Brazilian Journal of Physical Therapy 26 (2022) 100348

Brazilian Journal of Physical Therapy

https://www.journals.elsevier.com/brazilian-journal-of-physical-therapy

ORIGINAL RESEARCH

"A journey to learn about pain": the development and validation of a comic book about pain neuroscience education for children

Felipe Reis[a,b,*], Tonya Mizell Palermo[c], Louise Acalantis[a], Leandro Calazans Nogueira[a,d], Ney Meziat-Filho[d], Adriaan Louw[e], Kelly Ickmans[b,f]

[a] *Physical Therapy Department of Instituto Federal do Rio de Janeiro (IFRJ)*
[b] *Pain in Motion research group, Department of Physiotherapy, Human Physiology and Anatomy, Faculty of Physical Education & Physiotherapy, Vrije Universiteit Brussel*
[c] *Seattle Children's Research Institute, Washington, USA*
[d] *Postgraduate Program in Rehabilitation Sciences – Centro Universitário Augusto Motta (UNISUAM), Rio de Janeiro, Brazil*
[e] *Evidence in Motion, Iowa, USA*
[f] *Research Foundation – Flanders (FWO), Brussels, Belgium*

Received 6 March 2020; received in revised form 15 March 2021; accepted 6 April 2021
Available online 2 May 2021

KEYWORDS
Biopsychosocial Model, Educational Technology, Pain
Pain Neuroscience Education
Pediatric Pain
Physical Therapy

ABSTRACT
Background: Pain education resources for children using appropriate language and illustrations remain scarce.
Objectives: We aimed to summarize the development process and testing for face and content validity of a structured comic book about pain education for children.
Methods: A first draft of a comic book was developed (Portuguese and English) based on pain education concepts. Experts in pediatric pain from different countries analyzed content, objectives, language, illustrations, layout, motivation, and cultural adjustment. A third draft developed in Portuguese considering experts' suggestions was presented to children and parents in Brazil. The total adequacy score was calculated from the sum of the scores obtained in each domain, divided by the maximum total score. Descriptive analysis is presented.
Results: The expert panel was composed of 11 (64.7%) physical therapists, and 6 (35.3%) psychologists. The total adequacy score (0-100%) was 87.74%. The third draft version of the comic book was presented to 28 children and the final version was presented to 16 children with a mean age of 9.6 years. Children were totally satisfied (n=4; 26.7%) or satisfied (n=9; 56.2%) with the story of the comic book. The readability of the comic book was considered suitable for grades 4 to 6 educational level.
Conclusion: The comic book "A Journey to Learn about Pain" was validated for face and content validity by the expert panel and the Brazilian target population. This comic book is available in

* Corresponding author: Felipe Reis, Instituto Federal do Rio de Janeiro, Campus Realengo - Rua Carlos Wenceslau, 343, Realengo. CEP 21715-000, Rio de Janeiro, RJ, Brasil.
E-mail: felipe.reis@ifrj.edu.br (F. Reis).

https://doi.org/10.1016/j.bjpt.2021.04.009

Portuguese and English and can be a potentially useful resource for children.

Introduction

Pediatric pain is an increasingly recognized clinical problem. The prevalence of chronic pain in children and adolescents ranges from 11 to 54% among different clinical conditions and with different reporting periods.[1] The cost of childhood chronic pain has been estimated at $19.5 billion annually in the USA, representing a substantial economic burden to families and society.[2] Headache, abdominal pain, back pain, and musculoskeletal pain are the most common types of chronic pain in children.[1] In some cases, chronic pain may be a consequence of a chronic disease process, injury or surgery or, in others, pain occurs without any identifiable cause.[3] Regardless of the cause, the experience of chronic pain involves the interaction between multiple factors including nociceptive, emotional, cognitive, social, behavioral, and environmental.[4–7]

Pain education (i.e., modern pain education, pain neuroscience education, or therapeutic neuroscience education) aims to address patient misconceptions about the physiology of pain and also helps to change their maladaptive beliefs and behaviors.[8–11] By explaining that pain is not always related to tissue damage, but is the result of multiple contributors, clinicians hope to change patient's negative beliefs and improve their knowledge about pain.[8–12] Therefore, pain education may decrease the high threat value of pain, fear of movement, catastrophizing thoughts, and passive behaviors.[8] A recent systematic review, including adults with chronic musculoskeletal pain, showed that pain education reduces pain, disability, pain catastrophizing, and kinesiophobia in the short-to-medium-term.[13] Despite the positive findings with pain education, previous studies have only focused on adult populations.[8, 14–17] Pain education can be delivered as a stand-alone intervention or combined with other treatments.[8, 18]

Although pain education is well established for adults, less attention has been devoted to development or evaluation of educational resources for children, despite the potential for early intervention in childhood to interrupt a vicious cycle of chronic pain.[19] Indeed, children may have inappropriate beliefs about their pain and high levels of pain catastrophizing, together which heightened risk for functional disability.[20] In addition, adolescents with chronic pain and inappropriate pain beliefs tend to adopt passive coping strategies.[21] Pain coping and pain beliefs might be positively addressed by pain education.[22–27] Currently, evidenced-based psychological interventions to address maladaptive cognitions and behavior in children and adolescents include psycho-education,[28] acceptance and commitment therapy,[29] biofeedback therapy,[30, 31] coping skills training,[32] mindfulness-based intervention,[33] guided imagery,[34] relaxation therapy,[30] and cognitive behavioral therapy.[35–39] These interventions may address different aspects of pain education, but generally are not focused on reducing the threat value of pain prior to initiating other interventions.

Considering the high number of children affected by pain, it is relevant to develop innovative and accessible methods of pain education for the pediatric population. The current study aims to present the development process, and testing for face and content validity of a structured pain education resource for children. To the best of our knowledge, this is the first resource that includes pain education contents in a comic book format developed specifically for children.

