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Research Article

## Pain and Behavioral Stress in Children Hospitalized in the Pediatric Intensive Care Unit -

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## ABSTRACT

Children requiring hospitalization may undergo multiple invasive procedures throughout their treatment, and most patients perceive such procedures as the most distressing part of their disease. This study aimed to examine the pain intensity and behavioral stress and to characterize the stressful and painful context experienced by children during hospitalization in a pediatric intensive care unit (PICU).

**Methods:** The sample comprised 44 children aged 1-to-7 years old. Two assessments of pain and behavioral stress were performed during acute painful procedures. The FLACC was used to assess acute pain intensity, and the OSBD was used to evaluate behavioral stress. The NISS was used to obtain indicators of the history of exposure to stressful events in the PICU context. Statistical descriptive, between- and within-group, and correlations analysis were performed.

**Results:** There was a significant increase in pain scores from the first to the second procedure. There was a higher reactivity to distress in the second assessment compared to the first one. Children with acute disease had higher behavior reactivity to pain than children with the chronic disease during and after the first pain assessment. Children who underwent surgery showed a higher sensitivity to pain and stress during the procedure, even before its onset. The boys had more difficulty recovering from the painful procedure than the girls, showing pain even after the painful procedure.

**Conclusion:** There was association between reactivity to pain and behavioral stress, with both becoming intensified during the treatment of children hospitalized in PICU.

**Keywords:** Pain; Behavioral stress; Children; Hospitalization; PICU

## ABBREVIATIONS

PICU: Pediatric Intensive Care Unit; FLACC: The Faces, Legs, Activity, Cry, and Consolability Scale; OSBD: Observational Scale of Behavior Distress; NISS: The Neonatal Infant Stressor Scale

## INTRODUCTION

Pain can be understood as a stressful experience, with children being a vulnerable population and generally undertreated concerning pain relief [1,2]. Despite the exponential growth of scientific evidence on pediatric pain in recent decades, there are many barriers to the adequate transfer of knowledge to clinical practice [3]. Consequently, children continue to experience pain unnecessarily during hospitalization.

Acute pain is a reaction to the painful stimulus and acts as a warning system for the body, is associated with neurovegetative changes, and is spatially and temporally delineated to the causative lesion, such as inflammation, trauma, or postoperative. There is a direct association with affective processes such as stress and anxiety [4,5]. It is important to highlight the existence of variables that may interfere with the painful experience that must be considered in its comprehension, evaluation, and treatment. One variable that has been the focus of research in the area of pain and requiring attention is sex differences in pain responses. At the same time, the literature on this subject in the adult population suggests that men and women differ in pain reactivity and responsiveness to treatment, with higher sensitivity to pain commonly observed among women [6], the literature in the pediatric area still shows inconsistent results and demands further investigation [7].

Children requiring hospitalization may undergo multiple invasive procedures throughout their treatment, and most patients perceive such procedures as the most distressing part of their disease [8]. Such painful procedures are present in both clinical and surgical treatment, the latter being a concern, as it necessarily implies invasive processes to the patient. The pain and stress assessment and management associated with medical procedures is an important responsibility of health professionals, as untreated pain can lead to short and long-term damage to the lives of small patients and is associated with a significant increase in anxiety and depression [9].

Approximately 25% of children requiring pediatric intensive care presented negative psychological and behavioral outcomes in the first year after discharge. The magnitude of the problem is even more significant when focusing on children under six years old [10].

There is a lack of scientific studies focusing on the pain reactivity and stress behavior presented by children in the intensive care unit context. Additionally, as far as we know, no studies were found dedicated to studying stress responses according to the type of medical treatment received by the children. The present study aimed to examine the pain intensity and behavioral stress in the medical procedures during intensive care and characterize the stressful and painful context experienced by children during hospitalization in a pediatric intensive care unit. The secondary aim of the study was to examine the influence of sex, type of disease, and type of treatment on pain and stress responses of the children.

