

## Approaches to dental management of children with Autism Spectrum Disorder (ASD)

***Abordagens para o tratamento odontológico de crianças com Transtorno do Espectro Autista (TEA)***

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### Abstract

This literature review aimed to explore and synthesize evidence regarding effective behavioral, sensory, and technological interventions in the dental care of children with Autism Spectrum Disorder (ASD). A scoping review was conducted according to the PRISMA protocol. The search was performed in the PubMed, Scopus, and Web of Science databases. Studies evaluating behavioral strategies, sensory adaptations, and assistive technologies in dental settings for children with ASD were included. The selected articles were analyzed thematically, focusing on clinical outcomes and practical feasibility. Out of 74 articles initially identified, 15 met the inclusion criteria. Behavioral interventions such as video modeling and social stories proved effective in reducing anxiety and enhancing patient cooperation. Sensory-adapted environments helped lower physiological and behavioral stress levels. Assistive technologies, including mobile applications, facilitated patient interaction and adherence to treatment. Structured protocols that combined caregiver training with visual pedagogy significantly improved cooperation during dental procedures. The analyzed interventions demonstrate the potential of personalized strategies to meet the specific needs of children with ASD, fostering inclusive and humanized oral healthcare. However, limitations such as small sample sizes and the absence of longitudinal studies highlight the need for future research to refine and validate these approaches across diverse clinical contexts.

**Keywords:** Autism Spectrum Disorder, Oral Health, Assistive Technologies, Behavioral

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## Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by deficits in social communication and the presence of repetitive and restrictive behaviors<sup>1</sup>. Leo Kanner, an American child psychologist, is widely acknowledged for his pioneering contributions to the understanding of ASD<sup>2</sup>. In his groundbreaking research, Kanner described distinctly atypical behaviors in 11 children, suggesting an innate predisposition that impaired their ability to establish social interactions<sup>3</sup>.

This condition, which originates prenatally and affects brain development, significantly hinders social engagement<sup>4</sup>. The diagnosis of ASD is primarily based on clinical observation, as no specific biomarkers are currently available for this purpose<sup>5</sup>. The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) classifies ASD under neurodevelopmental disorders<sup>6</sup>. Its etiology is multifactorial, involving genetic components, prenatal influences, cerebral biological conditions, and associated medical comorbidities<sup>7,8</sup>. Research has identified genetic mutations in neural substrates as correlates of the core symptoms of ASD, emphasizing the underlying genetic complexity<sup>8</sup>. Furthermore, environmental factors, such as advanced parental age, parental smoking, maternal stress during pregnancy, and neonatal conditions—including hypoxia and low birth weight—have been identified as significant risk factors<sup>7</sup>.

The global incidence of ASD in children has shown a marked increase, with studies reporting a steady rise in diagnoses over the Years<sup>8</sup>. The World Health Organization estimates that 21 in every 10,000 individuals worldwide are affected by autism<sup>9</sup>. Behavioral characteristics of ASD include social difficulties, lack of eye contact, aversion to physical touch, and repetitive behavior patterns<sup>10,11</sup>. These behavioral manifestations can interfere with daily activities, such as oral hygiene, and

complicate interactions with dental professionals<sup>12</sup>. In the dental context, clinical signs within the stomatognathic system and deleterious oral habits, such as bruxism, thumb-sucking, mouth breathing, and object biting, are commonly observed<sup>13</sup>. Maintaining proper oral hygiene poses significant challenges for this population<sup>13</sup>.

Dental management of patients with ASD is further complicated by hypersensitivity to sensory stimuli<sup>14</sup>. Given the increasing number of diagnoses, it is essential to train healthcare professionals to adequately address the needs of this population, taking into account potential comorbidities, hyperactivity, self-injury, dietary peculiarities, and specific oral cavity alterations<sup>15</sup>.

Several strategies have been proposed to improve dental care for children with ASD, including behavioral management techniques, clinical environment adaptations, and caregiver-targeted educational programs<sup>16</sup>. However, the efficacy of these approaches varies, underscoring the need to consolidate existing knowledge to support evidence-based clinical practices<sup>17</sup>.

The present study aims to conduct a scoping review to explore and synthesize evidence on the effectiveness of behavioral interventions, sensory adaptations, and assistive technologies in the dental management of children with Autism Spectrum Disorder (ASD), highlighting their practical implications and challenges for clinical implementation.

