Published in final edited form as:

J Pain. 2016 June ; 17(6): 678–684. doi:10.1016/j.jpain.2016.02.005.

Association between widespread pain scores and functional impairment and health-related quality of life in clinical samples of children

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Abstract

Pain involving several body regions generally represents nervous system pathophysiology shifting from predominantly peripheral to more central. In adults, higher widespread pain scores are clinically meaningful and confer risk for poor response to treatment. It is unknown whether widespread pain is similarly important in children. To address this gap, we conducted an observational study examining (1) associations between widespread pain and functional impairment and health-related quality of life (HRQOL) in clinical pediatric samples, and (2) associations among sociodemographic factors and pain catastrophizing with widespread pain scores. Participants were 166 children age 10-18 years from three samples (acute pain, pre-surgery, chronic pain). Children self-reported pain intensity, pain catastrophizing, functional impairment and HRQOL. Children indicated pain locations on a body diagram, which was coded using the American College of Rheumatology definition of widespread pain. Results revealed higher widespread pain scores were associated with greater functional impairment with routine activities ($F=3.15$, $p=0.02$) and poorer HRQOL ($F=3.29$, $p=0.02$), adjusting for pain intensity, study group and demographics. Older age ($B=0.11$, $p=0.01$), and Hispanic ethnicity ($B=0.67$, $p=.03$) were associated with higher widespread pain scores. Findings support incorporating evaluation of widespread pain into pediatric pain assessment. Future research is needed to examine longitudinal impact of widespread pain on children's treatment outcomes.

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Conflicts of interest: There are no conflicts of interest

Introduction

Widespread pain is defined as the presence of pain that crosses anatomical boundaries and peripheral nerve distributions, and is therefore generally thought to represent amplification at the central nervous system level^{20,27}. Emerging research in adults supports consideration of widespread pain as a continuum^{24,26}, where increasingly widespread pain represents pain mechanisms shifting from more peripherally driven by nociceptive input, to more centrally driven by augmented pain and sensory processing. By this definition, widespread pain may occur across painful conditions including those previously thought to primarily have peripheral mechanisms driving the pain (e.g., knee osteoarthritis). Thus, the concept of the “widespreadness” of pain has potential implication across a wide range of clinical samples.

Previous research suggests that the spatial distribution of pain may provide unique information on pain experience above and beyond pain intensity, which has historically received the most focus in research. In adult studies, higher scores on a widespread pain scale have been found to be associated with poorer health than lower widespread pain scores^{4,5,11}. Identifying the presence of widespread pain may also have potential impact on treatment decisions. For example, pain which is becoming more centralized on the continuum is also less likely to respond to treatments targeting nociceptive signaling²⁷ and potentially more likely to respond to centrally acting analgesics. Moreover, recent studies examining response to surgical treatment have shown that widespread pain is associated with greater opioid requirements^{4,11} and persistence of pain after surgery⁵, even with widespread pain scores well below the threshold for a diagnosis of fibromyalgia. Another aspect of spatial distribution of pain found to influence health and function in adults is the specific pattern of pain sites^{2,8,10}. For example, axial pain² and knee pain^{8,10} were associated with greater disability in several clinical samples of adults.

In children, widespread pain has been characterized as either present or absent, with terms such as widespread pain¹⁶ or multiple pains¹⁴ used descriptively in community samples or in clinical samples¹³. In community samples, prevalence rates of widespread pain in school-age children range from 7-15 %^{12,15}. In clinical samples, children with fibromyalgia report poor physical and psychosocial functioning¹³. The measurement of pain location on a standard body outline is widely used in clinical research and practice^{9,22}. However, there has been surprisingly little attention to understanding the entire continuum of the spatial distribution of pain in children, and whether increasingly widespread pain confers higher risk for poor health-related functioning as found in adult cohorts. The influence of specific patterns of pain location has also not been explored.

