

# Development and validation of an educational application for caregivers of children with autism spectrum disorder

Desenvolvimento e validação de aplicativo educacional para cuidadores de crianças com transtorno do espectro autista

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 Cláudia Sorelle Cavalcanti de Santana<sup>1</sup>

 Carlos Augusto Moreira de Sousa<sup>1</sup>

<sup>1</sup>Universidade do Estado do Rio de Janeiro.  
Rio de Janeiro, RJ, Brazil.

## Corresponding author:

Cláudia Sorelle Cavalcanti de Santana  
Rua Silvino Burgos, 103, Pedra Redonda.  
CEP:55200-000. Pesqueira, PE, Brazil.  
E-mail: claudiascavalcanti@hotmail.com

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## ABSTRACT

**Objective:** to develop and validate the content of a prototype health educational application intended for caregivers of children with autism spectrum disorder. **Methods:** methodological study developed in two stages: requirements gathering for prototype construction and content validation by specialists. Validation was carried out by 50 health specialists using the Content Validity Index, with a four-point Likert scale and a cutoff point of  $\geq 0.80$ . **Results:** the application showed high content validity indices, with agreement ranging from 94% to 100% in the Objectives domain, from 92% to 100% in Structure and Presentation, and from 96% to 98% in Relevance. Confidence intervals were narrow (0.81–1.00), indicating precision of the estimates. Considering all evaluated items, the instrument's overall content validity index was 0.97. **Conclusion:** the application showed valid, clear, and relevant content, with potential to support caregivers and strengthen home care. **Contributions to practice:** the application can be used as a complementary resource to educational actions developed by nurses and other professionals who follow children with autism and their families. **Descriptors:** Autism Spectrum Disorder; Mobile Applications; Health Education; Nursing.

## RESUMO

**Objetivo:** desenvolver e validar o conteúdo de um protótipo de aplicativo educacional em saúde destinado a cuidadores de crianças com transtorno do espectro autista. **Métodos:** estudo metodológico, desenvolvido em duas etapas: levantamento de requisitos para construção do protótipo e validação de conteúdo por especialistas. A validação foi realizada por 50 especialistas da saúde, utilizando o Índice de Validade de Conteúdo, com escala Likert de quatro pontos e ponto de corte  $\geq 0,80$ . **Resultados:** o aplicativo apresentou elevados índices de validade de conteúdo, com concordância entre 94% e 100% nos domínios Objetivos, entre 92% e 100% em Estrutura e Apresentação e entre 96% e 98% em Relevância. Os intervalos de confiança foram estreitos (0,81–1,00), indicando precisão das estimativas. Considerando todos os itens avaliados, o índice de validação de conteúdo global do instrumento foi de 0,97. **Conclusão:** o aplicativo apresentou conteúdo válido, claro e relevante, com potencial para apoiar cuidadores e fortalecer o cuidado domiciliar. **Contribuições para a prática:** o aplicativo pode ser utilizado como recurso complementar às ações educativas desenvolvidas por enfermeiros e demais profissionais que acompanham crianças com autismo e suas famílias. **Descritores:** Transtorno do Espectro Autista; Aplicativos Móveis; Educação em Saúde; Enfermagem.

## Introduction

Autism Spectrum Disorder (ASD) is characterized by persistent changes in social communication and restricted, repetitive patterns of behavior, with onset in childhood and significant impact on overall development. It is a condition marked by broad clinical heterogeneity, which requires continuous, individualized care strategies adapted to the specific needs of each family<sup>(1)</sup>.

In Brazil, approximately 2.4 million people are estimated to have been diagnosed with ASD, highlighting the relevance of this condition in the national context. Historically, access to rights in education, social assistance, and health has been challenging for this population, reflecting inequalities in access to and organization of services. In this context, a significant portion of care-related demands is absorbed by the family unit<sup>(2)</sup>.

These individuals often face difficulties related to routine organization, behavioral management, communication, and access to reliable health information. Evidence indicates that the absence of systematic and accessible guidance may compromise continuity of home care and intensify family burden<sup>(3-4)</sup>.

Given these difficulties, digital technologies have been progressively incorporated into health practices as strategies to expand access to information, support home care, and promote caregivers' autonomy. Mobile health applications are low-cost interventions with the potential to provide educational guidance, continuous support, and care monitoring in different contexts<sup>(5)</sup>.

