

## Prototype application for family members and caregivers about adverse effects of cancer treatment in children

*Protótipo de aplicativo para familiares e cuidadores sobre efeitos adversos do tratamento oncológico em crianças*  
*Aplicación prototipo para familiares y cuidadores sobre los efectos adversos del tratamiento del cáncer en niños*

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### Abstract

**Objective:** To develop and assess, through a methodological study, a prototype mobile application for family members and caregivers regarding adverse effects in children undergoing cancer treatment.

**Methods:** A methodological study based on the Double Diamond Process stages, following the Contextualized Instructional Design phases. Content development was supported by an integrative review and benchmarking of technological solutions. Content assessment took place between July and September 2022 with seven expert nurses, using the Likert scale and the Content Validity Index. Usability was assessed between October and November 2022 with seven caregivers in a pediatric unit of a private hospital in Fortaleza, Ceará, using the Smartphone Usability questionnaire.

**Results:** Literature review identified four thematic dimensions: sensory, nutritional, immunological, and comfort. Prototyping resulted in 48 screens and 65 illustrations. The overall Content Validity Index was 0.85. In usability assessment, the prototype obtained a satisfaction score of 66%. **Conclusion:** The “Três, três, passará” prototype demonstrated content validity and good user acceptance, establishing itself as a promising educational technology to support informal caregivers of children undergoing cancer treatment.

### Descriptors:

Educational Technology. Medical Oncology. Caregivers. Child. Nursing.

### Whats is already known on this?

Educational technologies promote understanding of therapies and procedures in pediatric oncology. These resources act as complementary support to the care provided to children with cancer and their families.

### What this study adds?

The prototype presented an overall content validity of 0.85 and 66% satisfaction in the usability assessment, demonstrating potential as an informative tool for family members and caregivers.

### Resumo

**Objetivo:** Desenvolver e avaliar, por meio de estudo metodológico, um protótipo de aplicativo móvel para familiares e cuidadores sobre efeitos adversos em crianças em tratamento oncológico. **Métodos:** Estudo



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metodológico baseado nas etapas do *Double Diamond Process*, seguindo as fases do *Design Instrucional Contextualizado*. A construção do conteúdo foi subsidiada por revisão integrativa e benchmarking de soluções tecnológicas. A avaliação de conteúdo ocorreu entre julho e setembro de 2022, com sete enfermeiras especialistas, utilizando a escala Likert e o Índice de Validade de Conteúdo. A usabilidade foi avaliada entre outubro e novembro de 2022, com sete cuidadores, em unidade pediátrica de hospital privado em Fortaleza, Ceará, por meio do *Smartphone Usability questionnaiRE*. **Resultados:** A revisão da literatura identificou quatro dimensões temáticas: sensorial, nutricional, imunológica e conforto. A prototipagem resultou em 48 telas e 65 ilustrações. O Índice de Validade de Conteúdo global foi de 0,85. Na avaliação de usabilidade, o protótipo obteve escore de satisfação de 66%. **Conclusão:** O protótipo “Três, três, passará” apresentou validade de conteúdo e boa aceitação pelos usuários, configurando-se como tecnologia educacional promissora para apoiar cuidadores informais de crianças em tratamento oncológico.

**Descritores:**

Tecnologia Educacional. Oncologia. Cuidadores. Criança. Enfermagem.

**Resumen**

**Objetivo:** Desarrollar y evaluar, mediante un estudio metodológico, un prototipo de aplicación móvil para familiares y cuidadores sobre los efectos adversos en niños sometidos a tratamiento oncológico. **Métodos:** Estudio metodológico basado en los pasos del Proceso del Doble Diamante, siguiendo las fases del Diseño Instruccional Contextualizado. El desarrollo del contenido se apoyó en una revisión integradora y un análisis comparativo de soluciones tecnológicas. La evaluación del contenido se realizó entre julio y septiembre de 2022 con siete enfermeras especialistas, utilizando la escala Likert y el Índice de Validez de Contenido. La usabilidad se evaluó entre octubre y noviembre de 2022 con siete cuidadores en una unidad pediátrica de un hospital privado en Fortaleza, Ceará, utilizando el *Smartphone Usability questionnaiRE*. **Resultados:** La revisión bibliográfica identificó cuatro dimensiones temáticas: sensorial, nutricional, inmunológica y comodidad. El prototipado dio como resultado 48 pantallas y 65 ilustraciones. El Índice de Validez de Contenido general fue de 0,85. En la evaluación de usabilidad, el prototipo obtuvo una puntuación de satisfacción del 66 %. **Conclusión:** El prototipo “Três, três, passará” demostró validez de contenido y buena aceptación por parte de los usuarios, consolidándose como una tecnología educativa prometedora para apoyar a los cuidadores informales de niños sometidos a tratamiento oncológico.