The primary aim of this study was to expand the study of widespread pain in children, by examining the association between widespread pain and functional impairment and health-related quality of life (HRQOL) in clinical samples of children. Similar to research conducted in adult samples, we were interested in examining widespread pain across the continuum (spanning low, and high levels of widespread pain) and comparing it to associations found using pain intensity. Based on literature in adults, we hypothesized that higher widespread pain scores would be associated with greater functional impairment and

poorer HRQOL, adjusting for pain intensity, study group, and sociodemographic characteristics. We also explored whether pain in specific locations was associated with functional impairment and HRQOL. Our secondary aim was to examine sociodemographic and psychological factors associated with widespread pain scores in these children, including age, sex, race, ethnicity, and pain catastrophizing, controlling for study group. We hypothesized that greater pain catastrophizing would be associated with higher widespread pain scores.

Methods

Setting and Participants

Participants included 166 children 10-18 years old from three clinical samples (acute pain, pre-surgery, and chronic pain) at a children's hospital in the northwestern United States, who were currently or previously enrolled in two ongoing longitudinal studies examining risk for development of chronic pain. Data from the first assessment (baseline) prior to any interventions were used. The three samples included: (1) acute pain group (n=58) presenting to Orthopedics clinic or Emergency Medicine for evaluation of a new-onset musculoskeletal pain problem (<2 weeks duration); (2) pre-surgery group (n=53) had a musculoskeletal deformity, including spinal deformity (adolescent idiopathic scoliosis, juvenile scoliosis, spondylolisthesis, kyphosis) or chest wall deformity (pectus excavatum and pectus carinatum) and were scheduled for surgery; (3) chronic pain group (n=55) was seeking treatment (initial evaluation) at a specialty pediatric chronic pain clinic for chronic musculoskeletal pain (> 3 months duration, weekly pain). Across all groups, children were excluded from the study if (1) they had a serious comorbid chronic medical condition (e.g., diabetes, cancer, arthritis), (2) they were developmentally delayed, or (3) they or their parent/guardian were unable to speak and read English fluently.

Procedures

Study procedures were approved by the Institutional Review Board. Potentially eligible children were identified from clinic schedules. Children interested in participation provided their assent and parents provided written consent for study procedures. Across groups, participation rate was 43% amongst children approached. The primary reason for non-participation was families indicating that they did not have time to take part in a research study. Participants either received surveys in the mail or they completed the questionnaires as part of a laboratory study visit.

Measures

Pain intensity—Children reported on average pain intensity experienced over the preceding week (“In the past 7 days...”) using an 11-point numeric rating scale (0 = “no pain” and 10 = “worst pain possible”). Numeric rating scales for pain intensity have been broadly used in samples of children in this age range with both acute and chronic pain²¹.

Widespread pain—Children were instructed to mark the location of pain experienced during the past 7 days on a validated body outline¹⁸, showing the front and back of the body. Children were instructed to “mark with “X” where on your body you have had aches or

pains”. Children also noted their most painful body part via free text (“most problems with aches or pains”). The body diagrams were coded by trained research personnel following a standardized protocol based on the American College of Rheumatology (ACR) definition of widespread pain contained in the ACR diagnostic criteria for fibromyalgia. Presence of pain was coded for each of the five regions: left side of the body, right side of the body, above the waist (head, neck, arms, hands, upper body, chest, abdomen), below the waist (lower abdomen/pelvis, low back, buttocks, legs, feet), and axial pain in the spine, chest or back²³ following procedures reported by Jones et al¹². In analyses, the number of regions (widespread pain score) was treated as an ordinal variable with four categories: 2 or fewer regions, 3 regions, 4 regions, and 5 regions. Widespread pain has not been consistently measured in prior pediatric studies¹⁹. We therefore chose to consider widespread pain across the continuum, as consistent with the recent approach in adult literature^{4,5,11,24,26}. In an exploratory manner we also coded specific pain regions (1: left/right/or both; 2: below the waist; 3: above the waist; and 4: axial pain) to examine associations between the site or location of pain and functional impairment.

