ASSISTIVE TECHNOLOGY APPS FOR COMMUNICATION IN AUTISM SPECTRUM DISORDER: A SYSTEMATIC REVIEW

Recebido em: 11/03/2026
Aceito em: 02/09/2026
DOI: 10.25110/educere.v26i2.2026-12681

Maria Antonia Souza da Silva [1]
Marta Regina Silva Pereira [2]
Silvia Regina Sampaio Freitas [3]
Vanessa Coelho da Silva [4]
Ricardo da Silva Barboza [5]
Ernande Ferreira de Melo [6]
Raimundo Corrêa de Oliveira [7]

ABSTRACT: This study presents a systematic review of assistive technologies (AT) for communication in individuals with Autism Spectrum Disorder (ASD). The objective was to analyze the impacts of apps and digital tools on functional communication, emotion recognition, and social interaction. Following the PRISMA 2020 protocol, 56 studies published between 2015 and 2025 were selected from national and international databases. Results indicate that mobile-mediated Augmentative and Alternative Communication (AAC) promotes autonomy and reduces challenging behaviors. Tools for emotional recognition and social pragmatics support showed efficacy in clinical and family settings. It is concluded that while ATs offer significant support, there is a need for greater methodological rigor and longitudinal studies to validate the generalization of skills acquired in natural environments, reinforcing the importance of human mediation in the educational process.

KEYWORDS: Augmentative and alternative communication; Digital accessibility; Inclusive education; Neurodevelopmental disorders; Evidence-based practices.

[1] Graduação; Universidade do Estado do Amazonas, Manaus/AM, Brasil.
E-mail: masds.ped22@uea.edu.br; ORCID: https://orcid.org/0009-0001-4232-0104
[2] Doutora. Universidade do Estado do Amazonas.
E-mail: mrpereira@uea.edu.br, ORCID: https://orcid.org/0000-0001-7236-2383
[3] Doutora; Universidade do Estado do Amazonas, Manaus/AM.
E-mail: srfreitas@uea.edu.br, ORCID: https://orcid.org/0000-0003-2987-7837
[4] Mestre; Universidade do Estado do Amazonas, Manaus/AM.
E-mail: vcsilva@uea.edu.br, ORCID: https://orcid.org/0009-0007-0006-3705
[5] Doutor. Universidade do Estado do Amazonas, Manaus/AM.
E-mail: rsbarboza@uea.edu.br, ORCID: https://orcid.org/0000-0002-7500-5258
[6] Doutor. Universidade do Estado do Amazonas, Manaus/AM.
E-mail: ernande@uea.edu.br, ORCID: https://orcid.org/0009-0004-7748-2973
[7] Doutor. Universidade do Estado do Amazonas, Manaus/AM.
E-mail: rcoliveira@uea.edu.br, ORCID: https://orcid.org/0000-0002-5428-8762

APLICATIVOS DE TECNOLOGIA ASSISTIVA PARA COMUNICAÇÃO NO TRANSTORNO DO ESPECTRO AUTISTA: UMA REVISÃO SISTEMÁTICA

RESUMO: Este estudo apresenta uma revisão sistemática sobre tecnologias assistivas (TA) voltadas à comunicação de pessoas com Transtorno do Espectro Autista (TEA). O objetivo foi analisar os impactos de aplicativos e ferramentas digitais na comunicação funcional, no reconhecimento de emoções e na interação social. Seguindo o protocolo PRISMA 2020, foram selecionados 56 estudos, publicados entre 2015 e 2025, em bases de dados nacionais e internacionais. Os resultados indicam que a Comunicação Aumentativa e Alternativa (CAA) mediada por dispositivos móveis promove a autonomia e reduz comportamentos desafiadores. As ferramentas voltadas ao reconhecimento de emoções e ao apoio à pragmática social demonstraram eficácia em contextos clínicos e familiares. Conclui-se que, embora as tecnologias assistivas ofereçam suporte significativo, é necessário maior rigor metodológico e a realização de estudos longitudinais para validar a generalização das habilidades adquiridas em ambientes naturais, reforçando a importância da mediação humana no processo educacional.
PALAVRAS-CHAVE: Acessibilidade digital; Comunicação aumentativa e alternativa; Educação inclusiva; Práticas baseadas em evidências; Transtornos do neurodesenvolvimento.

