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Presurgical Psychosocial Predictors of Acute Postsurgical Pain and Quality of Life in Children Undergoing Major Surgery

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Abstract: **Limited research has examined presurgical risk factors for poor outcomes in children after major surgery. This longitudinal study examined presurgical psychosocial and behavioral factors as predictors of acute postsurgical pain intensity and health-related quality of life (HRQOL) in children 2 weeks after major surgery. Sixty children aged 10 to 18 years, 66.7% female, and their parent/guardian participated in the study. Children underwent baseline assessment of pain (daily electronic diary), HRQOL, sleep (actigraphy), and psychosocial factors (anxiety, pain catastrophizing). Caregivers reported on parental pain catastrophizing. Longitudinal follow-up assessment of pain and HRQOL was conducted at home 2 weeks after surgery. Regression analyses adjusting for baseline pain revealed that presurgery sleep duration ($\beta = -.26$, $P < .05$) and parental pain catastrophizing ($\beta = .28$, $P < .05$) were significantly associated with mean pain intensity reported by children 2 weeks after surgery, with shorter presurgery sleep duration and greater parental catastrophizing about child pain predicting greater pain intensity. Adjusting for baseline HRQOL, presurgery child state anxiety ($\beta = -.29$, $P < .05$) was significantly associated with HRQOL at 2 weeks, with greater anxiety predicting poorer HRQOL after surgery. In conclusion, child anxiety, parental pain catastrophizing, and sleep patterns are potentially modifiable factors that predict poor outcomes in children after major surgery.**

Perspective: ***This study addresses an important gap in literature, examining presurgical risk factors for poorer acute postsurgical outcomes in children undergoing major surgery. Knowledge of these factors will enable presurgical identification of children at risk for poorer outcomes and guide further research developing prevention and intervention strategies for these children.***

Key words: *Acute pain, health-related quality of life, children, spine fusion, surgery.*

Around 5 million children undergo surgery in the United States each year,[8,38] and it is estimated that between 40 and 60% experience moderate-severe pain while in the hospital.[13] Reported rates of acute postsurgical pain in children have remained similar over the past 2 decades[7,13,44] despite advances in perioperative care. Once present, moderate-severe postsurgical pain can be difficult to control[13] and can contribute to poorer clinical outcomes, including delayed recovery, and decreased satisfaction with care.[6,19,46] Moreover, recent studies suggest that postsurgical pain may persist beyond the healing period in many children after general or orthopedic surgical procedures such as spine fusion and pectus repair surgery.[3,11,21,35,47] A critical barrier to targeted prevention and treatment strategies in this context is that modifiable presurgical risk factors have not yet been identified.

The biopsychosocial model of pain demonstrates the interrelationship among biological, psychological, and social processes in determining response and adaptation to painful events and has been used to highlight factors applicable to perioperative management and postsurgical recovery.[26] Extensive research has established the importance of biopsychosocial factors in predicting pain after surgery in adults.[18] In the few studies conducted in children after surgery, several factors have emerged as potentially important risk factors for poor outcomes, including emotional factors (eg, child anxiety, child

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pain catastrophizing[10,34]), behavioral factors (eg, postsurgical sleep problems[16]), and social factors (eg, parental anxiety, parent pain catastrophizing[1,10]). However, several significant methodologic limitations in this prior research (including single retrospective ratings of pain, lack of measurement of functional outcomes, and lack of baseline assessment of risk factors) has precluded interpretation and application of findings. Weak measurement strategies such as use of single retrospective pain ratings introduce recall bias[36] and limit conclusions that can be drawn about postsurgical pain intensity. There has also been a lack of inclusion of functional outcomes in addition to pain intensity. Multidimensional assessment of function, for example, health-related quality of life (HRQOL), has been recommended for comprehensive understanding of acute pain outcomes in children.[28] Furthermore, assessments conducted prior to surgery are necessary to test risk factors that can eventually be targeted in children before surgery. Most prior studies have not performed assessments prior to surgery, and thus the literature is dominated by cross-sectional associations and limited understanding of variables that play a causal role in predicting poor postsurgical outcomes. Another limitation of prior research is that although studies have examined anxiety and pain catastrophizing in parents as potentially important factors in their child's pain experience,[32] there has been limited investigation of parental pain catastrophizing about *their child's* pain, which may be more relevant in this setting.

