Objective To examine the patterns of cognitive functioning and academic achievement in children and adolescents with chronic pain attending a tertiary-care interdisciplinary pain service. Methods The standardized psychoeducational testing results of 57 children and adolescents with chronic pain aged 8–18 were retrospectively reviewed. Results On average, participants scored higher in general intelligence, verbal ability, nonverbal reasoning, word reading, and math reasoning than the general population. The level of academic achievement for most participants was consistent with their intellectual ability. Conclusions In this clinical sample with complex, disabling pain, the group mean data do not indicate overall cognitive impairment, or a single atypical achievement pattern. Future research will need to look beyond cognitive and achievement scores to explore the links between school functioning and chronic pain in children.

Key words academic achievement; chronic pain; cognitive ability; intelligence; learning; school.

Chronic pain syndromes, such as headache and recurrent abdominal pain, are surprisingly common in the pediatric population, affecting ~15–25% of children and adolescents (Perquin et al., 2000). In adults, chronic pain has been shown to associate with significant disability and astronomical costs based on missed work and health care utilization, whereas in children the disability and costs associated with chronic pain are more difficult to quantify (Bennett, Huntsman, & Lilley, 2000; Palermo, 2000). Recent research has confirmed that a subset of children with chronic pain experience significant functional impairment (Gauntlett-Gilbert & Eccleston, 2007; Kashikar-Zuck et al., 2007). Given that school is a child’s equivalent to work, one of the most important measures of pain-related disability in children is school absenteeism. In clinical samples, high levels of school absenteeism have been shown to associate with chronic pain in children (Konijnenberg et al., 2005; Roth-Isigkeit, Thyen, Stoen, Schwarzenberger, & Schmucker, 2005). Returning to school is a key outcome targeted by interdisciplinary pain treatment programs for children with chronic pain (Bennett, Chambers et al., 2000; Eccleston, Malleson, Clinch, Connell, & Sourbut, 2003).

The relationship between chronic pain in children and school functioning is likely complex and bidirectional. Some data and clinical anecdotes suggest that children and adolescents with chronic pain syndromes, such as idiopathic musculoskeletal pain, tend to be perfectionistic “overachievers,” and a causal link is implied between pain and school-related stress (Malleson, Al-Matar, & Petty, 1992; Sherry & Malleson, 2002). Alternately, chronic pain is speculated to cause school problems through impaired concentration or disrupted learning opportunities due to absenteeism and incomplete homework (Bennett, Huntsman et al., 2000; Eccleston & Crombez, 1999). Equally plausibly, cooccurring conditions such as depression may account for the relationship between chronic pain in children and school functioning (Gauntlett-Gilbert & Eccleston, 2007).

Sound empirical data on the level of cognitive functioning and academic achievement in children with chronic pain are lacking, and constructs such as “overachievement” have been used without operational definitions. Only three studies were identified that used standardized measures of cognitive ability or academic achievement in
clinical samples of children with chronic pain. First, Sherry and colleagues (1991) measured cognitive functioning in 62 patients at a pediatric rheumatology center using the Wechsler Intelligence Scale for Children-Revised. The results indicated that their mean Full-Scale IQ, Verbal IQ, and Performance IQ were all within the Average range. Second, Woodbury (1993) summarized findings on a clinical sample of children presenting to a hospital GI clinic, indicating that 6 out of 50 participants were diagnosed with a learning disability through standardized testing. However, psychoeducational testing was administered only to those suspected to have learning problems. More recently, Haverkamp, Honscheid, and Muller-Sinik (2002) compared 37 pediatric outpatients with migraine with 17 healthy siblings on their performance on the German version of the Kaufman Assessment Battery for Children. The scores from this sample of patients fell within the normal range, and no between-group difference was found. While these findings suggest that children with chronic pain are not at risk of general cognitive impairment, none has provided a comprehensive picture of both the cognitive and achievement levels in this population.

