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SYSTEMATIC REVIEWS

Challenges and solutions in managing dental problems in children with autism

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Abstract

BACKGROUND

Children with autism spectrum disorder (ASD) face unique challenges in maintaining oral health due to sensory sensitivities, communication difficulties, and behavioral barriers. These factors, along with limited access to ASD-trained dental professionals, increase their risk of dental caries, periodontal disease, bruxism, and other oral health issues. Despite growing awareness of these challenges, a comprehensive synthesis of evidence-based solutions remains lacking.

AIM

To review synthesizes existing research on dental problems in ASD, barriers to care, management strategies, and future directions for improved oral health outcomes.

METHODS

A systematic search of PubMed, Cochrane Library, and Scopus was conducted using predefined search terms. Related to ASD, dental health, and management strategies. Inclusion criteria encompassed studies focusing on children with ASD, dental health issues, and interventions. Data extraction included study design, participant characteristics, key findings, and intervention outcomes. The quality of studies was assessed using appropriate tools such as the Cochrane Risk of Bias Tool and the Newcastle-Ottawa Scale. A narrative synthesis approach, incorporating thematic analysis, was utilized to evaluate the findings.

RESULTS

A total of 165 studies met the inclusion criteria. Children with ASD exhibited a higher prevalence of dental caries, gingivitis, bruxism, and malocclusion compared to neurotypical peers. Barriers to dental care included sensory sensitivities, communication difficulties, financial constraints, and a shortage of ASD-trained dental professionals. Effective interventions included desensitization programs, behavioral therapy, digital applications, and interdisciplinary collaboration. Parental education and professional training were crucial for improving oral health outcomes.

CONCLUSION

Tailored dental care strategies, including sensory adaptations, behavioral interventions, and interdisciplinary collaboration, are essential for children with ASD. Standardized guidelines and long-term studies are needed to refine evidence-based protocols. Future research should explore digital interventions and probiotic applications in ASD dental care.

Key Words: Autism spectrum disorder; Pediatric dentistry; Oral health; Dental care barriers; Behavioral management; Sensory sensitivities; Interdisciplinary Dental care

Core Tip: This systematic review highlights the significant challenges faced by children with autism spectrum disorder (ASD) in maintaining oral health and accessing dental care. Sensory sensitivities, communication difficulties, and behavioral challenges contribute to poor oral hygiene, dental anxiety, and limited cooperation during treatment. The findings underscore the need for tailored interventions, including behavioral desensitization, sensory-friendly dental environments, and interdisciplinary collaboration. Parental education and ASD-specific training for dental professionals play crucial roles in improving outcomes. Future research should focus on developing standardized guidelines, increasing access to ASD-trained dentists, and exploring innovative solutions, such as digital interventions, to enhance dental care for this population.

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INTRODUCTION

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition characterized by persistent challenges in social interaction, communication, and restricted or repetitive behaviors. The disorder exists on a spectrum, meaning individuals with ASD can exhibit a wide range of abilities and challenges, varying in severity from mild to profound[1]. According to the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, ASD encompasses conditions previously classified separately, such as autistic disorder, Asperger's syndrome, and pervasive developmental disorder not otherwise specified[2]. ASD is typically diagnosed in early childhood, with

symptoms becoming noticeable within the first two to three years of life. The exact cause remains unclear, though a combination of genetic, environmental, and neurological factors is believed to contribute to its development. While there is no cure for ASD, early intervention strategies, behavioral therapies, and tailored educational programs can significantly improve outcomes and quality of life[3].

Children with ASD often experience difficulties in various aspects of daily living, including communication, sensory processing, and social interactions. These challenges extend into healthcare settings, where routine medical and dental care can become stressful and overwhelming[4]. Sensory sensitivities, common in ASD, may make children hypersensitive to sounds, textures, and lights, leading to heightened anxiety during medical or dental examinations. Additionally, verbal and non-verbal communication difficulties can hinder their ability to express discomfort or follow instructions, complicating healthcare procedures[5]. In the context of dental health, children with ASD may struggle with oral hygiene routines due to sensory aversions to the taste or texture of toothpaste and the sensation of toothbrush bristles. Behavioral rigidity and resistance to change can make establishing regular dental care habits challenging[6]. Furthermore, the unfamiliar environment of a dental clinic, combined with the presence of unfamiliar sounds and tactile sensations, often leads to heightened anxiety and non-compliance during dental visits[7]. Healthcare providers, including dentists, must adopt specialized approaches to accommodate the unique needs of children with ASD. This includes using visual aids, desensitization techniques, and individualized communication strategies to ensure a more comfortable and effective healthcare experience[8]. By understanding the specific challenges associated with ASD, dental professionals can play a crucial role in improving oral health outcomes for this vulnerable population.

Good oral health is essential for children's overall well-being, as it affects their nutrition, speech development, and self-esteem. Establishing proper oral hygiene practices early in life helps prevent common dental issues such as cavities, gum disease, and malocclusion. Regular dental check-ups, fluoride treatments, and a balanced diet are crucial in maintaining oral health in all children[9]. Children with ASD are at a higher risk for some dental issues due to behavioral, sensory, and dietary factors. Children with ASD have a higher prevalence of dental caries due to dietary preferences for soft, carbohydrate-rich foods and difficulty maintaining oral hygiene routines. They also have an increased risk of gingivitis and periodontal disease due to oral hygiene challenges and difficulties in tolerating brushing and flossing[10]. Bruxism is common in children with ASD and may lead to tooth wear, fractures, and temporomandibular joint disorders. Non-nutritive oral habits, such as tongue thrusting, lip biting, and chewing on non-food items, can contribute to dental issues [11]. They also have a higher incidence of crowded or misaligned teeth, which can complicate oral hygiene and lead to further dental concerns. Understanding these specific risks enables the development of tailored dental care strategies to enhance oral health outcomes in children with ASD[12].

Despite the growing awareness of the unique healthcare needs of children with ASD, there remains a significant gap in understanding their specific dental challenges and effective management strategies. Many studies have explored the general healthcare needs of children with ASD; however, a comprehensive synthesis of the existing evidence on their oral health issues, barriers to dental care, and best practices for management is lacking. Given the increased prevalence of ASD worldwide and the high risk of poor oral health outcomes in this population, a systematic review is crucial to consolidate current knowledge and inform clinical practice. This review will provide valuable insights for dental professionals, caregivers, and policymakers, enabling them to develop targeted interventions and enhance the overall dental care experience for children with ASD. Additionally, by identifying the key challenges faced in dental settings, this review aims to propose evidence-based strategies for improving access, communication, and treatment outcomes for this vulnerable group. The primary objectives of this systematic review are to identify and categorize the most common dental problems in children with ASD, analyze the key barriers to dental care, including behavioral, sensory, and communication challenges, evaluate the effectiveness of various management strategies and interventions used by dental professionals in treating children with ASD, and highlight best practices for improving the dental care experience for children with ASD, including modifications in clinical settings, specialized training for dental professionals, and caregiver involvement.

MATERIALS AND METHODS

A systematic search was conducted across PubMed, Cochrane Library, and Scopus databases using comprehensive search strings to identify relevant studies on dental problems in children with ASD. The search included combinations of "Autism Spectrum Disorder", "ASD", "Paediatric Dentistry", "Oral Health Challenges", Oral care", and "Barriers to dental care", and "Behavioral Management". Boolean operators and MeSH terms were applied to refine results. A detailed search strategy, including full Boolean search strings for each database, is now provided in the supplementary material. This includes specific keyword combinations, MeSH terms, truncation methods, and logical operators used to maximize the identification of relevant studies while minimizing bias. Studies were included if they: (1) Focused on children with ASD; (2) Addressed dental health challenges or interventions; (3) Were peer-reviewed articles in English; and (4) employed randomized controlled trials (RCTs), observational studies, or mixed-method approaches. We included all papers (RCTs and NRSI) dealing directly or indirectly with the seven fundamental questions reported in the PICO framework (Table 1). Exclusion criteria included studies on adults with ASD, non-English articles, and commentaries.

