, anxiety, and depressive symptoms). Furthermore, the PPST discriminated references cases for pain-related disability at a two-month follow-up showing its ability to predict outcomes over time. In youth with sickle cell disease, Sil and colleagues found youth classified as high-risk on the PPST had significantly higher pain intensity, greater pain frequency, higher pain-related disability and more depressive symptoms than youth classified as low or medium-risk. PPST total and psychosocial subscale scores discriminated youth who met clinical cut-offs on key measures of (e.g., pain interference, pain frequency, inpatient admissions, catastrophizing and fear).

Models emphasizing the importance of prevention of pain in pediatric populations call for intervention in the acute pain period. While some preventive interventions for chronic musculoskeletal pain in children have been developed and tested (e.g., exercise-based prevention for chronic back pain), to our knowledge no programs have been developed to intervene during the acute phase of musculoskeletal pain problems. In fact, a key challenge is how identify youth with acute pain who may benefit from such interventions. To fill this gap, the current study examined the utility of the PPST in quickly and efficiently assessing pain and psychosocial symptomatology in youth with acute musculoskeletal pain. Data from two cohort studies that administered the PPST as part of the larger study protocols were included; PPST data from these cohorts has not previously been published. The first aim was to identify concurrent associations among PPST risk groups and measures of pain-related emotional and physical function in this sample. The second aim was to examine the ability of PPST total and psychosocial subscale scores to discriminate reference standard “cases” versus “non-cases” on measures of pain anxiety and disability. The third aim was to identify cut-offs for both the PPST total score and the PPST psychosocial subscale, that identified elevated symptomatology in an acute musculoskeletal pain sample.
Questionnaire Measures

**Demographics.** Parents reported on their child’s age, sex, race and ethnicity.

**Pain intensity.** Youth were asked to report on “usual pain intensity” over the past 7 days using a Numerical Rating Scale (11 point NRS 0-10).15

**Pain location(s).** Location of primary acute MSK pain complaint was reported verbally by participants at study enrollment and checked with the medical record. Responses were coded into 1 of 5 MSK pain location categories: leg/foot, arm/hand/shoulder, back/spine/neck, rib/chest, or hip.

**Pain-related disability**

Either the Child Activity Limitations Interview (CALI-21)16 or the Child Activity Limitations Interview Short Form (CALI-9)17 was used to assess pain-related disability. On both versions of the measure, the five response options ask participants to rate difficulty of engaging in tasks from 0 ‘not difficult’ to 4 ‘extremely difficult’, higher scores indicate greater impairment due to pain. For those that completed the CALI-21 (n = 63) the 9 items that make up the short form were extracted to calculate the disability score to permit combining the samples from the 2 studies. The CALI-21 and CALI-9 have demonstrated reliability and validity in assessing pain-related disability in school aged children and adolescents with pain.16,17

**Fear of pain**

Youth reported on fear and avoidance related to pain using the Fear of Pain Questionnaire (FOPQ-C).18 The 24 items on the scale are rated on a 5-point scale ranging from 0 ‘strongly disagree’ to 4 ‘strongly agree’ and items are summed for a total score, with higher scores indicating more pain-related fear. The FOPQ-C has excellent reliability and construct validity and the measure has been used to assess pain-related fear in diverse pain samples.

**Pain catastrophizing**

The 13-item Pain Catastrophizing Scale for Children (PCS-C) was used to assess catastrophizing about pain symptoms in children and adolescents.21 The measure prompts children to reflect on past painful experiences (“Below are some things that happen to you when you have pain”) with response options on a 5-point scale (0-4) ranging from 0 ‘not at all’ to 4 ‘extremely’. Higher scores reflect greater pain catastrophizing. The measure has demonstrated reliability in youth with pain.21,22 The clinical reference points for the measure are 0–14 (low); 15–25 (moderate); and 26 and greater (high) catastrophizing symptoms.22 The clinical cut-off of ≥ 26 indicating high catastrophizing symptoms was used to categorize “cases” versus “non-cases” in ROC curve analyses.