APLICACIONES DE TECNOLOGÍAS ASISTIVAS PARA LA COMUNICACIÓN EN EL TRASTORNO DEL ESPECTRO AUTISTA: UNA REVISIÓN SISTEMÁTICA

RESUMEN: Este estudio presenta una revisión sistemática sobre el uso de tecnologías asistivas (TA) para la comunicación de individuos con Transtorno del Espectro Autista (TEA). El objetivo fue analizar los impactos de aplicaciones y herramientas digitales en la comunicación funcional, el reconocimiento de emociones y la interacción social. Siguiendo el protocolo PRISMA 2020, se seleccionaron 56 estudios publicados entre 2015 y 2025 en bases de datos nacionales e internacionales. Los resultados indican que la Comunicación Aumentativa y Alternativa (CAA) mediada por dispositivos móviles favorece la autonomía y la reducción de conductas desafiantes. Las herramientas de reconocimiento emocional y apoyo a la pragmática social demostraron eficacia en contextos clínicos y familiares. Se concluye que, aunque las TA ofrecen un apoyo significativo, existe la necesidad de un mayor rigor metodológico y estudios longitudinais para validar la generalización de las habilidades adquiridas en entornos naturales, reforzando la importancia de la mediación humana.
PALABRAS CLAVE: Comunicación aumentativa y alternativa; Accesibilidad digital; Educación inclusiva; Trastornos del neurodesarrollo; Prácticas basadas en la evidencia.

1. INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by persistent differences in social communication and interpersonal interaction, together with restricted and repetitive patterns of behavior, interests, or

activities (Liu *et al*., 2023; Araújo *et al*., 2024). The concept of a spectrum highlights the marked heterogeneity of clinical presentation, developmental trajectories, and support needs, reinforcing the importance of individualized interventions that take cognitive, communicative, and socioemotional profiles into account. Communication-related challenges may affect verbal and nonverbal expression, social reciprocity, pragmatic competence, and the recognition and expression of emotions, with direct consequences for autonomy, participation, and quality of life across family, school, and community settings (Liu *et al*., 2023; Araújo *et al*., 2024).

In educational contexts, communication is not merely a clinical dimension but a foundational condition for meaningful participation in learning processes. Students' opportunities to engage in classroom routines, peer interaction, collaborative activities, and shared meaning-making are strongly shaped by their communicative experiences. Communication also underpins relationship-building and emotional co-regulation, both of which are central to inclusive education and everyday school life (Barbosa; Montenegro; Queiroga, 2024). When communication differences are insufficiently supported or misinterpreted, barriers to participation may intensify, reducing opportunities for interaction, belonging, and academic engagement. In response to these challenges, intervention strategies have expanded over recent decades, and digital assistive technologies have increasingly been adopted as complementary supports to strengthen functional communication, autonomy, and participation in everyday environments (Montenegro *et al*., 2023).

The widespread diffusion of smartphones and tablets has accelerated the development and dissemination of applications designed to address communication-related outcomes in ASD (Walia *et al*., 2021). Many of these tools combine visual and auditory supports, interactive feedback, gamification, and, more recently, artificial intelligence-based features. Within this growing ecosystem, Augmentative and Alternative Communication (AAC) applications and tools aimed at emotion recognition and expression have gained prominence in both clinical and educational practice, with the purpose of supporting communicative functioning and socioemotional development (Branco *et al*., 2021; Silva; Goukart, 2022). However, from an educational perspective, the central issue is not only whether users demonstrate improvement during structured tasks or in-app activities, but whether these gains transfer to everyday interactions with communication partners, especially family members and peers, in naturalistic contexts.

Although research on assistive technology applications for ASD has expanded, the available evidence remains heterogeneous and fragmented (Toma *et al*., 2024). Studies differ substantially in design, sample composition, intervention characteristics, assessment instruments, and reported outcomes, limiting cross-study comparability and the consolidation of robust conclusions regarding impacts on functional communication, emotion-related outcomes, interpersonal interaction, and autonomy. Important gaps also persist regarding the generalization of gains to real-world settings, including school routines and peer relationships, the maintenance of effects over time, and the suitability of specific tools across age groups and different levels of support needs within the spectrum (Liu *et al*., 2023; Walia *et al*., 2021). In addition, the literature still lacks a sufficiently integrated synthesis capable of linking technological innovation to real educational and family-mediated demands.

Given this scenario, a systematic and critical examination of recent scientific production is needed to clarify how assistive technology applications have been used to support communication and socioemotional development in individuals with ASD and which outcomes have been documented in practice. Such a synthesis is relevant not only for identifying advances and methodological limitations, but also for informing the design of more robust and context-sensitive technological solutions aligned with educational inclusion and everyday family needs (Penev *et al*., 2021; Panda *et al*., 2025).