## **Materials and methods**

### **Research Questions**

This study aimed to map preventive strategies in dental care for children with Autism Spectrum Disorder (ASD), addressing the following questions:

What are the primary preventive strategies used in dental care for children with ASD? How can these strategies be applied to improve care experiences and outcomes? Which sensory and behavioral adaptations are most effective in this context?

## Search Strategy

The research was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol guidelines<sup>19</sup>. Three widely recognized databases were consulted: PubMed, Scopus, and Web of Science. The search was performed using English keywords such as "Autism Spectrum Disorder," "preventive approaches," "dental care," and "children," combined with the Boolean operator AND. The search strategy was iteratively refined to include additional terms identified in the retrieved studies.

## Study Selection

The initial search yielded a total of 74 potentially relevant articles. After the removal of 7 duplicates, the study selection process proceeded in three main stages: (1) screening of titles and abstracts to eliminate articles not related to the topic; (2) full-text assessment to determine eligibility; and (3) application of predefined inclusion and exclusion criteria.

The inclusion criteria were as follows: original studies evaluating preventive strategies in dental care for children with Autism Spectrum Disorder (ASD), and studies published in English. Exclusion criteria comprised review articles, book chapters, conference papers, notes, short communications, studies not focused on preventive dental approaches, and articles not written in English.

## Data Analysis

Extracted data included complete references, objectives, methodology/interventions, and main findings. A thematic analysis was conducted, categorizing studies into groups such as behavioral strategies, sensory adaptations, assistive technologies, and educational programs. Additionally, the relevance and risk of bias were qualitatively assessed to ensure the inclusion of reliable and pertinent studies.

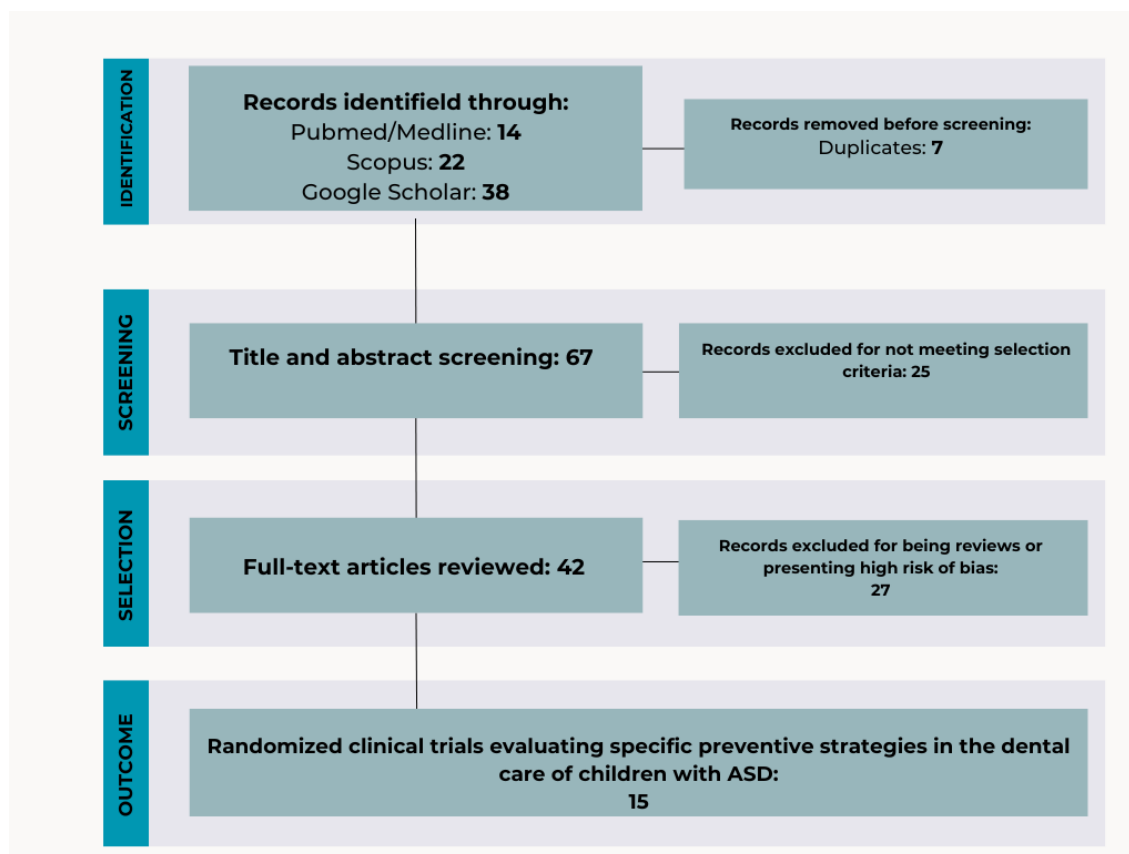
## Results

To understand preventive strategies in dental care for children with Autism Spectrum Disorder (ASD), a comprehensive search was conducted in the PubMed, Scopus, and Web of Science databases. However, upon applying the predefined inclusion and exclusion criteria, the final selection of articles was limited.