Functional impairment—Children self-reported on functional impairment on the Child Activity Limitations Interview (CALI) self report version. This is a 21-item scale that comprehensively assesses functional impairment with active and routine activities due to pain in the past 7 days. Children reported “how difficult or bothersome” each activity was “because of pain”, on a 5-point Likert-type scale from 0=not very difficult to 4=“extremely difficult. Items include physical activities (e.g. “riding a bike or scooter”, “walking one or two blocks”), activities of daily living (e.g. “sleep”, “eating regular meals”), school function (e.g. “going to school”, “schoolwork”), social activities (e.g. “playing with friends”, “doing things with friends”), and recreational activities (e.g. “doing a hobby”). Scores are summed to tabulate a total difficulty score ranging from 0 to 84, with higher scores indicate greater difficulty with activities. Five items assessing difficulty with activities of daily living are summed to yield a Routine factor score, and eight items assessing difficulty with activities requiring vigorous physical activity are summed to yield an Active factor score. This measure has shown good internal consistency ($\alpha = 0.95$), and high cross-informant reliability with parent reported functional impairment ($r = 0.73$)¹⁷.

Health-related quality of life—HRQOL was measured using the Pediatric Quality of Life Scale, Short-Form (PedsQL), acute version. This is a 15-item questionnaire assessing physical, emotional, social, and school function over the preceding 7 days, reported on a Likert-type scale from 0 = never, to 4 = almost always. Responses are reverse scored and transformed to a 0 to 100 range, and are then summed and divided by number of items, to yield a Total Score and 2 subscale scores for Psychosocial Health and Physical Health. Higher scores on the PedsQL indicate better HRQOL. The PedsQL and the PedsQL Short-Form have been used broadly in general and disease specific pediatric populations, with the Short-Form comparable to the full-length version⁶.

Pain catastrophizing—Pain catastrophizing was measured with the Pain Catastrophizing Scale-Child Version (PCS-C), a 13-item self-report measure that assesses children's thoughts and feelings in response to pain⁷. Items are rated on a 5-point Likert-type scale with a

maximum possible total score of 52, with higher scores indicating greater rumination, magnification and/or helplessness about pain. The PCS-C showed good internal consistency ($\alpha = .87 - .90$) in schoolchildren with and without pain, and correlated highly with pain intensity ($r = .49$) and disability ($r = .50$) in children with chronic pain⁷.

Sociodemographics—Parents reported on child race and ethnicity, parental education, and parental income, on a caregiver questionnaire.

Statistical analyses

Data were analyzed using STATA / SE12.1 (StataCorp, College Station, TX). We conducted multiple linear regression analyses to address our first aim, examining relationships between widespread pain score and pain intensity with functional impairment and HRQOL. Age, sex, race, ethnicity, and study group were included as covariates. Widespread pain score, sex, race, ethnicity, and study group were entered as categorical variables. Pain intensity and age were entered as continuous variables. Testing for possible multicollinearity indicated that this would not bias the results of the planned regression analyses; the highest variance inflation factor for all planned regression analyses was 2.06. An interaction variable for widespread pain score and pain intensity was non-significant and therefore was not included in the analyses. Separate regression analyses were conducted to test associations with total score and factor scores (Routine and Active factors) of the Child Activity Limitations Interview and with the Total score and summary scales (Psychosocial Health and Physical Health) of the Pediatric Quality of Life Inventory. Posttest analyses were used to test equality of coefficients across widespread pain scores.

To explore the relationship between specific pain locations and functional impairment and HRQOL, multiple linear regression analyses were conducted examining relationships between four pain locations (left/right sided pain, pain above the waist, pain below the waist, axial pain) and functional impairment and HRQOL, controlling for pain intensity and study group. Pain location and study group were entered as categorical variables. Pain intensity was entered as a continuous variable. Separate regression analyses were conducted to test associations with total score on the Child Activity Limitations Interview and with total score on the Pediatric Quality of Life Inventory.

To address our second aim, a linear regression analysis was conducted to examine associations between age, sex, race, ethnicity, and pain catastrophizing, and widespread pain score, controlling for study group. Age and pain catastrophizing were entered into the model as continuous variables. Sex, race, ethnicity, and study group were entered as categorical variables. Unstandardized beta coefficients and adjusted R-square were reported for all models.

Results

Descriptive data

Participants were on average 14.4 (SD=2.0) years of age, 71.1% female, and 76.3% white. Sociodemographic characteristics are presented in Table 1. Pain intensity, functional

impairment and HRQOL are displayed along the continuum of the widespread pain score (2, 3, 4, and 5 regions) in Table 2.