**Descriptor:**

Tecnología Educacional. Oncología Médica. Cuidadores. Niño. Enfermería.

## INTRODUCTION

Childhood cancer is characterized by the uncontrolled multiplication of abnormal cells in a child's body, usually of embryonic origin, which can arise in any part of the body.<sup>(1)</sup> In Brazil, childhood cancer has a high mortality rate, with estimates of around 8,460 new cases per year, resulting in approximately 2,554 deaths.<sup>(2)</sup>

Despite their severity, advances in diagnosis and treatment have enabled a significant increase in cure rates, even in cases with a poor prognosis.<sup>(3)</sup> It is important to highlight that the treatment of childhood cancer is tailored to a child's metabolism, the biological characteristics of the tumor, and the therapeutic goals, integrating approaches such as chemotherapy, surgery, radiotherapy, and supportive clinical care, with an emphasis on cure, increased survival, and minimization of adverse effects (AEs).<sup>(4)</sup>

AEs can manifest during or after treatment, depending on the type of cancer, the therapeutic modality, and the child's age. Among the most common effects are restrictive lung changes, sensorineural hearing loss, scoliosis, and impaired growth, even years after the end of therapy.<sup>(5,6)</sup> Strategies such as early diagnosis, dosage adjustments, and preventive measures are essential to minimize these impacts.

In this scenario, family caregivers play a central role in identifying AEs and managing their signs and symptoms, using both pharmacological and non-pharmacological approaches. Nurses, in turn, can play a role in training these caregivers to recognize and manage AEs, especially in home settings.<sup>(7)</sup>

The use of digital technologies, such as mobile health (mHealth), has become a promising strategy to support healthcare. Recognized by the World Health Organization since 2011, mHealth involves the use of mobile devices for health promotion, prevention, and education, expanding access to qualified information and promoting self-care.<sup>(8)</sup> In the context of pediatric oncology, these technologies can provide ongoing support to family caregivers, contributing to treatment adherence and improving the quality of life for children.<sup>(9,10)</sup>

However, the literature shows that most digital technologies in oncology have been directed towards adult patients, with less production specifically aimed at supporting family members and caregivers of children, especially for AE recognition and management in home settings.<sup>(11-12)</sup>

Therefore, the development and assessment of digital educational products, such as mobile applications, with reliable content, accessible language, and appropriate usability, becomes relevant.<sup>(13)</sup> Considering the need to develop a user-centered solution that is appropriate to the complexity of home care in pediatric oncology, a methodological study was chosen, guided by the Double Diamond Process, which structures the stages of problem exploration, definition, development, and solution refinement.

This study aimed to develop and assess a prototype mobile application for family members and caregivers regarding AEs in children undergoing cancer treatment, focusing on the identification and management of chemotherapy-related AEs in home settings.

## METHODS

This is a methodological study of technological development based on the Double Diamond Process model; a Design Thinking methodology used for the development of innovative health products. The process consists of four sequential phases, namely Discovery, Define, Development, and Delivery, which enables the systematic construction of user-centered solutions.<sup>(14)</sup> The study used the Guideline for Reporting of Intervention Development Studies as a framework, while the methodological report followed the EQUATOR network Template for Intervention Description and Replication recommendations.

### Phase 1 – Discovery

The discovery phase aimed to identify the content and functional requirements for building the prototype. Two complementary strategies were conducted: an integrative literature review to identify thematic dimensions related to the care of children with cancer, focusing on the AEs of treatment and the role of family caregivers; and technological prospecting through benchmarking in the Play Store and App Store to identify similar applications focused on pediatric oncology. This search allowed for mapping gaps, existing functionalities, and limitations of available technologies.

### Phase 2 – Define

Based on the data obtained, the contents, functionalities and the way users would go through the stages within the application were defined. This phase followed the assumptions of Fixed Instructional Design, anchoring itself in the Analysis, Design, Development, Implementation, and Evaluation model,<sup>(15)</sup> in addition to considering the guidelines proposed by Garrett<sup>(16)</sup> to organize the screens, structure the information and plan the interaction with users.