## MATERIALS AND METHODS

### Participants

The convenience sample was composed of 44 children hospitalized in the Pediatric Intensive Care Unit (PICU) of the Hospital of Clinics of Ribeirao Preto Medical School, University of Sao Paulo. The inclusion criteria were the following: children aged 1-to-7 years old with several clinical diagnoses who were under intensive care for at least two days involving painful procedures due to clinical demands. The exclusion criteria were the following: children with neurological deficits or with alterations at the consciousness level, which could make the assessment of the child's behavior unfeasible.

The eligible study sample included 50 children. After beginning the study, it was found that four children presented significant neurological problems interfering with the assessment of behavioral stress. Also, two other children were clinically discharged from the PICU without needing puncture procedures for blood collection. The final study sample comprised 44 (88% of the eligible sample) children to be assessed twice (i.e., assessments 1 and 2). Nevertheless, seven children were not evaluated in the second assessment because no procedure for clinical puncture was required at the moment of data collection.

## Setting

The assessments of the children were performed at the bedside in PICU, which is linked to the Department of Pediatrics of the Hospital of Clinics of Ribeirao Preto Medical School, University of Sao Paulo. In the PICU, there was an interdisciplinary health team and a pharmacological pain management protocol implemented.

## Ethical aspects

The Hospital of Clinics of Ribeirao Preto Medical School, University of Sao Paulo Research Ethics Committee approved the study. The parents signed informed consent forms before the inclusion of their children in the study.

## Instruments

**Pain measure:** The Faces, Legs, Activity, Cry, and Consolability Scale (FLACC) [11,12]. The FLACC scale is an observational measurement of behavior, which is indicated to assess acute pain intensity in children aged two months to seven years old or children unable to communicate the pain they experience. This scale has a score ranging from zero to two for each of the following categories: face, legs, activity, cry, and consolability. The higher the score, the higher intensity of acute pain. The scale ranging from 0 to 10 points, which the following classification: 0 = no pain; 1 to 3 = mild pain; 4 to 6 = moderate pain; 7 to 10 = severe pain. The FLACC scale has good sensitivity and validity [13], is also translated into the Portuguese language, and adapted for the Brazilian population [14].

**Behavioral stress measure:** Observational Scale of Behavioral Distress (OSBD) [15]. The OSBD scale is used for the assessment of distress in the context of acute pain. It consists of a checklist for the identification of presence or frequency of 13 behaviors (i.e., information seeking, verbal resistance, verbalization of fear, verbalization of pain, emotional support, crying, screaming, muttering, rigidity, denial behavior, restraint, flail, and nervous behavior), all indicators of distress assessed on a 4-point scale measuring the intensity of disturbance. The rater assesses whether each one of the behaviors is occurring or not at 15-second intervals. The higher the score is, the greater the distress shown by the child [16]. This instrument has validity and reliability, being translated into the Portuguese language and adapted for the Brazilian culture [17].

**Stressful and painful context measure:** The Neonatal Infant Stressor Scale (NISS) [18]. The NISS scale assesses the measurement, monitoring, and management of cumulative stress during procedures in an intensive care environment. This instrument comprises a list of acute events and chronic living conditions that could be assessed retrospectively by medical and nurse charts. The acute stressful events are organized into four blocks, according to the intensity of the stress, extremely stressful, very stressful, very stressful, moderately stressful, and slightly stressful. The higher the score, the more stress suffered by the child. The NISS scale was translated into the Portuguese language and adapted to the Brazilian population [19]. In the present study, the acute procedure classified as painful procedures were calculated according to the pain-related stress index, including the following procedures: extremely stressful (intubation, multiple attempts at intravenous insertion, eye examination, insertion of pneumothorax chest drain); very stressful (endotracheal suctioning, intravenous insertion, heel pricks, insertion of a percutaneous long line, lumbar puncture, surgery, insertion of nasal continuous positive airway pressure tube); slightly stressful (blood gases sampling). The pain-related extremely stressful index, pain-related very stressful index,

and pain-related slightly stressful index were calculated by summing the acute painful procedures during the NICU hospitalization. The pain-related stress total index was calculated by summing all acute painful procedures during the NICU hospitalization [20]. The NISS items that were not used in the PICU clinical routine were excluded in the assessment in the present study (i.e., heel lance, removal of the infant of the incubator).

