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CLINICAL RESEARCH

Validation of the Brazilian version of the child pain catastrophizing scale and its relationship with a marker of central sensitization

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Abstract

Objectives: The Pain Catastrophizing Scale-Child version (PCS-C) allows to identify children who are prone to catastrophic thinking. We aimed to adapt the Brazilian version of PCS-C (BPCS-C) to examine scale psychometric properties and factorial structure in children with and without chronic pain. Also, we assessed its correlation with salivary levels of Brain-Derived Neurotrophic factor (BDNF).

Methods: The Brazilian version of PCS-C was modified to adjust it for 7–12 years old children. To assess psychometric properties, 100 children (44 with chronic pain from a tertiary hospital and 56 healthy children from a public school) answered the BPCS-C, the visual analogue pain scale, and questions about pain interference in daily activities. We also collected a salivary sample to measure BDNF.

Results: We observed good internal consistency (Cronbach's value = 0.81). Parallel analysis retained 2 factors. Confirmatory factor analysis of our 2-factor model revealed consistent goodness-of-fit (IFI = 0.946) when compared to other models. There was no correlation between visual analogue pain scale and the total BPCS-C score; however, there was an association between pain catastrophizing and difficulty in doing physical activities in school (p = 0.01). BPCS-C total scores were not different between groups. We found a marginal association with BPCS-C (r = 0.27, p = 0.01) and salivary BDNF levels.

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Discussion: BPCS-C is a valid instrument with consistent psychometric properties. The revised 2-dimension proposed can be used for this population. Children catastrophism is well correlated with physical limitation, but the absence of BPCS-C score differences between groups highlights the necessity of a better understanding about catastrophic thinking in children.
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Introduction

Pain is a multidimensional experience with a complex and dynamic interaction among physiological, psychological, and social factors that can perpetuate or worsen it. The biopsychosocial approach views the pain as an experience; thus, we must identify the variables that account for the initiation, exacerbation, waning, maintenance of pain, and suffering.

The emotional reaction to pain is intrinsically unpleasant, causing suffering and distress. While the acute pain is an adaptive reaction to physical injuries, chronic pain is a maladaptive process. Chronic pain induces dysfunctional changes in the central nervous system function, both in adults and children. The prevalence of chronic pain in childhood reaches 20–35%.[1,2] It is associated with decreased quality of life, higher incidence of school absenteeism, and prevalent symptoms of depression, anxiety, and catastrophic thoughts about life.

Intense pain may trigger adverse emotional reactions, especially catastrophic thinking. Such reactions may modify the subjective experience of pain and amplify its transmission process; they constitute an exaggeratedly negative mental state that appears during actual or predicted pain experience, representing a dysfunctional way of coping with stressors.[3] Previous studies in adults, children, and adolescents, showed that high scores of catastrophizing were associated with greater emotional distress,[4–7] severe physical disability,[8,9] and higher pain scores.[4,6,11] In this context, the Pain Catastrophizing Scale-Child version (PCS-C) allows identifying children who are prone to catastrophic thinking and at risk of suffering from its psychological consequences. The PCS-C is validated and well established in other countries, yet there is no study to measure catastrophic thinking in Brazilian children with or without chronic pain.

The present study aimed to adapt the English version of the PCS-C to be used with Brazilian children and evaluate its psychometric properties. We investigated the internal consistency, the factor structure, and the correlations of the PCS-C and functional capabilities in a sample of children with chronic pain and healthy ones. We also hypothesized that the degree of catastrophic thoughts in children could be associated with their salivary levels Brain-Derived-Neurotrophic Factor (BDNF).

Methods

The Institution ethics committee approved the project. We obtained Informed Consent from every parent or guardian before starting the study. The scale validation was divided into three standardized phases, as recommended by Beaton[12] and presented in Figure 1.