Initially, a manual sketch (low-fidelity wireframe) was created, representing the screen layout, navigation paths, and planned features. Subsequently, this material was transformed into a more refined visual version (high-fidelity prototype), built on the Canva® platform, with the support of a graphic

designer. This stage involved defining visual elements such as icons, typography, colors, and images, using specific digital design software.

### Phase 3 – Development

The prototype was built between May and June 2022, based on previous definitions. During development, the aim was to represent, in a visual and interactive way, the information related to the AEs of chemotherapy treatment in children with cancer, considering the users' language, literacy level, and home care context.

### Phase 4 – Delivery

The assessment phase involved two distinct groups, acting as experts. For content and appearance assessment, a committee of seven nursing experts was formed, following a methodological recommendation of six to twenty participants, ensuring the representativeness of the group.<sup>(17)</sup> Selection used the snowball technique,<sup>(18)</sup> and started from a key informant (a nurse working in pediatric oncology at a private hospital in Fortaleza, Ceará).

Selection criteria for participants were defined in order to guarantee the participation of experts with recognized theoretical and practical experience in the study's subject matter as presented in the literature:<sup>(19)</sup> minimum of three years of clinical experience with the target population, understood as professional experience in the care of children with cancer; scientific production or participation in scientific events, evidenced by publications in journals, book chapters, or presentation of papers at scientific events in pediatric oncology and/or health educational technologies (ETs); academic training at the graduate level (*lato sensu* or *stricto sensu*) in areas related to pediatric oncology, pediatric nursing, health technologies, or related fields; and participation in or affiliation with national or international scientific societies or professional associations relevant to the area of study were eligible. Professionals who did not fully respond to the data collection instruments or who did not return the completed instrument within the stipulated 15-day period were excluded.

Furthermore, the second group included family caregivers. To assess the prototype satisfaction and usability, family members of children undergoing cancer treatment in a pediatric inpatient unit of a private hospital in Fortaleza, Ceará, participated. The snowball sampling technique was also used, starting with a family member (key informant) who had lived with the hospitalized child undergoing cancer treatment for at least one month. Inclusion criteria considered caregivers with a direct relationship with the child, capable of understanding and interacting with the proposed material. Therefore, literacy and the absence of visual impairment that could compromise the proper use of the ET were required. Participants who did not return the duly signed Informed Consent Form (ICF) and the usability measurement instrument within a maximum of 15 days after being invited to participate were excluded from the study. The sample was intentional and non-probabilistic, meeting the literature requirements regarding representativeness and expertise.<sup>(20)</sup>

Data collection with experts took place in a non-immersive virtual environment, while data with caregivers were collected in person at the hospital by appointment. To ensure assessment quality, usability principles and Nielsen's Heuristics criteria,<sup>(21)</sup> applicable to the assessment of digital health products were considered.

Data collection with experts for content assessment took place between July and September 2022, after participant acceptance. At this stage, a link to access Google Forms® was sent via WhatsApp®. This form contained the ICF, a copy of the prototype, and the instrument organized with a three-point Likert scale (0, 1, and 2), as well as two tabs: one for expert characterization (sociodemographic, academic, and professional data) and another for expressing agreement with the content. The stipulated deadline for feedback was 15 days.

Data collection with family members and caregivers of children undergoing cancer treatment took place between October and November 2022. After acceptance by the participants, the link to access Google Forms® containing the ICF, a copy of the prototype and the usability measurement instrument called Smartphone Usability questionnaire (SURE)<sup>(22)</sup> version (1.0) of the questionnaire was sent via WhatsApp®.

SURE assesses the perceived usability of smartphone applications globally, through 31 items distributed across different aspects of user-application interaction. The items cover topics such as ease of use, clarity and understanding of information, learning and memorization, efficiency in performing tasks, system control and responsiveness, error prevention and recovery, and user satisfaction during interaction.

Elements related to interface layout, readability, visual organization, consistency of commands, and feedback provided by the application are also addressed, allowing for a comprehensive assessment of usability experience in mobile contexts.<sup>(22)</sup>

Statistical analysis was performed based on data collected between November and December 2022, which were extracted and organized in a Microsoft Excel® spreadsheet. The variables analyzed were defined using a synthesis of the content obtained in the integrative review. The variables analyzed were weight, pain, vomiting, diarrhea, nausea, constipation, oral mucositis, febrile neutropenia, alopecia, fatigue, and self-esteem.