## Assessment procedures

Two assessments (Assessment 1 and Assessment 2) of the pain intensity and behavioral stress were performed during two procedures involving needles as prescribed by the medical team for clinical reasons. It was performed an observation including three phases, such as Baseline (i.e., 5 minutes before insertion of the needle), Procedural (from the needle's insertion to its removal), and Recovery (5 minutes after removal of the needle). The average interval between the first and second assessments was two days, with a minimum period of one day being required between them.

Pain intensity was assessed as follows: The FLACC scale was specifically used during two painful procedures involving the needle (e.g., a puncture for blood collection) by systematically observing the child's behavior. The child's behavioral stress, in turn, was assessed by using the OSBD scale during the same painful procedures. The patients were video-recorded during the procedures for further analysis of the data.

A retrospective review of the medical and nurse charts was performed to obtain the following variables: data on daily clinical evolution, prescription of examinations and description of daily routine procedures during the child's hospitalization, rate of stress experienced during the stay in the PICU, and pain-related stress index. All this information was obtained between the date of hospitalization and the time of assessment of the child.

## Data analysis

A systematic analysis of the video records of the child behavior during painful procedures was submitted to the coding system of the FLACC and OSBD scales, respectively. The unit of time used was 15 second-intervals. The scores were obtained for each scale in the three respective phases, such as Baseline, Procedure, and Recovery.

The first author was previously trained and certified to use the FLACC and OSBD scales. Also, Intra-Rater Reliability (IRR) analysis of two independent coders (first author and the author of the scale) regarding pain intensity and behavioral stress of five children was performed. The values of IRR were 92% for pain intensity and 84% for behavioral stress.

## Statistical analysis

The statistical analyses included the following: descriptive, between groups (i.e., Mann-Whitney test), within-group (i.e., Wilcoxon test for scores, McNemar test for classifications, and ANOVA for repeated measures), correlations for two numerical variables (i.e., Pearson test), and association of variables for two categorical variables analysis (i.e., Chi-square test). A significance level of 5% ( $p \leq 0.05$ ) was adopted in all statistical tests.

## RESULTS

### Characteristics of the sample

As seen in Table 1, the children were, on average, 38 months of

age, and the majority were at 1 to 3 years old and were boys. The mean stays in PICU of 12 days, and there was a prevalence of patients presenting chronic diseases. The main reason for hospitalization was the surgical treatment, and the treatment length was six months or longer for most of the children. The mean number of previous admissions corresponded to two hospitalizations in the child's previous medical history. Table 1 also of these data, at the moment of the pain assessments, the children were not intubated or in mechanical ventilation.

### Characteristics of the assessments

The mean interval time between both assessments was two days. The arterial blood collection was the predominant procedure in the Assessment 1 (89%) and Assessment 2 (65%), followed by venous blood collection (9%, in the Assessment 1, and 29%, in the Assessment 2), venous access (2%, in the Assessment 1), injection (3%, in the Assessment 2), and myelogram (3%, in the Assessment 2).

In the majority of the cases, there was no intervention to manage the pain at the moment of the procedure during both assessments. In the Assessment 1, 15 children (34%) received management for pain relief, such as topical anesthetic (54%), non-pharmacological management, including distraction (13%) or non-nutritive suction (13%), and topical anesthetic plus non-pharmacological management (20%). In the Assessment 2, 8 children (22%) received management for pain relief, such as topical anesthetic (50%), non-pharmacological management, such as distraction (12,5%) or non-nutritive suction (25%), and topical anesthetic plus non-pharmacological management (12,5%).

Regarding the number of needle-insertion attempts, in both assessments, the majority of procedures were performed with only one attempt (80%, in Assessment 1, and 79%, in Assessment 2), followed by two attempts (18%, in Assessment 1, and 16%, in Assessment 2), and three attempts (2%, in Assessment 1, and 5%, in Assessment 2).