The initial search identified a total of 74 potential articles related to the topic, of which 7 were excluded as duplicates. After screening titles and abstracts, 25 articles were excluded for not meeting the inclusion criteria, such as focusing on adult populations or lacking practical, applicable results. Of the 42 articles selected for full-text review, 27 were excluded, primarily due to being reviews or presenting a high risk of bias.

The final selection included 15 articles that fully met the inclusion criteria. These consisted of randomized clinical trials evaluating specific preventive strategies for dental care in children with ASD (Figure 1).

Figure 1 – Flowchart of Sample Selection Process



These studies addressed a range of interventions, from behavioral techniques to the use of assistive technologies and training programs for parents and professionals. Table 1 summarizes the main objectives, methods, results, and identifying information of each study, highlighting their contributions to the topic in question.

## Discussion

Dental care for children with Autism Spectrum Disorder (ASD) is a field that requires solutions carefully tailored to the specific needs of each patient<sup>16</sup>. A review of the studies highlights the efficacy of various approaches that, by integrating behavioral, sensory, and technological elements, have achieved significant progress in reducing anxiety and improving collaboration during procedures. These strategies stand out not only for their ability to address clinical demands but also for promoting humanized and personalized care that considers the unique characteristics of each child and actively involves their caregivers.

### Behavioral Interventions

Gandhi et al. (2014) demonstrated that both video modeling (VM) and social stories (TSS) are effective in reducing plaque and gingivitis indices, with video modeling showing greater acceptance among caregivers due to its interactivity<sup>20</sup>. This preference highlights the importance of visual tools that engage children in a practical and appealing manner. This approach is complemented by the findings of Murshid (2017), which revealed that the use of specific children's books not only promoted positive behaviors in 47.5% of children but also significantly increased caregivers' knowledge about oral health, demonstrating the impact of family education on the success of interventions<sup>24</sup>.

In another context, Tounsi (2017) demonstrated the efficacy of progressive desensitization, with 88% of children completing examinations after five visits, particularly among those with moderate ASD<sup>25</sup>. This method underscores the relevance of gradual interventions that respect individual capabilities. Similarly, Hidayatullah et al. (2018) highlighted the benefits of Applied Behavior Analysis (ABA) combined with visual cue cards, observing progressive improvements in cooperation over the course of four sessions<sup>27</sup>. These studies emphasize the effectiveness of structured and personalized

Table 1 – Selected Studies: Preventive Strategies in Dental Care for Children with ASD