For content validity of the prototype, the Content Validity Index (CVI) was used, employed to verify the degree of agreement among experts regarding the adequacy of the assessed items. The CVI was calculated from the proportion of experts who assigned scores considered valid to the item, obtained by the ratio between the number of adequate responses and the total number of assessors. A weighted score was adopted, in which the value zero received no weight, the value one corresponded to 0.75, and the value two to 1.00. The CVI was calculated by averaging the weighted scores assigned by all experts to each item, with those that reached values equal to or greater than 0.70<sup>(23)</sup> being considered valid, the cut-off point adopted to indicate satisfactory content validity. The qualitative suggestions presented by experts were analyzed and incorporated into the final version of the prototype, contributing to improving the content and structure of the developed technology.

Usability and user satisfaction assessment was conducted using SURE. Participants indicated their level of agreement on a four-point scale, ranging from one (Inadequate) to four (Completely adequate), in addition to the option "Not applicable", used when the item did not apply to user experience. For statistical analysis, the total score of the instrument was calculated by summing the valid responses assigned to each item, disregarding the "Not applicable" option. Subsequently, the overall mean of the scores was obtained and adopted for the interpretation of results. Higher values, especially those close to the upper limit of the scale, were considered indicative of good or excellent usability and greater user satisfaction, while lower means signaled the need for adjustments and improvements in the assessed prototype.

The study was conducted after approval by the Research Ethics Committee, and respected the guidelines of Resolution 466/2012 of the Brazilian National Health Council. It was approved on September 29, 2022, under Opinion 5,673,339.

## RESULTS

### Phase 1 – Discovery

The first stage of the study consisted of conducting an integrative literature review, the objective of which was to identify the main AEs of cancer treatment in children and the management strategies used in home settings, with a view to defining the prototype content.

Six articles published between 2013 and 2020 were selected, four from international journals and two from national journals. Based on a full reading, four main dimensions of AEs secondary to chemotherapy treatment were identified, as well as the respective care strategies indicated for home settings (Chart 1).

The second search involved technological prospecting in the Play Store and App Store virtual stores. Several applications focused on pediatric oncology were identified, but with an emphasis on other themes such as emotional support, support networks, and donations. No application found directly addressed AEs and home care for children with cancer, which reinforced the technological gap and justified the development of this prototype.

**Chart 1.** Strategies for managing adverse side effects of cancer treatment in children according to scientific literature. Fortaleza, Ceará, Brazil, 2023.

Article	Title	Authors	Year of publication
A1	<i>Pacientes oncológicos e a enfermagem: relação entre grau de mucosite oral e a terapêutica implementada.</i>	Araújo SN, Luz MHBA, Almeida LHRB, Silva GRF, Moita Neto JM, Costa ACMMA.	2013
A2	<i>A enfermagem ante os desafios enfrentados pela família na alimentação de criança em quimioterapia.</i>	Sueiro IM, Silva LF, Goes FGB, Moraes JRMM.	2015
A3	<i>Cuidador de criança com câncer: religiosidade e espiritualidade como mecanismos de enfrentamento.</i>	Alves DA, Silva LG, Delmondes GAD, Lemos ICS, Kerntopf MR, Albuquerque GA.	2016

A4	Current variations in childhood cancer supportive care in the Netherlands.	Loeffen EA, Mulder RL, van de Wetering MD, Font-Gonzalez A, Abbink CC, Ball LM <i>et al.</i>	2016
A5	<i>Fadiga em crianças e adolescentes com câncer sob a perspectiva dos profissionais de saúde.</i>	Silva MCM, Lopes Júnior LC, Nascimento LC, Lima RAG.	2016
A6	Pain at home during childhood cancer treatment: Severity, prevalence, analgesic use, and interference with daily life.	Simon JDHP, van Loon FRAA, van Amstel J, Elmont GS, Zwaan CM, Fiocco M <i>et al.</i>	2020
Article	Dimension	Adverse effects	Management
A3, A4, and A6	Sensory.	Algia.	Use non-pharmacological therapies for pain relief; Administer medications orally (analgesics and non-steroidal anti-inflammatory drugs).
A2, A4, and A5	Nutritional.	Nausea, vomiting, diarrhea, constipation, food refusal, cachexia, anorexia, dysgeusia.	Administer antiemetics; Provide nutritional support through guidance from professionals; Change eating habits; Increase fluid intake; Optimize hygiene in food preparation; Cook favorite foods; Offer different foods.
A1, A4, and A5	Immunological.	Oral mucositis, febrile neutropenia, infections, sépsis.	Provide guidance on brushing; Supervise antibiotic therapy.
A5	Comfort.	Fatigue.	Engage in interactive activities; Establish adequate rest time; Build relationships.