### Reactivity to pain and behavioral stress

Table 2 shows the results of the FLACC scale and the OSBD scale to the children during Assessments 1 and 2 (Table 2).

Table 2 shows that, concerning pain intensity, in Assessment 1,

Table 1: Characteristics of the sample (n = 44).	
Neonatal, sociodemographic, and clinical characteristics	Values
Age of children at assessment (months) - mean (SD; range)	38 (± 23; 12 - 89)
Sex - f (%)	
Girls	18 (41)
Boys	26 (59)
Length of stay in the PICU (days) - mean (SD; range)	
Assessment 1	12 (± 18; 2 - 115)
Assessment 2	15 (± 20; 3 - 116)
Type of disease - f (%)	
Chronic	25 (57)
Acute	19 (43)
Type of treatment - f (%)	
Surgical	30 (68)
Clinical	14 (32)
Treatment length - f (%)	
< six months	21 (47)
≥ six months	23 (53)
Number of the previous hospitalization - mean (SD; range)	2 (± 2; 0 - 7)
<b>Abbreviations:</b> SD: Standard Deviation; f: frequency; %: Percentage; PICU: Pediatric Intensive Care Unit	

the children presented mean total scores of five and four points in the procedural and recovery phases, respectively, in which pain intensity was ranked as moderate in both phases. In the baseline phase, the participants had a mean total score of three (mild pain intensity). Nevertheless, it should be highlighted that 43% of them already had moderate-to-severe pain intensity before the procedure. Concerning Assessment 2, the children had a mean total score of 6 points in the procedural phase, meaning moderate pain intensity. In the baseline phase, 71% of the children already had moderate-to-severe pain intensity as they had a mean total score of five points before the procedure. Children showed difficulties during the recovery phase as they experienced moderate pain intensity (mean overall rating of five points) even after removing the needle. There were statistically significant differences regarding the Baseline, procedural, and recovery phases, as there was an increase in pain intensity during Assessment 2 compared to Assessment 1. About the classification of pain intensity (i.e., no/mild pain vs. moderate/severe pain). No statistically significant difference was observed between Assessments 1 and 2 despite the concentration of moderate-to-severe pain intensity in both the procedural and recovery phases.

Complementing the data about pain intensity presented in table 2, one should highlight that statistically significant differences were found between the study phases in both Assessment 1 and 2, thus indicating that pain intensity was higher in the procedural phase compared to the baseline ( $p < 0.001$ ) and recovery ( $p < 0.001$ ) ones.

Regarding the behavioral stress of the children, the Table 2 reveals that there were statistically significant differences between Assessments 1 and 2 indicating higher score in the Baseline, procedural, and recovery phases in Assessment 2 in comparison to the Assessment 1. Besides, there were statistically significant differences in both Assessment 1 and 2 when one compares the scores of the phases, indicating that behavioral stress was higher in the procedural phase compared to the baseline ( $p < 0.001$ ) and recovery ( $p < 0.001$ ) ones.

### PICU environmental stress

Table 3 presents the stressful events experienced by the children in the PICU during their hospitalization from their admission to the day of the first assessment, which was performed by using the NISS scale. Scores and rates of stressful events obtained during hospitalization are also shown; that is, the sum of scores divided by the number of days in the hospital from admission to the first assessment of pain and stress intensity.

As shown in Table 3, there was a high total score for stressful events during the children's hospitalization in the PICU, which may involve 2,209 procedures performed during the hospitalization period. However, analyzing the types of stressful events, it was observed that moderately stressful events were predominant to very, slight, or extremely ones, with high variability in the scores. The rates of stressful events, in turn, showed that children underwent an average of 17 procedures per day, and, as expected, there were a predominance of moderately and slightly stressful events.