Instrument validation

Adapted from the Pain Catastrophizing Scale for adults, the Pain Catastrophizing Scale-Child version[6] is a validated self-report measure[13] including a 13-item questionnaire that assesses the extent of catastrophizing thoughts of child patients in pain. It comprises three domains (helplessness, magnification, and rumination) that can be rated according to a 5-point Likert-type scale that considers intensity and frequency. The total score is the sum of points from the three domains.

Phase I

Translation, synthesis, and back translation

We carried out both the translation of the PCS-C scale (original English version) into Brazilian Portuguese and its adaptation to our culture according to previously published guidelines.[12] In order to adapt the wording of the answers, we made some changes in the keywords.

Two native English speakers with Brazilian Portuguese as their second language were responsible for back-translating the scales. Both translators worked under blinded conditions. A third bilingual person highlighted the conceptual errors and contradictions of the translated versions for later examination by a committee of experts. For feedback, we sent the back-translated scales to the original authors.

Delphi method to assess the semantics and the conceptual content of each item

A panel of experts, including translators, back-translators, methodologists, clinical researchers, and the English-language authors of the PCS-C verified the semantic, idiomatic, experimental, and conceptual equivalence of the scales. The aim was to confirm that the translated version reflected the same content of the original one.

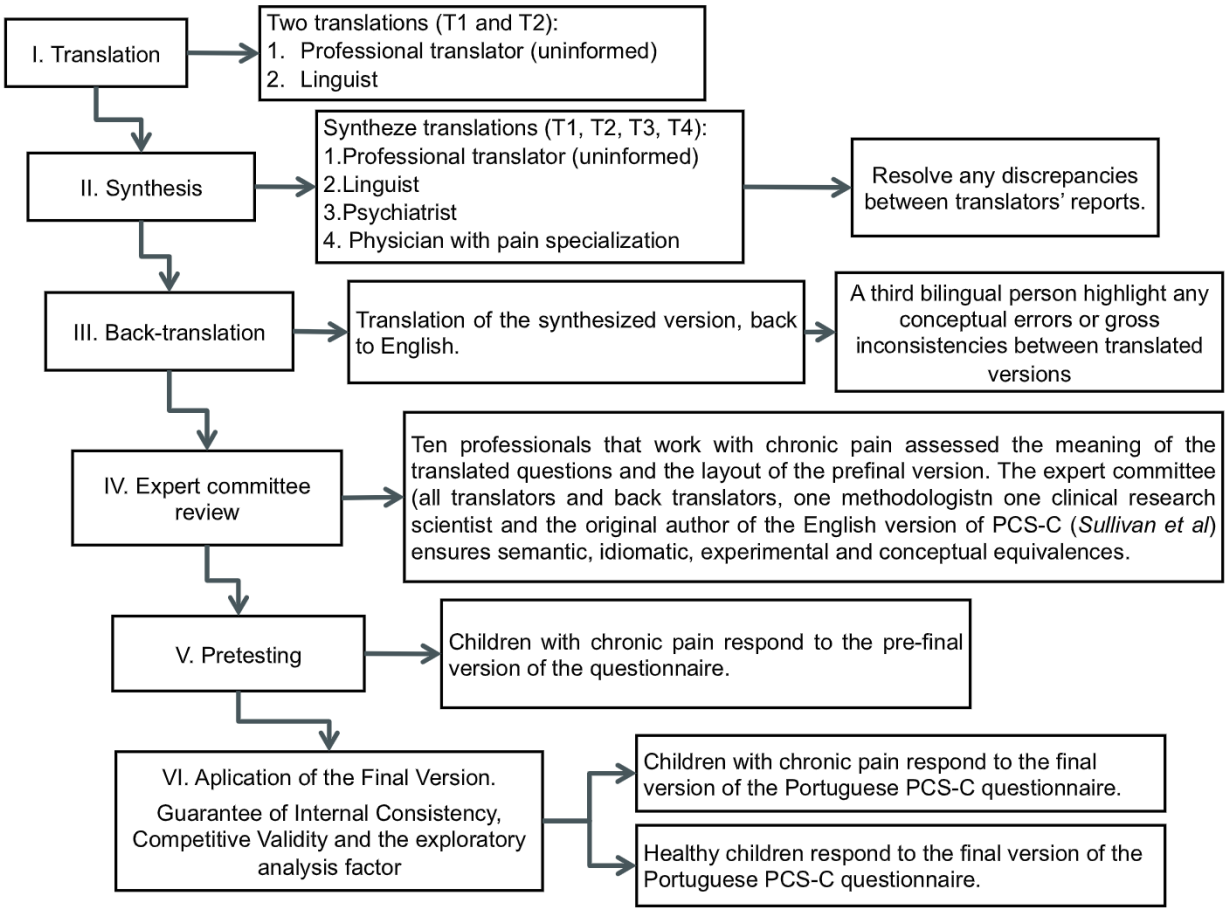

Figure 1 Flow of the multiple standardized phases of the study 20.

Phase II

Pretesting the PCS-C in the pilot version

To check comprehension, we selected a small group of children of both genders to explore the subjective thoughts that each question and answer could arouse. Also, fifteen professionals who work daily with children, related or not with the health area, were asked to participate.

We used a visual 10-cm analogue scale, ranging from zero (completely incomprehensible) to 10 (comprehensible), to gauge understanding of each question from both questionnaires. The mean ± SD of the comprehension degree of the 13 questions on the PCS-C scale was 9.19 ± 1.10. After gathering information, we made small adaptations for better understanding from the children. The ultimate goal was to obtain idiomatic and conceptual equivalence rather than the literal equivalence of the scales. The final version of the Brazilian PCS-C is in Figure 2.

Phase III

Assessment of psychometric properties and the validation of the PCS-C's final version

Subjects