**Sleep quality**

Either the Adolescent Sleep-Wake Scale (ASWS) 28 item version of ASWS Short-form (10-itmes) was used to assess children’s perceptions of their sleep quality.23,24 Youth reported on their sleep using a 6-point scale (range from 1 ‘always’ to 6 ‘never’) with higher scores indicating better sleep quality. For those that completed the full 28-item ASWS (n=63), the 10 items that make up the short form were extracted to calculate the total score to permit combining the samples from the 2 studies. The ASWS measures five behavioral dimensions of sleep (going to bed, falling asleep, maintaining sleep, initiating sleep, returning to wakefulness). The ASWS and ASWS short-form are a valid and reliable assessment tool that has been used extensively in both pain and non-pain populations.23,24

**Pediatric Pain Symptomatology**

The nine-item Pediatric Pain Screening Tool (PPST) was used to assess physical and psychosocial symptomatology.9 Individual items assess pain, ambulation, school attendance, sleep, pain-catastrophizing, pain-related fear, anxiety, depression, and pain-related bother. The consists of two subscales, Physical and Psychosocial, and a total score can also be calculated. The measure has been shown to be reliable and valid in a variety of pediatric pain samples including: mixed chronic pain samples and youth with headache and sickle cell disease.9

**Data analysis**

Data were analyzed using SPSS v.27. Summary statistics were used to describe characteristics of the sample and are reported in Table 1. Means and standard deviations were used for continuous data, and categorical items were described using frequency statistics. ANOVA was used to examine differences among PPST risk groups and study measures (age, number of days between pain onset and survey completion, pain intensity, pain-related disability, sleep quality, pain catastrophizing, and fear of pain). Chi-square was used to examine differences among PPST risk groups and both demographic and clinical characteristics (e.g., gender, race, ethnicity, pain location, recruitment setting, and fracture status). Receiver Operating Characteristics (ROC) curves were used to calculate the area under the curve (AUC) for the PPST total score and PPST psychosocial subscale scores comparing PPST scores against “cases” versus “non-cases” on established clinical cutoffs on both the Pain
Catastrophizing Scale (PCS-C; clinical cut-off ≥ 26 indicating high catastrophizing) and Fear of Pain Questionnaire (FOPQ; clinical cut-off ≥ 51 indicating high pain-related fear). Because the CALI-9 does not have a published clinical cut-off, “cases” were calculated using participant scores > 1 SD above the mean. Specifically, the youth who scored > 1 SD above the CALI-9 total score sample mean were labeled as “cases” and all other participants were labeled as “non-cases”. For all AUC analyses, evaluation of discrimination was classified using published criteria: <.07 poor, ≥0.7 fair, ≥0.8 good, and ≥0.9 excellent. ROC curves were also used to derive clinical cut-offs for the PPST total score and PPST psychosocial subscales for this acute musculoskeletal pain sample. Missingness was considered at random and sample size for all statistical analyses that did not include the full sample is presented in the tables.

Results

Participant demographic and descriptive statistics are located in Table 1. Participants were 166 youth ages 10-18 years (M = 14.17, SD = 2.07), were 53.6% female, and 70.5% non-Hispanic. 57.8% of youth identified race as White, with 20.5% identifying as biracial or multiracial. 50.6% of youth had sought pain treatment in the emergency department and 49.4% outpatient clinics (e.g., orthopedics, sports medicine). Most common pain location was leg/foot pain (68.7%) with 28.3% of youth experiencing a fracture as part of their injury. Usual pain intensity over the past 7 days was moderate, M = 3.97 (SD = 2.13).

Frequency of PPST item endorsement in this acute pain sample is located in Table 2. Findings show most commonly endorsed PPST items were: “It is not really safe for me to be physically active” (49.4%), “My pain is in more than one body part” (42.8%), and “In general I don’t have as much fun as I used to” (38.0%). Item endorsement from the validation sample, and youth with headache and sickle cell disease are included in Table 2 for comparison.

Total PPST scores in the acute pain sample ranged from 0-9 (M = 2.97, SD = 2.18) and PPST psychosocial subscale scores ranged from 0-5 (M = 1.61, SD = 1.43). Using published PPST cut-offs, 28.3% of youth were classified as high-risk, 23.5% moderate risk, and 48.2% low risk. PPST risk groups differed significantly by

Table 1. Demographic characteristics of the sample (n = 166).