Accordingly, this study aimed to analyze the impacts of assistive technology applications on functional communication, emotion-related outcomes, and social interaction in individuals with ASD, with particular attention to outcomes involving everyday communication partners such as family members and peers. The review aimed to synthesize recent evidence on mobile applications and other assistive technology tools designed to support functional communication and social interaction in individuals with Autism Spectrum Disorder (ASD), with particular attention to interactions involving everyday communication partners, especially family members and peers.

2. METHODOLOGY

This study was conducted as a systematic review and reported in accordance with the PRISMA 2020 statement. The review aimed to synthesize recent evidence on assistive technology applications designed to support communication-related outcomes in individuals with Autism Spectrum Disorder (ASD), with particular attention to

interactions involving everyday communication partners, especially family members and peers.

2.1 Research question and eligibility framework

The review was guided by the following research question: What are the impacts of assistive technology applications on functional communication, emotion-related outcomes, and social interaction in individuals with ASD, particularly in relation to communication with family members and peers.

To structure the review question and define the scope of the search, the PICO/PICo framework was applied, considering: (i) individuals with ASD; (ii) assistive technology applications; (iii) communication-related outcomes; and (iv) contexts involving communication partners, particularly family members and peers. The primary outcomes of interest were functional communication and social interaction, whereas secondary outcomes included emotion recognition and expression, as well as usability and user engagement.

2.2 Information sources and search strategy

The literature search was conducted between January 19 and January 21, 2026, in the following databases: SciELO, LILACS (via BVS), PubMed/MEDLINE, IEEE Xplore, Scopus, and Google Scholar. Studies published between January 2015 and December 2025 were eligible for screening. Search strategies combined controlled descriptors and free-text terms in English and Portuguese related to ASD, assistive technology, mobile applications, communication, social interaction, and emotion recognition. The complete search strings for each database, including search fields and exact dates of execution, should be reported in an appendix or supplementary file to ensure reproducibility.

For Google Scholar, the first 200 results ranked by relevance were screened, given the platform's limitations regarding systematic retrieval and export procedures.

2.3 Eligibility criteria

Studies were included if they met all of the following criteria:

- They were peer-reviewed journal articles or full conference papers;
- They involved individuals with ASD;

- They evaluated or described an assistive technology application, such as a mobile application or other digital tool, aimed at supporting communication, emotion-related skills, or social interaction;
- They reported empirical outcomes or implementation findings.

Studies were excluded if they were review articles, editorials, dissertations, study protocols without results, or if they did not focus on communication-related outcomes. For the purposes of this review, assistive technology applications were operationalized as digital tools explicitly developed to support functional communication and/or social communication outcomes in ASD. Tools exclusively focused on screening, diagnosis, or non-communicative cognitive training were considered outside the scope of the review.

2.4 Study selection and screening

All records retrieved from the databases were exported to a reference management system for duplicate removal and subsequently imported into Rayyan for screening. Duplicate records were removed prior to title and abstract screening. Two reviewers independently screened titles and abstracts, followed by full-text eligibility assessment of potentially relevant studies. Disagreements were resolved through discussion, and when consensus could not be reached, a third reviewer adjudicated the decision. Reasons for exclusion at the full-text stage were recorded to ensure transparency in the selection process.

The search identified a total of 4,749 records. After duplicate removal, the remaining records were screened by title and abstract. Full texts were retrieved for potentially eligible studies and assessed according to the predefined inclusion criteria. In total, 84 full-text reports were evaluated for eligibility. Of these, 56 studies met the inclusion criteria and were included in the qualitative synthesis, whereas 28 reports were excluded with documented reasons. The study selection process is summarized in the PRISMA 2020 flow diagram.

2.5 Data extraction and quality appraisal

Data extraction was performed independently by two reviewers using a standardized form designed to capture: (i) application or technology characteristics; (ii) intervention objectives and procedures; (iii) participant characteristics, including age and ASD profile when reported; (iv) study setting, such as home, school, or clinical

environment, and the communication partners involved; (v) study design and comparator, when applicable; (vi) outcomes and measurement instruments; and (vii) main findings. Any discrepancies were resolved by consensus, with third-reviewer adjudication when necessary.

To strengthen methodological transparency, the included studies should also be assessed for methodological quality and, where appropriate, risk of bias using validated tools aligned with the design of each study. For example, randomized studies may be appraised using the Cochrane risk-of-bias framework, while non-randomized or single-case studies may require design-specific instruments. Reporting the results of quality appraisal would allow readers to better interpret the strength and reliability of the evidence.