Participants were 7–12 years old children divided into two subsamples: one with 56 healthy children recruited from the 5th grade of a state school in Southern Brazil; the other with 44 children with chronic pain recruited from the gastroenterology ambulatory, and the pediatric oncology, and reumatology clinics in a quaternary university hospital. All the children with chronic pain and their caregivers were recruited through a convenience sample. Before the interviews, participants were asked to answer a questionnaire exploring social and health issues including questions about chronic disabilities and psychiatry disorders. The children with chronic pain did so using mobile devices while their parents/caregivers, paper forms. The healthy children wrote answers to the same questions during school time. The consent from their parents/caregivers was obtained previously.

Additional measures

In addition, the chronic pain group completed two further self-report measures.

Pain intensity

Severity was assessed with a Visual Analogue Scale (VAS). Children rated their ''average pain intensity'' in the previous 2 weeks on a 10-cm VAS (0 cm, ''no pain'', 10 cm, ''the worst pain possible''). They were also asked about pain medications and hospital stays.

Disability

To correlate total catastrophism score with functional disabilities, we asked the participants a simple ques-

Escala de Catastrofização – Versão Infantil, Crombez et al. (PCS-C)

Pensamentos e sentimentos durante a dor

Abaixo, há 13 frases sobre diferentes pensamentos e sentimentos que você pode ter quando está com dor.

Ao ler cada frase, marque a palavra que melhor define com qual FORÇA você tem cada pensamento.

1. Quando eu estou com dor, me preocupo o tempo todo se ela vai acabar				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
2. Quando eu estou com dor, penso que é impossível continuar assim por muito tempo				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
3. Quando eu estou com dor, penso que ela é terrível e que nunca vai melhorar				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
4. Quando eu estou com dor, é horrível e sinto que ela vai tomar conta de mim				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
5. Quando eu estou com dor, penso que não aguentarei mais				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
6. Quando eu estou com dor, tenho medo de que a dor piore				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
7. Quando eu estou com dor, penso em outras situações de dor				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
8. Quando eu estou com dor, desejo que a dor vá embora				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
9. Quando eu estou com dor, não consigo pensar em outra coisa				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
10. Quando eu estou com dor, fico pensando no quanto ela dói				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
11. Quando eu estou com dor, fico pensando no quanto eu quero que a dor pare				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
12. Quando eu estou com dor, nada que eu faça faz a dor parar.				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*
13. Quando eu estou com dor, penso que algo grave pode acontecer				
NUNCA	*POUCO*	*MAIS OU MENOS*	*MUITO*	*MUITÍSSIMO*