Methods

Study design and ethical considerations

The study consisted of three phases to develop and evaluate pain education resource for children as follow: (i) development of the content for pain educational material, (ii) evaluation of the educational material by experts, and (iii) evaluation of the educational material by the target population of children with pain and parents/guardians. The second phase consisted of a two-round internet-based modified Delphi poll to obtain consensus from a group of experts. The process ensured participants remained anonymous throughout the study. In the third phase, we recruited children with pain and parents/guardians to evaluate the version-3 (black and white draft) and the final version (colored version) of the comic book. The study was approved by the Ethics Committee of Instituto Federal do Rio de Janeiro, Brazil (CAAE: 83265417.0.0000.5268).

Phase 1: development of the comic book

The pain education resource (hereafter referred to as comic book) was based on a literature review about the content of pain education and pain self-management strategies.[40] The comic book was developed according to the recommendations for conception and efficacy of educational tools, considering content, language, organization, layout, illustration, learning, and motivation.[41, 42]

A professional graphic designer developed a first version (version-1) of the comic book in Portuguese and English. This version entitled *"A Journey to Learn about Pain"* consisted of 40 pages, with dimensions of 210 × 297mm (A4), comic book format, black and white, font Comic Sans MS, sizes 12 and 14, with cover, authorship, and character presentation. The story described the adventure of three main characters, Clara, Fred, and professor Dexter. The comic book contained five sections: (1) characterization of pain as the alarm system of the body, (2) pain neurophysiology (neurons, nociceptive system, nociceptive pathways, up- and down-regulation of the nervous system, peripheral and central sensitization), (3) cognitive, emotional, and behavioral factors that might contribute to pain, (4) a summary of the most important concepts in the book, and (5) a true or false quiz consisting of affirmative statements about pain adapted from Pate et al.[43]

Phase 2: evaluation of the educational material by experts

In sequence, we conducted a modified Delphi approach to obtain the experts' evaluation and suggestions of version-1 of the comic book. The classic Delphi technique involves open-ended questions in the first-round questionnaire and having as many rounds as necessary to achieve consensus. For this study, two modifications were made: (1) presenting the pain neuroscience education contents in the comic book in the first round instead of only having the open-ended questions; (2) defining a pre-established number of two rounds.

Two authors (FR and LA) selected a convenience sample of health care professionals including physical therapists, physicians, psychologists, and occupational therapists to judge the content of the comic book. There is not a generally accepted definition for the term 'expert.' For the purpose of this study, 'experts' were defined by meeting at least two of the following criteria: (i) professional experience in the area of pain education, (ii) professional experience of more than five years in the management of pain in children; (iii) has published scientific papers on pain in children in the last three years; (iv) has knowledge on the development and validation of educational technologies; and (v) has master's or doctoral degree with scientific productivity in the area of pain. The exclusion criteria were: (i) health care professionals who did not respond to the invitation e-mail within 30 days, and (ii) those who answered the form incompletely. The sample size of the expert panel followed the recommendations from Delphi literature (10 to 18 participants).[44]

An invitation was sent by email to the experts including the aims of the study, the consent form, and a link to download the comic book and to complete the online survey.

The first round consisted of three parts: (i) demographic data, (ii) questions to evaluate the comic book (i.e., content, language, illustrations, layout, and design), and (iii) open-ended questions. Experts were instructed to evaluate the comic book items using a scale of three levels of agreement: adequate, partially adequate, or inadequate. The questionnaire was developed by the investigators based on the Suitability Assessment of Materials (SAM),[42, 45] an instrument used to evaluate the difficulty and convenience of educational materials. We also asked experts to identify in the comic book the presence of the most common contents used in pain neuroscience education (i.e., pain as an alarm system of the body, peripheral receptors, pain and nociception are not the same, neurons, danger messages to the brain - spinal pathway, spinal inhibition and facilitation, peripheral sensitization, central sensitization, plasticity of the nervous system, psychosocial factors and beliefs contributing to pain, the importance of staying active, how to deal with pain, and the importance of sleep hygiene).[8, 40, 46] Finally, at the end, there were five open-ended questions that allowed experts to formulate suggestions. Answers to the open-ended questions were analyzed qualitatively by two authors (FR and LN) (physical therapists with knowledge about pain education and more than 15 years of experience). Disagreements were resolved by consensus or by arbitration by a third professional from our research team. After the review process, the same professional graphic designer drafted version-2 of the comic book, incorporating suggestions from the experts.

In the second round, experts involved in the previous round received version-2 of the comic book as well as written feedback highlighting all modifications included. Experts were asked if there were missing concepts about pain education and to provide suggestions if any content (i.e., text, figures, and layout) should be excluded/modified. At the end of the second round, we prepared the black and white version-3 of the comic book.

Phase 3: evaluation of the educational material by children with pain and parents/guardians

Social media advertisements (Instagram and Facebook) were posted to recruit children and families into the study. Parents/guardians were invited to contact the researchers directly if they were interested in participating. To be eligible for this study, parents needed to live with a child (aged 8−12) with chronic pain (i.e., persistent [ongoing] and recurrent [episodic] for more than 3 months),[47] and be comfortable using a computer. We instructed parents/guardians to read the book and confirm if they presented the book to their child. However, if parents/guardians did not present the comic book to the child, we still included their evaluation in the analysis as representing the parent perspective. In cases where both parents and more than one child in a family met the inclusion criteria, they were allowed to participate in the study separately.

First, children and parents/guardians evaluated version-3 of the comic book. Parents/guardians reported on their perceptions of the comic book including the (1) organization, (2) writing style, (3) illustrations and layout, and (4) motivational aspect.[48] They also rated their overall satisfaction level with the comic book on an 11-point numerical rating scale ranging from totally dissatisfied (0) to totally satisfied (10). Children also reported on their perceptions of the comic book by answering four questions, *"In general, were you satisfied with the book?"*, *"How much did you like the story of the book?"*, *"How much did you like the messages of the book?"*, "*How much did the illustrations help to understand pain?"* using a facial expression 5-point Likert scale ranging from zero (totally unsatisfied) to 5 (totally satisfied). We considered that version-3 was adequate if: (i) most participants (≥70%) reported positive perceptions according to each criterion, (ii) satisfaction reached at least 7/10, and (iii) most participants (≥70%) indicated to be at least satisfied in the questions measured with the Likert scale. If all these criteria were met, the illustrator prepared the final colored version of the comic book. Subsequently, children and parents/guardians evaluated the final color-version of the comic book using the same criteria described previously.