Two independent reviewers screened studies to minimize bias. Extracted data included the study design, participant demographics, key findings, and the effectiveness of the intervention. Quality assessment utilized the Cochrane Risk of Bias Tool for RCTs and the Newcastle-Ottawa Scale for observational studies. AMSTAR 2 was used to assess systematic reviews.

Table 1 PICO framework for systematic search study

Questions	Population	Intervention	Comparison	Outcome
What are the most common dental problems in children with ASD?	Children with autism	Identifying most common dental problems in children with ASD	Typically developing children	Understanding autism-related dental problems
What are the main challenges in managing dental health in children with autism?	Children with autism	Identifying key barriers (behavioral, sensory, dietary, and communication challenges)	Typically developing children	Understanding autism-specific dental care needs
How effective are behavioral and sensory adaptation techniques in improving dental care compliance?	Children with autism	Use of desensitization techniques, visual aids, and social stories	Standard dental care approaches	Improved cooperation and reduced dental anxiety
Can oral probiotics help in reducing dental caries and periodontal disease in children with ASD?	Children with autism	Administration of dental probiotics	Standard fluoride and antimicrobial treatments	Reduced dental caries, improved oral microbiome balance
How can interdisciplinary collaboration improve dental care for children with autism?	Dentists, pediatricians, behavioral therapists	Integrated care approach	Standalone dental care	Enhanced dental outcomes and reduced stress for children
What role does parental education and involvement play in improving oral hygiene for children with ASD?	Parents of children with autism	Parent training programs on oral care	No structured parental guidance	Better at-home oral hygiene practices
How do modified dental tools and techniques (*e.g.*, weighted blankets, noise-canceling headphones) improve dental experiences for children with ASD?	Children with autism	Use of specialized dental equipment and techniques	Conventional dental setting	Reduced sensory overload, improved compliance
Can digital tools (*e.g.*, mobile apps, virtual reality) improve dental visits for children with autism?	Children with autism	Implementation of telehealth, VR simulations, and mobile applications	Traditional in-person consultations	Reduced dental anxiety and increased familiarity with dental procedures

ASD: Autism spectrum disorder; VR simulations: Virtual reality simulations.

A thematic narrative synthesis approach was employed, categorizing the findings into thematic domains, including prevalence, barriers, intervention effectiveness, and emerging technologies. NVivo qualitative software to systematically code and analyze qualitative data, ensuring a structured and reproducible synthesis of results. Statistical methods from reviewed studies, including meta-analysis results, odds ratios, and confidence intervals, were summarized where applicable. The study selection process followed PRISMA guidelines, including records identified, screened, assessed for eligibility, and excluded with reasons (Figure 1)

RESULTS

The systematic review identified 165 relevant studies meeting the inclusion criteria. Figure 1 illustrates the article's flowchart. After a comprehensive analysis of studies related to the dental and oral health of children with ASD, we categorized the results into various themes, including prevalence, barriers to access, the effectiveness of specialized dental tools and techniques, behavioral and sensory adaptation strategies, the impact of digital applications, parental and healthcare professional education, and oral microbiota alterations. Each subsection summarizes key findings contributing to understanding the unique challenges and potential solutions for improving dental care in autistic children. Given the unique challenges faced by this population, researchers have investigated multiple strategies, including parental education, digital interventions, oral microbiota analysis, and behavior guidance techniques. These studies offer valuable insights into effective interventions that can support children with autism in maintaining better oral health and enhancing their experiences in dental settings. While some studies directly address specific interventions, others highlight broader systemic needs, such as improved access to care, specialized training for dental professionals, and the potential role of interdisciplinary collaboration.

Prevalence and most common dental problems in children with ASD

Table 2 summarizes studies concerned with the prevalence and types of dental disorders in children with ASD. Studies consistently show that children with ASD have significantly higher rates of dental caries compared to their neurotypical peers, mainly due to sensory sensitivities, behavioral challenges, and dietary preferences[13,14]. Salivary imbalances, including decreased calcium, sodium, and phosphorus levels, may further contribute to enamel erosion and an increased risk of decay[14]. Additionally, many ASD children require hospitalization and general anesthesia for dental procedures, as limited cooperation and delayed interventions often lead to severe untreated dental disease[15,16]. This issue is particularly pronounced among Indigenous and lower-income children, who face additional barriers to preventive care[15,16].

Table 2 Summary of studies on the prevalence of dental disorders in children with autism spectrum disorder using the PICO framework

Ref.	Population	Intervention/Exposure	Comparison	Outcome	Study design	Key risk factors identified	Clinical implications	Study quality rating
Burgette and Rezaie [13], 2020	Children with ASD (n = 1228)	Caregiver-reported dental caries	Neurotypical children (n = 43927)	ASD children had 40% higher odds of developing dental caries (AOR = 1.4, 95%CI = 1.2–1.7)	Cross-sectional study using 2016 National Survey of Children's Health	Behavioral difficulties in oral hygiene; Dietary habits high in sugar; Limited access to specialized dental care	Need for early preventive measures, including caregiver education and fluoride use; Policy changes to improve insurance coverage for ASD dental care	High Quality
Azimi *et al*[15], 2022	Children with ASD and/or Intellectual Disability (ID)	Dental procedures under general anesthesia in hospitals	Neurotypical children	ASD/ID children had more extractions (68.7%) and fewer restorations (16.2%) Indigenous children had worse outcomes	Population-based cohort study (Western Australia)	Delayed diagnosis leading to severe decay; Sensory issues preventing routine care; Socioeconomic disparities (Indigenous children had worse outcomes)	Increase ASD-friendly preventive dental programs to avoid invasive treatments; Address racial and socioeconomic disparities in dental care	Moderate Quality
Babu and Roy [14], 2022	Children with ASD (n = 50)	Dental caries and salivary electrolyte analysis	Neurotypical children (n = 50)	ASD children had higher DMFT scores Altered salivary composition: Increased magnesium & decreased calcium, sodium, potassium.	Case-control study	Salivary imbalance may contribute to enamel erosion; Nutritional deficiencies (low calcium, sodium, and phosphorus)	Potential use of salivary biomarkers for early detection of caries risk; Saliva-enhancing therapies should be explored	High Quality
Azimi *et al*[16], 2022, WA study	Children with ASD and/or Intellectual Disability (ID)	Hospitalization for dental conditions	Neurotypical children	Higher hospitalization rates due to severe untreated dental disease Socioeconomically disadvantaged ASD children were at the highest risk	Retrospective cohort study (1983-2010)	Lack of preventive dental visits; Severe dental disease requiring extractions; Lower socioeconomic status	Mobile dental clinics & school-based interventions to improve access; Early screening programs in ASD children	Moderate quality
Lai *et al* [17], 2012	Children with ASD (n = 568)	Identifying barriers to dental care	General pediatric population	12% of ASD children had unmet dental needs Main barriers: Behavioral challenges, cost, and lack of insurance	Survey-based cross-sectional study	Caregiver's own dental visit history influenced child's access; Lack of ASD-trained dentists; Behavioral resistance to treatment	Expand insurance coverage for ASD-specific dental care - Train more dentists in ASD-friendly treatment approaches	Moderate Quality
de Souza *et al*[18], 2024	Children with ASD (n = 100)	Utilization of dental services	General pediatric population	25% had never been to a dentist Primary care engagement improved access	Cross-sectional study (Brazil)	Lack of awareness about the importance of dental care; Activity limitations due to ASD severity; Male caregivers were less likely to seek dental care for their children	Strengthen the role of primary care providers in promoting dental visits; Improve caregiver education and awareness	Moderate Quality

AOR: Adjusted odds ratio; ASD: Autism spectrum disorder; DMFT scores: Number of decayed (D), missing due to caries (M) and filled (F) teeth (T); ID:

Intellectual disability.