Source: authors (2023).

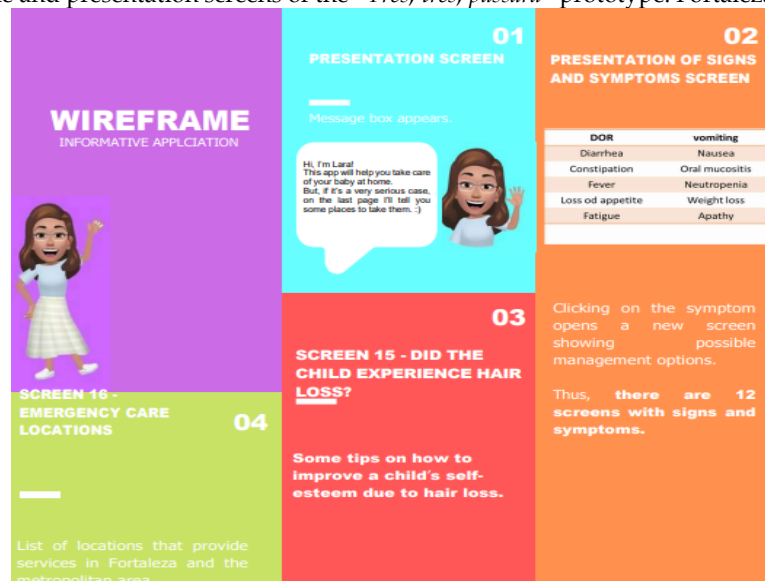
## Phase 2 – Define (*Definição*)

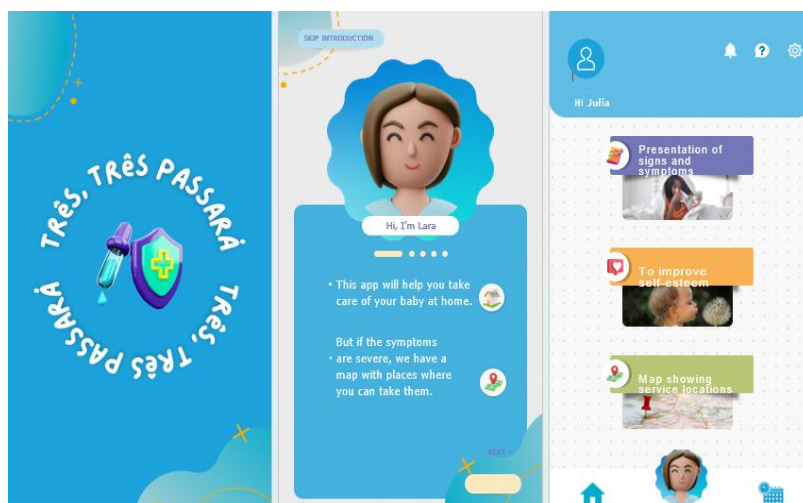
Based on the dimensions mapped in the literature review, a wireframe was developed (Figure 1), which served as the basis for the prototype's structural design. The low-fidelity prototype allowed for the preliminary organization of screens, icons, and navigation flows, ensuring a user-friendly experience.

During the creative process, the product's visual identity was defined, as well as its name: “Três, três, passará”. The choice of title refers to a well-known children's game, in which children form a bridge with their arms and sing “três, três, passará, bom barqueiro, dá licença para eu passar” (three, three, it will pass, good boatman, give permission for me to pass), while their friends cross underneath. The metaphor represents the application's proposal to offer lightness, comfort, and playfulness, even in the face of the seriousness of the context of childhood cancer, bringing digital care closer to the experience of childhood.

The first version of the prototype included 48 screens and 65 illustrations, grouped into the four identified dimensions. The illustrations were developed with the help of a graphic designer and professional tools (Photoshop® and Illustrator®), while the application was assembled on the Fabapp® platform.

Figure 1. Wireframe and presentation screens of the “Três, três, passará” prototype. Fortaleza, Ceará, Brazil, 2023.





Source: authors (2023).