The purposes of the present descriptive study were to first examine the levels of cognitive ability and academic achievement, using standardized testing, in a consecutively referred sample of children and adolescents with chronic pain presenting for tertiary care, and to compare their performance to population norms. Second, “overachievement” and “underachievement” were operationalized and their prevalence was measured in this clinical sample.

Methods

Participants

Participants were child and adolescent outpatients consecutively referred to the Complex Pain Service (CPS), a tertiary care interdisciplinary pain management service at BC Children’s Hospital, between 1998 and 2004. The CPS receives referrals from across the province of British Columbia, Canada. Patients seen by the CPS present with a variety of chronic pain syndromes of both known and unknown etiology. All have significant pain-related disability that has remained despite community-based health care, which typically includes analgesic medications, physiotherapy, and alternative or complementary care.

Between 1998 and 2004, psychoeducational assessments were administered to all new patients of the CPS as part of the interdisciplinary treatment plan to screen for learning issues and assist in the development of a return-to-school plan. Of the 93 outpatients presenting to the CPS between 1998 and 2004, 19 (20%) dropped out of treatment before the assessment, 6 (6%) had up-to-date psychoeducational assessments previously conducted, 6 (6%) were consultation-only cases, 3 (3%) were too young for testing, 1 (1%) was on a waiting list for assessment, and 1 (1%) could not complete the assessment due to geographical restrictions. This resulted in a total sample of 57 outpatients who were included as participants for the current study. No significant differences in age, gender, or pain parameters (diagnosis, location, intensity, frequency, and history of pain) were found between those assessed and those who were not.

The participants’ age at the time of assessment ranged from 8 to 18 (M = 14.64, SD = 2.39). The majority (n = 46, 81%) were females. Diagnoses included headache (n = 17), back pain (n = 6), abdominal pain (n = 6), leg pain (n = 2), diffuse idiopathic musculoskeletal pain (n = 7), localized idiopathic musculoskeletal pain (n = 6), and multiple pains (e.g., headache and back pain) (n = 13). On average, participants had been experiencing pain for 46.98 months (SD = 34.92). Most reported being in pain on a daily basis (n = 48, 84%), and their mean pain intensity rating on a 10-point scale was 6.26 (SD = 1.63). While school absence was not systematically documented in the charts used for this study, it was known from a previous sample of CPS patients studied (Bennett, Huntsman et al., 2000) that the majority of children and adolescents (91%, n = 39) seen in this tertiary care pain service reported school absence due to pain, with up to 26% (n = 11) missing more than 1 month of school within a school year.

Procedures

Ethics approval for this study was obtained from Simon Fraser University, University of British Columbia, and BC Children’s Hospital. The Psychology Charts of participants were retrospectively reviewed. Data collected included age, gender, clinical information on pain parameters, and scores on the standardized measures used in the psychoeducational assessments.

Measures

General Cognitive Ability

Thirty-eight participants aged 8–15 who completed psychoeducational assessment between 1998 and 2003 were assessed using the Wechsler Intelligence Scale for Children-Third Edition (WISC-III; Wechsler, 1991). Seven participants seen in 2004 were administered the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003). The Wechsler Adult Intelligence Scale-Third Edition (WAIS-III; Wechsler, 1997) was used for 12 participants aged 16 or above.
Academic Achievement
Given the 6-year span covered by this retrospective chart review, changes occurred in the measures of academic achievement used in the assessments. The Wide Range Achievement Test-Third Edition (WRAT-3; Wilkinson, 1993), the Gray Oral Reading Test-Third Edition (GORT-3; Wiederholt & Bryant, 1992), and the Test of Written Language-Third Edition (TOWL-3; Hammill & Larsen, 1996) were administered to patients seen prior to 2001. After 2001, the Wechsler Individual Achievement Test-Second Edition (WIAT-II: The Psychological Corporation, 2001) and the Gray Oral Reading Test-Fourth Edition (GORT-4; Wiederholt & Bryant, 2001) were used.