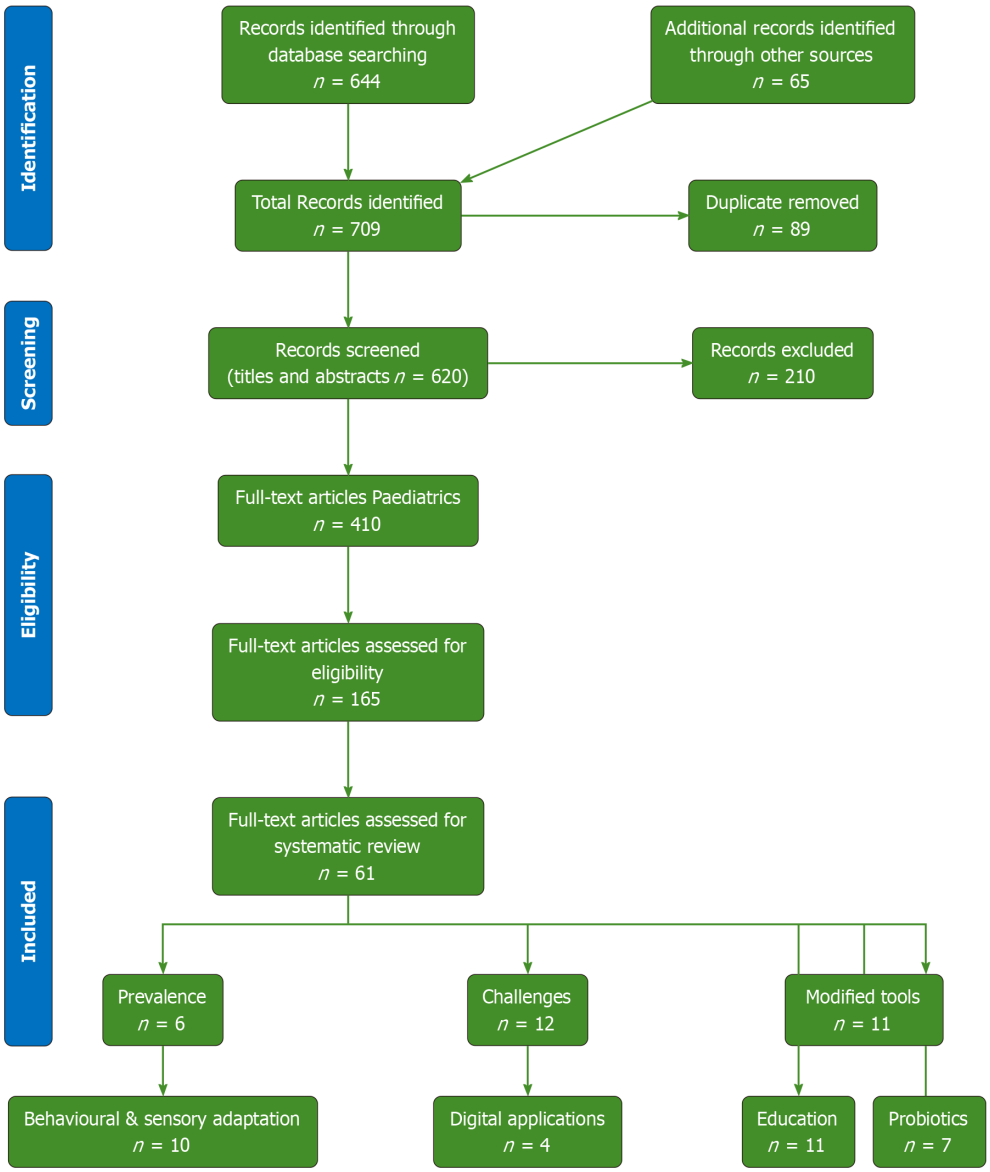

Figure 1 The flow chart of the included studies.

Access to dental services for children with ASD is further complicated by financial constraints, a shortage of ASD-trained dentists, and behavioral resistance to treatment[17]. Studies indicate that a significant proportion of ASD children have unmet dental needs, with a caregiver's dental visit history strongly influencing the likelihood of their child receiving timely oral care[17]. However, research suggests that engagement with primary healthcare services improves access to dental care[18], emphasizing the need for stronger collaboration between pediatricians and dental professionals. Educational programs targeted at caregivers could further enhance awareness and promote preventive measures, ultimately improving long-term oral health outcomes in this vulnerable population.

Challenges

Table 3 summarizes the key studies focused on barriers and challenges encountered by children with ASD and their caregivers in accessing and receiving dental care. Sensory and behavioral challenges are among the most significant barriers to dental care for children with ASD. Uncooperative behavior is frequently reported, with up to 65% of ASD children being uncooperative in dental settings, making routine dental procedures difficult[19]. Additionally, sensory sensitivities contribute to distress during dental visits, often leading to delayed treatments and an increased reliance on general anesthesia for procedures[20,21]. Financial burdens and insurance limitations further restrict access to dental care for ASD children. Studies indicate that ASD dental care incurs higher costs than for neurotypical children, exacerbating disparities in access[22]. Furthermore, 75.4% of caregivers report cost as a major barrier, with many struggling to afford specialized dental services[23,24]. The lack of insurance coverage for ASD-specific dental needs remains a persistent

Table 3 Summary of studies on challenges faced by children with autism spectrum disorder and their parents in dental care using the PICO framework

Ref.	Population	Intervention/Exposure	Comparison	Outcome	Study design	Key challenges identified	Clinical implications	Study quality rating
Alvares *et al*[20], 2023	Parents of children with ASD (n = 140)	Parental reports on oral health and barriers to care	None	26% of ASD children had untreated dental problems; 33% required general anesthesia for dental procedures	Cross-sectional study (Australian Autism Biobank)	Intellectual disability increased dental care challenges; sensory difficulties made access harder; functional limitations linked to greater dental problems	Need for personalized ASD-friendly dental care models; expand desensitization programs for children with ASD	Moderate quality
Alshihri *et al*[23], 2021	Parents of ASD children (n = 142)	Barriers to accessing professional dental care	None	68.3% of parents found it difficult to access dental care; 75.4% cited cost as a major barrier	Cross-sectional survey	Cost, lack of ASD-trained dentists, and child's behavior were the main challenges; medical insurance and past dental experiences influenced access	Improve insurance coverage for ASD-specific dental care; increase training for dental professionals in ASD patient management	Moderate quality
Taneja and Litt[28], 2020	Parents of ASD children (n = 46)	Caregiver-reported barriers to dental care	Parents of neurotypical children with chronic illnesses (n = 37)	39% of ASD caregivers reported uncooperative child behavior as a key barrier	Case-control survey	Finding ASD-trained dentists was a major issue; parents of severe ASD cases reported the most difficulties	Promote ASD-specific behavior management training for dentists; develop caregiver education programs on oral hygiene techniques	Moderate quality
Barry *et al*[24], 2014	Parents of ASD children (n = 112)	Access and barriers to dental care	Parents of neurotypical children	ASD children had greater difficulties traveling to dental clinics; predicted more negative behaviors in dental settings	Case-control questionnaire	Difficulty accessing ASD-adapted dental clinics; travel to the dental office was harder for ASD children	Establish mobile dental services and home-based preventive care	Moderate quality
Azevedo Machado *et al*[29], 2022	Parents of ASD children and adolescents (n = 1001)	Impact of COVID-19 on dental care	None	61.6% of parents reported significant routine disruption; 59.3% believed their child feared PPE use	Cross-sectional online survey (Brazil)	Fear of PPE and changes in routine disrupted care; dental visits decreased during the pandemic	Develop tele-dentistry models for ASD children; train dentists to use ASD-friendly PPE and gradual exposure techniques	Moderate quality
Logrieco *et al*[27], 2021	Parents of ASD children (n = 57) & dentists (n = 61)	Experiences of ASD children, parents, and dentists during dental visits	Parents of neurotypical children (n = 275)	ASD children had higher dental anxiety; dentists found it difficult to manage ASD behaviors	Comparative study (Italy)	Lack of ASD-trained dentists was a major concern; caregivers struggled to find professionals	Increase dental training programs in ASD care; improve dentist-parent communication on behavior strategies	Moderate quality
Baek *et al*[22], 2024	ASD children (n = 209780)	Frequency and cost of dental visits	Neurotypical children	ASD children had fewer visits but higher costs; ASD children had higher rates of	Population-based cross-sectional study (Korea)	Financial burden was higher for ASD families; trauma rates were	Improve affordable access to ASD-friendly dental services; increase preventive dental	High quality