<table>
<thead>
<tr>
<th>Age in years (M, SD)</th>
<th>14.2 ± 2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (n, %)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>77 (46.4)</td>
</tr>
<tr>
<td>Female</td>
<td>89 (53.6)</td>
</tr>
<tr>
<td>Ethnicity (n, %)</td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>37 (22.7)</td>
</tr>
<tr>
<td>Not Hispanic/Latino</td>
<td>117 (71.8)</td>
</tr>
<tr>
<td>Unknown/Not reported</td>
<td>9 (5.5)</td>
</tr>
<tr>
<td>Race (n, %)</td>
<td></td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>3 (1.8)</td>
</tr>
<tr>
<td>Asian</td>
<td>6 (3.6)</td>
</tr>
<tr>
<td>Biracial or Multiracial</td>
<td>34 (20.5)</td>
</tr>
<tr>
<td>Black or African American</td>
<td>10 (6.0)</td>
</tr>
<tr>
<td>White</td>
<td>96 (57.8)</td>
</tr>
<tr>
<td>Other</td>
<td>16 (9.6)</td>
</tr>
<tr>
<td>BMI Percentile (age corrected %)</td>
<td>23.4</td>
</tr>
<tr>
<td>Referral Source (n, %)</td>
<td></td>
</tr>
<tr>
<td>Emergency department</td>
<td>84 (50.6)</td>
</tr>
<tr>
<td>Outpatient Clinic</td>
<td>82 (49.4)</td>
</tr>
<tr>
<td>Fracture (n, %)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>47 (28.3)</td>
</tr>
<tr>
<td>No</td>
<td>118 (71.1)</td>
</tr>
<tr>
<td>Primary Pain Complaint (n, %)</td>
<td></td>
</tr>
<tr>
<td>Leg/foot</td>
<td>114 (68.7)</td>
</tr>
<tr>
<td>Arm/hand/shoulder</td>
<td>21 (12.7)</td>
</tr>
<tr>
<td>Back/spine/neck</td>
<td>17 (10.2)</td>
</tr>
<tr>
<td>Hip</td>
<td>13 (7.8)</td>
</tr>
<tr>
<td>Rib/chest</td>
<td>1 (0.6)</td>
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Table 2. Frequency of PPST Item Endorsement.

<table>
<thead>
<tr>
<th>PPST ITEMS</th>
<th>ACUTE PAIN</th>
<th>CHRONIC PAIN</th>
<th>HEADACHE</th>
<th>SICKLE CELL</th>
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<tbody>
<tr>
<td>Physical subscale</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My pain is in more than one body part</td>
<td>42.8</td>
<td>69.4</td>
<td>40.9</td>
<td>83.6</td>
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<tr>
<td>I can only walk a short distance because of pain</td>
<td>34.9</td>
<td>56.8</td>
<td>25.6</td>
<td>50.7</td>
</tr>
<tr>
<td>It is difficult for me to be at school all day</td>
<td>27.7</td>
<td>73.1</td>
<td>76.9</td>
<td>52.1</td>
</tr>
<tr>
<td>It is difficult for me to fall and stay asleep at night</td>
<td>30.7</td>
<td>63.6</td>
<td>54.5</td>
<td>49.3</td>
</tr>
<tr>
<td>Psychosocial subscale</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>49.4</td>
<td>45.9</td>
<td>19.4</td>
<td>30.1</td>
</tr>
<tr>
<td>I worry about my pain a lot</td>
<td>30.7</td>
<td>48.3</td>
<td>54.5</td>
<td>52.1</td>
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<tr>
<td>I feel my pain is terrible and it is never going to get any better</td>
<td>7.8</td>
<td>36.6</td>
<td>45.9</td>
<td>31.5</td>
</tr>
<tr>
<td>In general, I do not have as much fun as I used to</td>
<td>38.0</td>
<td>61.7</td>
<td>54.5</td>
<td>32.9</td>
</tr>
<tr>
<td>Overall, how much has pain been a problem in the past 2 weeks</td>
<td>21.7</td>
<td>79.2</td>
<td>73.1</td>
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gender, with females more likely to be identified as high-risk. There were no differences in PPST risk group on other clinical or demographic factors (race, ethnicity, age, BMI, pain location, fracture status, recruitment setting). Furthermore, there were no associations among PPST scores nor PPST risk group and the number of days between pain onset and survey completion.