Table 4 shows data on the pain-related stress index obtained from the NISS scale. As seen in table 4, the pain-related stress total index to which the children were exposed during hospitalization had a mean score of 47 points, with high variability that might undergo up to 335 events. The significant part of the pain-related stressful index was classified as being very pain-related stressful, and their rates showed

**Table 2:** Pain intensity (FLACC) and behavioral stress (OSBD) in children.

Pain intensity and behavioral stress Total score and classification	Assessment 1 (n = 44)	Assessment 2 (n = 37) <sup>(1)</sup>	p-value
FLACC			
Baseline score - mean (SD; range)	3 (± 2; 0 - 9)	5 (± 2; 0 - 10)	0.001
Classification - f (%)			0.60
No pain	7 (16)	2 (5)	
Mild pain	18 (41)	9 (24)	
Moderate pain	12 (27)	15 (41)	
Severe pain	7 (16)	11 (30)	
Procedural score - mean (SD; range)	5 (± 2; 1 - 10)	6 (± 2; 1 - 10)	0.03
Classification - f (%)			0.60
No pain	10 (23)	7 (19)	
Moderate pain	16 (36)	8 (22)	
Severe pain	18 (41)	22 (59)	
Recovery score - mean (SD; range)	4 (± 2; 0 - 10)	5 (± 2; 0 - 8)	0.01
Classification - f (%)			0.10
No pain	3 (6)	2 (5)	
Mild pain	17 (39)	9 (24)	
Moderate pain	17 (39)	18 (49)	
Severe pain	7 (16)	8 (22)	
OSBD			
Baseline score - mean (SD; range)	3 (± 3; 0 - 10)	5 (± 3; 0 - 14)	0.001
Procedural score - mean (SD; range)	7 (± 4; 0 - 17)	7 (± 4; 2 - 19)	0.001
Recovery score - mean (SD; range)	4 (± 3; 0 - 12)	4 (± 2; 1 - 9)	0.001

<sup>(1)</sup>No second assessment was performed for seven children of the sample due to lack of clinical demand for puncture procedure; comparative analyses were performed in 37 children in both assessments.  
**Abbreviations:** FLACC: Faces, Legs, Activity, Cry, and Consolability, with scale ranging from 0 to 10 points; classification: 0: No pain; 1-3: Mild pain; 4-6: Moderate pain; 7-10: Severe pain; OSBD: Observational Scale of Behavioral Distress; SD: Standard Deviation; f: frequency; %: percentage

**Table 3:** Stressful events experienced by the children during hospitalization in the PICU (n = 44).

Stressful events in PICU (NISS scores)	Mean (SD; range)
Total of stressful scores	237 (± 374; 6 - 2,209)
Extremely stressful events	2 (± 2; 0 - 12)
Very stressful events	63 (± 103; 0 - 479)
Moderately stressful events	120 (± 209; 2 - 1346)
Slight stressful events	52 (± 70; 2 - 373)
Rates <sup>1</sup> of stressful events <i>per day</i> of hospitalization <sup>2</sup>	
Rate of total stressful events	17 (± 8; 3 - 40)
Rate of extremely and very stressful events	4 (± 4; 0 - 13)
Rate of moderately and slight stressful events	13 (± 5; 2 - 27)

<sup>1</sup>Rates = Sum of scores divided by the number of days from hospitalization to the day of Assessment 1; <sup>2</sup>Length of hospitalization until the day of Assessment 1.  
**Abbreviations:** NISS: Neonatal Infant Stressor Scale; SD: Standard Deviation.

**Table 4:** Rates of pain-related stress index in the PICU hospitalization of children (n = 44).

Rates of pain-related stress index (NISS scores)	Mean (SD; range)
Rate of pain-related stress total index	47 (± 71; 1 - 335)
Rate of pain-related extremely stressful index	2 (± 2; 0 - 12)
Rate of pain-related very stressful index	32 (± 54; 0 - 275)
Rate of pain-related slightly stressful index	14 (± 18; 0 - 107)
Rates <sup>1</sup> of painful events <i>per day</i> of hospitalization <sup>2</sup>	
Rate of pain-related stress total events	4 (± 2; 0 - 9)
Rate of pain-related extremely stressful events	0.2 (± 0.2; 0 - 0.8)
Rate of pain-related very stressful events	2 (± 2; 0 - 7)
Rate of pain-related slightly stressful events	1 (± 0.7; 0 - 4)