Figure 2 Final version of the Brazilian Catastrophizing Scale-Children's version.

tion about their abilities to perform physical activities or sports at school. They reported their difficulties using an ordinary scale (1–3), from little to extreme.

Salivary biological marker

Salivary samples were passively collected by expectoration for BDNF dosing. After harvest, the samples were stored on ice until biochemical evaluation, which was performed

Table 1 Participants characteristics (n = 100).

Characteristic	Healthy children	Chronic pain	*p*
	n = 56	n = 44	
Gender (female)	23 (41.07%)	21 (47.72%)	0.1
Age (y)	11.16 (0.73)	9.7 (1.63)	0.001
Years of education (mean)	5.57 (0.49)	4.38 (1.59)	0.001
Psychiatric disease		6 (13.63%)	
Months of pain		39.84 (SD = 37.4)	
Pain diagnosis			
Abdominal		34 (77.27%)	
Oncologic		3 (6.81%)	
Rheumatologic		7 (15.9%)	
BDNF	2,814 (1.57)	1,875 (1.41)	0.008
Catastrophism score	20.32 (7.69)	20.16 (9.19)	0.9

Data are presented as mean and Standard Deviation (SD) or frequency and percentual.

within one hour. The samples were frozen at -80 °C after centrifugation at 5000 rpm for 10 minutes at 4 °C. Afterwards, samples were thawed, centrifuged, and analyzed as described by Mandel et al to optimize the detection of BDNF by ELISA kits.[14]

Statistical analysis

To identify the relevant dimensions of the PCS-C we conducted a parallel analysis[15] of the 13 items. Then, we performed an exploratory factor analysis with squared multiple correlations for the prior communality estimating Kaiser measures of sampling adequacy, with promax rotation to confirm the factor retention.

Given that PCS-C was a previously validated measure, we used a Confirmatory Factor Analysis (CFA) with structural equation model to evaluate if the original 3-factor model proposed by Crombez[6] and the other models fit a sample from a new population. We assessed the models' fit by using root mean square error of approximation (RMSEA – values should be < 0.05), the Bentler Comparative Fit Index (CFI), and the Bollen Non normed Index (IFI – values close to 1 indicate a very good fit).[16] The latter is preferred because it is the least affected by the sample size.[17] Internal consistency was assessed through Cronbach's alpha using the data from the baseline questionnaires. We calculated descriptive statistics for all demographic and study variables. We tested continuous variables for normality using the Shapiro-Wilk test. Comparisons between continuous variables were performed using *t*-test for independent samples. Categorical variables were compared using the χ^2 or Fisher exact test. The association of the catastrophizing scale and pain variables was analyzed by Spearman Rank correlation. Moderate positive correlation coefficients were expected not to exceed 0.7.[18] One-way ANOVA was used to understand how the variables ''total months of pain'' and ''physical activity at school'' related to the child pain catastrophizing scores in the group of children with pain. For all statistical analysis, the significance was set at $p < 0.05$. Data were analyzed using SAS 9.4.

Results

Participants were divided in healthy and chronic pain groups. Most of the children with chronic pain (77%) were recruited from the pediatric gastroenterology ambulatory of abdominal pain. Table 1 shows the demographic characteristics.