Aim one examined associations among PPST risk groups and measures of pain-related emotional and physical function. Results of one-way ANOVAs revealed differences in pain, pain-related disability, pain-related fear, pain catastrophizing, and sleep quality by PPST risk group (see Table 3). Post-hoc conducted using Tukey’s range test revealed all three groups were significantly different on pain-related fear with higher PPST risk categorization corresponding to higher FOPQ scores. Regarding pain and pain catastrophizing, youth categorized as high risk had significantly higher pain and more pain-catastrophizing than youth in the low risk group. In terms of pain-related disability, significant differences were found between the low risk and both moderate and high risk groups; differences between moderate and high risk groups approached significance (p=.058).

Aim two examined the ability of PSST total and psychosocial subscale scores in discriminating reference standard “cases” versus “non-cases”. ROC curve analyses examining the 5 items PPST psychosocial subscale in discrimination “cases” versus “non-cases” for pain catastrophizing (≥ 26), fear of pain ≥ 51, and activity limitations (> 1 SD above the mean) were similarly fair to good with values ranging from .77 - .87.

Aim three identified clinical cut-offs for both the PPST total score and PPST psychosocial subscale. Results revealed a PPST total score of ≥ 4 was the best concurrent predictor of high pain-related disability (> 1 SD above the mean) in youth with acute musculoskeletal pain. See Figure 1. Furthermore, a PPST psychosocial subscale score of ≥ 3 was the best concurrent predictor of reference standard psychosocial distress on the both the pain catastrophizing and fear of pain measures. See Figures 2i-ii.

**Discussion**

Findings from the current study revealed the utility of using the PPST for rapidly screening and assessing pain and psychosocial symptomatology in a sample of treatment-seeking youth with acute musculoskeletal pain. While previous work has demonstrated the utility of the PPST in identifying youth with elevated symptomatology and poor outcomes in chronic pain samples, this is the first study to show the PPST can effectively discriminate youth with acute musculoskeletal pain who present with different levels of pain and psychosocial symptoms. Findings support the potential utility of screening symptomatology of youth with musculoskeletal pain in the acute care setting before pain becomes chronic. This information might be used to target youth who may need additional intervention.

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**Table 3. Results of ANOVA comparing PPST risk groups on clinical characteristics.**

<table>
<thead>
<tr>
<th>PPST RISK GROUP</th>
<th>Low M(SD)</th>
<th>Moderate M(SD)</th>
<th>High M(SD)</th>
<th>F</th>
<th>P</th>
<th>η² F</th>
<th>95% CI (LL, UL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain intensity</td>
<td>3.35 (1.94)</td>
<td>4.13 (2.04)</td>
<td>4.87 (2.21)</td>
<td>8.27</td>
<td>.000</td>
<td>.26</td>
<td>.02, .18</td>
</tr>
<tr>
<td>Activity limitations</td>
<td>16.06 (12.61)</td>
<td>26.15 (15.32)</td>
<td>44.92 (18.30)</td>
<td>32.88</td>
<td>.000</td>
<td>.29</td>
<td>.17, .39</td>
</tr>
<tr>
<td>Fear of pain</td>
<td>8.69 (6.47)</td>
<td>12.25 (6.99)</td>
<td>18.79 (11.86)</td>
<td>21.15</td>
<td>.000</td>
<td>.24</td>
<td>.10, .30</td>
</tr>
<tr>
<td>Pain catastrophizing</td>
<td>4.23 (.79)</td>
<td>3.72 (.83)</td>
<td>3.66 (.90)</td>
<td>8.79</td>
<td>.000</td>
<td>.10</td>
<td>.02, .18</td>
</tr>
</tbody>
</table>

Notes: i) superscripts represent group differences using Tukey post hoc comparisons; ii) Fear of pain cut score calculated for n = 165 (one participant missing data)

**Table 4. AUC for PPST total score and PPST psychosocial subscale scores against reference standard cases.**

<table>
<thead>
<tr>
<th>Reference Standards</th>
<th>Case Definition</th>
<th>PPST TOTAL AUC (95% CI)</th>
<th>PPST Psychosocial AUC (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain-Related Disability</td>
<td>&gt; 1 SD above CALI-9 sample mean</td>
<td>.81 (.71-.90)</td>
<td>.77 (.69-.86)</td>
</tr>
<tr>
<td>Fear of Pain</td>
<td>FOPQ ≥ 51</td>
<td>.79 (.69-.89)</td>
<td>.82 (.72-.92)</td>
</tr>
<tr>
<td>Pain Catastrophizing</td>
<td>PCS-C ≥ 26</td>
<td>.85 (.76-.94)</td>
<td>.87 (.81-.94)</td>
</tr>
</tbody>
</table>

*Fear of pain cut score calculated for n = 165 (one participant missing data)
benefit from ongoing monitoring, more intensive follow-up, and referrals for additional psychosocial assessment. Screening of youth acute pain is in line with recently proposed frameworks (e.g., The Integrated Prevention Model for pediatric pain;11 the Developmental Model10) which emphasize the importance of expanding the focus of pediatric chronic pain treatment to include identification of vulnerabilities and pain prevention.