2.6 Data synthesis

Due to substantial heterogeneity across study designs, intervention formats, and outcome measures, a meta-analysis was not considered appropriate. Therefore, the findings were synthesized narratively. For analytical purposes, the included studies were grouped into three thematic domains: (1) Augmentative and Alternative Communication and functional communication; (2) emotion recognition and expression; and (3) social skills, pragmatics, and social interaction. This narrative approach allowed for a more consistent interpretation of the evidence while accounting for methodological diversity across the included studies.

3. RESULTS

The analysis of the 56 studies included in this review indicates a steady increase in research on assistive technologies for Autism Spectrum Disorder (ASD) between 2015 and 2025, accompanied by a diversification of intervention approaches, implementation contexts, and reported outcomes. The studies were retrieved from Google Scholar (n = 20), LILACS (n = 12), Scopus (n = 9), PubMed/MEDLINE (n = 7), SciELO (n = 5), and IEEE Xplore (n = 3). At the full-text eligibility stage, 28 reports were excluded with documented reasons, most commonly restricted access to the full text, focus on non-digital or analog technologies, or absence of outcomes related to emotion recognition, communication, and/or social interaction.

For analytical purposes, the findings were organized into three intervention domains: (1) Augmentative and Alternative Communication (AAC) and functional communication; (2) emotion recognition and expression; and (3) social skills, pragmatics, and interpersonal interaction. Among these, studies on social skills/pragmatics constituted the largest cluster (n = 36), followed by AAC and functional communication (n = 13) and emotion recognition/expression (n = 7). This distribution suggests that the field has progressively expanded beyond basic communicative support toward broader socioemotional and interactional goals.

3.1 Domain 1: AAC and functional communication (n = 13)

AAC emerged as a central domain in the corpus, particularly in studies focusing on applications designed to expand functional communication for nonverbal or minimally verbal children through pictograms, structured vocabularies, and text-to-speech synthesis. Brazilian applications such as Bela Tagarela, Matraquinha, PictoTEA, Falaê, Leeloo AAC, and SymboTalk were examined by Macedo and Ramalho (2021) and Sousa and Carvalho (2021), who emphasized the relevance of usability and economic accessibility for family adoption and sustained use. Gallo and Ribeiro (2025) further noted that offline solutions, such as Card Talk and CoughDrop AAC, may broaden access in settings with limited internet connectivity.

Taken together, studies in this domain indicate that AAC applications can support functional communication and may reduce barriers associated with communicative frustration, particularly when their use is embedded in clinician-, educator-, or caregiver-mediated routines. However, the predominance of case studies, descriptive designs, and small samples limits the generalizability of these findings. Thus, although the results are promising, the evidence base remains stronger in terms of feasibility and practical utility than in terms of robust causal inference.

3.2 Domain 2: Emotion recognition and expression (n = 7)

Applications targeting emotion recognition and expression typically focused on the training of basic emotions through interactive tasks, multimodal feedback, and, in some cases, automated facial-recognition systems. PECS, analyzed by Santos *et al.* (2021), was described as a low-cost visual support system associated with improvements

in the comprehension of visual and oral instructions, potentially contributing to contextual interpretation and communicative organization.

More recent tools, such as Emotismo (Nunes *et al*., 2020), SunflowerAPP (Fonseca *et al*., 2024), and Emotion Recognition Assistance (ERA) (Irvan *et al*., 2022), incorporated structured activities and interactive feedback to support emotion-related skills. Although gains in basic emotion recognition were reported (Irvan *et al*., 2022), usability constraints were also identified (Junaidi *et al*., 2022), highlighting the gap between technical functionality and real-world applicability. Similarly, PandaSays (Popescu *et al*., 2022) introduced a machine-learning approach for affective-state classification, illustrating an emerging direction in the field, but with only moderate performance and limited evidence regarding the long-term sustainability of outcomes.

Overall, the evidence in this domain suggests that digital tools may facilitate the teaching of emotion-related skills in structured contexts. Nevertheless, the available studies provide less robust evidence regarding the transfer of these gains to spontaneous, real-life social interactions, especially in school and family environments.

3.3 Domain 3: Social skills, pragmatics, and interpersonal interaction (n = 36)

The largest body of studies addressed social skills, pragmatics, and interpersonal interaction, frequently through gamified interventions and, in a smaller subset, wearable devices incorporating artificial intelligence. The randomized controlled trial by Voss *et al*. (2019), which evaluated Superpower Glass, stands out as one of the most methodologically robust studies in the corpus, reporting significant gains in the Socialization subscale of the Vineland Adaptive Behavior Scales when compared with treatment as usual. Hachisu *et al*. (2018) found that the FaceLooks device increased the duration of in-person engagement behaviors under a visual-feedback condition, whereas GuessWhat, analyzed by Penev *et al*. (2021), demonstrated significant improvements in SRS-2 and VABS-II scores in home settings, suggesting feasibility in family-mediated contexts. SIPNENA, described by Twmips *et al*. (2024), integrated communication, literacy, and emotional monitoring, reflecting a trend toward multimodal and multidomain intervention platforms.