Associations between widespread pain scores and functional impairment and health-related quality of life

Results of the multiple linear regression analyses examining associations between widespread pain and pain intensity, and functional impairment and HRQOL are presented in Table 3. All models adjusted for age, sex, race, ethnicity, and study group.

Higher widespread pain scores were significantly associated with greater functional impairment with routine activities (Routine factor, $F=3.15$, $p=0.02$). Widespread pain scores were not associated with functional impairment with activities requiring vigorous physical activity (Active factor, $F=0.26$, $p=0.85$), or overall functional impairment (Total CALI, $F=1.16$, $p=0.32$). On the contrary, higher pain intensity was associated with overall functional impairment (Total CALI, $B=1.12$, $p=0.04$), and greater functional impairment with activities requiring vigorous physical activity (Active factor, $B=0.59$, $p=0.04$), but not with routine activities (Routine factor, $B=0.08$, $p=0.43$).

As hypothesized, higher widespread pain scores were associated with Total HRQOL ($F=3.29$, $p=0.02$). Higher widespread pain scores were associated with Psychosocial Health ($F=4.83$, $p<0.01$), but were not associated with Physical Health ($F=0.48$, $p=0.69$). Higher pain intensity was not associated with Total HRQOL ($B=-0.27$, $p=0.70$), Psychosocial Health ($B=0.51$, $p=0.48$), or Physical Health ($B=-1.87$, $p=0.10$). Exploratory regression analyses did not find any association between pain location and functional impairment or HRQOL ($p's>0.05$).

Factors associated with widespread pain score

A linear regression analysis was conducted to examine demographic and psychosocial factors associated with widespread pain scores. The results of the regression analysis showing associations between sex, age, race, ethnicity, and pain catastrophizing, and widespread pain score, controlling for study group are presented in Table 4. Increasing age ($B=0.11$, $p=0.01$) and Hispanic ethnicity ($B=0.67$, $p=0.03$) were associated with higher widespread pain scores. Contrary to hypotheses, pain catastrophizing was not associated with widespread pain scores ($B=0.01$, $p=0.29$).

Discussion

Our findings suggest that similar to adults, higher widespread pain scores are associated with greater functional impairment and poorer health-related quality of life in children. In fact, this dimension of pain experience (i.e. the spatial distribution) had greater associations with health-related quality of life scores than pain intensity, the measure most often used to describe pain. Specifically, increasingly widespread pain was associated with greater functional impairment with routine activities (activities of daily living) and poorer psychosocial health and total health-related quality of life, across the spectrum of widespread pain scores. In contrast, higher levels of pain intensity were associated with impairment with vigorous physical activities and total functional impairment. These findings

suggest that measurement of widespreadness of pain captures a broader psychosocial impact of the pain experience, distinct from pain intensity. These findings also extend prior literature, which has shown that children who meet the full criteria for widespread pain, i.e. diagnosed fibromyalgia, have poor physical and psychosocial functioning¹³.

Our study used an innovative sampling strategy including three clinical pediatric cohorts. Demonstrating the association between widespread pain and functional impairment and HRQOL across clinical samples is novel. Further research is needed in both pediatric and adult samples with acute pain to examine characteristics associated with persistence and/or spatial extension of pain locations. In our sample, functional impairment and HRQOL had different patterns of association with children's pain characteristics. Only the Active factor on the CALI was associated with pain intensity, while the Routine factor on the CALI and Psychosocial Health on the PedsQL were associated with spatial distribution of pain. Physical Health on the PedsQL was not associated with either dimension of pain experience. These findings highlight the importance of incorporating measures of both perceived function and health-related quality of life, and consideration of subscales of these metrics in pediatric pain research, as they encompass different domains and may have differing influences. Future studies can expand this assessment to include relevant psychological variables that may moderate the association between widespread pain and functional impairment and HRQOL.

In clinical samples of children with pain, central sensitization and altered somatosensory processing is thought to play a role in pain persistence³. However, experimental measurement of central pain processing is relatively complex and not commonly conducted in children¹. Assessment of the spatial distribution of pain is potentially a non-invasive surrogate measure to assess the presence of central pain augmentation that is feasible in the clinical setting. Future research should examine the relationship between central mechanisms using additional methodologies (e.g. quantitative sensory testing) and widespread pain, as well as the relationship to pain persistence in clinical samples of children.