Data and statistical analysis

The process of validation of the comic book was guided by the theoretical referential of validity of content and appearance, which describes the percentage of experts who agreed on the content and appearance of the material. The validation data were entered in the software Excel for Mac OSX. The material was analyzed using a checklist composed of seven domains including: content, objectives, language,

illustrations, layout, motivation, and cultural adjustment.[42] Each item was scored as: 2 (adequate), 1 (partially adequate), or 0 (inadequate). A total adequacy score was derived from the sum of the scores obtained, divided by the maximum total score (18 items = 36 points) and then multiplied by 100 to obtain a percentage score, which we interpreted as follows: 70-100% (superior), 40-69% (adequate), or 0-39% (not suitable).[42] Descriptive statistics (means, standard deviations [SDs], ranges) were computed for all variables and are presented in the tables. The readability was estimated using the Gunning Fog index, the Flesh Reading Ease, and the Flesch-Kincaid Grade level. The Gunning-Fog index is a measure of text readability based upon sentence length and difficult words in a passage. The Flesch Reading Ease ranges from 0 to 100, with a lower score indicating more difficult to read. It uses sentence length and polysyllabic words to determine difficulty to read. A score of 70 or above is considered "easy."[49] The Flesch-Kincaid Grade level has been the most used to assess the readability of a text and its result estimates the years of study necessary for proper understanding of the text (e.g., 8.0 = 8th grade). Illustrations and other graphic objects were not included in the readability analysis. Written text was copied and pasted into Python for analysis. All readability scores were calculated using the package "textstat 0.6.2" on Python.

Table 1 Sociodemographic characteristics (expert panel).

Variables	Expert panel (n=17)
Age, mean ± SD (years)	38.8 ± 8.95
Sex, n (%)	
Male	7 (41.2%)
Female	10 (58.8%)
Profession, n (%)	
Physical therapist	11 (64.7%)
Psychologist	6 (35.3%)
Country, n (%)	
Brazil	11 (64.7%)
United States of America	3 (17.6%)
Netherlands	1 (5.9%)
Belgium	2 (11.8%)
Main professional role in pain, n (%)	
Clinician	2 (11.8%)
Researcher	6 (35.3%)
Both	9 (52.9%)
Academic degree, n (%)	
Master degree	7 (41.2%)
Doctoral degree	10 (58.8%)
Experience, mean ± SD years	13.8 ± 8.58

Results

Evaluation of the educational material by experts

We invited 20 healthcare professionals to review the draft version of the comic book. Three professionals did not answer our invitations and the final sample consisted of 17 pain specialists. The expert panel consisted of 10 women and 7 men and had a mean ± SD age 38.8 ± 8.95 years (range=26 to 60). The majority of the health professionals were physical therapists (n=11; 64.7%), had doctoral degrees (n=10; 58.8%), and were working as both clinicians and researchers (n=9; 52.9%), and had a mean of 13.82 ± 8.58 years (range=2 to 30) of professional experience (Table 1).

The results of the expert panel evaluation of the comic book are shown in Table 2.

Figure 1 represents the pain neuroscience education components identified by the members of the expert panel within the comic book. In the draft version, all components were identified by more than 70% of the members of the expert panel. The main suggestions recommended by the expert panel and modifications for the final version of the comic book are presented in the supplementary material.

Evaluation of the educational material by children with pain and parents/guardians

The evaluation of version-3 of the comic book was performed by 28 (82.4%) parents and 6 (17.6%) guardians; 30 females (88.2%) and 4 males (11.8%); 32 (94.1%) parents had a higher education level, and the mean age was 37.5 ± 6.87 years (range=20 to 51). The final version of the comic book was evaluated by 21 adults (female =20; 95.2%) with 17 parents (81.0%) and 4 guardians (19.0%). Most of the adults had a higher education level (n=15; 71.4%). The evaluation of the comic book by parents/guardians is presented in Table 3.

Version-3 of the comic book was presented to 28 children ranging from 8 to 12 years old (56.6% female) with a mean age of 9.68 ± 1.44 years. Overall, most children were satisfied (n=11; 39.3%) or totally satisfied (n=14; 50%) with the story of the comic book. The final Portuguese version of the book was presented to 16 children ranging from 8 to 12 years old (62.5% female) with a mean age of 9.6 ± 1.30 years. Children were totally satisfied (n=4; 26.7%) or satisfied (n=9; 56.2%) with the story of the comic book (Table 4). The final Portuguese version was translated into English and the cover and some illustrations of the comic book are presented in **Supplementary material.**

Readability

The comic book was considered easy to read (Flesch Reading ease = 84.47) and was suitable for grades 4 to 6 educational level (Flesch-Kincaid Grade Level = 4.5; Gunning Fog index = 5.41).

Discussion

The aim of this study was to describe the development, and testing for face and content validity of a freely available educational resource about pain in a comic book format for children. The estimated readability of the comic book was considered suitable for grades 4 to 6 educational level (children ranging from eight to 12 years). The evaluation of the comic book entitled "A Journey to Learn about Pain" by the expert panel was considered adequate in all domains (content, objectives, language, illustrations, layout, motivation, and cultural adjustment) and overall ratings classified the resource as highly suitable material (above 70%).

Table 2 Expert panel ratings of the pain education resource.