### Phase 3 – Development (Content review with experts)

Content assessment involved seven nurses, aged between 24 and 36 years. Six of them resided in the state of Ceará (four in Fortaleza, one in Eusébio and one in Caucaia), and one resided in the state of São Paulo. Most worked or had worked in the care of children with cancer (57%), while the others worked in higher education and had completed a multidisciplinary residency in oncology (43%). Of the total, six held an expert title and one a master's degree.

A total of 77 assessments of prototype screens were carried out. The results indicated that 83% of screens were assessed as adequate (score +1); 14% were considered partially adequate (score 0), with suggestions for adjustment; and 3% were assessed as inadequate (score -1), specifically the screen on febrile neutropenia.

Based on experts' recommendations, adjustments were made to the partially adequate screens and to the screen with a Concordance Index (CI) lower than 0.70, which was redesigned for the final prototype. Therefore, no screen was kept in the prototype without review if it was considered inadequate. The overall CI was higher than 0.70, demonstrating an overall content assessment.

**Table 1.** Index of agreement by screen and globally for the “Três, três, passará” prototype. Fortaleza, Ceará, Brazil, 2023.

Screens	Exp 01	Exp 02	Exp 03	Exp 04	Exp 05	Exp 06	Exp 07	Total	CI on screen
Presentation	2	2	2	2	2	2	2	14	1
Weight	1	1	1	1	1	1	1	7	0.86
Pain	2	1	1	2	2	1	1	10	
Weight	1	0.75	0.75	1	1	0.75	0.75	6	
Vomiting	2	1	1	2	2	1	2	11	0.89
Weight	1	0.75	0.75	1	1	0.75	1	6.25	
Diarrhea	2	2	1	2	2	1	2	12	0.93
Weight	1	1	0.75	1	1	0.75	1	6.5	
Nausea	2	1	1	2	2	1	2	11	0.89
Weight	1	0.75	0.75	1	1	0.75	1	6.25	
Constipation	1	1	1	2	2	1	1	9	0.82
Weight	0.75	0.75	0.75	1	1	0.75	0.75	5.75	
Oral mucositis	1	1	1	2	2	1	0	8	0.71
Weight	0.75	0.75	0.75	1	1	0.75	0	5	
Febrile neutropenia	2	1	0	2	2	1	0	8	0.64
Weight	1	0.75	0	1	1	0.75	0	4.5	
Alopecia and fatigue	2	1	0	2	2	1	1	9	0.75
Weight	1	0.75	0	1	1	0.75	0.75	5.25	
Self-esteem	2	2	1	2	2	2	2	13	0.96
Weight	1	1	0.75	1	1	1	1	6.75	
Maps	2	1	2	2	2	1	2	12	0.93

Weight	1	0.75	1	1	1	0.75	1	6.5	<b>Overall CI</b>	<b>0.85</b>
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**Legend:** CI – Concordance Index; Exp – expert.

**Source:** authors (2023)

#### Phase 4 – Delivery (Usability assessment with caregivers)

Seven family caregivers of children undergoing cancer treatment participated in the study; 71% were women and 29% were men, aged between 22 and 56 years. All resided in the state of Ceará (Fortaleza (28.6%); Eusébio (14.3%); Juazeiro do Norte (28.6%); Caucaia (14.3%); Sobral (14.3%)). Regarding education, 14.3% had incomplete elementary school; 28.6% had completed high school; 14.3% had incomplete higher education; and 43% had completed higher education, one of whom held a master's degree.

The caregivers were parents, grandparents, siblings, or guardians of children aged 4 to 11 years, with 71% responsible for children diagnosed with leukemia. Usability assessment showed that, of the 30 items assessed, 16 items (53.3%) were rated as satisfactory by the majority of caregivers (items 3, 4, 7, 10, 12, 13, 14, 15, 16, 17, 19, 21, 22, 24, 26, and 30); four items (13.3%) showed signs of dissatisfaction (items 5, 9, 20, and 23); and ten items (33.3%) were marked as “Not applicable” because they related to functionalities not yet implemented in the initial prototype. These results were used to guide adjustments and improvements in the final version of the product.