The measurement of pain location on a standard body outline such as that used in this study is a simple technique, which is widely used in clinical research and practice^{9,22}. Our data suggest that consideration of this information in terms of widespreadness of pain as a routine part of clinical assessment will potentially enhance measurement of the pain experience in children. Although we did not find a relationship between specific pain locations and impairment/HRQOL it is possible in a mixed heterogeneous pediatric pain sample spanning musculoskeletal and non-musculoskeletal types of chronic pain (e.g., abdominal pain, headache), other patterns would emerge. The findings of the current study would also be extended by research examining the predictive validity of widespread pain scores on pain persistence and health outcomes after intervention. In addition, research is needed to examine the relevance of widespread pain scores in determining treatment response in children, for example the relationship to medication requirements, and to recovery in health after surgery. While studies have begun to address this relationship in adults^{4,5,11}, these questions still need to be answered in children. Furthermore, it is unknown whether tailored pain management, for example as guided by widespread pain status, would

improve outcomes in both pediatric and adult clinical samples. Research is needed examining change in widespread pain with treatments that are focused on altering central mechanisms²⁷.

While we found a significant relationship between widespread pain scores and psychosocial health, our study was not designed to examine the direction of this relationship, i.e. whether widespread pain impacts Psychosocial Health or whether impaired psychosocial health puts children at risk for experiencing increasingly widespread pain. Interestingly, pain catastrophizing was not associated with widespread pain scores. Incorporation of broader psychosocial measures (e.g., measures of depression or anxiety) into future research would allow further examination of patterns of psychological characteristics associated with increasingly widespread pain, and whether psychosocial characteristics differ based on varying patterns of widespread pain.

The results of this study should be interpreted in the light of several limitations. As we used a simple body outline alone for measurement of pain locations, we were limited to using the definition for widespread pain contained in the 1990 ACR Diagnostic Criteria for fibromyalgia, which contains fewer pain regions than the 2010 ACR preliminary diagnostic criteria²⁵. The 1990 criteria have been used in prior pediatric studies^{12,15,16}, however recent research in adults has used the newer 2010 preliminary criteria and the 2011 modified criteria^{4,5,11}. Future research should examine whether use of the definition in the newer criteria, and of the body diagram contained in these criteria, yields similar results in children. This would also allow further exploration of whether particular pain locations contribute more strongly to pain-related disability in children. While we were able to control for study group, we were limited by sample size in our ability to compare widespread pain associations between different samples. In addition, our cross-sectional study design limited us to examining associations between widespread pain scores and functional impairment and HRQOL. Future research should examine the longitudinal impact of widespread pain scores on pain persistence and health outcomes.

In conclusion, findings from the current study revealed higher widespread pain scores were associated with greater functional impairment and poorer HRQOL in clinical and community samples of children. Although the spatial distribution of pain is commonly measured in children, consideration of this dimension of pain in terms of widespreadness across the continuum has not typically been considered in children, and may prove to be clinically meaningful for identifying youth in most need of treatment. Widespread pain is an important domain that we should routinely assess in pain measurement in children in both clinical and research settings.

Acknowledgments

Disclosures: This study was supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award No. K23HD078239 (PI: Jennifer A. Rabbitts) and Award No. K23HD071946 (PI: Amy Lewandowski Holley). Tonya M. Palermo is supported by NIH K24HD060068. Cornelius B. Groenewald is supported by T32GM086270 (P.I. Palermo).

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Perspective

This article examines the association between widespread pain scores and functional impairment and HRQOL in community and clinical samples of children. Assessment of the spatial distribution of the pain experience provides unique information that may identify children at risk for poorer health.