Therefore, this longitudinal study aims to address these methodological limitations by 1) examining the impact of major surgery on pain and HRQOL in children over time and 2) prospectively identifying modifiable psychosocial and behavioral factors at baseline that predict acute postsurgical pain intensity and HRQOL 2 weeks after major surgery in children. Based on prior literature, we hypothesized that 1) the majority of children would report moderate-severe pain and impairments in HRQOL at 2 weeks after surgery and that 2) presurgical assessments of higher child anxiety, higher child pain catastrophizing, shorter sleep duration, and higher parental catastrophizing about child pain would predict greater pain intensity and impairments in HRQOL 2 weeks after surgery.

Methods

Participants and Setting

Sixty children ages 10 to 18 years undergoing major surgery at a children's hospital in the northwestern United States and their parent or guardian (caregiver) were recruited into the study. The study was approved by the institutional review board. Caregivers provided informed consent, and children provided assent prior to research procedures.

Inclusion/Exclusion Criteria

Children were eligible if they were 1) ages 10 to 18 years, 2) undergoing either spinal fusion or pectus repair surgery, and 3) able to speak and read English. Children were excluded if 1) they had a serious comorbid health condition (eg, cancer, neuromuscular disease), 2) they had undergone prior major surgery, 3) they did not reside with their parent or guardian, or 4) their caregiver was not fluent in English. Eligible surgeries were chosen based on prior literature identifying these invasive procedures as at high risk for pain complications.[3,20,34,40,47] Indications for these surgeries include adolescent idiopathic scoliosis, juvenile scoliosis, spondylolisthesis, kyphosis, pectus excavatum, and pectus carinatum.

Recruitment

Eligible participants were identified from surgery clinic and procedure schedules and review of the electronic medical record over a 21-month period. Of 110 eligible families, 99 (90%) were approached in person or by telephone interview for potential participation in the study, and 11 (10%) were unable to be reached in time for baseline assessments. Of the 99 families approached, 60 (61%) agreed to participate and 39 (39%) refused because of lack of time or interest.

Procedures

Children underwent 2 assessments: a presurgery baseline assessment during the week immediately preceding surgery and a follow-up assessment that started 2 weeks after surgery. Each assessment was 7 days in duration and was completed at home.

Prior to surgery, children completed 7 days of daily monitoring of sleep with actigraphy and a daily electronic pain and sleep diary, with the final night being the night before surgery. At any time during this presurgery assessment, children and caregivers completed baseline self-report measures of sociodemographics, psychosocial factors (anxiety, pain catastrophizing), pain characteristics, and HRQOL. Baseline questionnaires, Actiwatches (Actiwatch 2; Phillips Respironics, MiniMitter Company Inc, Bend, OR), and personal digital assistants, used for the daily electronic diary, were couriered to the participants 1 week before surgery and were subsequently collected in-person on the participants' day of surgery.

The window of timing of participants starting the follow-up (2 weeks) assessment ranged from 8 to 21 days after surgery, with a mean of 14 days. During the postsurgical assessment, children repeated measures with the 7-day daily electronic pain and sleep diary, and questionnaires (pain characteristics and HRQOL) at home. Follow-up questionnaires and personal digital assistants were couriered to the participants 2 weeks after surgery and subsequently returned by participants via courier service. Clinical data were collected from the electronic medical record.

During the follow-up phase, 1 participant dropped out of the study because of lack of time, and 1 participant was lost to follow-up after surgery. Participants received gift cards to local stores on completion of assessments. Participants in this study are currently undergoing longer-term follow-up for which data collection is

ongoing. Thus, the focus of the present report is on short-term outcomes at 2 weeks only.

Measures

Daily Electronic Pain and Sleep Diary

Children rated their average pain intensity in an end-of-day diary completed each evening[36] on a personal digital assistant. Pain intensity was assessed using an 11-point numerical rating scale (NRS) (0 = no pain, 10 = worst pain). We defined moderate-severe pain based on prior literature as a mean pain score of equal to or greater than 4 out of 10 on the NRS.[43] Numerical rating scales are recommended for assessment of pain intensity for acute postsurgical pain.[33] Diary entries were time-stamped and could only be made during the corresponding time window, thereby reducing the potential of recall bias.[25] Children reported medication usage daily on the pain diary. Children also responded to items concerning their sleep and times that they removed the actigraph to assist with scoring actigraphy data.