In this scenario, despite the growth in the development of technological solutions aimed at this population, many of these tools have limitations related to the absence of content validation, low cultural adequacy, and limited participation of specialists in the development process<sup>(6-8)</sup>.

Additionally, there is a gap in the literature regarding the availability of scientifically validated educational technologies specifically directed to caregivers of children with this condition in the Brazilian context. This limitation compromises the reliability of

the information provided and restricts the potential of these tools as effective strategies to support care<sup>(8)</sup>.

Therefore, content validation is a fundamental stage in the development of educational health technologies, since it ensures clarity, scientific relevance, and adequacy for the target audience. The participation of specialists in this process contributes to the construction of reliable instruments applicable to practice, especially when intended for lay caregivers<sup>(9)</sup>.

In view of this scenario, the present study aimed to develop and validate the content of a prototype health educational application intended for caregivers of children with autism spectrum disorder.

## Methods

### Type, design, and study period

This is a methodological study carried out from October 2024 to December 2025, developed in the context of health education and home care for children with ASD, with a focus on informational support for family caregivers.

The study was conducted in two stages: (1) development of a prototype health educational application; and (2) quantitative content validation by professionals in the field. To conduct the methodological study, recommendations from the scientific literature regarding the development and validation of educational and technological health instruments were followed<sup>(10)</sup>.

### Stage 1 – Development of the application prototype

The development of the prototype was based on an exploratory requirements assessment derived from listening to caregivers of children with ASD, conducted in a focus group format within the context of professional practice, with the purpose of identifying difficulties, needs, and expectations related to daily care, as well as guiding language adequacy, the definition of educational content, and the application's functionalities.

Two focus groups were held, one composed of five mothers and the other of three mothers, totaling eight participants. The participants were directly responsible for the care of children with this condition and were recruited by convenience from a health service. As this was an exploratory stage, no prior sample size was defined, and data collection continued until recurring elements were identified in the participants' statements. The information was recorded and organized by thematic group, considering recurring difficulties, information needs, demands related to activities of daily living, routine organization, and crisis management. This information supported the definition of the prototype's modules, language, and functionalities.

## Stage 2 – Content validation by professionals in the field

Content validation was conducted in a virtual environment by expert evaluators in the fields of neurology and neurodiversity. For the selection of professionals, the following inclusion criteria were established: specialization in the field of neurodiversity; or experience in clinical practice, scientific production, teaching, or professional training directed toward neurodivergent children. The exclusion criterion was not currently working in the field and/or being on leave.

Data collection was performed through the application of a content evaluation instrument structured on a Likert-type scale and submitted to expert evaluators. The analysis was conducted using the Content Validity Index (CVI), validated and grounded in three main domains: Objectives, Structure and Presentation, and Relevance, using a structured instrument and a four-point Likert-type scale, ranging from 1 (strongly disagree) to 4 (strongly agree)<sup>(11)</sup>.

## Data analysis and sample

The Content Validity Index (CVI) was calculated as the proportion of responses 3 and 4 in relation to the total number of responses for each evaluated item. The minimum acceptable agreement among

specialists was analyzed using the one-sided binomial test, adopting a 5% significance level ( $p \leq 0.05$ ) and a 95% confidence interval<sup>(11-12)</sup>. The data were analyzed using R software, version 4.4.2, and descriptive measures, the CVI, the binomial test, and their respective confidence intervals were calculated.

The sample size for the content validation stage was determined by calculation for an infinite population, according to the formula  $n = Z\alpha^2 \cdot P(1-P)/e^2$ , in which  $Z\alpha$  corresponds to the 95% confidence level (1.96),  $P$  to the expected agreement proportion (0.80), and the acceptable margin of error to 11%. The calculation resulted in a sample of 50 expert evaluators<sup>(13)</sup>.

## Ethical aspects

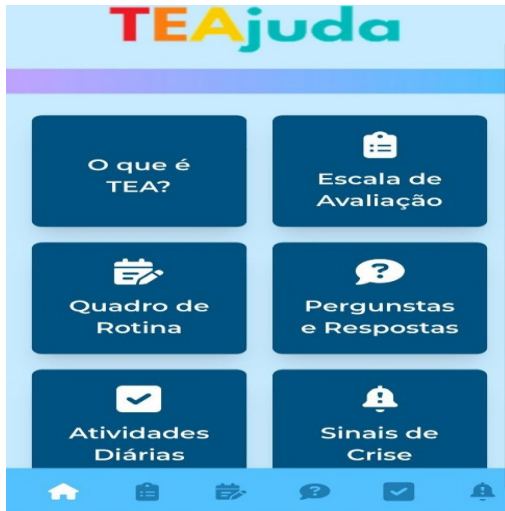
The study complied with the ethical principles of Resolution No. 466/2012 of the National Health Council and was approved by the Research Ethics Committee of the Rio de Janeiro State University under Certificate of Presentation for Ethical Consideration No. 85965225.9.0000.5282, and substantiated opinion No. 7.455.019/2025. All participants signed the Informed Consent Form.

