Lack of Specificity of Post-Concussive Symptoms and Correlation with Depressive Symptoms in Concussed and Non-Concussed Pediatric Patients

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INTRODUCTION
- While there is no universally accepted list, post-concussive symptoms generally consist of somatic, cognitive, and affective complaints.
- Post-concussion symptoms are non-specific and occur at comparable or higher rates in non-concussed medical and psychiatric adult samples.
- We previously demonstrated that post-concussion symptoms are as common in concussed children as non-concussed children with neurologic/neurodevelopmental disorders.
- Depressive symptoms are frequently exacerbated by or emerge after concussion and are likely correlated with increased post-concussive symptoms, although causality has not been established in either direction for these associations.
- It is unknown if this relationship is unique to concussion or generalizes to other disorders.
- The purpose of this study was to examine the relationship between depressive symptoms and post-concussive symptoms in a pediatric concussed sample and separately in a non-concussed sample with neurologic/neurodevelopmental disorders, then compare the magnitude of the relationship between groups.
- We hypothesized that depressive symptoms would positively correlate with post-concussive symptoms comparably in each group.

PARTICIPANTS & METHODS
Participants:
- We initially identified 567 patients ages 8-18 years referred for neuropsychological evaluation from 2012-2018 who completed post-concussive symptom measures.
- Of those, 362 patients ages 13-18 years (i.e., 259 concussed and 103 non-concussed with other neurologic/neurodevelopmental disorders) completed both post-concussive and depressive symptom questionnaires.
- Children with other neurologic/neurodevelopmental disorders had conditions or a history of conditions such as epilepsy, extremely low birth weight, encephalitis, chromosomal abnormalities, etc.
- Patients with mild complicated, moderate, or severe traumatic brain injuries (TBI) were excluded.

Measures:
- Postconcussion Checklist (Gouvier, Cubic, Jones, Brantley, & Cutlip, 1992): 30-item questionnaire assessing duration, intensity, and frequency (collectively referred to here as severity) of specific post-concussive symptoms.
- PCS” will be used hereafter to refer to the two checklists and does not post-1Post-Concussion Syndrome Checklist (Gouvier, Cubic, Jones, Brantley, & Cutlip, 1992): 30-item questionnaire assessing duration, intensity, and frequency (collectively referred to here as severity) of specific post-concussive symptoms.

RESULTS
Participants:
- The groups did not differ significantly on age (p = 0.09) or sex (p = 0.58).

Statistics:
- Analyses were conducted using SPSS & JASP.
- Independent-samples t-tests were used to compare groups on age, PCS (total symptoms and severity), and BDI-II total (effect sizes: Cohen’s d), while a chi-square test was used to compare sex between groups (effect size: Cramer’s V).
- Pearson correlations were conducted between BDI-II total and PCS scores (total and severity) for the separate groups.
- Fisher r-to-z transformations were used to compare the sizes of the correlations between groups. Two-tailed p-values are reported.

CONCLUSIONS & IMPLICATIONS
- Findings support the lack of specificity of post-concussive symptoms.
- The relationship between post-concussive symptoms and depressive symptoms is equally strong in children with concussion and without concussion who have another neurologic/neurodevelopmental disorder.
- Notably, children with concussion reported greater symptom severity (including duration) than non-concussed children with another neurologic/neurodevelopmental condition, despite many of the latter group’s conditions being congenital or chronic.
- Present findings lend support to the notion that reliance on post-concussive symptoms to diagnose concussion provides no diagnostic specificity, presumes a causal relationship that may not exist, and often leads to delayed or missed treatment of mood symptoms.
- Athletic trainers, psychologists, and other providers should always assess depressive symptoms when post-concussive symptoms are assessed.
- The role of depressive symptoms in prolonged concussion recovery must be considered by all practitioners, particularly in the absence of quantifiable physical symptoms.

LIMITATIONS & FUTURE DIRECTIONS
- The measures used to assess post-concussive symptoms in this study are somewhat dated.
- Correlations among other post-concussive symptom questionnaires, BDI-II, and other well-validated psychiatric measures should be studied in concussed and non-concussed samples.
- Complaints of prolonged post-concussive symptoms also may be heavily influenced by other psychiatric factors that remain to be explored (e.g., apathy, anxiety, family psychiatric history).
- Few studies have reported on pre-teens, and the relationship between post-concussive symptoms and depression should be investigated in younger concussed and non-concussed samples.

Table 1. Mean age and sex distribution

<table>
<thead>
<tr>
<th>Measure</th>
<th>Concussed (n = 259)</th>
<th>Non-Concussed (n = 103)</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>15.83 ± 1.46</td>
<td>15.51 ± 1.65</td>
<td>d = 0.21</td>
</tr>
<tr>
<td>Sex (% male)</td>
<td>55.21</td>
<td>51.96</td>
<td>V = 0.03</td>
</tr>
</tbody>
</table>

Table 2. Correlations and r-to-z transformations.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Concussed (n = 259)</th>
<th>Non-Concussed (n = 103)</th>
<th>r</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCS Total</td>
<td>0.67</td>
<td>0.63</td>
<td>0.59</td>
<td>0.55</td>
<td></td>
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<tr>
<td>PCS Frequency</td>
<td>0.64</td>
<td>0.62</td>
<td>0.28</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>PCS Intensity</td>
<td>0.64</td>
<td>0.62</td>
<td>0.28</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>PCS Duration</td>
<td>0.60</td>
<td>0.54</td>
<td>0.75</td>
<td>0.45</td>
<td></td>
</tr>
</tbody>
</table>