Domains (score range)	Expert Panel (n = 17)			
	Adequate	Partially adequate	Inadequate	Score mean ± SD
1. Content (0-4)				3.64 ± 0.60
1.1 The objective is clear, facilitating immediate comprehension of the material?	14 (82.4%)	3 (17.6%)	-	-
1.2 The content addresses behavioral information that helps children to understand pain?	14 (82.4%)	3 (17.6%)	-	-
2. Objectives (0-2)				1.88 ± 0.33
2.1 The material proposal is limited to the objectives?	15 (88.2%)	2 (11.8%)	-	-
3. Language (0-10)				8.64 ± 2.02
3.1 The reading level is appropriate for the reader's comprehension?	13 (76.5%)	3 (17.6%)	1 (5.9%)	-
3.2 The style of conversation facilitates the understanding of the text?	14 (82.4%)	3 (17.6%)	-	-
3.3 The information is clearly transmitted?	13 (76.5%)	3 (17.6%)	1 (5.9%)	-
3.4 The vocabulary uses common words?	11 (64.7%)	5 (29.4%)	1 (5.9%)	-
3.5 The learning is facilitated by topics?	15 (88.2%)	1 (5.9%)	1 (5.9%)	-
4. Illustrations (0-6)				5.0 ± 1.12
4.1 The cover captures the reader's attention and expresses the purpose of the material?	11 (64.7%)	6 (35.3%)	-	-
4.2 The illustrations present fundamental visual messages so that the reader can understand the main outlines by himself?	10 (58.8%)	6 (35.3%)	1 (5.9%)	-
4.3 The illustrations are relevant?	14 (82.4%)	3 (17.6%)	-	-
5. Layout (0-4)				3.82 ± 0.39
5.1 The organization of the material is adequate?	16 (94.1%)	1 (5.9%)	-	-
5.2 The size and type of font promote an enjoyable reading experience?	15 (88.2%)	2 (11.8%)	-	-
6. Motivation (0-6)	-	-	-	5.47 ± 0.87
6.1 Interaction occurs between text and/or figures and the reader. Facilitates problem solving, making choices, and/or demonstrating skills?	15 (88.2%)	1 (5.9%)	1 (5.9%)	-
6.2 The desired behavior patterns are modeled or well demonstrated?	14 (82.4%)	3 (17.6%)	-	-
6.3 There is a motivation for self-efficacy?	14 (82.4%)	3 (17.6%)	-	-
7. Cultural adjustment (0-4)	-	-	-	3.11 ± 1.11
7.1 The material is culturally appropriate to the logic, language, and experience of the public?	9 (52.9%)	7 (41.2%)	1 (5.9%)	-
7.2 Displays culturally appropriate images and examples?	12 (70.6%)	4 (23.5%)	1 (5.9%)	-
Total score (0-36)	-	-	-	31.58 ± 3.48
Total score (0-100%)	-	-	-	87.74 ± 9.67

Although most children included in the study were totally satisfied or satisfied with the comic book, some children (26.7%) did not find that the book helped them to understand pain, three (18.8%) did not like the story, and one (6.3%) was not satisfied with the final version of the comic book. Because we did not provide any open-ended questions to children, we are unsure of the reasons for the low ratings. It will be important to further study the individual factors such as the child's pain condition, age, sex, or family beliefs that may contribute to their perceptions of pain education. Some studies in the literature have shown that parents are important influencers of beliefs, symptoms, and functioning in children with chronic pain.[50] The best method to present the comic book developed in this study, that is, as a standalone approach with parental support or within a health care visit still needs to be clarified. Thus, it is important to evaluate the comic book in different settings such as clinics and schools, with different levels of support provided by adult health care providers or other caregivers.

In the last few decades, different pain education interventions for adults with a wide range of chronic pain conditions have been developed. These have included various formats (books, booklets, drawings, videos),[8] delivery methods (one-to-one, small group, large group, or via the

