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Non-organic back pain signs in children with amplified musculoskeletal pain involving the back

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Abstract

Background Traditionally, back pain in childhood was presumed to be organic. However, children with amplified musculoskeletal pain syndrome (AMPS) commonly experience back pain. Our objective was to assess the frequency of non-organic back pain signs in children with amplified pain experiencing back pain and to determine if a difference existed between those with diffuse AMPS and those with localized AMPS.

Methods Retrospective cross-sectional cohort study of children ≤ 18 years old with AMPS and back pain presenting for an initial consultation to a pediatric rheumatology subspecialty pain clinic from 2009 to 2021. Data from an existing patient registry was combined with abstracted data from the electronic medical record including demographics, clinical characteristics, and physical exam findings. We used Fisher's exact test or Wilcoxon rank-sum test, as appropriate, to compare clinical findings among patients with localized versus diffuse AMPS.

Results At total of 334 patients with AMPS had back pain. The majority (62%) had diffuse AMPS. The most common non-organic back pain signs were failure to guard back when going from supine to sitting, presence of allodynia, and an incongruent affect. Positive straight leg raising test, and overreaction were rare. Patients with localized AMPS were more likely to have a positive straight leg raising test ($P = 0.01$). Patients with diffuse AMPS were more likely to have allodynia and an incongruent affect (both $P < 0.01$).

Conclusions The most common non-organic back pain signs in children with AMPS involving the back include incongruent affect, allodynia, and failure to guard the back when sitting up. Almost a third had a positive passive rotation and axial loading test. A positive straight leg raising test was rare and disappeared with distraction. These tests may help establish a diagnosis of amplified pain in children with back pain.

Keywords Child, Adolescent, Back pain, Amplified pain, Non-organic back pain signs, Fibromyalgia, Functional disability inventory (FDI)

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Introduction

Back pain in children has traditionally been regarded as indicative of an organic condition [1, 2]. However, over the past few decades, there is a significant number of children with chronic back pain in whom no organic disease can be found [3, 4]. Back pain in children is increasing worldwide and in a recent survey, 50% of children aged 9 to 19 years reported back pain at least once [5]. It is unknown how many of these children ultimately presented to a pediatric rheumatologist.

In 1980, Waddell, et al. reported 8 non-organic signs found in adults who did not have a discernable underlying pathological process leading to low back pain [6]. These signs include axial loading, passive rotation, distracted straight leg raising, superficial pain (allodynia), nonanatomic pain, overreaction, giving away weakness, and non-anatomic sensory deficit. These signs are frequently reported in adults and have been shown to have construct validity [7]. However, we could not find any description of or incidence of non-organic signs in children with back pain, and, in specific, in children with amplified musculoskeletal pain (AMPS) involving the back. There is one report of AMPS causing low back pain that mentions allodynia and an incongruent affect but there is no mention of the other non-organic signs [8]. We reported back/flank pain in 316 of 636 children (50%) with AMPS in 2020 [9]. Most authors reporting on the evaluation of back pain in children discuss imaging studies and do not focus on the physical examination [3, 8, 10]. Therefore, we were interested in the incidence of non-organic signs in children with amplified pain who present with back pain. Additionally, we hypothesized that there would be more non-organic signs in those with more localized AMPS since they would be more focused on their back than patients with widespread pain.

Documenting the incidence of these signs may help identify children with non-organic back pain early on and may help limit unnecessary investigations and avoid a delay effective care [11].

Methods

This retrospective cross-sectional cohort study included patients with AMPS ≤ 18 years who reported back pain at time of their initial clinic visit. All were enrolled in our Institutional Review Board approved patient registry between January 2009 and April 2021. The registry prospectively captures data from the initial visit and includes approximately 96% of all new patients. Patient data included age, race, duration of pain, and physical examination findings. AMPS was defined as disproportionate pain to the stimulus in the absence of other medical causes [12]. These children differ from those with organic musculoskeletal pain and those with active musculoskeletal diseases, such as arthritis. were excluded. All were examined by one physician (DDS). Pain was reported on a 0–10 scale verbally (10 highest level) and with a 100 mm visual analog scale (100 highest level) [13]. Function was assessed by the patient Functional Disability Inventory (FDI) score [14]. The widespread pain index (WPI; range 0–19) and symptom severity score (SSS; range 0–12) were obtained using standard intake forms [15]. Fibromyalgia was defined according to the 2010 American College of Rheumatology criteria for adults [15, 16]. Localized AMPS was defined as amplified back pain and no more than 4 body areas with amplified pain during the initial examination [9, 17]. Diffuse AMPS included those with ≥ 5 body areas with amplified pain as long as one of those areas included the back.