<sup>1</sup>Rates = Sum of scores divided by the number of days from hospitalization to the day of Assessment 1; <sup>2</sup>Length of hospitalization until the day of Assessment 1.  
**Abbreviations:** NISS: Neonatal Infant Stressor Scale; SD: Standard Deviation.

that the children suffered an average of four pain-related stressful events a day. As expected, there was also a predominance of very pain-related stressful events.

**Associations between pain intensity and child behavioral stress**

The pain intensity had statistically significant positive correlations with the distress experienced by the children in the different phases of both assessments; the higher the pain intensity in children, the greater their behavioral stress, in the baseline (Assessment 1;  $r = 0.88$ ;  $p < 0.01$  and Assessment 2;  $r = 0.74$ ;  $p < 0.001$ ), procedural (Assessment 1;  $r = 0.84$ ;  $p < 0.001$  and Assessment 2;  $r = 0.74$ ;  $p < 0.001$ ), and recovery (Assessment 1;  $r = 0.70$ ;  $p < 0.001$  and Assessment 2;  $r = 0.33$ ;  $p < 0.04$ ) phases.

**Associations of length time stay in the hospital, pain intensity and environmental stress**

There were also statistically significant positive correlations of length time stay in hospital with total score of stressful events ( $r = 0.94$ ;  $p < 0.001$ ) and with pain-related stressful events ( $r = 0.81$ ;  $p < 0.001$ ) in the Assessment 1. The longer the hospitalization of the children, the higher the environmental stress and the number of pain-related stressful events experienced by them during intensive care.

**Comparison of pain and behavioral stress in groups of children differentiated by the type of disease, type of treatment, and sex**

Table 5 presents the indicators of pain and behavioral stress, with statistical significance, in children split into groups differentiated by the type of disease (acute vs. chronic). In this table shows that in Assessment 1, in both the Procedural and Recovery phases, the children with acute disease had significantly higher pain reactivity and behavioral stress compared to chronic diseases.

Table 6 presents the indicators of pain and behavioral stress, with statistical significance, in children split into groups differentiated by the type of treatment (surgical vs. clinical). This table shows that the children who underwent surgical treatment expressed significantly higher reactivity to pain and stress than those who received clinical treatment in Baseline and Procedural phases in Assessment 2.

Regarding sex differences, there was a statistically significant difference between the groups in the Recovery of Assessment 2 ( $p = 0.02$ ); boys (mean score =  $5 \pm 2$ ) had higher pain reactivity with difficulty recovering after needle removal compared to girls (mean score =  $4 \pm 2$ ). Also, regarding behavioral stress, it was noted that girls were more rigid than boys in the Procedural of Assessment 1 ( $p = 0.04$ ). At the same time, they were more tearful than girls in Recovery of Assessment 2 ( $p = 0.05$ ).

**DISCUSSION**

The pain intensity was found to be moderate in almost all phases assessed in the assessment of pain intensity performed during acute painful procedures in children in the PICU. This finding seems to reflect a situation of vulnerability to painful stimuli experienced by intensive care unit patients. In the context of hospitalization, particularly, the assessment of pain intensity is needed to identify the levels of pain experienced by the patient, determine possible associations with other variables and define more adequate interventions to be applied [21,22]. Concerning the results from the comparison between pain intensity scores obtained in Assessments 1 and 2, it was observed that

**Table 5:** Pain and behavioral stress in groups differentiated by the type of disease.

Pain and behavioral stress Assessment 1	Acute Disease (n = 19)	Choric Disease (n = 25)	p-value
	Mean (SD)	Mean (SD)	
Pain			
Procedural	7 (± 2)	5 (± 2)	0.02
Recovery	5 (± 2)	3 (± 2)	0.04
Behavioral stress			
Procedural	8 (± 4)	5 (± 3)	0.03
Recovery	5 (± 3)	3 (± 3)	0.04