Actigraphy Monitoring of Sleep

Daily monitoring of sleep patterns over 7 days was conducted using the Actiwatch 2, a motion sensor actigraph. This small noninvasive watchlike device worn on the nondominant wrist senses movement by an omnidirectional mercury switch that is open when there is no movement and closed when movement above a set threshold is detected. Each time the switch closes, activity counts are generated that are stored in 1-minute epochs. An event marker on the Actiwatch allows the patient to indicate bedtime and wake times. Actiware software (version 5.61.0010; Phillips Respironics, MiniMitter Company Inc) was used in conjunction with the event markers and the daily diary to calculate sleep duration, the total amount of time from sleep onset to offset. Sleep onset was defined as the first 10-minute segment with no more than 1 epoch of activity, and sleep offset was defined as the last 10-minute segment with no more than 1 epoch of activity. These methods have been used in previous studies in this age group.[23,24,29] Actigraphy has 85 to 95% agreement with traditional polysomnographic recordings for certain sleep variables (eg, sleep duration).[14]

Pain Questionnaire

This self-report measure assesses pain characteristics. Pain location is marked on a validated body outline.[39] Pain frequency and duration are assessed with a response time frame of "in the past 7 days" using Likert-type scales with 5 response options for frequency ("not at all" to "daily") and 4 response options for duration ("less than 1 hour" to "all day").

HRQOL

HRQOL over the preceding 7 days was measured with the Pediatric Quality of Life Scale, Short-Form (PedsQL), acute version. This is a 15-item questionnaire assessing physical, emotional, social, and school function with response options on a Likert-type scale from 0 = never to 4 = almost always. The responses are reverse scored and transformed to a 0 to 100 range. Responses are then summed and divided by number of items, to yield a Total score, and Psychosocial and Physical Health Summary subscale scores, with higher scores indicating better HRQOL. The PedsQL has been used in a wide variety of general and disease-specific populations and has an established at-risk cut-off score of 69.7, below which children are considered at risk for impaired HRQOL, based on a normative sample of healthy children.[45] The PedsQL Short-Form has been shown to be comparable to the full-length version.[2]

State Trait Anxiety Inventory for Children (STAIC)

This 40-item self-report measure assesses state and trait anxiety on 2 separate subscales, each of which has 20 items. The trait subscale assesses stable individual differences in the tendency to experience anxiety. The state subscale assesses the child's transient level of anxiety, typically elevated in stressful situations. Items are each rated on a 3-point scale. Items indicating less anxiety are reverse scored, and items are then totalled for a maximum possible score of 60 on each subscale, with higher scores indicating greater anxiety symptoms. The STAIC was shown to have good internal consistency (Cronbach's α = .82–.87 for the state subscale, and Cronbach's α = .78–.81 for the trait subscale) in a population-based sample of schoolchildren. Evidence of concurrent validity in this setting was shown by strong correlation with the Children's Manifest Anxiety Scale (r = .75) and the General Anxiety Scale for Children (r = .63).[42] The STAIC has been used in prior surgical studies in children.[1,3]

Pain Catastrophizing Scale–Child and Parent Versions (PCS-C and PCS-P)

The PCS-C is a 13-item self-report measure that assesses children's thoughts and emotions in response to pain. The PCS-P is a 13-item measure assessing parental response to their child's pain. Items on both the PCS-C and PCS-P are rated on a 5-point scale yielding a maximum possible score of 52, and 3 subscale scores, rumination, magnification, and helplessness. For both the PCS-C and PCS-P, higher scores indicate greater rumination, magnification, and/or helplessness about pain. The PCS-C showed good internal consistency (Chronbach's α = .87–.90) in schoolchildren with and without pain and correlated highly with pain intensity (r = .49) and disability (r = .50) in those with chronic pain.[5] The PCS-P showed good internal consistency (Cronbach's α = .81–.93) in children with and without chronic pain, and it correlated highly with parenting stress and functional disability in the children with pain.[12] Both the PCS-C and the PCS-P have been used in pediatric surgical studies.[10,34]

Sociodemographics

Caregivers provided sociodemographic information, including child race, ethnicity, and parent/guardian education level and income.