				dental trauma		significantly elevated	trauma education	
Marshall *et al*[19], 2007	ASD children (n = 108)	Factors influencing cooperation in dental settings	None	65% of ASD children were uncooperative; language, sensory issues, and routine disruption affected cooperation	Survey-based study	Nonverbal children were less likely to cooperate; poor sensory adaptation increased uncooperative behavior	Implement structured pre-visit sensory adaptation; use individualized behavior management techniques	Moderate quality
McKinney *et al*[30], 2014	ASD children (n = 2772)	Predictors of unmet dental needs	None	15.1% of ASD children had unmet dental needs; lack of a medical home increased risk (AOR = 4.46)	National survey analysis (US)	Children with ASD and intellectual disability had worse access; lack of a primary healthcare connection increased risk	Integrate dental screenings into pediatric medical visits; improve referral pathways between doctors and dentists	High quality
Brickhouse *et al*[26], 2009	Parents of ASD children (n = unknown)	Barriers to dental care in Virginia	None	Difficult behavior and lack of ASD-trained dentists were the biggest barriers	Survey-based study	ASD children visited the dentist less frequently; difficulty finding willing and trained providers	Develop ASD training for general dentists; improve dental accessibility through policy reforms	Moderate quality
Loo *et al* [21], 2009	ASD children (n = 395)	Behavioral management in dental care	Neurotypical children (n = 386)	ASD children were more uncooperative; severe ASD cases required general anesthesia more often	Retrospective chart review	ASD patients with higher caries severity and sensory issues were harder to manage	Train dentists in non-pharmaco-logical behavioral guidance techniques	Moderate quality
Wiener *et al*[25], 2016	Parents of ASD children (n = 16323)	Caregiver burdens and dental care access	None	16.3% of ASD children had unmet preventive dental needs; financial and employment burdens increased risks	National survey analysis	Financial and time constraints prevented access to preventive care	Improve dental insurance coverage and flexible scheduling for ASD families	High quality

ASD: Autism spectrum disorder; COVID-19: Coronavirus disease 2019; PPE: Personal protective equipment; US: United States.

issue, preventing families from seeking necessary preventive and therapeutic interventions[25].

Another major challenge is the difficulty in finding ASD-trained dentists. Many providers lack the necessary training to manage ASD patients effectively, making it hard for caregivers to secure appropriate dental care[26,27]. Parents of children with severe ASD face even greater obstacles, as these children require more specialized care and tailored behavioral management techniques, which are not always available[27,28]. The coronavirus disease 2019 (COVID-19) pandemic further exacerbated these challenges by disrupting routine dental care. Many ASD children experienced a significant drop in dental visits, and the widespread use of personal protective equipment in clinics contributed to increased dental anxiety, making treatment sessions more challenging[29]. Despite these barriers, improved medical-dental integration could enhance access to care for ASD children. Research indicates that ASD children who have a medical home—meaning they receive coordinated care through a regular pediatrician—are more likely to receive necessary dental services[30]. This highlights the need for stronger collaboration between pediatricians and dental professionals to ensure timely referrals and comprehensive oral healthcare for ASD patients.

Effectiveness of modified dental tools and techniques in managing dental disorders in children with autism

Children with ASD face unique challenges during dental visits, necessitating the use of modified tools and techniques to improve their dental care experiences. Various studies have demonstrated that structured behavioral interventions, visual aids, and technology-based strategies can significantly enhance cooperation and compliance in this population (Table 4). For instance, older children with ASD and those enrolled in special education programs exhibited better cooperation during dental treatment, highlighting the importance of tailored educational interventions[31]. The integration of information and communication technologies (ICT), such as the MyDentist program, has been found to improve oral hygiene and treatment compliance without the need for pharmacological interventions[32]. Similarly, structured-visual

Table 4 Summary of studies on modified dental tools and techniques for managing dental disorders in children with autism spectrum disorder using the PICO framework

Ref.	Population	Intervention	Comparison	Outcome	Study design	Key findings	Study quality rating
Dangulavanich *et al*[31], 2017	Children with ASD (*n* = 95)	Evaluated cooperation during dental treatment based on sensory processing factors and behavioral characteristics	None	Age, education, behavior before treatment significantly influenced cooperation	Cross-sectional study	Older children (11–18 years) and those in special education showed better cooperation	Moderate quality
Narzisi *et al*[32], 2020	Children with ASD (*n* = 59)	ICT-based intervention (MyDentist) to familiarize children with dental settings	Conventional dental visits	Improved oral hygiene and cooperation during treatment	Feasibility study	ICT interventions can enhance dental care acceptance without pharmacological interventions	Moderate quality
Octavia *et al*[33], 2025	Children with ASD (*n* = 37)	Structured-visual behavioral model for compliance and cooperation	Standard dental approach	Improved cooperation and compliance during dental exams	Quasi-experimental study	75% achieved the highest cooperation scores on the Frankl Behavior Scale (FBS)	Moderate quality
Mah and Tsang[34], 2016	Children with ASD (*n* = 14)	Visual schedule system for dental visits	Tell-show-do method	Faster task completion and lower behavioral distress	RCT	Visual schedules improved dental visit success rates	High quality
Isong *et al*[35], 2014	Children with ASD (*n* = 80)	Electronic screen media to reduce dental anxiety	No media intervention	Decreased anxiety and improved behavior during dental visits	RCT	Video peer modeling and video goggles reduced fear and increased cooperation	High quality
Cenzon *et al*[36], 2022	Dental hygiene students	SVT for ASD patient management	No SVT training	Improved confidence and knowledge in treating ASD patients	Pilot study	Virtual training enhances ASD dental care preparedness	Moderate quality
Thomas *et al*[37], 2018	Parents of children with ASD (*n* = 17)	Parental experiences with dental care access and needs	None	Identified need for flexible dental environments and better communication	Qualitative study	Family-centered care and dentist-parent communication are crucial	Moderate quality
Wibisono *et al*[38], 2016	Children with ASD & caretakers	Use of dental visit pictures as communication tools	None	Positive perception of visual aids for dental preparation	Qualitative study	Pictures enhanced understanding of dental visits among ASD children	Moderate quality
Cagetti *et al*[39], 2015	Children with ASD (*n* = 83)	Visual supports-based dental care protocol	Standard dental care	Increased acceptance of dental procedures	Observational study	Non-verbal children benefitted from visual training	Moderate quality
Naidoo and Singh[40], 2020	Children with ASD	Dental communication board for improved communication	No communication board	Enhanced interaction between children and dentists	Mixed-methods study	Visual communication tools facilitated dental visits	Moderate quality
Nilchian *et al*[41], 2017	Children with ASD (*n* = 6-12 years)	Visual pedagogy for dental check-ups	Standard approach	Increased compliance with dental check-ups	RCT	Visual pedagogy improved cooperation in dental visits	High quality

ASD: Autism spectrum disorder; ICT: Information and communication technologies; RCT: Randomized controlled trial; SVT: Simulated-virtual training.

behavioral models, including visual pedagogy and storytelling approaches, have proven effective in increasing cooperation levels, with 75% of participants achieving the highest Frankl Behavior Scale score after intervention[33]. The use of visual schedule systems during dental visits has also been beneficial, allowing children to complete procedures more efficiently and with less distress compared to traditional tell-show-do methods[34].