Abbreviations: SD: Standart Deviation

**Table 6:** Pain and behavioral stress in groups differentiated by the type of treatment.

Pain and behavioral stress Assessment 2	Surgical Treatment (n = 23)	Clinical Treatment (n = 14)	p-value
	Mean (SD)	Mean (SD)	
Pain			
Baseline	6 (± 2)	4 (± 2)	0.02
Procedural	7 (± 2)	5 (± 3)	0.01
Behavioral stress			
Baseline	6 (± 3)	3 (± 3)	< 0.001
Procedural	9 (± 3)	5 (± 4)	< 0.001

Abbreviations: SD: Standart Deviation

pain intensity increased in all phases, indicating that the children showed reactivity to pain in the first procedure to the second one. Previous studies reported the consequences of unmanaged pain during the treatment of ill children. The study by Noel, et al. [23] highlights that negative memories on a specific procedure can result in an exaggerated response to pain, which increases maladaptive behaviors during subsequent procedures. This phenomenon was also observed in the present study, which pointed to a possible impact of a painful experience on a further procedure involving pain. Nevertheless, when procedural pain is adequately managed to employ interventions such as distraction during painful procedures may have a positive effect in decreasing the pain intensity in further procedures [24].

In the present study, it should be emphasized that children showed reactivity to pain in the second assessment, even in the baseline phase, as the pain intensity was ranked as moderate before the procedure and maintained as such in the phase of recovery. About the continuity of pain in the recovery phase, the present study corroborates the previous study by Noel, et al. [23] in which the impact of acute pain does not end when the painful stimulus is removed. It should be of concern that acute procedural pain may be related to the development and maintenance of chronic pain later in the child's life. Because pain is a multimodal phenomenon, it can be mistaken for psychological aspects. Pain and stress are commonly associated with each other despite being distinct constructs [25]. Stress is a type of negative affect that can interfere with painful procedures and have psychological implications on the child's development [26]. However, it should be evaluated and treated separately, as not all stress means pain. Because of these dynamics of combined variables in the process of pain, it is important to pay attention to the cumulative effect of pain and stress on the child's development.

By focusing on the children's behavioral stress during painful procedures, one could observe an already expected increase in the presence of stressful behavior in the procedural phase in both first

and second painful procedures. According to McMurtry [27], the stress factors increase the risk of physiological symptoms, negative memories, and non-cooperative responses in further procedures involving pain. The findings of the present study corroborate this aspect, showing that the stress experienced in a painful procedure makes the children more sensitive to a future situation involving pain.

The findings of the present study also demonstrated that there is a significant relationship between indicators of pain and behavioral stress experienced by children during hospitalization in a PICU. There is a positive association between acute pain and stress. The latter is considered an important affective variable that can activate the body's alert systems and amplify the perception of painful experiences [4,5,28]. Concerning the affective variables expanding the painful experience, the pain catastrophizing should be considered. In association with the psychological suffering and functional deficits, the catastrophizing thinking is a factor modulating the patient's response to pain and can be defined by the perception of a lack of self-control, in addition to an excessive preoccupation with the future [29].

The findings of the present study showed that children with acute disease had higher behavioral reactivity to pain than children with the chronic disease during and after the first pain assessment. This result suggests that the form of pain expression in children with chronic conditions, who have long treatment paths, is different from children suffering from acute illness. Children with acute illnesses seem to suffer an abrupt disruption of their routines in healthy conditions, being more reactive and anxious about procedural pain. Indeed, the literature points out that the impacts of acute and chronic pain differ in childhood. In contrast, acute experiences are associated with anxiety, and chronic conditions are positively associated with states of helplessness and depression [4,28,30].

Moreover, even before its onset, children who underwent surgery showed a higher sensitivity to pain and stress during the procedure. Our findings are consistent with the audit study, which examined postoperative pain in eight different types of surgery [31]. Pain after surgery was found to have moderate to severe intensity and had an average duration of two days. In this sense, one can understand the presence of pain found at Baseline by the children of the present study who underwent surgery. Several studies report that postoperative pain is still undertreated and has consequences for the behavior and quality of life of the sick child [31,32].