These findings indicate that digital and wearable technologies may serve as mediators of social engagement by creating structured opportunities for practicing turn-taking, emotional responding, and context-sensitive interaction. At the same time, the

variability of outcome measures, intervention formats, and assessment instruments makes direct comparison across studies difficult. Consequently, although this domain is the most numerous, it is also marked by substantial methodological dispersion, which weakens the comparability and cumulative strength of the evidence.

3.4 Cross-cutting trends: AI, design, accessibility, and contexts of use

Across domains, recent studies increasingly incorporated artificial intelligence, machine learning, and augmented reality (Rehman *et al*., 2021; Toma *et al*., 2024; La Fauci De Leo *et al*., 2025). At the same time, usability and accessibility emerged as decisive determinants of intervention quality and feasibility (Jaramillo-Alcázar *et al*., 2022). Design-oriented studies proposed parameters tailored to users with ASD, emphasizing simplicity, visual organization, predictability, and reduced sensory overload (Quezada *et al*., 2018; Dattolo and Luccio, 2017). In parallel, analyses of large-scale user feedback have contributed to the refinement of applications based on real-world experience (Haoues and Mokni, 2023).

The included studies also showed that these technologies have been implemented across clinical, educational, and home settings (Lima *et al*., 2017; Fage *et al*., 2018; Chistol *et al*., 2023), reinforcing the understanding that they are most often embedded within broader support ecosystems rather than used as stand-alone solutions. Evidence involving adolescents and young adults (Montenegro *et al*., 2023; Araújo *et al*., 2024) further suggests that the field is expanding beyond early childhood and beginning to address communication and participation needs across the life course.

Taken as a whole, the results indicate positive trends in functional communication, emotion recognition, and social interaction. However, methodological heterogeneity, small sample sizes, and limited longitudinal follow-up remain substantial challenges, underscoring the need for greater standardization and stronger experimental rigor (Toma *et al*., 2024; Liu *et al*., 2023).

4. DISCUSSION

The findings of this review confirm that assistive technology applications have assumed a strategic role in interventions aimed at supporting individuals with ASD. The diversity of identified tools, ranging from structured AAC systems to artificial intelligence-based platforms and wearable devices, reflects not only technological

innovation but also a growing effort to address the multiple dimensions involved in communicative and socioemotional development. More importantly, the review suggests that assistive technologies are increasingly being conceived not merely as isolated tools, but as components of broader educational, clinical, and family-mediated support systems.

In the domain of communication, the evidence reinforces the structuring role of AAC systems in promoting functional communication. Studies such as Lima *et al*. (2017) and Barbosa, Montenegro, and Queiroga (2024) indicate that interventions based on pictograms, visual supports, and semantically organized vocabulary can lead to measurable gains in receptive and expressive communication, including among nonverbal adolescents. These findings are consistent with the argument that communication support, when systematically organized and contextually mediated, may broaden opportunities for participation and reduce behaviors associated with communicative frustration (Walia *et al*., 2021). At the same time, studies on applications such as aBoard (Montenegro *et al*., 2021) and Yuudee (An *et al*., 2017) suggest that personalization, lexical organization, and speech synthesis are key features for fostering communicative autonomy across different contexts.

However, the review also shows that the effectiveness of AAC applications cannot be attributed solely to their technological features. Usability analyses by Macedo and Ramalho (2021) and Sousa and Carvalho (2021), together with the discussion of economic accessibility presented by Gallo and Ribeiro (2025), indicate that adoption and sustainability depend heavily on real-world conditions of access and use. This is particularly relevant in educational and family settings, where connectivity limitations, cost barriers, and the need for adult mediation may directly shape the practical value of these tools.

With regard to emotion recognition and expression, the evidence suggests that digital applications may help make socially and cognitively complex skills more concrete and teachable. PECS-based strategies and related visual mediation systems, as discussed by Santos *et al*. (2021) and Lourenço (2025), appear to support not only alternative communication but also contextual interpretation and the organization of social responses. More recent applications, such as Emotismo, SunflowerAPP, and ERA, extend this logic through multimodal feedback and interactive tasks. Yet, despite encouraging results, this domain remains marked by a tension between technical promise and ecological validity. The usability limitations identified by Junaidi *et al*. (2022), as well as

the moderate performance of AI-based tools such as PandaSays (Popescu *et al*., 2022), indicate that advances in computational sophistication do not automatically translate into effective, sustainable improvements in everyday emotional functioning.