The six core academic areas assessed were:

1. **Word reading.** Twenty-seven participants completed the WIAT-II Word Reading subtest and 24 completed the WRAT-3 Reading subtest.
2. **Reading comprehension.** Reading comprehension was assessed using the WIAT-II Reading Comprehension subtest (n = 5), the GORT-3 (n = 20), or the GORT-4 (n = 16).
3. **Arithmetic computation.** Participants completed either the WIAT-II Numerical Operations subtest (n = 28) or the WRAT-3 Arithmetic subtest (n = 24).
4. **Mathematical reasoning.** The WIAT-II Math Reasoning subtest was used to assess the participants’ ability to reason mathematically and to apply mathematical concepts (n = 21).
5. **Spelling.** Participants’ single-word spelling was assessed using either the WIAT-II Spelling subtest (n = 26) or the WRAT-3 Spelling subtest (n = 24).
6. **Written expression.** Writing skills were assessed either with the WIAT-II Written Expression subtest (n = 14) or the TOWL-3 Story Construction subtest (n = 26).

**Data Analyses**
Data were analyzed using SPSS and Microsoft Excel. For comparisons with the general population, the data were first weighted by gender to correct for the unequal gender distribution in the sample, and to better reflect the gender composition of the standardization samples of the tests. Sample means and SDs based on the weighted data were then calculated for the composite scores on the cognitive and achievement tests.

Given that different measures of cognitive and academic functioning were used for different participants, independent sample t-tests and one-way ANOVAs were conducted to examine possible between-test differences in mean scores.

To compare the cognitive functioning and academic achievement level of the current sample to the general population, one-sample z-tests were conducted to examine whether the sample means significantly differed from the mean of the test standardization samples.

A regression model suggested by Reynolds (1985) was used to operationalize the constructs of “overachievement” and “underachievement” by examining the discrepancy between each participant’s general cognitive ability and academic achievement. First, for each academic test, a “predicted achievement standard score” was computed through regression analysis using a participant’s Full-Scale IQ. In those cases where there was significant discrepancy between verbal and nonverbal abilities, Verbal IQ was used (Flanagan & Alfonso, 1993). The participant’s actual score on an achievement test was subtracted from the “predicted achievement standard score.” The difference score was then compared to a critical value to determine whether a statistically and clinically significant discrepancy (2 SDs of the distribution of the difference scores) existed between a participant’s actual versus predicted achievement level on that test. Therefore, “overachievement” was defined as a significantly higher actual level of achievement compared to the level predicted based on the individual’s measured cognitive ability (and vice versa for “underachievement”).

**Results**

**Between-test Differences**
Three cognitive tests (WISC-III, WISC-IV, and WAIS-III) were used in the current study. One-way ANOVAs revealed no difference in the Wechsler composite scores among the three tests. The effect sizes of the differences (in the form of η²) were <.1, the threshold for a small effect size (Cohen, 1988). On academic testing, independent sample t-tests and a one-way ANOVA also failed to detect significant differences between achievement measures testing the

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1Among the three cognitive tests used, one-way ANOVAs revealed no difference in the Wechsler composite scores: Full-Scale IQ (FSIQ) \( F(2, 54) = 1.64, p = .20, \eta^2 = .06 \), Verbal IQ (VIQ) \( F(1,48) = 1.09, p = .30, \eta^2 = .02 \), Performance IQ (PIQ) \( F(1,48) = 1.16, p = .29, \eta^2 = .02 \), Verbal Comprehension Index (VCI) \( F(2,54) = 1.44, p = .25, \eta^2 = .05 \), Perceptual Organization Index (POI) (or Perceptual Reasoning Index, PRI, in WISC-IV) \( F(2,54) = 1.58, p = .22, \eta^2 = .06 \), Working Memory Index (WMI) (or Freedom from Distractibility Index, FDI, in WISC-III) \( F(2,51) = 1.82, p = .17, \eta^2 = .07 \), and Processing Speed Index (PSI) \( F(2,52) = 2.04, p = .14, \eta^2 = .07 \).
same domain. The effect sizes (in the form of $d$ and $Z^2$) fell below Cohen’s (1988) threshold for a small effect size. Thus, Wechsler composite scores from all participants, and standard scores from academic achievement tests measuring the same academic domain, were combined and analyzed as a whole.