Clinical Factors

Demographic factors (age, sex, height, weight) and surgical factors (procedure type, duration of surgery, length of stay) were collected from the electronic medical record by study personnel. Body mass index (BMI) percentile category was calculated using the Centers for Disease Control and Prevention's online pediatric BMI calculator (available at: http://nccd.cdc.gov/dnpabmi/Calculator.aspx). BMI categories are based on the following percentile ranges: underweight, <5%; healthy weight, ≥5 to <85%; overweight, ≥85 to <95 %; and obese, ≥95%.

Statistical Analyses

Summary statistics were used to describe the sociodemographic and clinical characteristics of the sample. Continuous data were summarized with means (Ms) and standard deviations (SDs), and categorical items were summarized using frequencies (n) and proportions (%). Moderate-severe pain was defined as a mean pain score of equal to or greater than 4 out of 10 on the NRS based on prior literature.[43] A child reporting moderate-severe pain on at least 1 day during the follow-up assessment was considered as having moderate-severe pain present at the 2-week follow-up. Mean pain was calculated for baseline and 2 weeks postsurgery for each individual from his or her available daily pain diary data from each assessment. On average, children completed 7 days (range = 4–14) of daily diary at baseline and for 8 days (range = 4–13) at follow-up. Pearson correlations were conducted to examine associations between predictor and outcome variables. Testing for multicollinearity was nonsignificant, and therefore we proceeded to conduct linear regression analyses to test trait anxiety, state anxiety, pain catastrophizing, parental pain catastrophizing, and baseline sleep as predictors of mean pain intensity and HRQOL 2 weeks after surgery, adjusting for baseline pain and HRQOL. Separate regression models were tested for Total HRQOL, Psychosocial Health, and Physical Health scales. Models testing predictors of HRQOL adjusted for the baseline values of the applicable HRQOL scale. Age and sex were not associated with pain intensity or HRQOL scales in this sample and therefore were not included in the regression models. The 2 participants who dropped out of the study during follow-up were not included in these models. Results of the linear regressions were reported as adjusted R^2 and standardized β. All analyses were conducted with SPSS v.21.0 (IBM Corp, Armonk, NY).

Results

Baseline Characteristics

Participants included 60 children, ages 10 to 18 years (M = 14.7 years, SD = 1.9) and their parent or guardian. One primary caregiver (56 female, 4 male) participated with each child. The sample was predominantly female (66.7%) and white (83.34%). The majority of families (55.0%) had an annual household income above $70,000. Sociodemographic and clinical characteristics of the study participants are summarized in Table 1.

At baseline, most children (82.5%) endorsed some pain (NRS ≥1) with an average pain intensity over 7 recorded days from daily diaries of 2.8 (SD = 2.5). The most frequently reported sites of pain were back/spine (55%), legs (8.3%), chest (6.7%), and shoulders (6.7%). Eleven children (18.3%) reported using over-the-counter pain medications on the daily diary during the week prior to surgery; no children reported using prescription pain medications. Children slept an average of 7.9 hours (SD = .9) per night during the week prior to their surgery. In addition, children reported an average total HRQOL score of 73.6 (SD = 17.7) at baseline, with similar scores on psychosocial and physical health on average. Pain and HRQOL data are summarized in Table 2.

Impact of Surgery on Pain and HRQOL at 2 Weeks After Surgery

Longitudinal data collected on daily pain diaries indicated an average pain intensity for the sample of 3.8

Table 1. Sociodemographic and Clinical Characteristics of Children Having Major Surgery

Characteristic	n (%) or M (SD)
Age (y)	14.7 (±1.9)
Sex	
Female	40 (66.7%)
Male	20 (33.3%)
Child race	
White	50 (83.34%)
African American	2 (3.3%)
Asian	2 (3.3%)
Other/not reported	6 (10.0%)
Child ethnicity	
Hispanic	1 (1.7%)
Non-Hispanic	53 (88.3%)
Not reported	6 (10.0%)
Annual household income ($)	
<29,999	8 (13.3%)
30,000-69,999	15 (25.0%)
>70,000	33 (55.0%)
Not reported	4 (6.7%)
Body mass index category (age adjusted)	
Underweight	8 (13.3%)
Healthy weight	41 (68.3%)
Overweight	5 (8.3%)
Obese	6 (10.0%)
Trait anxiety	33.9 (±7.7)
State anxiety	33.7 (±6.2)
Pain catastrophizing (child)	13.7 (±9.6)
Pain catastrophizing (parent)	15.9 (±10.6)
Presurgery sleep duration (h)	7.9 (±.9)
Surgical procedure	
Posterior spinal fusion	48 (80.0%)
Anterior-posterior spinal fusion	2 (3.3%)
Nuss procedure for pectus deformity	9 (±15.0%)
Ravitch procedure for pectus deformity	1 (±1.7%)
Length of surgery (h)	5.2 (±1.6)
Length of hospital stay (d)	4.5 (±1.1)