## Results

The application was developed for a *web* environment and made available for access as an academic prototype version. Named TEAjuda, it was structured for free access and organized into educational modules focused on supporting caregivers of children with ASD. The organization of the content prioritized clarity of information, accessible language, and the use of illustrative visual resources, favoring understanding and navigation by users with different levels of health literacy.

The structure of the application includes modules related to the definition of ASD and presents six main buttons: What is ASD?; Autistic Traits Assessment Scale (ATA); Routine Board; Questions and Answers; Daily Activities; Crisis Signs. The first tab (What is ASD?) presents an illustrated conversation, with accessible dialogue to explain early signs of Au-

tism Spectrum Disorder (ASD). This tab also includes a speaker icon that allows the user to listen to the dialogue content (Figure 1).



Note: the illustrations above (screenshots from the mobile app) were only available in Portuguese

**Figure 1** – Home screen of the TEAjuda application. Pesqueira, PE, Brazil, 2026

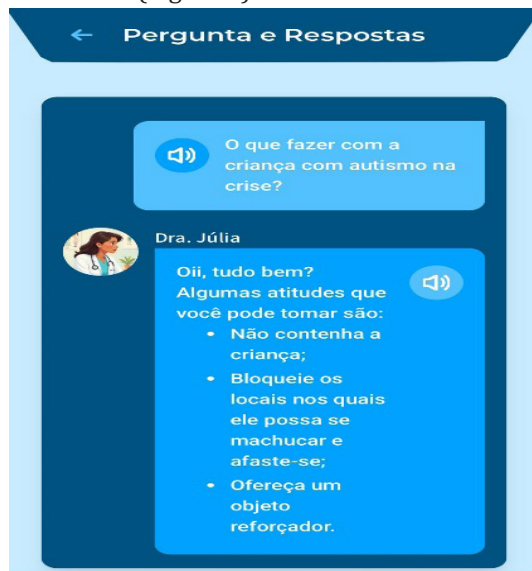
The responses entered by the caregiver in the ATA tab do not generate diagnostic scores or risk classifications; they are used only for the display of educational guidance, reinforcement of information, and referral to seek professional evaluation, when necessary.

The Routine Board tab helps the caregiver and the child organize the daily routine. It is divided by shifts and uses images according to each child’s individual and personalized schedule. After constructing the board, it is possible to download the completed instrument for sharing or printing. The Daily Activities tab provides guidance on the importance of teaching and encouraging everyday activities, such as eating, drinking, bathing, dressing, and sleeping. For each described item, practical guidance reinforced by images is presented, facilitating understanding and the learning of the guidance.

In the Crisis Signs tab, a visual and textual list is presented with behaviors frequently observed during crisis episodes, such as: aggressing people, repeating words, intense crying, trying to run away or hide, increased repetitive movements, hitting one’s own head,

biting oneself, or scratching oneself. All behaviors are accompanied by illustrative images, making identification clearer for caregivers.

On the Questions and Answers screen, there is a section with practical questions such as: What should I do when a child with autism is in crisis? What should not be said/done to a child with autism? How can a child with autism be stimulated? How can an activity for a child with autism be finished? What services should be sought for people with ASD? Each question has answers with clear instructions, support images, and a speaker icon that allows the content to be heard in audio, making the experience more accessible and interactive (Figure 2).



Note: the illustrations above (screenshots from the mobile app) were only available in Portuguese

**Figure 2** – Interface of the TEAjuda application with educational guidance for managing crises in children with Autism Spectrum Disorder, with an audio resource icon. Pesqueira, PE, Brazil, 2026

Regarding the profile of the specialists who validated the content, an age range from 25 to 56 years was observed, with a marked concentration in the state of Pernambuco (94%). Regarding professional background, psychologists predominated (36%), followed by neuropsychopedagogists and speech therapists. Regarding educational level, most participants (80%) had postgraduate education (Table 1).