| Reference                                | Objective                                                                                                                       | Method/Intervention                                                                                                              | Main Results                                                                                                 |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Gandhi et al. (2014) <sup>10</sup>       | Compare video modeling and social stories in improving oral hygiene in children with ASD                                        | Randomized pilot study with 25 children evaluating plaque and gingivitis indices after 30 days of intervention.                  | Both interventions were effective, with greater acceptance in the video modeling group.                      |
| Cermak et al. (2015) <sup>8</sup>        | Evaluate a sensory-adapted dental environment (SADE) to reduce anxiety and improve behavior in children with ASD.               | Cross-over pilot study with 22 children with ASD and 22 neurotypical children exposed to SADE and regular settings.              | SADE significantly reduced anxiety, pain, and sensory discomfort.                                            |
| Cagetti et al. (2015) <sup>7</sup>       | Assess the effectiveness of a protocol based on visual supports for dental exams and treatments in children with ASD.           | Four-step protocol (exams, hygiene, sealants, and restorations) with 83 children; parents participated in training.              | 92.8% completed the first two steps; higher acceptance among children with verbal fluency.                   |
| Marion et al. (2016) <sup>20</sup>       | Investigate the effectiveness of digital dental stories, printed or video-based, to prepare children with ASD for appointments. | Study with 40 children and caregivers, evaluating preferences and perceptions through pre- and post-intervention questionnaires. | Digital/combined stories were the most preferred; caregivers reported reduced fear and improved preparation. |
| Murshid (2017) <sup>21</sup>             | Evaluate the effectiveness of a children's book in preparing children with ASD for dental appointments.                         | Double-blind, cross-sectional study with 40 children (ages 5–9), using the Frankl scale for behavioral assessment.               | 47.5% showed positive behavior; parents reported increased knowledge about oral health.                      |
| Tounsi (2017) <sup>31</sup>              | Assess the effectiveness of progressive desensitization to reduce anxiety and improve cooperation in children with ASD.         | Cohort study with 168 children, involving gradual visits for adaptation.                                                         | 77% completed exams in 1–2 visits; greater success among children with moderate ASD.                         |
| Nilchian et al. (2017) <sup>22</sup>     | Evaluate the impact of visual pedagogy on dental exams and preventive practices in children with ASD.                           | Randomized clinical trial with 40 children, divided into experimental and control groups.                                        | The experimental group demonstrated greater cooperation during fluoride therapy and dental procedures.       |
| Hidayatullah et al. (2018) <sup>13</sup> | Evaluate ABA-based behavioral management methods to improve cooperation during dental exams.                                    | Observational study with 13 children using visual cards over six weekly sessions.                                                | Significant improvement in cooperation, statistically confirmed ( $p < 0.01$ ).                              |
| Zink et al. (2018) <sup>35</sup>         | Develop and evaluate an app for communication between dentists and children/adolescents with ASD during their first visit       | Study with 40 children divided into groups using either the app or the Picture Exchange Communication System (PECS).             | The app was more effective, reducing attempts (9.5 vs. 15) and necessary appointments (3 vs. 5).             |
| Lefer et al. (2019) <sup>18</sup>        | Evaluate the effectiveness of an iPad® application program to train children with ASD to cooperate during dental examinations.  | Monthly training based on visual schedules involving 52 children over 8 months.                                                  | Cooperation increased from 25% to 65.4%; 59.6% of children exhibited no anxiety at the end of the program.   |
| Pastore et al. (2023) <sup>27</sup>      | Assess the efficacy of a specific protocol to improve collaboration                                                             | Quasi-experimental study with 84 children in the experimental group and 84 in the control group,                                 | Significant improvement in collaboration (from 9.52% to 50%) and reduction in general anesthesia usage.      |

|                                         |                                                                                                                                            |                                                                                                                                    |                                                                                                                      |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
|                                         | among children with ASD in dental care.                                                                                                    | using visual pedagogical tools and adapted consultations every two months.                                                         |                                                                                                                      |
| Pai Khot et al. (2023) <sup>25</sup>    | Evaluate the effectiveness of the PAIR system (Picture Assisted Illustration Reinforcement) in improving oral health in children with ASD. | Randomized clinical trial with 60 children, assessing hygiene practices, gingival indices, and cognitive parameters over 12 weeks. | Significant improvement in gingival health and hygiene practices in the PAIR group..                                 |
| Stein Duker et al. (2023) <sup>30</sup> | Assess the effects of SADE on reducing physiological and behavioral stress in autistic children during dental visits                       | Cross-over randomized clinical trial involving 162 children undergoing cleanings performed with SADE and in a regular environment. | Significant reduction in physiological stress (measured by skin conductance level) and behavioral stress.            |
| Kumari et al. (2024) <sup>17</sup>      | Evaluate the impact of audiovisual modeling on children's behavior during dental treatments.                                               | Observational study with 100 children (aged 4 to 10) using videos before preventive and major procedures.                          | Significant improvement in behavior; 61% showed positive behavior during preventive treatments.                      |
| Kaintura et al. (2024) <sup>15</sup>    | Explore sympathetic responses of children with ASD during dental treatments in a sensory-adapted environment (SADE).                       | Case series with three children monitored for electrodermal activity (EDA) to assess reactions to stressors and calming stimuli.   | SADE reduced physiological stress and promoted greater cooperation, highlighting its efficacy for children with ASD. |



approaches in overcoming behavioral barriers frequently encountered during dental consultations.

Behavioral strategies are complemented by sensory adaptations investigated by Cermak et al. (2015)<sup>21</sup> and Kaintura et al. (2024)<sup>34</sup>. In sensory-adapted dental environments (SADE), these authors reported significant reductions in physiological and behavioral stress, resulting from modifications designed to address the sensory hypersensitivity of children with ASD. The use of electrodermal data, as presented by Kaintura, introduced a novel perspective by enabling real-time monitoring of responses, allowing personalized adjustments that enhance tolerance and collaboration during procedures<sup>34</sup>.