Table 2. Descriptive Statistics for Pain and HRQOL in Children at Baseline (Presurgery) and 2 Weeks After Major Surgery

Outcome	Baseline, M (SD)	2 Wk, M (SD)
Pain intensity (NRS)*	2.8 (±2.5)	3.8 (±2.2)
HRQOL		
Total score	73.6 (±17.7)	60.3 (±15.5)
Psychosocial Health	74.5 (±18.1)	78.0 (±16.9)
Physical Health	71.9 (±26.2)	24.7 (±22.4)

*NRS 0 to 10, daily electronic pain diary.

(SD = 2.2) at 2 weeks postsurgery. The majority of children (79.2%) reported moderate-severe pain on at least 1 day during this 7-day assessment period. The most frequently reported sites of pain were back/spine (52%), chest (16.7%), and shoulders (11.7%). Forty (66.7%) children reported using pain medications 2 weeks after surgery, including over-the-counter pain medications (61.7% of children) and opioids (36.7% of children). Moreover, 6.7% of children reported using benzodiazepines.

Children reported impairments in total HRQOL 2 weeks after surgery (M = 60.3, SD = 15.5). Physical health was severely impaired on average (M = 24.7, SD = 22.4) compared to psychosocial health (M = 78.0, SD = 16.9) (see Table 2). Correlational analyses with baseline and 2-week variables are presented in Table 3.

Baseline Risk Factors for Pain 2 Weeks After Surgery

A linear regression was conducted to test baseline predictors of pain intensity at 2 weeks after surgery. Mean baseline pain was controlled for. The following baseline predictor variables were included in the multivariate model: trait anxiety, state anxiety, child pain catastrophizing, parental pain catastrophizing, and sleep duration. As hypothesized, parental pain catastrophizing ($\beta = .28$, $P < .05$) and presurgery sleep duration ($\beta = -.26$, $P < .05$) were significantly associated with mean pain intensity reported 2 weeks after surgery. Specifically, greater parental catastrophizing about child pain and shorter presurgery sleep duration predicted greater pain intensity at 2 weeks. However, contrary to hypotheses, child anxiety variables including trait anxiety, state anxiety, and child pain catastrophizing were not associated with child-reported pain 2 weeks after surgery. Overall, the model explained 33.8% of the variance (adjusted $R^2 = .34$, $P < .001$; see Table 4).

Baseline Risk Factors for Impairments in HRQOL 2 Weeks After Surgery

Three separate linear regressions were conducted to test baseline predictors of Total HRQOL, Psychosocial Health, and Physical Health scales at 2 weeks after surgery. Controlling for mean baseline pain and the applicable HRQOL scale, the model tested the following baseline predictors: trait anxiety, state anxiety, pain catastrophizing, parental pain catastrophizing, and sleep duration. Presurgery child anxiety was significantly associated with total HRQOL reported 2 weeks after surgery. Specifically, greater state anxiety at baseline ($\beta = -.29$, $P < .05$) predicted poorer HRQOL at 2 weeks. Trait anxiety, pain catastrophizing (child and parent), and sleep duration were not associated with total HRQOL 2 weeks after surgery. Overall, the model explained 49.7% of the variability in total HRQOL reported 2 weeks after surgery ($P < .001$) (see Table 5). In addition, parental pain catastrophizing at baseline predicted physical health 2 weeks after surgery ($\beta = -.34$, $P < .05$), with the total model explaining 22.0% of the variance in physical health (adjusted $R^2 = .22$, $P < .05$). The total model examining psychosocial health explained 50.8% of the variance in psychosocial health (adjusted $R^2 = .51$, $P < .001$); however, no unique predictors of psychosocial health were identified ($Ps > .05$).