Internal consistency of the PCS-C and item variability

The Supplementary Table shows the distribution of item scores. There was a good internal consistency with Cronbach's alpha of 0.813, indicating that each of the items contributed similarly to the construct we intended to measure. Reliability testing further revealed good factor stability with only a negligible gain in Cronbach's value by omitting item 8, which had the lowest total correlation.

Parallel and exploratory factor analysis

In order to determine the instrument dimensions, we ran a parallel analysis which retained two factors. These two dimensions were confirmed by the exploratory factorial analysis.

Confirmatory factor analysis

It was used to evaluate the aforementioned model and other models already proposed. Model 1 is a 1-factor model in which the 13 items are assumed to be indicators of a single latent trait (pain catastrophizing). Model 2, proposed by Pielech,[20] has two factors: one composed of the items measuring rumination and magnification, and the other, with items measuring helplessness. Model 3 is the original 3-factor model (magnification, rumination, and helplessness) proposed by Sulivan in adult scale and by Crombez for the child scale. Model 4 is the 2-factor model found in our analysis. Our model retained different items in two factors that could be included in the rumination domain (1,8,9,11,12) and in the magnification and help-

Table 2 Goodness-of-fit values for the different models tested (n = 100).

		IFI	RMSEA	95% IC; RMSEA	CFI
Model 1	1 factor (13 itens)	0.8790	0.0694	(0.0279; 0.1025)	0.8726
Model 2	2 factors (5 + 8 itens)	0.8762	0.0709	(0.0301; 0.1040)	0.8690
Model 3	3 factors (6 + 4 + 3 itens)	0.8962	0.0662	(0.0195; 0.1006)	0.8894
Model 4	2 factors (5 + 8 itens)	0.9467	0.0465	(0.0000; 0.0849)	0.9437

Model 1, 1 factor, 13 items; Model 2, factor structure by Pielech[20]; Model 3, factor structure suggested by Crombez[10]; Model 4, model revealed by the current study.
CFI, Comparative Fit Index; IFI, Incremental Fit Index; RMSEA, Root Mean Square Error of Approximation.

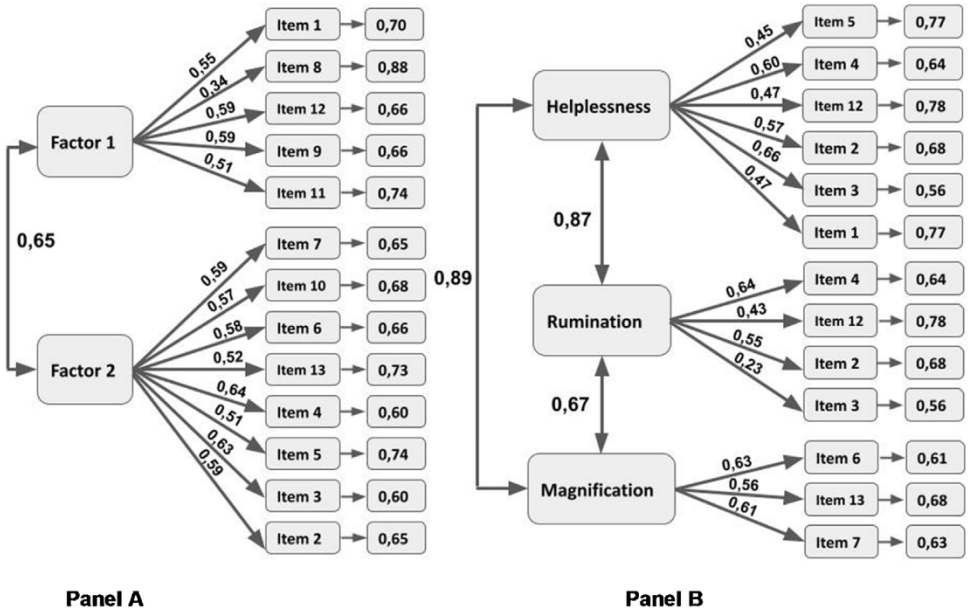

Figure 3 Factorial structure of the Brazilian Portuguese Version of Pain catastrophizing scale for Children (Panel A: 2-factor model revealed by the current study; Panel B: the classical 3-factor model).