**Table 1** – Characterization of the expert panel that evaluated the content of the TEAjuda application. Pesqueira, PE, Brazil, 2026

| Variables                  | n (%)    |
|----------------------------|----------|
| Age (years)                |          |
| <40                        | 32(64.0) |
| 40-50                      | 15(30.0) |
| 50-56                      | 3(6.0)   |
| Sex                        |          |
| Male                       | 6(12.0)  |
| Female                     | 44(88.0) |
| State                      |          |
| Pernambuco                 | 47(94.0) |
| Alagoas                    | 1(2.0)   |
| Rio Grande do Sul          | 1(2.0)   |
| São Paulo                  | 1(2.0)   |
| Profession                 |          |
| Psychology                 | 18(36.0) |
| Neuropsychopedagogy        | 8(16.0)  |
| Fonoaudiologia             | 5(10.0)  |
| Enfermagem                 | 4(8.0)   |
| Outros                     | 15(30.0) |
| Education level            |          |
| Postgraduates              | 40(80.0) |
| Completed higher education | 10(20.0) |

Regarding the CVI domains, it was observed that in Objectives, agreement indices ranged from 94% to 100%; in Structure and Presentation, from 92% to 100%; and in Relevance, from 96% to 98%. In addition, the confidence intervals (CI) for the evaluated items showed a narrow range between the minimum and maximum limits (95% CI: 0.81–1.00), indicating high precision in the estimates of consensus among the judges. The binomial test results were statistically significant ( $p < 0.05$ ) for most items, reinforcing the consistency and reliability of the evaluation carried out (Table 2).

The overall Content Validity Index (CVI) by domain showed high values. In the Objectives domain, the CVI was 0.96; in the Structure and Presentation and Relevance domains, the index was 0.97 in both, indicating high agreement among specialists regarding the adequacy of the application content. Considering all the evaluated items together, the instrument's overall CVI was 0.97, demonstrating excellent content validity and strong consensus among the judges participating in the evaluation.

**Table 2** – Distribution of content validation among the expert evaluators of the TEAjuda application. Pesqueira, PE, Brazil, 2026

| Items  | CVI  | p-value* | 95% CI    |
|--|------|----------|-----------|
| <b>Objectives</b>  |      |          |           |
| Is the text compatible with the target audience, meeting the different knowledge levels of the lay population?                   | 1.00 | <0.001   | 0.93–1.00 |
| Is the information/content adequate to provide guidance on awareness, prevention, and management of crises in children with ASD? | 0.94 | 0.002    | 0.86–0.99 |
| Could it provide appropriate guidance for a child with mild signs of ASD-related crises?   | 0.98 | <0.001   | 0.89–0.99 |
| Could it provide appropriate guidance for a child at high risk of ASD-related crises?  | 0.94 | 0.002    | 0.86–0.99 |
| Is the information used sufficient and adequate for the early identification of crises in children with ASD?                     | 0.94 | 0.002    | 0.86–0.99 |
| Is the content clear about what ASD is?  | 0.94 | 0.002    | 0.83–0.99 |
| <b>Structure and Presentation</b>  |      |          |           |
| Is the information presented scientifically correct?   | 0.98 | <0.001   | 0.90–0.99 |
| Is the information presented up to date and safe?  | 0.96 | <0.001   | 0.86–0.99 |
| Is there a logical sequence in the proposed content?   | 1.00 | <0.001   | 0.93–1.00 |
| Is the information used sufficient and adequate to help caregivers with the activities of daily living of children with ASD?     | 0.92 | 0.016    | 0.81–0.98 |
| Is the information used sufficient and adequate for the early identification of crises in children with ASD?                     | 0.94 | 0.002    | 0.83–0.99 |
| Is the information used sufficient and adequate to raise awareness about the management of crises in children with ASD?          | 0.94 | 0.002    | 0.83–0.99 |
| Are the content and messages attractive?   | 0.98 | <0.001   | 0.89–0.99 |
| Is the language clear and objective?   | 1.00 | <0.001   | 0.93–1.00 |
| Are the illustrations relevant?  | 1.00 | <0.001   | 0.93–1.00 |
| Are the illustrations clear and easy to understand?  | 1.00 | <0.001   | 0.93–1.00 |
| Is the number of illustrations adequate?   | 1.00 | <0.001   | 0.93–1.00 |
| Are the text colors appropriate and easy to read?  | 1.00 | <0.001   | 0.93–1.00 |
| Is the font used easy to read?   | 1.00 | <0.001   | 0.92–1.00 |
| <b>Relevance</b>   |      |          |           |
| Does the application encourage the user to acquire knowledge about ASD?  | 0.98 | <0.001   | 0.89–0.99 |
| Does the application address the topics needed to guide users toward other sources of research on ASD?                           | 0.96 | <0.001   | 0.86–0.99 |
| Is the application suitable for use by any mother of children with ASD?  | 0.96 | <0.001   | 0.86–0.99 |
| Could the application improve the monitoring and care of the child with ASD in the family environment?                           | 0.98 | <0.001   | 0.89–0.99 |
| Would the application contribute to mothers' knowledge about ASD in general?   | 0.98 | <0.001   | 0.89–0.99 |