Discussion

To our knowledge, this is the first study to prospectively identify baseline psychosocial risk factors for acute postsurgical pain and HRQOL in children after major surgery. Consistent with prior studies of acute postsurgical pain experienced while in the hospital,[13] the majority of children in our sample also reported moderate-severe pain that persisted at 2 weeks after surgery. As expected, children also reported HRQOL impairments 2 weeks after major surgery, which is consistent with studies of HRQOL at long-term follow-up in children after major surgeries.[9,22,30] Physical health was markedly

Table 3. Correlations Between Predictor and Outcome Variables

Variables	1	2	3	4	5	6	7	8	9
1. Baseline pain intensity	1.00	−.21	.32*	.12	.34*	.29*	−.10	.56**	.12
2. Baseline HRQOL		1.00	−.61**	−.47**	−.47**	−.44**	.01	−.04	.59**
3. Trait anxiety, child			1.00	.36**	.46**	.27	.02	.12	−.50**
4. State anxiety, child				1.00	.09	.27	.04	−.02	−.50**
5. Pain catastrophizing, child					1.00	.32*	.16	.06	−.12
6. Pain catastrophizing, parent						1.00	.15	.30*	−.09
7. Presurgery sleep duration							1.00	−.30*	.02
8. Pain intensity at 2 wk								1.00	.02
9. HRQOL at 2 wk									1.00

*$P < .05$, **$P < .01$.

Table 4. Linear Regression Predicting Average Postsurgical Pain Intensity in Children 2 Weeks After Major Surgery

Predictors	β	R^2	F
Baseline pain intensity	.44**		
Trait anxiety, child	.05		
State anxiety, child	−.16		
Pain catastrophizing, child	−.15		
Pain catastrophizing, parent	.28*		
Presurgery sleep duration (min)	−.26*		
Total		.34	4.8**

*$P < .05$, **$P < .01$.

impaired with average levels 6.2 SDs below established mean scores for children without a chronic health condition.[2] We were able to identify several baseline risk factors for increased pain and impairments in HRQOL at 2 weeks after discharge. Our findings indicated that psychosocial and behavioral factors including higher levels of parental pain catastrophizing and shorter child sleep duration significantly predicted higher levels of postsurgical pain. Psychosocial factors (higher child state anxiety) predicted greater impairments in HRQOL in children 2 weeks after major surgery. Although a few previous studies have examined psychosocial factors associated with acute pain after surgery,[1,10,16,17,32,34] our findings extend prior research with longitudinal assessment of presurgical risk factors and postsurgical outcomes. Identification of presurgical risk factors may present an opportunity to intervene with children (and their parents) before undergoing major surgery, in order to improve their pain and health outcomes.

Table 5. Linear Regressions Predicting Postsurgical Total, Psychosocial, and Physical HRQOL in Children 2 Weeks After Major Surgery

Predictors	β	R^2	F
Total HRQOL			
Baseline HRQOL	.37*		
Baseline pain intensity	.38**		
Trait anxiety, child	−.26		
State anxiety, child	−.29*		
Pain catastrophizing, child	.01		
Pain catastrophizing, parent	−.11		
Presurgery sleep duration (min)	.05		
Total		.50	6.8**
Psychosocial Health			
Baseline psychosocial health	.48*		
Baseline pain intensity	.29*		
Trait anxiety, child	−.16		
State anxiety, child	−.22		
Pain catastrophizing, child	−.17		
Pain catastrophizing, parent	.05		
Presurgery sleep duration (min)	.12		
Total		.51	7.1**
Physical Health			
Baseline physical health	.27		
Baseline pain intensity	.30		
Trait anxiety, child	−.20		
State anxiety, child	−.19		
Pain catastrophizing, child	.29		
Pain catastrophizing, parent	−.34*		
Presurgery sleep duration (min)	−.09		
Total		.22	2.6*

*$P < .05$, **$P < .01$.

There are several prior studies that have examined factors associated with pain after surgery. For example, one study found that child anxiety and pain catastrophizing measured 48 to 72 hours after major surgery were associated with greater concurrent pain intensity and unpleasantness, respectively.[34] However, assessment of psychological factors during the postsurgical period can only provide information about cross-sectional associations. Multiple factors may affect the child's reporting after surgery such as his or her perioperative experience, experience of postsurgical pain, and effects of medications. We are aware of only 1 prior study that has examined child pain catastrophizing prior to surgery. Contrary to our results, that study found a significant relationship between catastrophizing and pain intensity in the recovery room in a group of children having outpatient surgery[10]; however, this was only in relation to a single pain score directly after surgery.