lessness domain (2,3,4,5,6,7,10,13). Item 8 revealed the lowest close fit (0.34), as was already demonstrated in other models.[20,21] To realize how well the models fit the data, we computed several goodness-of-fit indices in Table 2. The 2-factor model (Model 4) revealed the best goodness-of-fit values with IFI and CFI close to 1, followed by the classical 3-factor model.[13] Figure 3 shows the diagrams and the factor loading generated for the hypothesized model by Sulivan and for the new factorial analysis proposed by the authors (Model 4).

Demographic and pain factors and concurrent validity

The PCS-C total score was not different between chronic pain and healthy children, whose age and schooling years varied. We performed a general linear model analysis with ''age'' and ''years of schooling'' in relation to the catastrophism score of healthy and pain children, but it showed no significant results. Also, it was not identified a correlation between a single measure of visual analogue scale and catastrophism (r = 0.17). But there was a negative moderate Spearman correlation (r = -0.387, p = 0.009) between the ''time of pain'' diagnosis in months and the catastrophism in the group of pain children. One-way ANOVA was used to examine differences in child pain catastrophism scores utilizing ''time of pain'' diagnosis and gauging progressive difficulty in doing physical education at school. There was significant difference just for physical school activities (p = 0.019). When examining post-hoc pairwise comparisons by Tukey test, the means of catastrophism for the group with great difficulty to do school physical activities were higher than for the groups with some and lower difficulties (Table 3).

Relationship between the PCS-C and salivary BDNF

Samples with a concentration of salivary BDNF below the lower limit were excluded from analysis (n = 18). PCS-C total scores were moderately correlated with levels of BDNF (r = 0.27, p = 0.012). The Supplementary Figure presents the scatter plot of the raw PCS-C and BDNF.

Discussion

The adaptation of the Brazilian Portuguese version of PCS-C was carried out by a panel of experts and included both lin-

Table 3 One-way ANOVA between child pain catastrophizing, months of pain, and physical activity at school (n = 44).

Variable	Catastrophism score		
	Means	F-value	*p*
Months of pain	-	2.36	0.135
Physical activity at school		4.34	0.019
Any difficult	18.28[a]		
Some difficult	19.74[a]		
Much difficult	30.49[b]		

Means with different superscripts differ significantly at $p < 0.05$ (e.g., a is significantly different from b).

guistic translation and cross-cultural adaptation to maintain the content validity of measures throughout the contexts. Strict and well-established guidelines were followed during the translation and validation steps. This process yielded a Brazilian Portuguese version that can be easily understood by Portuguese-speaking children and adults. The translation process was followed by the evaluation of the psychometric properties, and by a number of validity analysis, including association with objective biological marker of central sensitization.

The test for internal consistency, Cronbach's alpha (0.81) showed adequate consistency of participant's responses. In our initial approach, we conducted a parallel analysis that identified two dimensions. The parallel analysis provides a superior alternative to other techniques for the same purpose, since it is minimally affected by the sample size.[19] The retention of psychometric properties reflects their validity despite the presence of differences in dimensions from the original one.

In the subsequent confirmatory factor analysis CFA, we evaluated our model structure and the framework of other models already described for children and adults.[6,20,22,23]