Non-organic signs

Non-organic back signs were documented at the initial clinic visit. Non-organic back pain signs included those outlined by Wadell as well as other typical signs of non-organic pain: (1) Axial loading (report of back pain when approximately 2 kg of downward pressure was applied to the head while the patient was standing erect), (2) passive rotation (report of back pain when the patient was rotated at the ankles while standing, keeping the hips and back in the same plane), (3) distracted straight leg raising (if back pain was reported with straight leg raising while supine, then it was observed if the patient reported back pain when the hip was flexed to 90˚with knee extended while the patient was sitting and attention was focused on the knee), (4) overreaction (exaggerated flinching, holding the back, and other pain behaviors out of proportion to the rest of the examination), and (5) allodynia (pain to a gentle touch) [6],. We did not include giving away weakness and non-anatomic sensory deficit since we typically categorize these signs as part of a functional neurologic disorder. All patients had nonanatomic pain since it would exclude the diagnosis of AMP. Not defined by Waddell, we included failure to guard the back when going from supine to sitting (guarding defined as using the elbow to prop oneself up, holding the legs or pants to sit up, turning on one's side and then sitting up by pushing with the arm to sit up) as a non-organic back pain sign. This was based on our experience observing children with spondyloarthropathy and other organic back pain. Although not specific to the back, an incongruent affect (manifesting a cheerful affect and no pain behaviors whilst reporting significant pain) was recorded as a non-organic sign of amplified pain [9]. It should be noted that allodynia, axial loading, passive rotation, and distracted straight leg raising are based on patient self-report, overreaction and incongruent affect are based on physician judgement, and only failure to guard one's back is objective.

Table 1 Demographics and self-reported scores of patients with amplified musculoskeletal pain and back pain

Characteristic	Total population *N* = 334	Localized AMPS *N* = 128	Diffuse AMPS *N* = 206	*P* between localized and diffuse
Age, median (IQR)	15 (13,16)	15 (13, 16)	15 (13,16)	0.31
Sex				< 0.01
Female	287 (86%)	99 (77%)	188 (91%)	
Male	47 (14%)	29 (23%)	18 (9%)	
Race N (%)				0.66
White	295 (88%)	111 (87%)	181 (88%)	
Black	26 (8%)	12 (9%)	17 (8%)	
Duration (months) median (IQR)	24 (9, 36)	18 (8, 36)	24 (9, 42)	0.22
Verbal pain median (IQR)	6 (5, 7)	6 (4, 7)	6 (5, 8)	0.19
VAS pain median (IQR)	61 64 (49, 74)	57 61 (38, 71)	63 66 (52, 75)	0.11
FDI (N) median (IQR)	26 (18, 34) 329 obs	23 (15, 32) 127 obs	28 (20, 35) 202 obs	< 0.01
SSS (N) median (IQR)	7 (5, 9) 294 obs	6 (4, 8) 116 obs	7.5 (6, 10) 178 obs	< 0.01
WPI (N) median (IQR)	8 (4, 12) 334 obs	4 (2, 6) 128 obs	11 (8, 14) 206 obs	< 0.01
Meets criteria for fibromyalgia (N) N (%)	176(60%) 294 obs	25 (22%) 116 obs	151 (85%) 178 obs	< 0.01

AMPS = amplified musculoskeletal pain, N = number of patients, IQR = interquartile range, VAS = visual analog score, SSS = symptom severity score, WPI = widespread pain index, obs = number of observations for that variable due to missing data