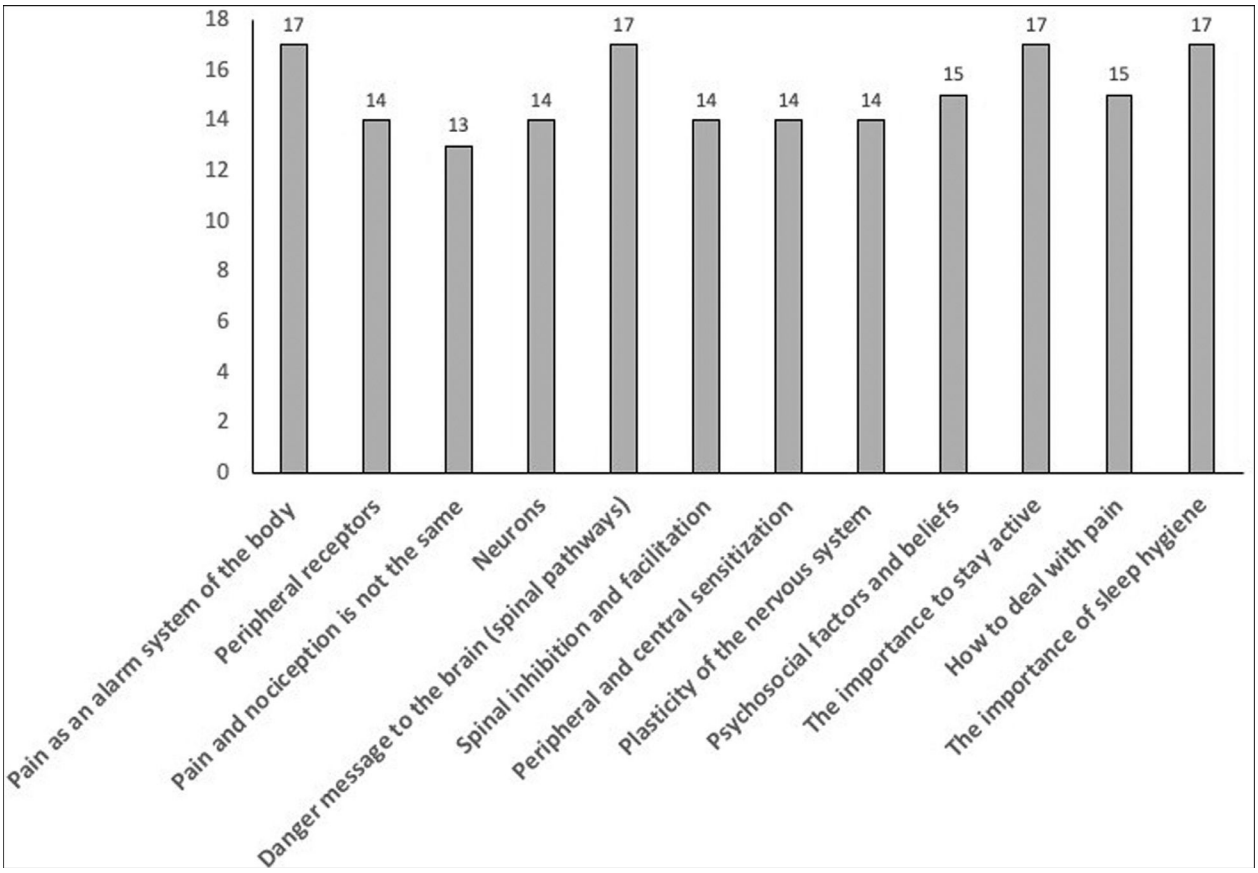

Figure 1 Frequency of the pain neurophysiology components identified by the expert panel (n =17 experts).

Internet),[8, 51] length of intervention (one session or multiple sessions),[52] as well as using different terminology to describe the intervention ("Explain pain", "Therapeutic neuroscience education", "Pain biology education", "Pain neuroscience education").[53] In pediatrics, the number of resources specifically designed to provide pain education available for clinical practice and research remains scarce. One exception is an interactive board game known as Pain Neuroscience Education for Kids (PNE4Kids). The authors suggested that a program with PNE4Kids lasts about 40 minutes and covers the following sections: the nociceptive system and its function, adaptations in the nociceptive system following chronic pain, and the translation and application of the content into the patient's life.[54] PNE4Kids is also freely available for clinicians and researchers at http://www.paininmotion.be/pne4kids.

The evidence for the effectiveness of pain education as a single intervention in the pediatric population with chronic pain is still lacking in the literature. However, there are some emerging promising applications of pain education not only in clinical settings but also in schools. For example, one study investigated the effectiveness of a 4-week program of pain education combined with exercise in a school-based sample of 43 adolescents with chronic neck pain. Findings showed that the pain education program was feasible and children reported small improvements in pain intensity, pain catastrophizing, and anxiety.[55] But the study presents some methodological shortcomings such as the small sample size, the control group received no treatment nor attention from the therapists, and there was a short follow-up period (5 weeks after the baseline). In a school setting, Louw et al.[56] reported that a 30-minute pain education lecture provided to 133 middle school children resulted in a significant increase in their knowledge of pain as well changes in maladaptive beliefs regarding pain. Further research is needed using more rigorous study designs to evaluate the efficacy of pain education in children.

We aimed to fill the gap in availability of pain education resources for school-aged children by designing a comic book format resource for children. Most educational programs for pediatric chronic pain consist of a psycho-education focus on pain management rather than explaining pain neuroscience[57] or use materials developed for parents.[58–60] The "Journey to Learn about Pain" was developed considering a range of components of pain education including pain neurophysiology and cognitive and behavioral factors involved in pain experiences delivered directly to children. The major strength of this resource is that it was developed in a comic book format with language, story, and characters appropriate for school age children. Given that children with chronic pain often have significant problems with functioning (e.g., school absenteeism, and lower participation in daily, sports, and family activities) this book might be a relevant tool in clinical, research, and school settings. However, it is important to highlight that severe chronic pain in children must be considered as a complex health condition that typically requires a comprehensive and multidisciplinary approach, including psychological interventions, as well as

Table 3 Ratings of the draft and the final version of the comic book by parents / guardians.

Domain	Draft version (n=34)	Final version (n=21)
1. Organization		
Did the cover catch your attention?		
Yes	24 (70.6%)	17 (81%)
No	4 (11.8%)	-
I don't know	6 (17.6%)	4 (19%)
Is the content sequence (story) adequate?		
Yes	31 (91.2%)	20 (95.2%)
No	-	-
I don't know	3 (8.8%)	1 (4.8%)
Is the structure of the book organized?		
Yes	32 (94.1%)	20 (95.2%)
No	-	-
I don't know	2 (5.9%)	1 (4.8%)
2. Writing style		
As for the understanding of the sentences, they are:		
Easy to understand	34 (100%)	20 (95.2%)
Hard to understand	-	1 (4.8%)
I don't know	-	-
Written content is:		
Clear	34 (100%)	21 (100%)
Confusing	-	-
I don't know	-	-
The text is:		
Interesting	33 (97.1%)	19 (90.5%)
Not interesting	1 (2.9%)	-
I don't know	-	2 (9.5%)
3. Illustrations and layout		
The illustrations are:		
Simple	33 (97.1%)	20 (95.2%)
Complicated	1 (2.9%)	-
I don't know	-	1 (4.8%)
Do the illustrations complement the text?		
Yes	34 (100%)	21 (100%)
No	-	-
I don't know	-	-
Are the pages organized?		
Yes	33 (97.1%)	21 (100%)
No	1 (2.9%)	-
I don't know	-	-
4. Motivation		
In your opinion, any parent/guardian who read this book will understand what it is about?		
Yes	29 (85.3%)	20 (95.2%)
No	1 (2.9%)	-
I don't know	4 (11.8%)	1 (4.8%)
Did you feel motivated to read the book to the end?		
Yes	29 (85.3%)	19 (90.5%)
No	4 (11.8%)	1 (4.8%)
I don't know	1 (2.9%)	1 (4.8%)
Does the educational material address the issue of pain so that parents or guardians and children understand the issue?		
Yes	32 (94.1%)	21 (100%)
No	-	-
I don't know	2 (5.9%)	-
Does the book suggest acting or thinking about children's pain?		
Yes	34 (100%)	21 (100%)
No	-	-
I don't know	-	-
Were you satisfied with the book? mean ± SD (0-10)	8.6 ± 1.0	8.8 ± 1.7

pharmacological, and physical and occupational therapies. The present resource is freely available in Portuguese and English, in different formats (pdf, flipbook, and e-book) and it can be accessed or downloaded at http://pesquisaemdor.com.br/?page_id=84.