Furthermore, the flexibility and personalization of interventions were reinforced by Marion et al. (2016), who investigated dental stories in various formats<sup>23</sup>. Preferences for digital or hybrid versions, influenced by the linguistic abilities of the children, highlight the necessity of adapting tools to the individual characteristics of each Family<sup>23</sup>. These findings align with the results of Nilchian et al. (2017), which demonstrated how repeated visits and familiarity with the dental environment significantly enhance cooperation, particularly in more complex procedures such as fluoride application<sup>26</sup>.

The integration of digital technologies has also proven promising in the studies by Zink et al. (2018)<sup>28</sup> and Lefer et al. (2019)<sup>29</sup>. The use of applications to facilitate communication and desensitization significantly reduced the number of required consultations and increased children's acceptance of procedures. These interactive tools not only enhance the patient experience but also optimize resources and alleviate stress for families.

## Sensory Adaptations

The integration of sensory-adapted dental environments (SADE) has emerged as a promising approach to improving stress management in children with Autism Spectrum Disorder (ASD). The study by Cermak et al. (2015) highlighted that reducing sensory stimuli, such as bright lights and loud noises, significantly decreased physiological and behavioral stress, as reflected in lower skin conductance levels during dental procedures<sup>21</sup>. This finding was corroborated by Stein Duker et al. (2023), who identified that SADE reduces both sympathetic activity and behavioral manifestations of distress, while also improving cooperation during consultations<sup>32</sup>.

Complementing these findings, Kaintura et al. (2024) explored the use of Electrodermal Activity (EDA) as a tool to personalize interventions in real time<sup>34</sup>. The study demonstrated that tonic and phasic variations in EDA levels enabled the identification of specific stressors and the adjustment of sensory management strategies, such as firm pressure or music, yielding promising results in stress reduction and improved collaboration<sup>34</sup>.

Despite methodological differences, the studies converge on the relevance of adapting the clinical environment to the individual needs of children. While Cermak et al.<sup>21</sup> and Stein Duker et al.<sup>32</sup> employed larger samples and robust quantitative analyses to evaluate the overall effects of SADE, Kaintura et al.<sup>34</sup> provided a detailed qualitative perspective, highlighting the efficacy of individualized approaches. This convergence underscores the potential of SADE as a central strategy to transform dental care for neurodiverse populations, promoting less traumatic and more inclusive experiences.

## Assistive Technologies

The analyzed studies highlight the significant impact of digital technologies in managing dental care for children with Autism Spectrum Disorder (ASD). The work by Zink et al. (2018) demonstrated that a mobile application was more effective than the PECS system in facilitating communication between autistic children and dental professionals<sup>18</sup>. This application reduced the number of attempts required to complete tasks and the number of consultations, providing an interactive and accessible approach that increased the acceptance of dental interventions.

Complementarily, the study by Lefer et al. (2019) evaluated the use of an iPad® equipped with the çATED application, showing that children's cooperation in performing basic dental examinations increased from 25% at the start of the study to 65.4% after eight months of training<sup>18</sup>. Furthermore, children's anxiety during procedures significantly decreased, highlighting the effectiveness of combining visual pedagogy and digital tools in the dental context<sup>18</sup>.

Pai Khot et al. (2023) introduced the PAIR system (Picture Assisted Illustration Reinforcement), which also utilized visual strategies to promote healthy oral hygiene practices<sup>31</sup>. This method significantly improved oral hygiene and gingival health indices, demonstrating that interventions based on sequential illustrations and behavioral reinforcement are effective in enhancing both oral hygiene and the cognitive development of children<sup>31</sup>.

When correlating these studies, a clear pattern emerges: digital technologies and visual systems are promising tools in the dental management of children with ASD. The three studies demonstrate how interactive and personalized approaches, tailored to individual needs, can not only improve cooperation during procedures but also promote long-term oral health practices. Although limitations such as small sample sizes and a focus on basic procedures exist, the results provide a solid foundation for implementing digital technologies in dental care for special needs populations, suggesting a promising path for future research.

## Structured Protocols

The joint analysis of the studies by Cagetti et al. (2015)<sup>22</sup>, Pastore et al. (2023)<sup>30</sup>, and Kumari et al. (2024)<sup>33</sup> highlights progressively refined approaches to enhance the collaboration of children with Autism Spectrum Disorder (ASD) during dental treatments. The multi-step visual protocol developed by Cagetti et al. demonstrated high acceptance in the initial stages of procedures, significantly reducing the need for general anesthesia<sup>22</sup>. This initial approach emphasized the importance of visual supports and gradual training, adapting to the individual capabilities of the children<sup>22</sup>.