Similar to work in chronic pain samples, results of this study revealed that higher risk classification by the PPST was associated with higher levels of pain intensity, greater activity limitations, more pain-related fear,}

Figure 1. Receiver operating characteristics for the PPST total score against CALI-9 cases defined as > 1 SD above sample mean. Sensitivity and specificity notated in boxes on line.

Figure 2. Receiver operating characteristics for the PPST Psychosocial subscale against i) Pain Catastrophizing Scale (PCS-C) cases defined as ≥ 26 and ii) Fear of Pain Questionnaire (FOPQ-C) cases as defined by ≥ 51. Sensitivity and specificity notated in boxes on line.
higher pain catastrophizing, and poorer sleep quality. This is important as it shows that a 9-item screening measure can quickly and efficiently identify concurrent symptomatology across a wide variety of domains. Moreover, in addition to effectively identifying risk groups, the ROC curve results revealed clinical cut-offs on both the PPST total score and PPST subscale that are appropriate for use with acute musculoskeletal pain samples. The recommended cut-off for the PPST total score in identifying concurrent high levels of pain-related disability in youth with acute musculoskeletal pain is ≥ 4. Importantly, this is different than the studies of youth with chronic pain which identified a PPST total score cut-off ≥ 5.6,9 This difference in cut-offs is not surprising given the mean/standard deviation obtained for the PPST total score in this acute pain sample is lower than those in the pediatric chronic pain studies. This lower mean score in youth with acute musculoskeletal pain likely reflects that youth with new-onset pain problems may have less overall disruption in pain-related function than those who have established chronic pain conditions. Interestingly, the findings revealed a psychosocial subscale cut-off of ≥ 3 for this acute pain sample is the same cut-off as identified in previous pediatric chronic pain research.5,8,9 This suggests that when youth with pain – either acute or chronic – endorse ≥ 3 psychosocial items on the PPST (e.g., “I worry about my pain a lot”, “In general, I do not have as much fun as I used to”) psychosocial risk is similar. This highlights that these cognitive-affective factors known to be associated with higher pain and disability in youth with chronic pain (e.g., pain catastrophizing, pain-related fear), are important even in the acute pain period.

It is also important to note that while findings from this acute pain sample show similar patterns in ROC analyses as previous studies (e.g., discrimination among “cases” versus “non-cases” on measures of disability, pain-related fear and pain catastrophizing), percent agreement on individual PPST items among pain samples differs (see Table 2). For example, endorsement of pain-related anxiety in item “I worry about my pain a lot” was 30.7% of youth with acute pain versus 48.8% of youth with chronic pain and 52.1% of youth with sickle cell disease. Similar differences emerged in perceptions about safety of physical activity with 49.4% of youth with acute pain endorsing “It is not safe for me to be physically active” versus 45.9% of youth with chronic pain, and 19.1% of youth with headache. While it could be argued that in context of acute pain the safety of physical activity may be different than for youth with chronic pain or headache, this does not make the item invalid. Rather, the screener gives the provider a brief tool for assessing cognitions about pain and function – including fear-avoidance. For example, while some activities may not be indicated in the context of an acute injury, it is likely that not all activity is “dangerous” and the patient/family many benefit from anticipatory guidance around safe movement.

Findings from this study also revealed females were more likely to be categorized as high risk than males. Overall this is not surprising given that we know in the context of chronic pain, the prevalence of MSK pain is higher in females compared to males, particularly in adolescence.26 These sex differences are also supported by our previous work that examined risk for transition from acute to chronic musculoskeletal pain which identified girls were more likely to develop chronic pain then
Additional research can further explore sex differences in youth with other types of acute pain complaints. Despite associations among gender and PPST scores in this acute pain sample, there were no associations among the PPST and other clinical or demographic factors (e.g., race, ethnicity, age, BMI, pain location, fracture status, recruitment setting). The lack of associations with individual level variables supports the use of the PPST in heterogeneous youth with acute MSK pain. Moreover, it parallels findings from other PPST studies in mixed chronic pain, headache and sickle cell samples which also did not show associations with clinical factors.