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Higher widespread pain scores were associated with poorer HRQOL in children
Widespreadness of pain had greater associations with HRQOL than pain intensity
Higher widespread pain scores were associated with greater functional impairment
Specifically widespread pain was associated with impairment with routine activities
Findings support routine evaluation of widespread pain in pediatric pain assessment

TABLE 1

Sociodemographic characteristics of children

CHARACTERISTIC	M (SD)/N (%)
Age (years)	14.4 (2.0)
Sex	
Female	118 (71.1%)
Male	48 (28.9%)
Child race	
White	122 (73.5%)
African American	9 (5.4%)
Asian	6 (3.6%)
Other/not reported	29 (17.5%)
Child Ethnicity	
Hispanic	18 (10.8%)
Non-Hispanic	138 (83.1%)
Not reported	10 (6.0%)
Annual household income	
< \$ 29,999	27 (16.3%)
\$ 30,000-\$69,999	47 (28.3%)
> \$ 70,000	89 (53.6%)
Not reported	3 (1.8%)
Parental education level	
High school or less	20 (12.0%)
Vocational school/ some college	56 (33.7%)
College	55 (33.1%)
Graduate/ professional school	33 (19.9%)
Other/ not reported	2 (1.2%)
Study group	
Acute pain	58 (34.9%)
Pre-surgery	53 (31.9%)
Chronic pain	55 (33.1%)

TABLE 2

Pain intensity, functional limitations, and HRQOL by widespread pain score

WIDESPREAD PAIN SCORE	N	PAIN INTENSITY M (SD)	FUNCTIONAL LIMITATIONS M (SD)	HRQOL M (SD)
2	61	4.3 (2.1)	12.8 (11.2)	73.8 (16.8)
3	27	6.0 (2.6)	16.4 (13.7)	70.5 (15.9)
4	34	5.4 (2.2)	19.0 (12.5)	64.1 (17.2)
5	44	6.2 (1.7)	25.4 (17.4)	56.4 (19.4)

WIDESPREAD PAIN SCORE, Increasing scores indicate increasing widespread pain; *HRQOL*, Health-related Quality of life

TABLE 3

Multivariate regression model examining association between widespread pain score (2, 3, 4, or 5 regions) and functional limitations and HRQOL^{*}

	Unstandardized Beta	T	R ²	F	P
<u>FUNCTIONAL LIMITATIONS:</u>					
<u>Total Functional Limitations</u>					
Widespread pain score					0.32
3	0.58	0.18			
4	2.71	0.89			
5	5.41	1.77			
Pain intensity	1.12	2.10			0.04
<i>Total</i>			0.37	6.28	<0.001
<u>Routine Factor</u>					
Widespread pain score					0.02
3	-0.06	-0.09			
4	0.46	0.76			
5	1.69	2.77			
Pain intensity	0.08	0.78			0.43
<i>Total</i>			0.48	9.73	<.001
<u>Active Factor</u>					
Widespread pain score					0.85
3	-0.20	-0.12			
4	1.06	0.66			
5	0.99	0.61			
Pain intensity	0.59	2.07			0.04
<i>Total</i>			0.27	3.82	<0.001
<u>HEALTH-RELATED QUALITY OF LIFE:</u>					
<u>Total HROOL Score</u>					
Widespread pain score					0.02
3	-1.75	-0.41			
4	-7.09	-1.78			
5	-11.75	-2.98			
Pain Intensity	-0.27	-0.39			0.70
<i>Total</i>			0.34	5.34	<0.001
<u>Psychosocial Health</u>					
Widespread pain score					<0.01
3	-5.80	-1.32			
4	-8.36	-2.05			
5	-15.35	-3.79			
Pain Intensity	0.51	0.71			0.48
<i>Total</i>			0.30	4.55	<0.001
<u>Physical Health</u>					

	Unstandardized Beta	T	R ²	F	P
Widespread pain score					
3	3.51	0.51			0.70
4	−3.68	−0.58			
5	−4.61	−0.73			
Pain Intensity	−1.87	−1.68			0.10
Total			0.25	3.47	<0.001

* Controlling for Age, sex, race, ethnicity, and study group; *HRQOL* Health-related quality of life

TABLE 4

Linear regression examining sociodemographic and psychosocial factors associated with widespread pain score

PREDICTORS	Unstandardized Beta	T	R ²	F	P
Pain catastrophizing	0.01	1.06			0.29
Age	0.11	2.43			0.02
Female Sex	0.20	0.98			0.33
Hispanic Ethnicity	0.67	2.13			0.04
White	reference				
Black	−0.46	−1.23			0.22
Asian	−0.43	−0.86			0.39
<i>Total</i>			<i>0.29</i>	<i>6.39</i>	<i><0.001</i>

Controlling for study group