Technological interventions, such as electronic screen media, have shown promise in alleviating dental fear, with video peer modeling and video goggles reducing anxiety and improving behavioral outcomes in children with ASD[35]. Additionally, simulated-virtual training for dental hygiene students has increased confidence and preparedness in treating ASD patients, suggesting that incorporating ASD-specific training into dental curricula could improve service quality[36]. Parental experiences further underscore the need for flexible dental environments and improved dentist-parent communication to address the unique challenges of ASD dental care[37]. The effectiveness of visual aids in

enhancing dental visit preparedness was reinforced by a study demonstrating that children with ASD responded positively to dental visit pictures, improving their perception and acceptance of clinical procedures[38]. A visual-support-based dental care protocol has also been associated with higher acceptance rates for dental procedures, particularly among non-verbal children with ASD[39]. Furthermore, implementing a dental communication board has been shown to facilitate interaction between children with ASD and dental professionals, ensuring better information exchange and cooperation during procedures[40]. Finally, using visual pedagogy techniques in dental check-ups has been linked to increased compliance, reinforcing the importance of structured, autism-friendly approaches in dental care settings[41]. Collectively, these studies highlight the necessity of integrating specialized tools, behavioral strategies, and technology-driven interventions to enhance the dental care experience for children with ASD.

Effectiveness of behavioral and sensory adaptation techniques in managing dental disorders in children with autism

Children with ASD often experience significant challenges in accessing and tolerating dental care due to sensory sensitivities and behavioral differences. Various studies have evaluated behavioral and sensory adaptation techniques to improve compliance and reduce anxiety in dental settings (Table 5). The use of dental stories as preparatory aids has been shown to be beneficial, with 64% of caregivers reporting them as useful in preparing their children for dental visits[42]. Similarly, a structured dental desensitization program based on task analysis has led to increased comfort and the successful completion of dental steps, particularly in children with expressive and receptive language skills[43]. Parent-reported studies on desensitization techniques further support their effectiveness in reducing anxiety and improving treatment acceptance, though barriers such as financial burden and frequent appointments remain significant challenges [44].

Long-term benefits of desensitization techniques have also been observed, with a two-year follow-up study demonstrating that 92% of children retained examination skills and 83% accepted toothbrush prophylaxis[45]. Individualized habituation programs, when implemented in collaboration with school personnel, have shown an 82% success rate in completing dental exams and increased compliance with mirror and probe use[46]. The role of occupational and speech therapists in dental care has also been explored, highlighting their potential in early intervention, pre-visit preparation, and behavior management strategies[47].

Desensitization techniques incorporating anxiety-reducing stimuli have been particularly effective, with experimental studies confirming that systematic desensitization improves step completion during dental visits[48]. The implementation of visual schedule systems has further facilitated smoother dental experiences by reducing distress and accelerating task completion[34]. Applied behavior analysis (ABA) has also been identified as an effective behavior management approach, enhancing cooperation in children with ASD during dental procedures[49].

Sensory adaptations within the dental environment have demonstrated significant physiological and behavioral benefits. A randomized crossover trial found that children undergoing dental care in a sensory-adapted dental environment exhibited reduced physiological stress and behavioral distress compared to those in a regular dental environment[50]. Furthermore, studies examining behavioral factors influencing dental health have revealed that children requiring higher levels of support exhibit increased caries prevalence due to poor mealtime behavior and dental noncompliance[51]. Collectively, these studies underscore the necessity of integrating behavioral and sensory adaptation strategies to optimize dental experiences for children with ASD and improve their long-term oral health outcomes.

Digital applications for improving dental and oral health in children with autism

Digital applications have emerged as promising tools to support oral health education and dental care experiences for children with autism. Recent studies have explored their effectiveness in enhancing oral hygiene, reducing anxiety during dental visits, and assisting caregivers in managing oral health routines. Tan *et al*[52] developed a mobile app featuring social stories, visual schedules, and direct communication tools for caregivers and dentists. Their findings indicated that the app was well-received and improved awareness and access to oral health resources. Similarly, Krishnan *et al*[53] evaluated the effectiveness of a mobile app called Brush Up compared to visual pedagogy in promoting oral hygiene among autistic adolescents. Both interventions significantly reduced plaque and gingival scores, demonstrating that mobile-based tools can be as effective as traditional educational methods in improving oral hygiene.

Lefer *et al*[54] investigated a tablet-based training program using pictograms (çATED app) to teach tooth brushing to children with ASD. Their study found that the app helped improve brushing skills and promoted greater autonomy in oral hygiene routines. Additionally, Stamatović *et al*[55] assessed the impact of a Serbian-language mobile app designed to assist autistic children during dental visits. Their results suggested that the app improved cooperation with dentists and reduced dental anxiety. These findings highlight the potential of digital applications as effective tools in promoting oral health behaviors and facilitating better dental experiences for autistic children. Integrating mobile-based interventions can bridge gaps in oral health education, support caregivers, and provide children with ASD a structured and familiar approach to dental care. Table 6 summarizes the key studies on the use of digital applications for improving oral health in autistic children.

Parental and healthcare professional education on managing dental disorders in children with autism

Parental and healthcare professional education plays a critical role in improving dental care outcomes for children with autism. Studies have consistently highlighted the challenges faced by parents and healthcare providers in ensuring effective dental care for autistic children. Table 7 summarizes these key studies and findings. Parents often struggle with knowledge gaps regarding hospital dentistry, as observed by Tahririan *et al*[56], which limits their ability to advocate for appropriate care. Parental education programs, such as training interventions and structured guidance, have shown positive effects on oral hygiene and cooperation during dental visits[57,58]. Parents with greater awareness of behavior management techniques and sensory adaptations are better equipped to support their children during dental visits,

Table 5 Summary of studies on behavioral and sensory adaptation techniques for managing dental disorders in children with autism spectrum disorder using the PICO framework

Ref.	Population	Intervention	Comparison	Outcome	Study design	Key findings	Study quality rating
Marion *et al* [42], 2016	Children with ASD (n = 40)	Use of dental stories to prepare for dental visits	No preparatory aids	64% of caregivers found dental stories useful for their child's preparation	Survey-based study	Caregivers preferred individualized story formats to match child's comprehension level	High quality
Star *et al*[43], 2023	Children with ASD (n = 52)	Dental desensitization program (task analysis approach)	Standard preventive visits	Increased comfort and step completion in dental visits	Prospective cohort study	Children with expressive and receptive language skills benefited most	Moderate quality
Cai *et al*[44], 2022	Parents of children with ASD (n = 13)	Parent-reported effectiveness of desensitization	No structured desensitization	Reduced anxiety and improved treatment acceptance	Qualitative study	Barriers include financial burden and frequent appointments	Low quality
Yost *et al*[45], 2019	Children with ASD (n = 138)	Two-year follow-up on desensitization treatment	Initial exam acceptance only	92% retained examination skills, 83% accepted toothbrush prophylaxis	Retrospective case series	Sensory-invasive skills (radiographs) were acquired less frequently	Moderate quality
Myhren *et al* [46], 2023	Children with ASD (n = 17)	Individualized dental habituation program	Standard dental exams	82% completed dental exams, increased compliance with mirror and probe	Mixed-methods study	Collaboration with school personnel improved outcomes	Moderate quality
Junnarkar *et al*[47], 2022	Occupational & speech therapists	Role of therapists in dental care	No therapist involvement	Identified barriers to oral care and potential solutions	Qualitative study	Therapists play a key role in early intervention and pre-visit preparation	Moderate quality
Luscre and Center[48], 1996	Children with ASD (n = 3)	Desensitization with anxiety-reducing stimuli	No desensitization	Increased step completion in a clinical setting	Experimental study	Systematic desensitization reduces dental fear	Moderate quality
Mah and Tsang[34], 2016	Children with ASD (n = 14)	Visual schedule system during dental visits	Tell-show-do method	Faster task completion, reduced distress	RCT	Visual schedules enhanced cooperation and reduced anxiety	High quality
Hernandez and Ikkanda [49], 2011	Children with ASD	ABA in dental care	Standard behavior management	Improved cooperation with dental procedures	Literature review	ABA principles effectively modify problematic dental behaviors	Low quality
Uliana *et al* [42], 2024	Children with ASD (n = 61)	Impact of behavioral factors on caries prevalence	Cooperative children	Higher support needs linked to increased caries rates	Cross-sectional study	Poor mealtime behavior and dental noncompliance increased caries risk	Low quality

ABA Applied behavior analysis; ASD: Autism spectrum disorder; RCT: Randomized controlled trial.

leading to improved outcomes[59,60]. Parents with greater awareness of behavior management techniques and sensory adaptations are better equipped to support their children during dental visits, leading to improved outcomes[61-63]. Additionally, studies indicate that individualized approaches, such as structured desensitization and visual schedules, can enhance dental visit success for autistic children[64-66].