Cognitive Functioning and Academic Achievement as Compared to the General Population

Table I presents the means and SDs of the seven weighted Wechsler composite scores and the weighted standard scores on each academic domain. Regarding cognitive functioning, while the Wechsler mean composite scores were all in the Average range, one-sample $z$-tests with Bonferroni adjustment revealed that 6 of the 7 mean scores were significantly different from the population mean of 100, with the exception of WMI. The participants’ mean FSIQ, VIQ, PIQ, VCI score, POI score, and PSI score were 5–12 IQ points higher than those of the general population. Their effect sizes approached or exceeded Cohen’s (1988) threshold of .50 for a medium effect.

Regarding academic achievement, the participants’ overall mean standard scores were within the Average range for all domains assessed. When compared to the general population norms using one-sample $z$-tests with Bonferroni adjustment, participants scored significantly higher than the general population on word reading and mathematical reasoning. The participants’ mean word reading and math reasoning scores were 8–9 points higher than the population mean. The effect sizes of these differences exceeded Cohen’s (1988) threshold of .50 for a medium effect.

Discrepancy Between Individual Intellectual Ability and Academic Achievement

Table II presents the numbers and percentages of participants with a significant discrepancy between actual performance on achievement tests and their predicted scores based on cognitive ability. The majority of participants (75–96%) did not exhibit any significant discrepancy between their cognitive and academic functioning. In the domains of reading and writing, the number of participants found to be performing above prediction (“overachieving”)

<table>
<thead>
<tr>
<th>Domain</th>
<th>n</th>
<th>$M^b$</th>
<th>$SD^b$</th>
<th>$Z$</th>
<th>ES$^c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wechsler composite scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-scale IQ</td>
<td>57</td>
<td>109.84</td>
<td>93.67</td>
<td>4.95*****</td>
<td>0.66</td>
</tr>
<tr>
<td>Verbal IQ</td>
<td>50</td>
<td>110.99</td>
<td>83.39</td>
<td>5.18*****</td>
<td>0.73</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>50</td>
<td>107.39</td>
<td>78.57</td>
<td>3.49***</td>
<td>0.49</td>
</tr>
<tr>
<td>VCI</td>
<td>57</td>
<td>112.23</td>
<td>95.18</td>
<td>6.16*****</td>
<td>0.82</td>
</tr>
<tr>
<td>POI</td>
<td>57</td>
<td>108.30</td>
<td>92.30</td>
<td>4.18****</td>
<td>0.55</td>
</tr>
<tr>
<td>WMI$^a$</td>
<td>54</td>
<td>101.88</td>
<td>90.38</td>
<td>0.92</td>
<td>0.13</td>
</tr>
<tr>
<td>PSI</td>
<td>55</td>
<td>105.70</td>
<td>80.87</td>
<td>2.82**</td>
<td>0.38</td>
</tr>
<tr>
<td>Achievement standard scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word reading</td>
<td>51</td>
<td>109.05</td>
<td>145.70</td>
<td>4.31****</td>
<td>0.60</td>
</tr>
<tr>
<td>Reading comprehension</td>
<td>41</td>
<td>104.25</td>
<td>91.37</td>
<td>1.82</td>
<td>0.28</td>
</tr>
<tr>
<td>Arithmetic computation</td>
<td>52</td>
<td>100.10</td>
<td>133.45</td>
<td>0.05</td>
<td>0.0007</td>
</tr>
<tr>
<td>Math reasoning</td>
<td>21</td>
<td>108.83</td>
<td>183.18</td>
<td>2.70*</td>
<td>0.59</td>
</tr>
<tr>
<td>Spelling</td>
<td>50</td>
<td>104.82</td>
<td>132.52</td>
<td>2.27</td>
<td>0.32</td>
</tr>
<tr>
<td>Written expression</td>
<td>40</td>
<td>105.95</td>
<td>76.25</td>
<td>2.51</td>
<td>0.40</td>
</tr>
</tbody>
</table>

$^a$FDI in WISC-III is the equivalent of WMI in WISC-IV and WAIS-III.