Regarding short-term impacts, the study by Rabbitts, et al. [33] evidence that pain in children in postoperative situations brings has implications to the short recovery and development of behavioral disorders. The present study indicates that children had a higher frequency of behavioral stress when submitted to surgery than those who did not need this type of therapy. It is worth remembering that acute pain after invasive procedures (surgeries) when not identified and untreated can trigger long-term consequences, such as the development of chronic pain and sleep problems [31]. There is a possible transition from acute pain to chronic pain in postoperative pediatric patients [30].

Concerning the influence of sex on pain reactivity, the boys had more difficulty recovering from the painful procedure compared to girls, showing pain even after the painful procedure was completed, and girls showed higher stiffness during the first assessment than boys. In contrast, boys showed more crying when recovering at the second assessment. The findings on sex differences in pain reactivity

described in the literature are still inconsistent with the pediatric population. Studies have reported differences between boys and girls in very early pain responses in human development [34]. Premature neonates indicated that boys had higher reactivity to pain than girls in physiological measures [35]. Finding that seems consistent is that sex differences in pain appear to arise at the time of puberty. However, most of the research did not report significant differences between boys and girls in pain-related outcomes. A meta-analysis of study data revealed that girls reported significantly higher pain intensity compared to boys in studies where the average age of participants was older 12 years [7].

The present study has some limitations and cautions, such as: (i) pain and stress were assessed by only observing the children's behavior and physiological measurements might have also been used to complement our investigation; (ii) data on the environmental stress experienced by the children in the PICU were collected from the physician's and nurse's records rather than from direct observations, which might minimize the problem of incomplete or poorly completed records; (iii) small sample size could compromise the representativeness of the sample.

### Clinical implications

The current study has some implications for the clinical practice by providing elements for a broad understanding of the assessment of pain and stress in children under critical healthy conditions. Considering that pain has an impact on the child's life in the short and long term, it is crucial to identify it early to subside the selection of effective strategies and interventions aimed at alleviating it. Recognizing and measuring the pain intensity and the distress experienced by children in PICU will help to implement child-focused preventive interventions for potentially stressful situations. It is important to highlight that, even in hospital with pain management protocol, we detected undertreatment of pain in the intensive care treatment of children. We recommend a continued training health professional team and the implementation and monitoring of pharmacological and non-pharmacological pain management and stress prevention, systematically as an institutional initiative. In this sense, the ChildKind, initiative [36], which is an institutional pain program, could be an option to improve the health professional training for pain assessment and management in hospitals. Consequently, the quality of pediatric pain management in hospitals could be improved and reach a awarding special recognition to qualifying institutions. This initiative is modelled on the Baby Friendly program of WHO/UNICEF that has influenced institutional approaches to breastfeeding practices around the world. Our findings could offer a model for pain and stress systematic assessments of children under intensive care treatment that could be incorporated in the pain training system in hospitals, as recommended in the ChildKind, initiative.

The ChildKind initiative is an attempt to improve the quality of pediatric pain management in hospitals by awarding special recognition to qualifying institutions. It is an alternative to other models which may be more punitive in nature and are often less successful at changing the inherent culture of the institution.

### CONCLUSION

In conclusion, the present study reveals that children have moderate levels of pain and behavioral distress as they experienced high exposure to painful and stressful events during their hospitalization in PICU. The study proceeds by demonstrating a positive association

between reactivity to pain and behavioral stress, with both variables increasing during hospitalization of children. Moreover, the study adds elements to the understanding of the variables that impact the expression of pain and stress in children, revealing that when exposed to surgical interventions, children are more vulnerable to higher pain intensity and that patients under acute disease have a higher expression of pain. The study also supports the identification of the effect of sex on pain reactivity by revealing that boys were more reactive to pain when recovering from painful procedures.

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