In the domain of social skills and interpersonal interaction, the results suggest that gamified interventions and wearable technologies can support engagement and the practice of social behaviors in structured environments. The trial by Voss *et al*. (2019) provides particularly important evidence because of its stronger methodological design and its use of standardized outcome measures. Findings related to FaceLooks (Hachisu *et al*., 2018) and GuessWhat (Penev *et al*., 2021) also reinforce the hypothesis that structured visual feedback and playful interaction can promote social behaviors, with some potential for transfer to family settings. SIPNENA (Twmips *et al*., 2024), in turn, points to a trend toward convergence among communication, literacy, and emotional monitoring, suggesting that future interventions may increasingly operate through multidomain platforms rather than narrowly defined applications.

Despite these advances, the review highlights persistent limitations that must temper the interpretation of positive findings. Case studies, pilot designs, and small samples remain predominant across the literature, which restricts external validity and weakens the consistency of conclusions. In addition, the marked heterogeneity of outcome measures and evaluation instruments complicates comparison across studies and prevents more robust quantitative synthesis. These limitations are consistent with previous observations by Toma *et al*. (2024) and Liu *et al*. (2023), who also emphasize the fragmented nature of recent evidence in this field.

Another important issue concerns design and accessibility. Studies by Quezada *et al*. (2018), Dattolo and Luccio (2017), and Haoues and Mokni (2023) show that apparently technical variables, such as pictogram size, interface responsiveness, visual clarity, and navigation simplicity, have direct implications for usability and engagement. For individuals with ASD, whose sensory and attentional profiles may vary substantially, these elements are not secondary design details but central aspects of intervention quality. This reinforces the need for an interdisciplinary development approach in which educational, technological, clinical, and ethical dimensions are considered simultaneously.

The review also reinforces the importance of context. Applications were used in schools, homes, and clinical settings, but their effectiveness was generally linked to

mediation by adults, educators, clinicians, or family members rather than to autonomous use alone. This suggests that assistive technologies should be understood as relational and contextual tools whose benefits depend on how they are integrated into everyday routines. From an educational perspective, this is especially relevant because it shifts the focus from technology as a stand-alone solution to technology as a support embedded in inclusive pedagogical practice. The inclusion of adolescents and young adults in part of the corpus further indicates that communication support through technology should be viewed across the life course, not only during early childhood.

Overall, the evidence suggests that assistive technology applications can make meaningful contributions to functional communication, emotion-related skills, and social interaction, particularly when they are integrated into structured educational, clinical, and family-mediated practices. At the same time, the field is still in a process of scientific consolidation. To advance beyond promising but fragmented findings, future research should prioritize larger controlled studies, greater standardization of outcome measures, longer follow-up periods, and more explicit investigation of the maintenance and generalization of gains across naturalistic contexts. In this sense, the field remains highly promising, but its maturation depends on a closer alignment between technological innovation and the production of robust, context-sensitive evidence.

5. FINAL CONSIDERATIONS

This systematic review indicates that assistive technology applications may support functional communication, emotion-related skills, and social interaction in individuals with Autism Spectrum Disorder (ASD), particularly when these tools are integrated into everyday contexts involving family members and peers. The findings suggest that mobile applications, augmentative and alternative communication systems, and other digital tools can contribute to communication support, but their effectiveness depends not only on technological features, but also on contextual mediation, usability, and implementation conditions.

From an educational perspective, the review highlights the relevance of assistive technologies as complementary resources that may expand participation, promote communicative autonomy, and support socially meaningful interactions in home, school, and clinical settings. In this sense, their value lies not in replacing human mediation, but

in strengthening the relational and instructional processes through which communication is developed and generalized in real-life environments.

At the same time, the review has important limitations. The included studies showed substantial methodological heterogeneity in design, sample size, intervention characteristics, and outcome measures, which limits direct comparison across studies and prevents meta-analysis. In addition, many studies provided limited evidence regarding long-term effects, maintenance of gains, and generalization of skills to naturalistic interactions with family members and peers. These limitations should be considered when interpreting the findings.

Overall, the evidence suggests that assistive technology applications are promising supports for communication-related outcomes in ASD, especially when grounded in everyday interactional contexts. However, further studies with stronger methodological rigor, larger samples, standardized outcome measures, and longitudinal follow-up are needed to clarify their educational impact and to better determine how these tools can be effectively integrated into inclusive practices.

6. ACKNOWLEDGEMENTS

This study received financial support from resources derived from fiscal (tax) incentives administered by Superintendência da Zona Franca de Manaus (SUFRAMA), through the company Transire/Tectoy.