This study has several strengths that can be highlighted. First, participants were a relatively diverse sample (29.5% Hispanic, 20.5% biracial or multiracial) compared to previous pain studies and the sample was well balanced by gender (46.4% male). This increases confidence that findings can be applied to diverse groups. An additional strength is this was a clinical sample of treatment-seeking youth with acute musculoskeletal pain. The majority of pediatric pain research is conducted when pain is chronic, disabling and difficult to treat or is conducted in community setting (e.g., schools) via epidemiologic studies. By studying youth with acute pain soon after they experienced injury, we are able to capture the exact sample we seek to target with future preventive interventions.

There are also limitations to the study that need to be acknowledged. First, participants were exclusively an acute musculoskeletal pain sample. While musculoskeletal pain is highly prevalent in youth and is one of the most common reasons for seeking medical care, it is unknown how study findings apply to other acute pain samples. A key sample of interest for future research is youth with other pain locations/injuries such as concussions/mild traumatic brain injury (TBI). Like musculoskeletal pain, mild concussions are common in youth and a frequent reason for seeking care. Moreover, data shows variability in recovery from concussions with some youth experiencing a remission of symptoms and others developing persistent pain and other problems. Key next steps are to see how the PPST works in youth with TBI and a variety of other acute pain presentations to support providers in identifying at-risk youth to target with preventive interventions.

An additional limitation is that the only psychological measures included in the current study were the Pain Catastrophizing Scale and the Fear of Pain Questionnaire, as these were the only two psychological measures given in both studies. While these measures have been previously associated with pain outcomes in acute and chronic pain samples and in the current study had clinical cut-offs used in ROC curve analyses for identification of “cases” versus “non-cases”, it is unknown how other measures (e.g., anxiety, depression) are associated with PPST scores. Future research can explore associations among PPST risk groups and clinical cut-offs for other standard measures in youth with acute musculoskeletal pain. This future research can also explore associations among PPST scores and strategies youth are using to manage their acute pain, as this could data was not available for participants in both studies.

Additional research will explore the effectiveness of the PPST for predicting pain outcomes over time, including the persistence of pain and pain-related disability. Longitudinal data collection is underway so examining associations among PPST scores and longitudinal pain outcomes is planned. Knowing if PPST scores can predict pain-related outcomes outside the acute pain period will be important for understanding if the utility of the screener extends beyond current assessment of risk classification in youth with acute musculoskeletal pain but also longitudinally predicts recovery.

An additional direction for research will be to evaluate best practices and procedures for administering the PPST in clinical settings. While youth in this study had sought care in either the emergency department or outpatient clinics (e.g., orthopedics, sports medicine), participants in these studies completed the PPST as part of a research project when they had already left the acute care setting. Clinical cut-offs supporting the feasibility of using this tool in a busy clinical environment and future implementation studies will help provide guidance regarding processes and procedures for administering and scoring the PPST in the acute care setting.

In conclusion, findings from this study suggest the PPST is a promising tool for assessment of pain and psychosocial symptomatology in youth with acute musculoskeletal pain. The ROC analyses highlight the PPST total score can effectively discriminate “cases” versus “non-cases” on key measures of pain-related disability, pain catastrophizing and fear avoidance suggesting this measure can give providers immediate data that can inform their treatment recommendations and potentially referrals additional psychosocial assessment based on risk categorization. Using the PPST in the acute care setting also provides a unique opportunity to identify youth with elevated symptomatology before pain becomes chronic. It is hoped that ultimately point-of-care screening for youth with acute pain can play a key role in the prevention of chronic pain, as traditionally chronic pain treatment has occurred when pain and disability have already set in. As recently highlighted in other manuscripts calling for a focus on pain prevention next steps will be the development of effective preventive interventions for use with acute pain samples.