One of the strengths of our study is the inclusion of a broad measure of physical and psychosocial health. We are not aware of any prior studies that have examined psychosocial predictors of postsurgical HRQOL in child surgical populations. By including both pain and HRQOL information in our assessment, we are able to integrate information about not only how much pain the child is experiencing after surgery but importantly whether the child is experiencing any impairment in his or her daily life activities and perceptions of well-being.

By including parents' perceptions, we also gathered important information on the potential role of child emotions prior to surgery and parents' emotions prior to surgery on the child's subsequent postsurgical outcomes. Although the child's own presurgery report of pain catastrophizing did not predict his or her postsurgical pain, the parents' pain catastrophizing did have an important effect on the child's pain experience after surgery. Parental pain catastrophizing also predicted level of physical function in children during the acute recovery phase after major surgery. These findings highlight the significant impact parents can have on their child's postsurgical recovery, particularly when they go home from the hospital. Prior research of the role of parental psychological factors in postsurgical pain in children is equivocal, with some studies finding concurrent associations between parental catastrophizing and child postsurgical pain,[1] and other studies finding no association.[32,34] However, our study used a stronger methodology with measurement of parental factors *before* the child's surgery, therefore reducing any impact that the early perioperative experience may have on parents' responses. Furthermore, in contrast to these studies, we measured parent catastrophizing specifically about their child's pain, which may be more relevant in this context. It is important to consider how

to best involve parents in interventions to reduce postsurgical pain and improve HRQOL. Parents play an important role before surgery in communicating with their children about the upcoming surgery and preparing for postoperative management. After surgery, parents take over their child's postsurgical pain management at hospital discharge and are in a unique position to apply pain management interventions. Our data suggest that future intervention efforts at preventing postsurgical pain should incorporate parents in a significant way.

Another unique aspect of our study design is that we measured sleep in the week prior to surgery using an objective assessment (actigraphy). Our finding that baseline sleep predicts subsequent postsurgical pain is consistent with studies in several adult postsurgical populations, which have identified a significant effect of presurgical sleep on postsurgical pain, with better sleep patterns even the night before surgery leading to less pain after surgery.[48] One prior study has employed actigraphic assessment of sleep patterns in children after surgery, finding postsurgical sleep problems to be associated with greater concurrent pain intensity at home after outpatient surgery.[16] Our study extends this research to identify short duration of sleep in the week prior to surgery as a risk factor for acute postsurgical pain in children. Although mechanistic data in children are lacking, sleep fragmentation among healthy adults results in subsequent decrements in endogenous pain inhibition and increase in pain sensitivity.[41] Sleep also promotes immune function and healing,[27,31] and sleep deprivation leads to sympathetic activation and increased stress response,[15] and in adults has been shown to impact postsurgical recovery.[4,37] Further research exploring the role of sleep on recovery and outcomes after major surgery in children over longer-term follow-up is needed.

The results of this study should be interpreted in light of several limitations. The sample size of the study was small, and thus we were unable to examine subgroups of patients (such as by surgery type) because of small cell sizes. Our preliminary findings should be replicated in a larger sample; this would enable examination of potentially complex interactions among child and parent variables, which our study was not large enough to explore. In addition, the sample size may have contributed to the lack of significant effects found with certain baseline variables. Although the refusal rate in eligible families was much lower than reported in prior surgical studies, the rate was still high enough to decrease the generalizability of our findings. It is possible that families declining to participate had a different psychosocial profile than those who participated. A limitation of our measurement approach was reliance on only 1 measure of physical health. The HRQOL survey completed at 2 weeks after surgery may have reflected activity restrictions related to surgery rather than impairments in physical activities due to health per se. Further research may incorporate additional measures of function to tease apart this issue. Our data are limited to the acute postsurgical period, and it will be equally important to examine baseline predictors of longer-term outcomes in children after major surgery. Our ongoing study includes long-term follow-up to 1 year after surgery.

In summary, our preliminary findings suggest that several presurgery psychosocial and behavioral factors influence acute postsurgical pain and HRQOL 2 weeks after major surgery in children. Child anxiety, parental pain catastrophizing, and sleep patterns are potentially modifiable factors that may serve as targets for preventive intervention strategies. Future research is needed to develop and test presurgical interventions to improve pain and health outcomes in the pediatric surgery population.

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