Pastore et al. expanded this scope by integrating a structured program that combined bi-monthly visits, caregiver training, and continuous visual support over three Years<sup>30</sup>. The results showed a remarkable increase in collaboration, from 9.52% to 50% within one year, even during the COVID-19 pandemic. This approach also minimized the use of general anesthesia, with nearly half of the procedures performed in the dental chair. Furthermore, personalization and caregiver involvement were essential for long-term success, emphasizing the importance of family adherence and continuity of care<sup>30</sup>.

In turn, Kumari et al. investigated the impact of audiovisual modeling by presenting videos that depicted cooperative children in dental settings<sup>33</sup>. This method resulted in significant behavioral changes, with 73% of children exhibiting positive behavior during more complex procedures, such as pulpal therapy<sup>33</sup>. The approach proved particularly effective in reducing anxiety associated with invasive treatments, using audiovisual stimuli as an accessible and practical means to facilitate acceptance and cooperation.

The correlation among these studies highlights the evolution of strategies for behavioral management in dental care for children with Autism Spectrum Disorder (ASD). While Cagetti et al.<sup>22</sup> established the foundation for effective visual interventions, Pastore et al.<sup>30</sup> integrated a comprehensive, long-term support program, and Kumari et al.<sup>33</sup> validated the use of audiovisual technologies to promote adaptive behaviors. These advances point to the necessity of individualized and integrative approaches that combine visual support, continuous training, and technological tools to optimize the dental experience and oral health outcomes in this population.

The results of this review reinforce the effectiveness of individualized strategies that combine behavioral approaches, sensory adaptations, and assistive technologies in the dental care of children with ASD. However, certain limitations of the analyzed studies, such as small sample sizes, the absence of control groups, and the lack of long-term research, restrict the applicability of findings to broader contexts.

Future investigations should prioritize the inclusion of larger samples and longitudinal analyses to better understand the effects of these interventions over time. Additionally, it is essential to explore the potential of integrated strategies, such as the simultaneous use of assistive technologies and sensory-adapted environments, to identify even more effective approaches. Cultural and contextual factors must also be considered to adapt interventions to different realities, contributing to more inclusive and universal dental care.

## Conclusion

This study highlights the relevance of personalized strategies in the dental care of children with Autism Spectrum Disorder (ASD). Interventions such as video modeling, sensory-adapted environments, and the use of assistive technologies, including mobile applications, have proven effective in increasing cooperation, reducing anxiety, and making dental care more welcoming and inclusive.

However, the presence of limitations, such as small sample sizes and the absence of long-term studies, underscores the need for future research to explore the sustained effectiveness of these approaches in diverse contexts and populations. By integrating consistent evidence, this work provides a pathway for improving dental care, promoting oral health and well-being in a humanized manner, and aligning with the specific needs of children with ASD.

## Resumo

Esta revisão de literatura teve como objetivo explorar e sintetizar evidências sobre intervenções comportamentais, sensoriais e tecnológicas eficazes no cuidado odontológico de crianças com Transtorno do Espectro Autista (TEA). Foi realizada uma revisão de escopo conforme o protocolo PRISMA. A busca foi conduzida nas bases de dados PubMed, Scopus e Web of Science. Foram incluídos estudos que avaliaram estratégias comportamentais, adaptações sensoriais e tecnologias assistivas em contextos odontológicos voltados para crianças com TEA. Os artigos selecionados foram analisados tematicamente, com foco nos desfechos clínicos e na viabilidade prática. Dos 74 artigos inicialmente identificados, 15 atenderam aos critérios de inclusão. Intervenções comportamentais, como modelagem por vídeo e histórias sociais, mostraram-se eficazes na redução da ansiedade e na melhora da cooperação dos pacientes. Ambientes adaptados sensorialmente contribuíram para a redução do estresse fisiológico e comportamental. Tecnologias assistivas, incluindo aplicativos móveis, facilitaram a interação e a adesão ao tratamento. Protocolos estruturados que combinaram treinamento de cuidadores com pedagogia visual aumentaram significativamente a colaboração durante os procedimentos odontológicos. As intervenções analisadas demonstram o potencial de estratégias personalizadas para atender às necessidades específicas de crianças com TEA, promovendo um cuidado odontológico inclusivo e humanizado. No entanto, limitações como tamanhos amostrais reduzidos e a ausência de estudos longitudinais ressaltam a necessidade de pesquisas futuras para aprimorar e validar essas abordagens em contextos clínicos diversos.

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