On the healthcare professional side, research underscores the need for specialized training in behavior guidance techniques[64-66]. Dentists with prior experience or training in managing autistic patients demonstrate better treatment success and higher parental confidence in dental care approaches[61,64]. The lack of ASD-trained dentists remains a significant barrier, emphasizing the importance of integrating autism-specific training into dental education curricula [65]. Furthermore, parents express a preference for dentists who adopt individualized and adaptive treatment strategies, reinforcing the importance of communication and partnership between caregivers and dental professionals[61,63,66]. Overall, the findings suggest that both parental training and healthcare professional education are essential in improving dental care experiences and outcomes for children with autism.

Oral microbiota alterations and their implications for probiotic use in children with autism

Currently, there is a lack of direct studies focusing on the use of probiotics to improve oral health specifically in children with ASD. While several studies have explored the role of probiotics in addressing gastrointestinal symptoms and

Table 6 Summary of studies on digital app use for improving dental and oral health in children with autism

Ref.	Population	Intervention	Comparison	Outcome	Study design	Key findings	Study quality rating
Tan *et al* [52], 2024	Caregivers and autistic children	Development of a mobile app with social stories, visual schedules, and communication tools for caregivers and dentists	No mobile app intervention	App was well-received by experts and parents; improved awareness and access to oral health resources	Developmental study	Highlighted the need for digital tools to support caregivers in managing oral health of autistic children	Moderate quality
Krishnan *et al*[53], 2021	Adolescents with ASD (13-17 years)	Mobile app (Brush Up) *vs* visual pedagogy for oral health education	No digital intervention	Significant reduction in plaque and gingival scores in both intervention groups	Interventional parallel-arm study	Mobile apps and visual pedagogy were equally effective in improving oral hygiene in autistic adolescents	High quality
Lefer *et al* [54], 2018	Children with ASD (3-19 years)	Tablet-based training program using pictograms (çATED app) for tooth brushing	Traditional instruction	Improved brushing skills and autonomy in children using the app	Exploratory study	Demonstrated effect-iveness of digital tools in teaching oral hygiene habits	High quality
Stamatović *et al*[55], 2023	Children with ASD and their families	Mobile app in Serbian for dentist visit support	No app intervention	App improved cooperation with dentists and reduced anxiety	Cross-sectional study	Suggested mobile apps can help autistic children adapt to dental visits	Moderate quality

ASD: Autism spectrum disorder; çATED: Digital agenda designed for individuals with autism (name of the application).

behavioral aspects in children with ASD, the research on their direct impact on oral health within this population remains limited. However, the potential benefits of probiotics on oral health are well-documented in the general pediatric population. Several studies have reported alterations in the oral microbiota of children with ASD, characterized by an increased prevalence of pathogenic bacteria and a reduction in beneficial commensals. These microbial imbalances have been associated with a heightened risk of dental caries and periodontal disease in this population. Research suggests that probiotics may play a therapeutic role by restoring microbial equilibrium, thereby potentially improving oral health outcomes. Probiotics have been shown to balance the oral microbiome, reduce the prevalence of dental caries, and improve periodontal health[67,68]. Given that children with ASD often face unique oral health challenges, such as a higher prevalence of dental caries and periodontal disease, there is a plausible rationale for investigating the application of probiotics as a therapeutic strategy in this group[69].

Recent studies have highlighted significant differences in the oral microbiota composition of children with ASD compared to neurotypical controls. Kong *et al*[70] identified distinct oral microbiota signatures in ASD patients and suggested that microbial biomarkers could potentially aid ASD diagnosis. Their findings also indicated that probiotics might alter the microbiome and help alleviate comorbid conditions. Evenepoel *et al*[71] found that specific bacterial genera, including *Solobacterium, Stomatobaculum, Ruminococcaceae UCG.014, Tannerella,* and *Campylobacter*, were significantly more abundant in ASD children, correlating with increased social difficulties and anxiety. Qiao *et al*[72] reported reduced bacterial diversity in ASD children's oral microbiota, with an increase in pathogenic bacteria like *Haemophilus* and *Streptococcus* and a decrease in beneficial commensals such as *Prevotella* and *Fusobacterium*. These findings suggest that the oral microbiome plays a critical role in ASD and may influence both oral and systemic health outcomes. Given the observed microbial imbalances, targeted probiotic interventions could be explored as a potential therapeutic approach. Further research is needed to determine whether modifying the oral microbiota through probiotic supplementation could improve oral health and reduce associated ASD symptoms. While existing research supports the general benefits of probiotics for oral health, there is a need for targeted studies to evaluate their efficacy specifically in children with ASD. Such research could provide valuable insights into potential therapeutic approaches tailored to the unique needs of this population. Table 8 summarizes key studies examining oral microbiota differences in children with ASD and their potential implications for probiotic interventions.

How can interdisciplinary collaboration improve dental care for children with autism?

Although there is a lack of direct studies investigating interdisciplinary collaboration in dental care for children with ASD, insights can be drawn from existing research. Many studies highlight the barriers that autistic children and their caregivers face, including financial constraints, behavioral challenges, and a shortage of ASD-trained dental professionals [65]. Addressing these challenges requires a collaborative approach involving dentists, pediatricians, occupational and speech therapists, behavioral specialists, and caregivers. Parental education and engagement are critical factors in improving dental outcomes for autistic children. Studies suggest that well-informed parents are more likely to seek early dental care and adopt preventive oral hygiene measures[57,59]. Additionally, interdisciplinary partnerships between pediatricians and dentists have been shown to enhance access to dental care by ensuring timely referrals and integrated health services[18].

Table 7 Summary of studies on parental and healthcare professional education on managing dental disorders in children with autism using the PICO framework

Ref.	Population	Intervention	Comparison	Outcome	Study design	Key findings	Study quality rating
Parry *et al*[59], 2021	Parents of autistic children	Partnership Working, System Change, and Training of Dental Staff	No structured intervention	Improved parent confidence and advocacy in dental settings	Qualitative Focus Group Study	Highlighted the need for tailored interventions and better understanding of sensory and communication barriers	Low quality
Chanin *et al*[60], 2023	Parents of autistic children (n = 235)	Parent perception assessment of child's behavior during first dental visit	No structured parental feedback system	Age and ethnicity influenced dental visit success; parental perception significantly predicted behavior	Cross-sectional study	Demonstrated that coordinating with parents improved dental visit outcomes	Moderate quality
Fenning *et al*[57], 2022	Underserved autistic children (n = 119)	Parent Training for oral hygiene improvement	Psychoeducational dental toolkit	Increased twice-daily toothbrushing (78% *vs* 55% at 3 months); reduced plaque and caries development	RCT	Parent Training significantly improved oral hygiene, reducing problem behaviors and dental caries	High quality
Du *et al*[58], 2019	Preschool children with ASD and their parents (n = 257)	Assessment of oral health behaviors and barriers	Age- and gender-matched neurotypical children	ASD children brushed less frequently and required more parental assistance; parents had higher dental knowledge	Cross-sectional study	Highlighted need for specialized parental education programs	Moderate quality
Lewis *et al*[61], 2015	Parents of autistic children (Focus Groups)	Parental perspectives on dental care experiences	No structured support system	Need for individualized care approaches and increased parental involvement	Qualitative study	Identified variability in ASD children's dental care tolerance and emphasized family-centered approaches	Low quality
Polprapreut *et al*[62], 2022	Children with developmental disabilities (n = 263)	Analysis of parenting styles and unmet dental needs	Positive *vs* less positive parenting styles	Less positive parenting styles were linked to higher unmet dental needs (OR = 2.19)	Cross-sectional study	Highlighted role of parenting styles in dental health outcomes	High quality
Manopetchkasem *et al*[64], 2023	Parents of autistic children (n = 141)	Parental acceptance of Advanced BGTs	Parents with *vs* without prior BGT experience	Parents with experience rated BGTs more favorably	Cross-sectional study	Prior exposure to BGTs increased acceptance and reduced resistance	Moderate quality
Tahririan *et al*[56], 2021	Parents of autistic children (n = 100)	Knowledge, attitude, and performance regarding hospital dentistry	No structured education on hospital dental services	56% had poor knowledge; 69% reported low child cooperation	Cross-sectional study	Identified gaps in parental knowledge about hospital dental care	Moderate quality
Junnarkar *et al*[65], 2023	Parents of autistic children (n = 23)	Barriers and coping strategies in accessing dental care	No structured parental education program	Identified sensory issues, financial constraints, and lack of specialized dentists as main barriers	Qualitative study	Recommended improving parental awareness and financial support for multiple acclimatization visits	Low quality
Verma *et al*[63], 2022	Parents of autistic children	Assessment of unmet dental needs and barriers	No targeted intervention	Identified socio-psychological factors influencing dental care utilization	Cross-sectional study	Found financial and psychological barriers were key obstacles to dental care	Moderate quality
Marshall *et al*[66], 2008	Healthcare professionals treating autistic children	Evaluation of BGTs used in dental treatment	No structured training on BGTs	Parents accurately predicted child cooperation; positive reinforcement and tell-show-do were most accepted	Survey-based study	Basic BGTs were more accepted than advanced techniques; parental attitudes influenced acceptance	Moderate quality