REFERÊNCIAS

ARAÚJO, Patrícia Pereira de *et al*. Avaliação e ensino de emoções com crianças e jovens adultos com autismo ou síndrome de down mediado pela família. **Psicologia: ciência e profissão**, v. 44, p. e258093, 2024.

BARBOSA, Fernanda Cristina de Oliveira Luna; MONTENEGRO, Ana Cristina de Albuquerque; QUEIROGA, Bianca Arruda Manchester de. Os efeitos do método DHACA na comunicação expressiva em crianças com transtorno do espectro do autismo. In: **CoDAS**. Sociedade Brasileira de Fonoaudiologia, 2025. p. e20240148.

BRANCO, Karina da Silva Castelo *et al*. Como o uso de aplicativos móveis educacionais impacta o cotidiano de crianças autistas? Uma avaliação por meio de diários de usuário. **Revista Brasileira de Informática na Educação**, v. 29, p. 1107-1136, 2021.

CAVALCANTI, Ricardo Sousa; DE CARVALHO, Lílian Amaral. Ferramentas educacionais digitais para crianças autistas. **Research, Society and Development**, v. 10, n. 10, p. e248101018823-e248101018823, 2021.

CHISTOL, Mihaela; TURCU, Cristina; DANUBIANU, Mirela. Autism assistant: A platform for autism home-based therapeutic intervention. **IEEE Access**, v. 11, p. 94188-94204, 2023.

DATTOLO, Antonina *et al*. Accessible and usable websites and mobile applications for people with autism spectrum disorders: a comparative study. **ICST Transactions on Ambient Systems**, v. 17, n. 13, p. 1-11, 2017.

DA SILVA, Vânia Maria Carneiro; GOUKART, Maria Tereza Carthery. Análise de Aplicativos digitais no Treino das Habilidades Comunicativas e Sociais de Crianças com o Transtorno do Espectro Autista. **Revincluso-Revista Inclusão & Sociedade**, v. 4, n. 1, 2024.

DE MACEDO, Edinadja M.; RAMALHO, Welliana B.; DE MEDEIROS, Joêmia Leilane G. Avaliando a Usabilidade de Aplicações Voltadas para a Comunicação de Crianças com TEA. In: **Congresso sobre Tecnologias na Educação (Ctrl+ e)**. SBC, 2021. p. 324-333.

FAGE, Charles *et al*. Tablet apps to support first school inclusion of children with autism spectrum disorders (ASD) in mainstream classrooms: A pilot study. **Frontiers in psychology**, v. 9, p. 2020, 2018.

FARZANA, Walia *et al*. Technological evolvement in AAC modalities to foster communications of verbally challenged ASD children: a systematic review. **IEEE Access**, 2021.

FONSECA, Allan Victor *et al*. SunflowerAPP: Um aplicativo Mobile para Auxiliar o Reconhecimento de Emoções de Crianças Atípicas. In: **Seminário Integrado de Software e Hardware (SEMISH)**. SBC, 2024. p. 49-60.

GALLO, Débora Regina; RIBEIRO, Karen. Comunicação alternativa: Comunicação alternativa: aplicativos para comunicação de pessoas com transtorno do espectro autista. **Revista Teias de Conhecimento**, v. 1, n. 5, 2025.

HACHISU, Taku *et al*. FaceLooks: A smart headband for signaling face-to-face behavior. **Sensors**, v. 18, n. 7, p. 2066, 2018.

HAOUES, Mariem; MOKNI, Raouia. Toward an autism-friendly environment based on mobile apps user feedback analysis using deep learning and machine learning models. **PeerJ Computer Science**, v. 9, p. e1442, 2023.

IRVAN, Muchamad *et al*. Emotional expressions recognize ability in children with autism: Intervention using emotion recognition assistance application. In: **2022 8th International Conference on Education and Technology (ICET)**. IEEE, 2022. p. 87-90.

JARAMILLO-ALCÁZAR, Angel *et al*. Method for the development of accessible mobile serious games for children with autism spectrum disorder. **International Journal of Environmental Research and Public Health**, v. 19, n. 7, p. 3844, 2022.

JUNAIDI, Ahsan Romadlon *et al*. Usability testing of emotion recognition assistance application for children with autism spectrum disorder. In: **2022 8th International Conference on Education and Technology (ICET)**. IEEE, 2022. p. 309-314.

LA FAUCI DE LEO, Andrea; BAGHERI ZADEH, Parisa; VODERHOBLI, K.; SHEIKH AKBARI, A. A new AI framework to support social-emotional skills and emotion awareness in children with autism spectrum disorder. *Computers*, v. 14, n. 7, art. 292, 2025. DOI: 10.3390/computers14070292.