This study is not free of limitations. Despite the comic book having been developed in Portuguese and English, we only tested the Portuguese version in a sample of Brazilian parents and children and we did not perform any transcultural validation of the final version into English. We also did not test the effectiveness of the comic book for changing knowledge or behaviors related to pain management. Another limitation that should be considered is the overall high level of education of the parent/guardian sample, which limits knowledge of the applicability to a broader range of family educational and socioeconomic characteristics. Last, the expert panel only included psychologists or physical therapists and thus the perspectives of other pediatric pain specialists were not included. Given those limitations the comic book will need language and cultural adaptations to be used in different countries. Future studies should investigate if there are any differences in perspectives among samples with more diverse educational backgrounds. We also recommend that future clinical trials investigate the effectiveness of this educational material in clinical samples of school-aged children with pain conditions in modifying beliefs and behaviors related to coping with pain; studies may also examine its utility in teaching pain education in school-based settings with healthy children. Although we used a comic book format, at this time, the best method to deliver pain neurophysiology education is unknown. Delivery via other types of educational materials (e.g., electronic games, quiz, board games, or videos)

Table 4 Ratings of the draft and the final version of the comic book by children.

Question	Draft version (n=28)	Final version (n=16)
In general, were you satisfied with the book?		
Totally satisfied	14 (50%)	7 (43.8%)
Satisfied	11 (39.9%)	5 (31.3%)
Not satisfied or unsatisfied	3 (10.7%)	3 (18.8%)
Unsatisfied	-	1 (6.3%)
Totally unsatisfied	-	-
How much did you like the story of the book?		
Totally satisfied	14 (50%)	4 (26.7%)
Satisfied	11 (39.9%)	9 (56.2%)
Not satisfied or unsatisfied	3 (10.7%)	3 (18.8%)
Unsatisfied	-	-
Totally unsatisfied	-	-
How much did the story help you to understand pain?		
Totally satisfied	10 (35.7%)	5 (31.3%)
Satisfied	12 (42.9%)	7 (43.8%)
Not satisfied or unsatisfied	6 (21.4%)	4 (26.7%)
Unsatisfied	-	-
Totally unsatisfied	-	-

remain an area for further studies. Nevertheless, we believe that this resource could be a starting point contributing to the delivery of pain education for children.

Conclusion

The comic book about pain education for children, entitled "A Journey to Learn about Pain," was validated for face and content validity by an expert panel, and children and their parents. Further work is needed to evaluate the comic book as a resource in school-age children to understand whether it may increase pain knowledge and/or modify beliefs about pain.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgments

We acknowledge the Instituto de Tratamento da Coluna Vertebral (ITC Vertebral) and everyone who contributed to the crowd funding campaign for the final version of this book.

The final phase of this study was supported by a private service known as Instituto de Tratamento da Coluna Vertebral (ITC vertebral).

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.bjpt.2021.04.009.

References

1. King S, Chambers CT, Huguet A, MacNevin RC, McGrath PJ, Parker L, et al. The epidemiology of chronic pain in children and adolescents revisited: a systematic review. *Pain*. 2011;152 (12):2729–2738. Elsevier.
2. Groenewald CB, Essner BS, Wright D, Fesinmeyer MD, Palermo TM. The economic costs of chronic pain among a cohort of treatment-seeking adolescents in the United States. *J Pain*. 2014;15 (9):925–933. Elsevier.
3. Rabbitts JA, Fisher E, Rosenbloom BN, Palermo TM. Prevalence and Predictors of Chronic Postsurgical Pain in Children: A Systematic Review and Meta-Analysis. *J Pain*. 2017;18(6):605–614.
4. Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. *Psychol Bull. American Psychological Association;*. 2007;133(4):581.
5. Liossi C, Howard RF. Pediatric chronic pain: biopsychosocial assessment and formulation. *Pediatrics. Am Acad Pediatrics;*. 2016;138:(5) e20160331.
6. Basch MC, Chow ET, Logan DE, Schechter NL, Simons LE. Perspectives on the clinical significance of functional pain syndromes in children. *J Pain Res*. 2015;8:675.
7. Bushnell MC, Čeko M, Low LA. Cognitive and emotional control of pain and its disruption in chronic pain. *Nat Rev Neurosci. NIH Public Access;*. 2013;14(7):502.
8. Louw A, Zimney K, Puentedura EJ, Diener I, Adriaan Louw PT, Kory Zimney PT, et al. The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature. *Physiother Theory Pract. Taylor & Francis;*. 2016;32 (5):332–355.
9. Nijs J, Torres-Cueco R, Wilgen P van, Lluch Girbés E, Struyf F, Roussel N, et al. Applying modern pain neuroscience in clinical practice: criteria for the classification of central sensitization pain. *Pain Physician*. 2014;17(5):447–457.
10. Moseley GL, Butler DS. Fifteen Years of Explaining Pain: The Past, Present, and Future. *J Pain*. 2015;16(9):807–813.
11. Moseley GL. Reconceptualising pain according to modern pain science. *Phys Ther Rev. Taylor & Francis;*. 2007;12(3):169–178.
12. Louw A, Puentedura EJ, Zimney K, Schmidt S. Know Pain, know gain? A perspective on pain neuroscience education in physical therapy. *J Orthop Sports Phys Ther*. 2016;46(3):131–134. JOSPT, Inc. JOSPT, 1033 North Fairfax Street, Suite 304, Alexandria, VA 22134-1540.
13. Watson JA, Ryan CG, Cooper L, Ellington D, Whittle R, Lavender M, et al. Pain Neuroscience Education for Adults With Chronic Musculoskeletal Pain: A Mixed-Methods Systematic Review and Meta-Analysis. *J Pain*. 2019;20(10):1140.e1–1140.e22.
14. Malfliet A, Kregel J, Meeus M, Danneels L, Cagnie B, Roussel N, et al. Patients With Chronic Spinal Pain Benefit From Pain Neuroscience Education Regardless the Self-Reported Signs of Central Sensitization: Secondary Analysis of a Randomized Controlled Multicenter Trial. *Pm r*. 2018;10(12):1330–1343. 2018/05/13.
15. Van Oosterwijck J, M Meeus, Paul L, De Schryver M, Pascal A, Lambrecht L, et al. Pain Physiology Education Improves Health Status and Endogenous Pain Inhibition in Fibromyalgia A Double-Blind Randomized Controlled Trial. *Clin J Pain. LWW;*. 2013;29 (10):873–882.
16. Gallagher L, McAuley J, GL M, Moseley GL. A randomized-controlled trial of using a book of metaphors to reconceptualize