ASD: Autism spectrum disorder; BGTs: Behavior guidance techniques; OR: Odds ratio; RCT: Randomized controlled trial.

Table 8 Summary of studies on oral microbiota in children with autism

Ref.	Population	Intervention	Comparison	Outcome	Study design	Key findings	Study quality rating
Kong *et al* [70], 2019	Children with ASD and neurotypical controls	Analysis of oral and gut microbiota using 16S rRNA sequencing	Neurotypical children	Identified distinct oral and gut microbiota signatures; explored microbial biomarkers for ASD diagnosis	Pilot study	ASD children had unique oral microbiota profiles with potential diagnostic biomarkers; suggested probiotics could alter microbiome and improve comorbid conditions	Moderate quality
Evenepoel *et al*[71], 2024	80 autistic children (8-12 years) and 40 neurotypical peers	Examination of oral microbiota differences using high-throughput sequencing	Typically developing children	ASD children had higher abundances of *Solobacterium, Stomatobaculum, Ruminococcaceae UCG.014, Tannerella,* and *Campylobacter*; associations found with social difficulties and anxiety	Cross-sectional study	Oral microbiome variations correlated with ASD symptom severity and were not significantly driven by lifestyle factors	High quality
Qiao *et al* [72], 2018	32 ASD children and 27 healthy controls	High-throughput sequencing of salivary and dental microbiota	Neurotypical children	ASD children had lower bacterial diversity, higher pathogenic bacteria (*Haemophilus, Streptococcus*), and reduced commensals (*Prevotella, Fusobacterium, Actinomyces*)	Case-control study	Significant microbiota differences in ASD children; proposed microbial markers for ASD diagnosis	Moderate

ASD: Autism spectrum disorder; rRNA: Ribosomal ribonucleic acid.

The role of behavioral specialists and occupational therapists in dental settings is also gaining recognition. These professionals can assist in desensitization programs and implement strategies to help ASD children adapt to dental procedures, reducing anxiety and improving cooperation[47]. The use of digital applications further supports interdisciplinary collaboration by allowing dentists, therapists, and caregivers to coordinate care through shared educational resources, structured behavioral interventions, and real-time communication tools[52,55]. Furthermore, studies on the effectiveness of specialized dental tools and techniques suggest that integrating behavioral therapy with structured visual and sensory supports significantly improves compliance during dental visits[33,34]. A coordinated effort among professionals trained in autism-specific strategies can help create individualized treatment plans that address both behavioral and oral health needs. Overall, interdisciplinary collaboration has the potential to enhance the accessibility and effectiveness of dental care for children with ASD. By fostering communication between healthcare providers, caregivers, and behavioral specialists, a more inclusive and supportive approach to dental health can be achieved. This highlights the importance of continued research and the development of integrated care models to improve oral health outcomes in autistic children.

DISCUSSION

Oral health in children with ASD

Children with ASD face unique and multiple challenges that can negatively impact their oral health. Children with ASD often experience a combination of sensory, behavioral, physiological, and environmental challenges that significantly impair their oral health. Sensory sensitivities play a significant role, as hypersensitivity to textures, tastes, temperatures, or sounds can overwhelm oral care[73]. For example, the foaming action of toothpaste, the bristle texture of a toothbrush, or the humming noise of an electric brush may trigger distress, leading to resistance or outright refusal of brushing[74]. This avoidance results in inconsistent hygiene practices, allowing plaque to accumulate and increasing the risk of cavities, gingivitis, and periodontal disease. Communication and behavioral challenges further complicate care, as children with ASD may struggle to articulate discomfort or understand verbal instructions about brushing techniques[75]. Non-verbal children, in particular, might not express dental pain, delaying diagnosis of issues like cavities or gum inflammation until they escalate into severe conditions such as abscesses, infections, or even tooth loss[69].

Dietary preferences, often shaped by sensory aversions or rigid eating habits, compound these risks. Many children with autism favor soft, sticky, or sugary foods (*e.g.*, crackers, candies, or processed snacks), which cling to teeth and create an acidic oral environment that erodes enamel and fuels bacterial growth. This dietary pattern heightens susceptibility to dental caries (cavities) and enamel erosion, particularly when combined with poor hygiene[76]. Medication side effects

introduce another layer of complexity. Drugs commonly prescribed for ASD-related symptoms—such as antipsychotics (*e.g.*, risperidone) or anticonvulsants—often cause dry mouth (xerostomia), reducing saliva's natural role in neutralizing acids, remineralizing enamel, and washing away food particles[77]. Chronic dry mouth elevates cavity risk and contributes to oral infections (*e.g.*, thrush) and persistent bad breath[78].

Motor skill difficulties, including poor hand-eye coordination or low muscle tone, can make brushing and flossing physically challenging. Children may struggle to maneuver a toothbrush effectively, leaving plaque trapped in hard-to-reach areas, accelerating gum inflammation (gingivitis) or more advanced periodontal disease. Resistance to routine changes further limits adaptability in oral care[79]. For instance, introducing fluoride rinses, interdental brushes, or even a new toothpaste flavor may provoke anxiety, leading to rejection of these preventive tools. Similarly, disruptions to established routines—like scheduling a dental visit—can trigger distress, causing families to delay or avoid professional care altogether[7]. This avoidance exacerbates untreated issues, allowing minor dental problems to progress into emergencies.

Self-injurious behaviors (SIB) and bruxism (teeth grinding) present additional risks. Repetitive actions like biting lips, cheeks, or fingers or grinding teeth during sleep can cause physical trauma, including fractured teeth, enamel wear, or soft-tissue injuries. These behaviors are often linked to sensory-seeking tendencies or stress, requiring targeted behavioral interventions to mitigate harm[80]. Finally, limited access to dental care stems from sensory overload in clinical settings—such as bright lights, loud equipment, or unfamiliar tactile sensations—which can overwhelm children with ASD, leading to dental anxiety and avoidance[81]. Without regular check-ups, conditions like untreated decay, advanced gum disease, or malocclusion (misaligned teeth) may go unaddressed, necessitating invasive treatments under sedation or general anesthesia. These factors usually operate together. For example, sensory aversions may lead to poor brushing, which creates a perfect storm for rapid decay combined with a sugary diet and dry mouth. Similarly, communication barriers and dental anxiety can delay diagnosis, allowing preventable issues to spiral into complex health crises[82]. Table 9 summarizes the Compounding Factors impacting oral health in children with ASD.

Common dental problems in children with ASD

Children with ASD are at higher risk of dental disorders, such as developmental teeth disorders, behavioral-related teeth disorders, infection-related teeth disorders, and medical comorbidities-related teeth disorders, than typically developed children. Table 10 compares the differences in prevalence and types of dental issues between children with ASD and neurotypical peers.