Table 2 Physical examination findings including non-organic back pain signs

	Total population *N* = 334	Localized AMPS *N* = 128	Diffuse AMPS *N* = 206	*P* between localized and diffuse
Allodynia by history N (%)	283 (85%) 333 obs	102 (80%) 127 obs	180 (88%) 206 obs	0.08
Allodynia on examination N (%)	253 (76%) 334 obs	86 (67%) 128 obs	167 (81%) 206 obs	< 0.01
Incongruent affect N (%)	301 (90%)	108 (84%)	193 (94%)	< 0.01
Overreaction N (%)	16 (5%)	8 (6%)	8 (4%)	0.33
Positive axial loading N (%)	89 (28%) 320 obs	28 (23%) 120 obs	61 (31%) 200 obs	0.17
Positive passive rotation N (%)	99 (31%) 320 obs	35 (30%) 118 obs	64 (32%) 202 obs	0.71
Positive straight leg raising N (%)	15 (5%) 309 obs	10 (9%) 114 obs	5 (3%) 195 obs	0.01
If positive, no pain on distracted straight leg raising N (%)	14 (93%) Only 15 obs	9 (100%) 9 obs	5 (83%) 6 obs	0.22
Failure to guard back when going from supine to sitting N (%)	189 (92%) 206 obs	70 (88%) 80 obs	119 (94%) 126 obs	0.08

AMPS = amplified musculoskeletal pain, N = number of patients, obs = number of observations for that variable due to missing data

Data analysis

Descriptive statistics on patient demographics and clinical characteristics were reported using the median and interquartile range (IQR) for continuous variables, and frequencies and percentages for categorical variables. We used Fisher's exact test or Wilcoxon rank-sum test, as appropriate, to compare clinical findings among patients with localized versus diffuse AMPS. Complete data analyses were conducted using StataCorp 18.0 (College Station, Texas).

Results

We identified 334 children with AMPS reporting back pain: 206 (62%) with diffuse AMPS and 128 (38%) with localized AMPS. The majority were female (86%) with a median age of 15 years (IQR: 13, 16 years) (Table 1). The racial breakdown was 88% White, 8% Black, 3% Asian and 1% Pacific Islander. 8% identified as Hispanic or Latino while 92% identified as not Hispanic or Latino. There was no difference in race between those with diffuse AMPS and those with localized AMPS ($P > 0.05$). The median duration was 2 years (IQR:9, 36 months). The reported pain intensity level was consistent between verbal and visual analog scores and there was no difference between the 2 groups. Patients with localized AMPS were more likely to be male (23% vs. 9%, $P < 0.01$).

Those with diffuse AMPS reported more disability (median FDI 28 (20, 35) vs. 23 (15, 32), $P < 0.01$), higher symptom severity score (7.5 [6, 10] vs. 6 [4, 8], $P < 0.01$), and were more likely to meet criteria for fibromyalgia syndrome (85% vs. 22%, $P < 0.01$), Table 1. Those with diffuse AMPS did not report more pain than those with localized AMPS either verbally or via the 100 mm scale.

The majority of patients reported pain in both the upper and lower back (69%, 79% of patients with diffuse AMPS and 52% of those with localized AMPS). Only 12% reported upper back pain. Low back pain was reported in 11% of patients with diffuse AMPS and in 33% of patients with localized AMPS. Only 26 patients (8%) had pain exclusively in the back (3 upper back, 6 lower back, and 17 both upper and lower back). The majority had pain, with or without allodynia in other body areas, including those with total body allodynia.

The frequency of non-organic signs is shown on Table 2. More patients with diffuse AMPS as compared to those with localized AMPS had allodynia of the back on examination and an incongruent affect (81% vs. 67%, $P < 0.01$, and 94% vs. 84%, $P < 0.01$, respectively). More patients with localized AMPS reported a positive straight leg raising test (9% vs. 3%, $P = 0.01$), although overall, straight leg raising was rarely positive, 5%, and when

it was positive, only 1 of 15 patients reported pain with distracted straight leg raising. Otherwise, there was no difference between the groups for the other non-organic signs. The most common non-organic signs were failure to guard the back when going from supine to sitting (92%), incongruent affect (90%), and allodynia on examination (76%). Allodynia by history (85%) was more commonly reported than evident on examination (76%). Positive passive rotation and axial loading were observed in 31% and 28%, respectively. The presence of either axial loading or passive rotation or both was 37%. Only 5% had overreaction.