**Table 2.** Assessment of family satisfaction with the “Três, três, passará” prototype. Fortaleza, Ceará, Brazil, 2023.

Item	Score				
	1	2	3	4	N/A
1. Entering information into the app was simple, especially with features like QR codes and selection lists.					N/A
2. Correcting mistakes I made while using it was easy to do.					N/A
3. The tips and instructions provided by the app were helpful to me.	1	0	0	6	
4. I quickly located the information I needed.	2	0	0	5	
5. I had a feeling of being in control when using the app.	4	0	0	3	
6. The time required to complete the tasks seemed appropriate to me.					N/A
7. Learning how to use the app was an easy task.	3	0	0	4	
8. The sequence of actions in the application follows the pattern I usually use.					N/A
9. I was able to easily perform my tasks using the app.	4	0	0	3	
10. Navigating between menus and screens was intuitive and simple.	1	0	0	6	
11. The app met my expectations and requirements.					N/A
12. I would recommend this app to others.	1	0	0	6	
13. Even under pressure, he/she is able to perform tasks without difficulty.	1	0	0	6	
14. The application's functions follow a consistent usage pattern.	2	0	0	5	
15. It was easy to remember how to use the application's features.	3	0	0	4	
16. I would use this app frequently in my daily life.	3	0	0	4	
17. The structure of the menus and buttons was organized in a logical and accessible way.	2	0	0	5	
18. I was able to successfully complete all tasks using the application.					N/A
19. I had a positive experience using the app.	0	0	0	7	
20. The information provided by the app was clear and sufficient to complete the tasks.	4	0	0	3	
21. I had difficulty using the app, as it seemed confusing to me.	7	0	0	0	
22. The icons and symbols used were easy to interpret.	3	0	0	4	
23. Reading the texts in the app was easy and straightforward.	4	0	0	3	
24. I found the app more complex than necessary, requiring too much effort to complete the tasks.	7	0	0	0	
25. The language used in the menus, labels, and titles was easy to understand.					N/A
26. To use the app, I felt I needed help from another person.	7	0	0	0	
27. I felt comfortable while using the app.					N/A
28. The application's functionality met my expectations.					N/A
29. My experience using the app was frustrating.					N/A
30. The different functionalities of the application were well connected to each other.	2	0	0	5	

**Source:** authors (2023).

## DISCUSSION

A reliable prototype was developed that, once programmed, could expand access to secure and evidence-based information, strengthening the interaction between healthcare services, family, and caregivers. This proposal aligns with the ET and relational approach, as it values bonding and acceptance,

recognizing the family and the child as subjects of rights in a more symmetrical relationship with the team.<sup>(25)</sup> In light of family-centered care and a socio-technical perspective, it is understood that ETs do not replace care, but can reorganize practices, communication, and autonomy in daily life, especially at home.<sup>(26)</sup>

The ET in mHealth format is configured as a low-cost tool with the potential for broad reach and a positive impact on health education. Developed from national and international recommendations, the resource brings together content organized in intuitive screens and instructional resources that promote access to evidence-based information in an objective, free, and 24/7 manner. This strategy seeks to expand accessibility, reduce frequent doubts, and support user autonomy, establishing itself as a promising technology to complement healthcare.<sup>(27)</sup>

Recent reviews in digital oncology health point to an accelerated expansion of digital interventions, but with heterogeneity of objectives and results, reinforcing the need to align content, usability, and context of use to generate sustained impact.<sup>(28)</sup>

Content assessment was conducted to verify whether the items addressed theoretically reflect the proposed content, considering the applicability of the technology in users' sociocultural and linguistic context. Assessing the ET with a level of agreement that meets the recommended standards is an essential stage to ensure that those responsible for and caring for pediatric patients undergoing cancer treatment are well-informed, acquire knowledge, and strengthen adherence to treatment.<sup>(10)</sup>

However, in addition to the agreement among experts, it is important to consider that educational effectiveness depends on how caregivers interpret and apply the content in the daily routine of home care, which is often marked by overload, stress, and decision-making under uncertainty. This reinforces the need for systematic stages with the target audience throughout the technology development and refinement.<sup>(29)</sup>

It is worth highlighting that the ET in this study achieved a higher degree of agreement than the recommended parameter. Furthermore, it is important that the suggested adjustments be made before the product is disseminated, as the concepts related to the disease must be consistent with the literature in order to reach the target audience meaningfully, based on a light and easily understandable interaction, with accurate information resulting from expert assessment.<sup>(30)</sup>

Treating childhood cancer is challenging because disease progression and treatment AEs can compromise therapeutic efficacy. In this context, strategies are needed to support symptom management, adherence, and quality of life, with family support and multidisciplinary care.<sup>(31)</sup> International evidence indicates that applications in pediatric oncology have been used primarily for symptom monitoring/management and communication with the team, varying in terms of target audience (child, parents/caregivers, or both) and clinical scope.<sup>(32)</sup>