\*Binomial test; CVI: Content Validity Index; CI: Confidence interval; ASD: Autism Spectrum Disorder

## Discussion

The development of the prototype health educational application for caregivers of children with ASD was grounded in the systematic identification of the target audience's informational needs and in the organization of content aimed at daily care. It can be accessed through the following link: <https://teajuda-k3iw.onrender.com>. Evidence indicates that digital health technologies are relevant strategies to expand access to information, promote health education, and strengthen caregivers' autonomy, especially in contexts of home care and longitudinal follow-up<sup>(14-15)</sup>.

The application proposal is aligned with recommendations that recognize the potential of mobile technologies as tools to support health education, continuity of care, and articulation among users, families, and health services<sup>(16)</sup>. The use of educational applications has been associated with improved understanding of health guidance, reduced insecurity in care management, and strengthening of the caregiver's role in the therapeutic process, especially when directed to chronic neurodevelopmental conditions such as ASD<sup>(17)</sup>.

In the international scenario, studies point to benefits related to usability, acceptance, and learning support in technologies directed to autism spectrum disorder; however, many of these tools are predominantly directed toward child development, with less emphasis on educational support for the caregiver. In addition, a large portion of these technologies does not clearly describe content validation processes, which represents an important limitation regarding the reliability of the information provided<sup>(18-19)</sup>.

Unlike this scenario, the prototype developed in this study was structured with a specific focus on the caregiver, prioritizing health education, routine organization, and management of daily care. This approach broadens the scope of existing technologies by recognizing the caregiver's central role in the therapeutic process and by offering continuous support beyond the clinical environment<sup>(19)</sup>.

The content validation results showed high le-

vels of agreement among specialists, with CVI values above the recommended cutoff point, indicating adequacy, clarity, and relevance of the evaluated items. These findings reinforce the theoretical and methodological consistency of the developed content and the pertinence of the proposed educational modules, in line with methodological studies addressing validation of educational health technologies<sup>(20-21)</sup>.

Validation by specialists is considered an essential stage in the development of educational technologies because it allows assessment of content representativeness, language adequacy, and alignment with proposed objectives. Studies that adopt rigorous validation processes indicate greater reliability of the technologies developed and greater potential applicability in care practice, contributing to the standardization of health guidance and strengthening evidence-based practice<sup>(22-23)</sup>.

In the present study, the high agreement observed in the domains related to objectives, structure and presentation, and relevance of the content suggests that the application was built in an organized manner, with accessible language and aligned with the informational demands of caregivers of children with ASD<sup>(21-22)</sup>. Similar results have been observed in validation studies of educational technologies directed to Autism Spectrum Disorder, such as games, booklets, and playful materials, in which evaluation by specialists resulted in high content validity indices, reinforcing the importance of rigorous methodological processes in the development of these technologies<sup>(24-25)</sup>.

The use of the binomial test as a complement to the CVI reinforces the statistical robustness of the validation process, allowing the inference that the observed agreement levels did not occur by chance. The association between content validity measures and inferential analyses has been recommended in methodological literature because it increases confidence in decisions related to maintaining or reformulating evaluated items and strengthens interpretation of the obtained results<sup>(26)</sup>.

Structuring the application into thematic mo-

dules favors intuitive navigation and enables caregivers to access content according to their immediate needs, respecting different levels of knowledge and demands throughout care. This organization is aligned with principles of usability and user-centered design, widely discussed in the development of mobile health applications, which contribute to greater acceptability, engagement, and continuous use of digital technologies<sup>(16,27)</sup>.