Discussion

Back pain in children presents a wide differential diagnosis and includes both organic and non-organic causes. The non-organic back pain signs are frequently found in children with AMPS that involves the back and may help with establishing a diagnosis. Careful attention to how the patient moves about the examination table to determine if the patient fails to guard his or her back when going from supine to sitting, the presence of allodynia, and an incongruent affect are most common signs we observed. However, the other signs of non-organic back pain such as axial loading and passive rotation are not uncommon. In the rare situation of a positive straight leg raising, a distracted test should be done to confirm it. Overreaction was rare in our population (5%) although Waddell reported it in 10–33% of adults [6].

The majority of the non-organic back pain signs are subjective, based on patient report. However, failure to guard one's back is objective and further study may prove it be of use in discrimination between organic and non-organic back pain. Overreaction and an incongruent affect is based on clinical judgment. Reproducibility studies between clinicians of all these non-organic signs in children are needed.

In line with the literature [9, 18], we found those with diffuse AMPS reported more disability, other somatic symptoms as reflected in the symptom severity score, and 85% fulfilled criteria for fibromyalgia [9]. However, 22% of those with localized AMPS also met fibromyalgia criteria. Despite higher levels of dysfunction, those with diffuse AMPS, did not report higher levels of pain than those with localized AMPS, Table 1.

We did not find, as hypothesized, more non-organic back pain signs in those with localized AMPS, but rather more allodynia and the presence of an incongruent affect in those with diffuse AMPS. Back specific signs, such as axial loading, and passive rotation were not more common in those with localized AMPS. Those localized AMPS were more likely to have a positive straight leg raising test, but all had no pain when repeated while distracted. Interestingly, males were more likely to have localized AMPS.

The reason there was not more differences between the groups is not clear. It may be that our division between diffuse and localized, that was based on literature, is different from those with exclusive back pain or even low back pain [9, 17]. There were few patients with exclusive back pain. Another reason could be that AMPS is more of a single entity and patients are on a continuum rather than separate. It may be reasonable to combine all patents as having a single condition rather than split them off into diffuse, fibromyalgia, or localized groups [12].

The percentage of patients with either a positive axial loading or positive rotation test it is comparable to that found in work compensation and problem back patients than that reported by Waddell [6]. However, we had far few patients with a positive straight leg raising test and almost all reported no pain when distracted. Likewise, we had fewer patients than Waddell with overreaction. It may be that an incongruent affect is the norm in children with AMPS so overreaction may be found in those with non-organic back pain signs without AMPS or is more of a feature of adult back pain patients. Wadell did not report on an incongruent affect or failure to guard the back when going from supine to sitting and these findings are very common in children with non-organic back pain associated with AMPS.

Our study has limitations. All were seen by one investigator and reproducibility between observers needs to be done. However, this eliminates any concerns about interrater reliability for this current study. Non-organic back pain signs have not been validated in children as they have been in adults, and we did not compare our non-organic back pain signs to children with organic causes of back pain [7]. Our division between diffuse and localized was based on published studies and may have skewed the results toward null. We had very few patients with exclusive back pain.

Conclusion

The non-organic back pain signs may be helpful in establishing a diagnosis of amplified pain in children who report back pain. The most common ones are failure to guard the back when going from supine to sitting, incongruent affect, and allodynia followed by passive rotation and axial loading. A positive straight leg raising test is rare, but more common in those with localized AMPS than those with diffuse AMPS and should be confirmed with a distracted straight leg raising test. Overreaction was rare in our population. Further investigation of these signs in children with both organic and non-organic back pain would help clarify their role in early diagnosis of non-organic back pain.

Abbreviations

AMPS	Amplified musculoskeletal pain
FDI	Functional disability inventory
WPI	Widespread pain index
SSS	Symptom severity score
N	Number
IQR	Interquartile range
VAS	Visual analog score

Supplementary Information

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Supplementary Material 1

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None.

Author contributions
DDS: inception, study design, IRB approval, writing first draft, subsequent revisions and final approval. MM: study design, IRB approval, RedCAP data extraction, statistical analysis, editing drafts, and final approval. SG: study design, statistical analysis, editing draft revisions, and final approval.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Conflict of interest
None.

Ethics
This study was approved by the Institution Review Board at the Children's Hospital of Philadelphia.

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