The CFA showed that our 2-dimension model provides a good fit (RMSA = 0.046, CFI = 0.94) and all items loaded on its original factor (> 0.5), except item 8 (Supplementary Table). This item (''When I am in pain, I want it to go away'') was the most highly endorsed in our study and in previous ones,[20,21] and probably reflects the tendency children have to worry about pain more than about their catastrophic thoughts.[21] The second model with a good fit was the original Sulivan's adult and Crombez's children 3-factor model (RMSA = 0.06 and CFI = 0.88), even showing correlations lower than 0.5 on items 1, 5, 8, 11 and 12. This result could express the difference between adults and children comprehension of the three original dimensions of the scale. The three separated dimensions of original adult scale were adapted for children, and should be interpreted with caution, considering cultural differences and educational levels between participants. The same authors of the first proposal of PCS-C validation suggest a reappraisal of the catastrophism thinking in children. The way children appraise threat and its potential consequences, and how they cope with it is different. Some social-cognitive development features like emotional control, magical thinking, egocentric distortion, and fragile coping differ a lot between adults and the young, and we should consider this[24,25] Because of these differences, the dimensions may not reflect the same constructs as in adult thinking. Furthermore, despite the establishment of PCS-C subscales and dimensions, the assessment of catastrophizing thinking in children with pain has been focused on the total score. Measuring the dimensions is unlikely to impact treatment decisions.[20,26]

We also examined the concurrent validity of PCS-C by investigating the strength of the relationship between the PCS-C scores and the scores for other pain-related aspects. The absence of correlation between moderate pain score on VAS and the catastrophizing score could be explained by the lack of consistency of just one pain measurement in an ordinary scale. Furthermore, the measure of pain intensity may be more accurate for acute pain than for chronic pain, since chronic pain is a multidimensional experience.

Likewise, we found a negative correlation between total months of pain and catastrophism. Resiliency could explain this finding. Those familiar with their diagnosis might know what to expect, suffer less from anxiety, and have fewer negative feelings.

Furthermore, catastrophizing relates to functional disability.[10,20] Difficulty in doing daily activities shows how much a disease affects the functionality and hinders day-to-day life.[27] When it comes to reflecting the consequences of pain and child fragility, assessment of pain-related disabilities seems a better measure than a visual scale to measure pain. In our chronic pain sample, we were able to show the dependence of the catastrophizing score on physical activity abilities.

We also examined the relationship between catastrophism (PCS-C total scores) with salivary BDNF, finding a modest positive correlation. Otherwise, healthy patients had higher levels than chronic pain children. The presented BDNF's association with higher catastrophism and probable lower resilience, even without definite disease, corroborates previous studies which demonstrated that BDNF has to do with cerebral modulation and is higher in patients under chronic pain.[28,29] Our findings suggest that it is not possible to assess directly and singly the effect of each one of these potential modifier factors on BDNF secretion and on the psychological constructs. Unfortunately, it is not established that salivary BDNF has an acceptable correlation with serum or central nervous system values.[14] Although the salivary measure of this biological marker demonstrated good feasibility, future studies should best define the significance of human salivary BDNF and its correlation with central nervous plasticity.

This study has some limitations. First, it was based on a sample of children from one single institution and from one single public school. Therefore, the findings may not generalize to community samples. Secondly, the limited sample could not be sufficient to infer conclusions about the psychometric properties of the tested scale. Hence, the reliability of factorial analysis does not depend exclusively on the sample size. Moreover, the magnitude of the loadings of the components could be more significant than the isolated sample size.[30] We could, however, demonstrate a relevant internal consistency and adequate loading factors even with limited sample.

Thirdly, catastrophism is a complex construct associated with psychiatric variables such as depressive symptoms or anxiety.[20] A better understanding of children catastrophizing thinking involves assessing their psychological state and

evaluating their personality traits and other components of health and wellness such as health conditions, lifestyles, social support, and socioeconomic conditions.

This study provides evidence for consistent psychometric properties of the Portuguese version of PCS-C. Our factorial analysis suggests that we can apply both the revised 2-dimension proposal and the original 3-dimension scale on Brazilian children. Children catastrophism is well correlated with physical limitations, but the absence of PCS-C score differences between healthy children and those with chronic pain highlights the necessity of a better understanding about catastrophic thinking in children.

Conflicts of interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.bjane.2021.02.057.

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