The incorporation of digital educational technologies into health education practices expands the reach of educational actions traditionally carried out in face-to-face care, allowing guidance provided during consultations and follow-up to be continuously reinforced. In this sense, the developed application is configured as a complementary resource to professional practice, by enabling standardization of health guidance, reinforcement of educational content, and directing caregivers to specific information according to the demands identified throughout care<sup>(23)</sup>.

In the context of caring for children with ASD, the strategic role of Nursing stands out in mediating knowledge, health education, and longitudinal follow-up of families, especially in Primary Health Care and specialized outpatient services. Nurses are often the professionals most accessible to caregivers, acting in the translation of technical information, qualified listening, and organization of care, in addition to playing a central role in articulating the care network<sup>(24)</sup>.

In this articulation, nurses also assume the role of disseminators and awareness builders regarding the rights of children with ASD. Beyond clinical support, they guide the family and function as a link that facilitates caregivers' movement through the different points of the health care and social assistance network. This role is fundamental to reducing social vulnerability and promoting citizenship and the effective inclusion of these individuals<sup>(28)</sup>.

The availability of systematized information based on scientific evidence and adapted to caregivers' needs may contribute to reducing informational gaps frequently reported by family members of chil-

dren with ASD. It is noteworthy that the search for information in informal and non-validated sources is common among caregivers, which reinforces the importance of reliable educational technologies as support for health education actions developed by Nursing professionals<sup>(11)</sup>.

Gaps are identified in the development and validation of educational technologies directed to family care, reinforcing the need for methodologically robust proposals in the field of digital health. In this panorama, recent critical analyses of the evolution of digital health indicate that the expansion of the use of mobile health technologies has occurred heterogeneously, often driven by the popularization of applications, without necessarily being accompanied by rigorous scientific validation or effective integration into health systems<sup>(17)</sup>.

The dissociation between technological development and the production of scientific evidence constitutes one of the main contemporary challenges of digital health, since many applications are made available without rigorous validation, which may compromise their clinical effectiveness and user safety. In this context, the present study advances by incorporating systematic validation stages that are still scarcely described in the literature<sup>(29)</sup>.

Family-centered educational interventions have demonstrated a positive impact on the psychological well-being of caregivers of children with ASD, including stress reduction, strengthening of daily care management, and greater confidence in the decision-making process, which reinforces the potential of the application developed as a tool for educational and psychosocial support<sup>(27,30)</sup>. The application developed in this study was designed with a focus on caregivers' informational needs, incorporating demands identified in the exploratory stage as a way to bring the proposed content closer to the reality of daily care.

In general, the developed prototype is consistent with theoretical and methodological assumptions described in the literature on educational health technologies, by organizing content in a systematic, clear manner aligned with the demands of caring for chil-

dren with autism spectrum disorder. This organization of content is identified as a central element for the effectiveness of educational health technologies, especially when mediated by digital resources and mobile applications<sup>(15,25)</sup>.

Educational technologies directed to health care can act as mediators of knowledge, favoring caregiver support and the integration of guidance into daily care, especially in contexts of home care and longitudinal follow-up<sup>(12,15)</sup>. This theoretical-methodological construction was guided by the authors' experience in the context of caring for families of children with Autism Spectrum Disorder, seeking to respond to demands observed in care practice and strengthen the role of educational technologies as support for professional practice and family care.

## Study limitations

A limitation of the study is that validation was restricted to content, specifically the quantitative validation of the instrument's content, without including assessment of usability and effectiveness in real contexts of use. Future studies are recommended to evaluate user experience, adherence to the application, and the impacts of TEAjuda use on home care.

## Contributions to practice

TEAjuda can be used as a complementary resource to educational actions developed by nurses and other professionals who follow children with ASD and their families. By systematizing guidance on routine, activities of daily living, and recognition of crisis situations, the application can support communication between professionals and caregivers, favor continuity of guidance at home, and contribute to greater caregiver confidence in daily management.

## Conclusion

The product developed in this study is configured as an educational health technology, created from the need to offer informational and educational sup-

port to caregivers of children with Autism Spectrum Disorder, as well as from the scarcity of technologies directed to this audience. Its importance is reinforced by the results of content validation carried out by specialists, which showed a high level of agreement regarding the adequacy, relevance, and quality of the developed material.

## Author contributions

Conception and design or data analysis and interpretation; manuscript writing or critical review of relevant intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the manuscript related to accuracy or integrity: **Santana CSC, Sousa CAM.**

## Data availability

All data supporting the results of this study are available in the body of the article.

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