In the production, validity, and dissemination of ETs, it is essential to consider real-world usage conditions, such as internet access and devices.<sup>(33)</sup> Prototypes with evidence of validity tend to incorporate functionalities that enhance the quality of care.<sup>(10)</sup> However, even "low-cost" technologies can widen inequalities when they presuppose continuous connectivity, digital literacy, and smartphone availability.<sup>(34)</sup>

The use of an ET can broaden the understanding of therapies and necessary care, acting as support for care in pediatric oncology.<sup>(35)</sup> However, gaps in health literacy persist among family members and caregivers regarding home care.<sup>(9)</sup> In this context, mHealth is promising, although studies indicate that there is still a smaller volume of caregiver-focused research in pediatric oncology compared to the broader field of oncology.<sup>(36)</sup>

Assessment with the target audience tends to increase accessibility and engagement by considering population specificities and promoting learning, bringing users closer to technology.<sup>(37)</sup> International evidence from applications co-designed with parents/caregivers reinforces that this participation improves acceptability and suitability for everyday use.<sup>(38)</sup>

Including users in the assessment is essential for the effectiveness and reliability of the technology as a secure source of information for caregivers.<sup>(5)</sup> Usability can be measured by SURE, verifying whether the product meets the audience's needs, focusing on satisfaction, efficiency, and effectiveness.<sup>(39)</sup> Furthermore, SURE has already been used in Brazilian studies assessing mobile technologies, contributing to measuring smartphone usability in the local context.<sup>(40)</sup>

Thus, the prototype stands out for its innovation in offering parents and caregivers evidence-based information for the home management of chemotherapy-related AEs. Compared to international solutions, many applications focus primarily on symptom monitoring/management and/or parental empowerment,

often with a restricted scope (specific type of cancer, platform, or age group), which can limit their application in other contexts.<sup>(29)</sup> Thus, the contribution of this proposal is strengthened by centering caregivers and organizing accessible and applicable content for the home, addressing the gaps identified in the literature on ETs for caregivers in pediatric oncology.<sup>(41)</sup>

One of the limitations is related to the low participation of family members and caregivers, attributed to the context of the COVID-19 pandemic, when the exchange of caregivers was limited by preventive measures, in addition to the decrease in hospitalizations and discharges. Furthermore, a crucial limitation was the exclusion of family members and caregivers who did not respond to the contact email and those with some type of visual impairment, since the prototype does not yet have accessibility features to assist this population. Therefore, the results regarding the suitability of the prototype for family members and caregivers of children undergoing cancer treatment are not generalizable to these specific populations. Thus, the findings of this study are relevant, but their interpretation should be carried out with caution, considering the limitations presented.

As a consequence, it is recommended to move to subsequent stages with more diverse samples (including different literacy levels and socioeconomic profiles) and incorporate accessibility features (e.g., contrast adjustments, screen reader, and simplified navigation), in addition to assessing real-world usage outcomes (adherence, reduction of doubts, and handling of AEs).

## CONCLUSION

The assessed prototype is suitable for programming for use as an information device for family members and caregivers of children undergoing cancer treatment. The prototyping process, combined with multiple assessments (content assessment with experts and satisfaction assessment with the target audience), facilitated prototype improvement.

The results of this study can help improve the systematic assessment of technologies by end users, suggesting adjustments for specific contexts and improving their usability. Furthermore, the study provides guidance for adopting care strategies aimed at children undergoing cancer treatment, especially regarding the identification of signs and symptoms, self-esteem, and locating resources for emergency situations.

As a perspective for future research, this study, by integrating an ongoing project and presenting an initial prototype, offers a solid foundation for technological implementation. Adjustments guided by real users strengthen its applicability and point to its potential use in healthcare services.

## CONTRIBUTIONS

Contributed to the conception or design of the study/research: Sales LS, Pereira RR, Teixeira E, Bomfim IS. Contributed to data collection: Sales LS, Pereira RR, Bomfim IS. Contributed to the analysis and/or interpretation of data: Sales LS, Pereira RR, Lima FC, Teixeira E, Bomfim IS. Contributed to article writing or critical review: Sales LS, Pereira RR, Lima FC, Teixeira E, Ueno TMRL, Bomfim IS. Final approval of the version to be published: Sales LS, Pereira RR, Lima FC, Teixeira E, Ueno TMRL, Bomfim IS.

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