pain and decrease catastrophizing in people with chronic pain. *Clin J Pain. LWW;*. 2013;29(1):20–25.
17. Lee H, McAuley JH, Hübscher M, Kamper SJ, Traeger AC, Moseley GL. Does changing pain-related knowledge reduce pain and improve function through changes in catastrophizing? *Pain. US: Lippincott Williams & Wilkins*. 2016;157(4):922–930.
18. Wood L, Hendrick P. A systematic review and meta-analysis of pain neuroscience education for chronic low back pain: short- and long-term outcomes of pain and disability. *Eur J Pain. Wiley Online Library;*. 2018;23(2):234–249.
19. Simons LE, Kaczynski KJ. The Fear Avoidance Model of Chronic Pain: Examination for Pediatric Application. *J Pain. Elsevier Ltd;*. 2012;13(9):827–835.
20. Vervoort T, Eccleston C, Goubert L, Buysse A, Crombez G. Children ' s catastrophic thinking about their pain predicts pain and disability 6 months later. *Eur J Pain. European Federation of International Association for the Study of Pain Chapters*. 2010;14(1):90–96.
21. Kaczynski KJ, Simons LE, Claar RL. Anxiety, Coping, and Disability : A Test of Mediation in a Pediatric Chronic Pain Sample*. 2011; 36(8):932–41.
22. Louw A, Diener I, Butler DS, Puentedura EJ. The effect of neuroscience education on pain, disability, anxiety, and stress in chronic musculoskeletal pain. *Arch Phys Med Rehabil. Elsevier Inc.*. 2011;92(12):2041–2056.
23. Oosterwijck J Van, Meeus M, Paul L, Schryver M, Pascal A, Lambrecht L, et al. Pain physiology education improves health status and endogenous pain inhibition in fibromyalgia: A double-blind randomized controlled trial. *Clin J Pain*. 2013;29 (10):873–882.
24. Oosterwijck J Van, Nijs J, Meeus M, Truijen S, Craps J, Keybus N Van den, et al. Pain neurophysiology education improves cognitions, pain thresholds, and movement performance in people with chronic whiplash: a pilot study. *J Rehabil Res Dev*. 2011;48(1):43–58.
25. Nijs J, Paul van Wilgen C, Oosterwijck J Van, Ittersum M van, Meeus M. How to explain central sensitization to patients with "unexplained" chronic musculoskeletal pain: Practice guidelines. *Man Ther. Elsevier Ltd;*. 2011;16(5):413–418.
26. Moseley L. Combined physiotherapy and education is efficacious for chronic low back pain. *Aust J Physiother. Australian Physiotherapy Association;*. 2002;48(4):297–302.
27. Meeus M, Nijs J, Oosterwijck J Van, Alsenoy V Van, Truijen S. Pain physiology education improves pain beliefs in patients with chronic fatigue syndrome compared with pacing and self-management education: a double-blind randomized controlled trial. *Arch Phys Med Rehabil*. 2010;91(8):1153–1159. Elsevier.
28. Fisher E, Law E, Dudeney J, Palermo TM, Stewart G, Eccleston C. Psychological therapies for the management of chronic and recurrent pain in children and adolescents. *Cochrane Database Syst Rev*. 2018(9). John Wiley & Sons, Ltd.
29. Wicksell RK, Melin L, Lekander M, Olsson GL. Evaluating the effectiveness of exposure and acceptance strategies to improve functioning and quality of life in longstanding pediatric pain - A randomized controlled trial. *Pain*. 2009;141(3):248–257.
30. Myrvik MP, Campbell AD, Butcher JL. Single-session biofeedback-assisted relaxation training in children with sickle cell disease. *J Pediatr Hematol Oncol*. 2012;34(5):340–343.
31. Stern MJ, Guiles RAF, Gevirtz R. HRV Biofeedback for Pediatric Irritable Bowel Syndrome and Functional Abdominal Pain: A Clinical Replication Series. *Appl Psychophysiol Biofeedback*. 2014;39(3–4):287–291.
32. Kashikar-Zuck S, Swain NF, Jones BA, Graham TB. Efficacy of cognitive-behavioral intervention for juvenile primary fibromyalgia syndrome. *J Rheumatol*. 2005;32(8):1594–1602.
33. Hesse T, Holmes LG, Kennedy-Overfelt V, Kerr LM, Giles LL. Mindfulness-Based Intervention for Adolescents with Recurrent Headaches: A Pilot Feasibility Study. Evidence-based Complement Altern Med. 2015.
34. Tilburg MAL Van, Chitkara DK, Palsson OS, Turner M, Blois-Martin N, Ulshen M, et al. Audio-recorded guided imagery treatment reduces functional abdominal pain in children: A pilot study. *Pediatrics*. 2009;124(5):e890–e897.
35. Kashikar-Zuck S, Flowers SR, Strotman D, Sil S, Ting TV, Schikler KN. Physical activity monitoring in adolescents with juvenile fibromyalgia: Findings from a clinical trial of cognitive-behavioral therapy. *Arthritis Care Res (Hoboken)*. 2013;65(3):398–405.
36. Law EF, Murphy LK, Palermo TM. Evaluating treatment participation in an internet-based behavioral intervention for pediatric chronic pain. *J Pediatr Psychol*. 2012;37(8):893–903.
37. Kashikar-Zuck S, Ting TV, Arnold LM, Bean J, Powers SW, Graham TB, et al. Cognitive behavioral therapy for the treatment of juvenile fibromyalgia: A multisite, single-blind, randomized, controlled clinical trial. *Arthritis Rheum*. 2012;64(1):297–305.
38. Warner CM, Colognori D, Kim RE, Reigada LC, Klein RG, Browner-Elhanan KJ, et al. Cognitive-behavioral treatment of persistent functional somatic complaints and pediatric anxiety: An initial controlled trial. *Depress Anxiety*. 2011;28(7):551–559.
39. Levy RL, Langer SL, Walker LS, Romano JM, Christie DL, Youssef N, et al. Cognitive-behavioral therapy for children with functional abdominal pain and their parents decreases pain and other symptoms. *Am J Gastroenterol*. 2010;105(4):946.
40. Valentim JC, de P, Meziat-Filho NA, Nogueira LC, Reis FJJ. ConheceDOR: the development of a board game for modern pain education for patients with musculoskeletal pain. *Brazilian J Pain*. 2019;2(2):166–175.
41. Hoffmann T, Worrall L. Designing effective written health education materials: considerations for health professionals. *Disabil Rehabil. Taylor & Francis;*. 2004;26(19):1166–1173.
42. Doak CC, Doak LG, Root JH. Teaching Patients with Low Literacy Skills. *Am J Nurs*. 1996:278.
43. Pate J, Hush J, Hancock M, Moseley G, Butler D, Simons L, et al. A Child's Concept of Pain: An International Survey of Pediatric Pain Experts. *Children*. 2018;5(1):12.
44. Okoli C, Pawlowski SD. The Delphi method as a research tool: An example, design considerations and applications. *Inf Manag*. 2004;42(1):15–29.
45. Sousa CS, Turrini RNT, Poveda VB. Translation and adaptation of the instrument "suitability assessment of materials" (sam) into portuguese. *Rev Enferm UFPE Line*. 2015;9(5):7854–7861.
46. Leake HB, Heathcote LC, Simons LE, Stinson J, Kamper SJ, Williams CM, et al. Talking to Teens about Pain: A Modified Delphi Study of Adolescent Pain Science Education. *Can J Pain*. 2019;3 (1):200–208.
47. Friedrichsdorf S, Giordano J, Desai Dakoji K, Warmuth A, Daughtry C, Schulz C. Chronic Pain in Children and Adolescents: Diagnosis and Treatment of Primary Pain Disorders in Head. *Abdomen, Muscles and Joints. Children.*. 2016;3(4):42.
48. Galdino YLS, Moreira TMM, Marques ADB, Silva FAA da. Validation of a booklet on self-care with the diabetic foot. *Rev Bras Enferm. SciELO Brasil;*. 2019;72(3):780–787.
49. Antunes H, Lopes CT. Analyzing the adequacy of readability indicators to a non-English language. International Conference of the Cross-Language Evaluation Forum for European Languages. Springer; 2019.
50. Palermo TM, Valrie CR, Karlson CW. Family and parent influences on pediatric chronic pain: A developmental perspective. *Am Psychol*. 2014;69(2):142.
51. Louw A. Therapeutic neuroscience education via e-mail: a case report. *Physiother Theory Pract. Taylor & Francis;*. 2014;30 (8):588–596.
52. Moseley GL. Widespread brain activity during an abdominal task markedly reduced after pain physiology education: fMRI evaluation of a single patient with chronic low back pain. *Aust J Physiother*. 2005;51(1):49–52.
53. Moseley GL, Butler DS. Fifteen Years of Explaining Pain: The Past, Present, and Future. *J Pain*. 2015;16(9):807–813.