$^b$Calculated based on weighted data.

$^c$ES is the difference between the obtained mean composite score and the population IQ mean (i.e., 100) divided by the population SD (i.e., 15).

$p < 0.01; *p < 0.005; ***p < 0.0005; ****p < 0.00005; *****p < 0.000001.
was similar to that of those performing below prediction (“underachieving”). In the domain of mathematics, however, the participants who displayed significant ability–achievement discrepancy all performed below prediction.

### Discussion

On average, this clinical sample of children and adolescents with chronic pain scored within the Average range on cognitive and academic achievement measures. This is consistent with prior results of Sherry et al. (1991) and Haverkamp et al. (2002). Furthermore, statistical comparisons to populations means, corrected for unequal gender representation in this sample, showed that this sample of children had a significantly higher mean score on general intelligence, verbal ability, visual–perceptual reasoning, and processing speed, but not working memory. In academic achievement, achievement scores in the six core academic domains were within the Average range for this sample as a whole, but further analyses revealed that on average, these children and adolescents with chronic pain were better in single-word reading and mathematical reasoning than the general population.

Thus overall, this sample of children is not lagging behind their same aged peers either cognitively or in basic core academic skills. This provides some reassurance that children and adolescents with chronic pain are capable of continuing to learn. However, the questions of the impact of pain and school absence on academic performance (i.e., school marks), or the broader impact on other areas of normal childhood development such as social competence or emotional adjustment, are not addressed in the current study.

Using a quantifiable operational definition of “over-” and “underachievement” based on achievement scores predicted from cognitive scores versus actual achievement scores, the previously speculated preponderance of “overachievers” in a clinical sample of children with chronic pain (Malleson et al., 1992; Sherry & Malleson, 2002) was not supported. In fact, the majority of the sample had cognitive and achievement scores that were commensurate. “Under-” or “overachievement” tended to occur at equivalent rates in this sample, and “overachievement” occurred in reading and writing only.

In this clinical sample with complex, disabling pain, the group mean data do not indicate overall cognitive impairment, or a single atypical achievement pattern. If anything, participants were indicated to be highly capable learners. Therefore, the group summary data did not shed light on a possible link between school- or learning-related stress and chronic pain. Intra-individual examination of cognitive and achievement profiles may be more helpful in exploring hypotheses about links between school-related stress, school absence, and chronic pain. For example, a child who is bright and doing well academically overall may find it stressful to be significantly weaker in math or to struggle with short-term memory difficulties, even if these do not constitute a learning disability.

The definition of “overachievement” used in future research may need to be broadened to include additional measures, such as incongruity between class placement and actual cognitive and achievement levels, school grades, personality traits such as perfectionism, or achievement expectations of the child and parents. Incongruity between actual achievement and perceived potential may be a significant source of school-related stress.

There are several limitations of the current retrospective, descriptive study. The small sample size and low statistical power precluded further analyses on possible differences across subgroups of chronic pain types. Furthermore, future research will need to protocolize measures to eliminate the possible introduction of measurement error, something that may have affected the current study due to the changes in testing protocols and varying measures used in assessments over the time span surveyed. Also, in future studies, it may be valuable to include more specific measures of cognitive functioning (e.g., working memory and executive function), as well as school records of academic performance (grades), class placement, and attendance.

Future research needs to evaluate school-based strategies that can minimize the impact of pain-related absence. School programs that are flexible enough to allow normalized peer interactions, yet accommodate for fluctuations in pain and functioning, such as reduced course load, self-paced curriculum, or a combination of school attendance and home-based learning, are predicted to best suit children and adolescents with chronic pain.

**Conflicts of interest:** None declared.
References