LIMA, Thiago *et al*. aBoard: uma plataforma computacional na nuvem para comunicação alternativa e educação inclusiva. In: **Anais dos Workshops do Congresso Brasileiro de Informática na Educação**. 2017. p. 102.

LIU, Xiongyi *et al*. A Survey on Autism Care, Diagnosis, and Intervention Based on Mobile Apps Focusing on Usability and Software Design. **Sensors**, v. 23, n. 14, p. 6260, 2023.

MONTENEGRO, Ana Cristina de Albuquerque *et al*. Contribuições da comunicação alternativa no desenvolvimento da comunicação de criança com transtorno do espectro do autismo. **Audiology-Communication Research**, v. 26, 2021.

MONTENEGRO, Ana Cristina de Albuquerque *et al*. Desenvolvimento das habilidades comunicacionais em adolescente autista com uso de comunicação alternativa: **relato de caso.** ***Revista CEFAC***, v. 25, n. 3, e11122, 2023. DOI: 10.1590/1982-0216/202325311122.

NUNES, Gustavo Maciel; AGUIAR, Yuska Paola Costa. **Emotismo: um aplicativo para auxiliar crianças no espectro autista a reconhecer e reproduzir emoções**. In: SIMPÓSIO BRASILEIRO DE INFORMÁTICA NA EDUCAÇÃO (SBIE), 31., 2020, Online. *Anais* [...]. Porto Alegre: Sociedade Brasileira de Computação, 2020. p. 692–701. DOI: https://doi.org/10.5753/cbie.sbie.2020.692.

PANDA, Prateek Kumar *et al*. Effectiveness of IMPUTE ADT-1 mobile application in children with autism spectrum disorder: An interim analysis of an ongoing randomized controlled trial. **Journal of neurosciences in rural practice**, v. 15, n. 2, p. 262, 2024.

PENEV, Yordan *et al*. A mobile game platform for improving social communication in children with autism: a feasibility study. **Applied clinical informatics**, v. 12, n. 05, p. 1030-1040, 2021.

POPESCU, Aura-Loredana *et al*. IoT and AI-based application for automatic interpretation of the affective state of children diagnosed with autism. **Sensors**, v. 22, n. 7, p. 2528, 2022.

QUEZADA, Angeles *et al*. Relations between touch target size and drag distance in mobile applications for users with autism spectrum disorders. **Journal of Medical Systems**, v. 42, n. 10, p. 180, 2018.

REHMAN, Ikram Ur *et al*. Features of mobile apps for people with autism in a post COVID-19 scenario: Current status and recommendations for apps using AI. **Diagnostics**, v. 11, n. 10, p. 1923, 2021.

SANTOS, Patricia de Almeida *et al*. The impact of the implementation of the Picture Exchange Communication System–PECS on understanding instructions in children with Autism Spectrum Disorders. In: **CoDAS**. Sociedade Brasileira de Fonoaudiologia, 2021. p. e20200041.

TOMA, Marian-Vladut *et al*. Extended reality–based mobile app solutions for the therapy of children with autism spectrum disorders: Systematic literature review. **JMIR Serious Games**, v. 12, p. e49906, 2024.

TWMIPS, Bandara *et al*. A comprehensive mobile platform for fostering communication, literacy, numeracy, and emotion understanding in children with ASD. In: **2024 International Conference on Electrical, Computer and Energy Technologies (ICECET**. IEEE, 2024. p. 1-6.

VOSS, Catalin *et al*. Effect of wearable digital intervention for improving socialization in children with autism spectrum disorder: a randomized clinical trial. **JAMA pediatrics**, v. 173, n. 5, p. 446-454, 2019.

AUTHOR CONTRIBUTIONS

Maria Antonia Souza da Silva: performed the data analysis and contributed to drafting the manuscript.

Marta Regina Silva Pereira: conceived and designed the study, conducted the investigation, developed the methodology, curated the data, performed the formal analysis and drafted the manuscript.

Silvia Regina Sampaio Freitas: conceived and designed the study, contributed to data analysis, and drafted the manuscript.

Vanessa Coelho da Silva: conceived and designed the study, contributed to data analysis, and drafted the manuscript.

Ricardo da Silva Barboza: conceived and designed the study, conducted the investigation, developed the methodology, curated the data, performed the formal analysis and drafted the manuscript.

Ernande Ferreira de Melo: conceived and designed the study, contributed to data analysis, and drafted the manuscript.

Raimundo Corrêa de Oliveira: performed the data analysis and contributed to drafting the manuscript.