References
factors are associated with pain and activity limitations in youth with acute musculoskeletal pain: a cohort study. Clin J Pain 35:222-228, 2019

5. Holley AL, Wilson AC, Cho E, Palermo T: Clinical pheno-
typing of youth with new-onset musculoskeletal pain: a

Schechter N, Borsook D, Hill J: Pediatric Pain Screening
Tool: rapid identification of risk in youth with pain con-

7. Hill JC, Dunn KM, Lewis M, Mullis R, Main CJ, Foster NE,
Hay EM: A primary care back pain screening tool: identi-
fying patient subgroups for initial treatment. Arthritis Rheum
59:632-641, 2008

LE: Rapid screening of risk in pediatric headache: applica-
tion of the Pediatric Pain Screening Tool. J Pediatr Psychol
43:243-251, 2018

9. Sil S, Cohen LL, Dampier C: Pediatric pain screening iden-
tifies youth at risk of chronic pain in sickle cell disease.
Pediatri Blood Cancer 66:e27538, 2019

10. Palermo TM: Pain prevention and management must
begin in childhood: the key role of psychological interven-
tions. Pain 161:S114-S121, 2020

11. Salamon KS, Cullinan CC: The integrated prevention
model of pain — chronic pain prevention in the primary

reduces the intensity and prevalence of low back pain in 12
55:97-104, 2009

13. Hill JJ, Keating JL: Daily Exercises and education for pre-
vanting low back pain in children: cluster randomized con-

14. Lewandowski Holley A, Rabbits JA, Zhou C, Durkin L,
Palermo TM: Temporal daily associations among sleep and
pain in treatment-seeking youth with acute musculoskeletal

15. Stinson JN, Kavanagh T, Yamada J, Gill N, Stevens B:
Systematic review of the psychometric properties,
interpretability and feasibility of self-report pain intensity
measures for use in clinical trials in children and adoles-

16. Palermo TM, Lewandowski AS, Long AC, Burant CJ: Val-
idation of a self-report questionnaire version of the Child
Activity Limitations Interview (CALI): The CALI-21. Pain
139:644-652, 2008

TM: The CALI-9: A brief measure for assessing activity limi-
tations in children and adolescents with chronic pain. Pain
159:48, 2018

18. Simons LE, Sieberg CB, Carpino E, Logan D, Berde C: The
Fear of Pain Questionnaire (FOPQ): assessment of pain-
related fear among children and adolescents with chronic

pain in the context of intensive pain rehabilitation among
children and adolescents with neuropathic pain: associa-

in pediatric headache. Cephalalgia 35:36-44, 2015

ens G, Goubert L, Verstraeten K: The child version of the
Pain Catastrophizing Scale (PCS-C): a preliminary validation.

22. Pielech M, Ryan M, Logan D, Kaczynski K, White MT,
Simons LE: Pain catastrophizing in children with chronic
pain and their parents: proposed clinical reference points
and reexamination of the Pain Catastrophizing Scale mea-

23. Essner B, Noel M, Myrvik M, Palermo T: Examination of
the factor structure of the Adolescent Sleep-Wake Scale

24. LeBourgeois MK, Giannotti F, Cortesi F, Wolfson AR,
Harsh J: The relationship between reported sleep quality
and sleep hygiene in Italian and American adolescents.
Pediatrics 115:257-265, 2005

25. Youngstrom EA: A primer on receiver operating charac-
teristic analysis and diagnostic efficiency statistics for pedi-
atrie psychology: we are ready to ROC. J Pediatr Psych
39:204-221, 2014

26. Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahim-Will-
liams B, Riley III JL: Sex, gender, and pain: a review of recent

27. Veliz P, McCabe SE, Eckner JT, Schulenberg JE: Preva-
ence of concussion among US adolescents and correlated
factors. JAMA 318:1180-1182, 2017

28. Blume HK, Vavilala MS, Jaffe KM, Koepsell TD, Wang J,
Temkin N, Durbin D, Dorsch A, Rivara FP: Headache after
129:e31-e39, 2012

29. Simons LE: Fear of pain in children and adolescents
with neuropathic pain and complex regional pain syn-

30. Tran ST, Jastrowski Mano KE, Hainsworth KR, Medrano
GR, Anderson Khan K, Weisman SJ, Davies WH: Distinct
influences of anxiety and pain catastrophizing on func-
tional outcomes in children and adolescents with chronic

31. Wojtowicz AA, Greenley RN, Gumidyala AP, Rosen A,
Williams SE: Pain severity and pain catastrophizing predict
functional disability in youth with inflammatory bowel dis-
ese. J Crohns Colitis 8:1118-1124, 2014

between pain-related fear and disability: a meta-analysis. J
Pain 14:1019-1030, 2013