54. Pas R, Meeus M, Malfliet A, Baert I, Oosterwijck S Van, Leysen L, et al. Development and feasibility testing of a Pain Neuroscience Education program for children with chronic pain: treatment protocol. *Brazilian J Phys Ther*. 2018;22(3):248—253. Elsevier.
55. Andias R, Neto M, Silva AG. The effects of pain neuroscience education and exercise on pain, muscle endurance, catastrophizing and anxiety in adolescents with chronic idiopathic neck pain: a school-based pilot, randomized and controlled study. *Physiother Theory Pract*. 2018;34(9):682—691.
56. Louw A, Podalak J, Zimney K, Schmidt S, Puentedura EJ. Can pain beliefs change in middle school students? A study of the effectiveness of pain neuroscience education. *Physiother Theory Pract*. 2018;34(7):542—550.
57. Robins H, Perron V, Heathcote LC, Simons LE. Pain Neuroscience Education: State of the Art and Application in Pediatrics. *Children. Multidisciplinary Digital Publishing Institute;*. 2016;3 (4):43.
58. Zeltzer L, Schlank CB. *Conquering Your Child's Chronic Pain: A Pediatrician's Guide for Reclaiming a Normal Childhood*. New York: HarperCollins; 2005.
59. Krane EJ, Mitchell D. *Relieve Your Child's Chronic Pain: A Doctor's Program for Easing Headaches, Abdominal Pain, Fibromyalgia, Juvenile Rheumatoid Arthritis, and More*. New York: Simon & Schuster; 2005.
60. Palermo TM, Law EF. *Managing Your Child's Chronic Pain*. Oxford: Oxford University Press; 2015.