Developmental teeth disorders in children with autism

Children with ASD are at increased risk for developmental dental anomalies (Figure 2) due to a combination of genetic, physiological, and environmental factors[83]. Enamel hypoplasia, characterized by thin, pitted, or discolored enamel, is particularly prevalent and often linked to genetic mutations affecting enamel formation (*e.g.*, *AMELX* or *ENAM* genes), prenatal stressors (*e.g.*, maternal infections or nutritional deficiencies), or postnatal factors like restricted diets low in calcium and vitamin D. This defect compromises tooth integrity, heightening susceptibility to cavities, sensitivity, and rapid decay[84]. Delayed tooth eruption is another common issue, with primary or permanent teeth emerging later than typical timelines, often due to systemic developmental delays, endocrine imbalances (*e.g.*, hypothyroidism), or nutritional deficits stemming from selective eating habits[85]. Irregular eruption patterns can lead to misalignment, crowding, or functional challenges in chewing and speech. Malocclusion (misaligned bites) frequently arises from oral motor dysfunction, such as hypotonia (low muscle tone) in the jaw, or persistent self-soothing behaviors like thumb-sucking, pacifier use, or bruxism (teeth grinding), which exert abnormal pressure on developing teeth and jaws. These misalignments can exacerbate difficulties in eating, speaking, and maintaining oral hygiene[86]. Additionally, structural anomalies like supernumerary (extra) or missing teeth (hypodontia) may occur, often associated with genetic syndromes overlapping with ASD (*e.g.*, Smith-Magenis syndrome), leading to crowding, impaction, or functional gaps[87]. Taurodontism, a condition where molars have enlarged pulp chambers and shortened roots, is also observed more frequently in children with neurodevelopmental disorders, potentially compromising tooth stability and increasing fracture risks[88]. These developmental disorders are further compounded by autism-related challenges, such as sensory aversions to oral care, dietary preferences for sugary or soft foods that promote decay, and medication side effects (*e.g.*, dry mouth) that reduce saliva's protective role[89]. Collectively, these dental anomalies not only elevate the risk of pain, infection, and tooth loss but also intersect with the social and sensory challenges faced by children with autism, impacting their overall well-being and quality of life[7]. Addressing these issues requires an understanding of their multifactorial origins, emphasizing the need for tailored, proactive approaches to mitigate their long-term effects (Table 11).

Behavioral-related teeth disorders in children with autism

Children with ASD frequently exhibit behaviors that directly or indirectly compromise oral health, leading to a range of dental disorders. Bruxism (teeth grinding), a common self-regulatory behavior in autism, often occurs during sleep or periods of stress, resulting in enamel wear, tooth fractures, jaw pain, and temporomandibular joint dysfunction[90]. SIB, such as repetitive biting of lips, cheeks, tongue, or fingers, can cause soft-tissue injuries, ulcers, and dental trauma, including chipped or displaced teeth. These actions are often sensory-seeking or stress-relieving, driven by difficulties in emotional regulation or communication[91]. Additionally, prolonged oral habits like thumb-sucking, pacifier use, or chewing on non-food objects (*e.g.*, toys, clothing) may persist beyond typical developmental stages, exerting abnormal pressure on teeth and jaws. Over time, these habits contribute to malocclusion (misaligned bites), anterior open bites, or palate deformation, which further complicate chewing, speech, and oral hygiene[86]. Food pouching (holding food in the cheeks) or selective eating behaviors, often tied to sensory aversions, can lead to prolonged food retention in the mouth,

Table 9 The compounding factors impacting oral health in children with autism spectrum disorder

Factor	Impact on oral health
Sensory aversions	Resistance to brushing/flossing due to texture/taste sensitivities
Dietary preferences	High sugar/carbohydrate intake (soft/sticky foods) promotes decay
Medication side effects	Dry mouth (xerostomia) reduces saliva's protective role, increasing cavity risk
Behavioral challenges	Self-injurious behaviors (*e.g.*, cheek biting) or bruxism cause physical damage to teeth and soft tissues
Communication barriers	Delayed diagnosis due to inability to express pain/discomfort

Table 10 Differences in prevalence and types of dental issues between children with autism spectrum disorder and neurotypical peers

Dental issue	Children with ASD	Neurotypical children
Caries (Cavities)	Varies; some studies report lower rates (due to diet and assistance with oral hygiene), while others indicate higher rates (due to difficulty in brushing and dietary preferences)	Generally moderate to high prevalence, influenced by diet and hygiene habits
Gingivitis	Higher prevalence due to oral hygiene challenges and sensory sensitivities that make brushing and flossing difficult	Lower prevalence with proper hygiene habits
Periodontal disease	Increased risk due to poor oral hygiene, limited dental visits, and difficulty tolerating dental care	Less common but can occur with inadequate hygiene
Malocclusion (Misalignment of Teeth)	More frequent, often associated with oral habits like bruxism, tongue thrusting, and prolonged pacifier use	Less frequent but can occur due to genetic or environmental factors
Bruxism (Teeth Grinding)	High prevalence; often linked to anxiety, sensory processing issues, or self-stimulatory behaviors	Less common; usually stress-related
Dental trauma	Higher prevalence due to self-injurious behaviors, seizures, or lack of motor coordination	Occurs mainly due to accidents during play or sports
Drooling and hypersalivation	More common, associated with low muscle tone and neurological differences	Less common, usually seen in younger children
Hypoplasia (Enamel Defects)	Increased prevalence; may be linked to genetic factors, medication use, or nutritional deficiencies	Less frequent but can still occur
Tooth extraction needs	Higher due to untreated dental issues, poor cooperation during treatment, and difficulty accessing dental care	Lower, as routine dental visits and interventions prevent extractions
Dental visit challenges	Anxiety, sensory sensitivities, difficulty with cooperation, and communication barriers lead to fewer and less successful visits	Generally cooperative with routine dental care, with fewer barriers

ASD: Autism spectrum disorder.

increasing the risk of cavities and gum disease[89]. Furthermore, resistance to oral care routines—due to sensory sensitivities (*e.g.*, aversion to toothbrush texture) or rigidity around routines—exacerbates plaque accumulation, gingivitis, and decay[74]. These behavioral challenges are compounded by communication barriers, as non-verbal children may struggle to articulate dental pain, delaying intervention until issues become severe[92]. Collectively, these behaviors create a cycle of oral health deterioration, where physical discomfort from dental problems may intensify anxiety or sensory overload, perpetuating harmful habits[93]. Addressing these disorders requires understanding their behavioral roots, emphasizing the need for sensory-friendly interventions, behavioral therapy, and tailored oral care strategies to mitigate their impact on dental and overall well-being.

Infection-related teeth disorders in children with autism

Children with ASD face a heightened risk of infection-related dental conditions due to interrelated behavioral, sensory, and physiological challenges. Dental caries (cavities) are particularly prevalent, driven by poor oral hygiene practices stemming from sensory aversions to brushing (*e.g.*, aversion to toothpaste texture or toothbrush bristles) and diets rich in sugary, carbohydrate-heavy foods favored by selective eaters[73]. Prolonged food retention in the mouth due to pouching or delayed swallowing further fuels bacterial growth, accelerating enamel erosion and decay. Untreated caries can progress to pulpitis (tooth nerve inflammation) or dental abscesses, where bacterial infections spread to the tooth's root or surrounding tissues, causing severe pain, swelling, and systemic complications if left unaddressed[94].

Gingivitis and periodontal disease are also common, as plaque accumulation from inadequate brushing and flossing triggers gum inflammation, bleeding, and eventual bone loss around teeth[95]. Additionally, oral thrush (candidiasis), a fungal infection, may arise due to dry mouth (xerostomia) caused by medications like antipsychotics or anticonvulsants, which reduce saliva's natural antimicrobial properties. Chronic dry mouth also elevates susceptibility to bacterial

Table 11 The developmental teeth disorders in children with autism spectrum disorders

Developmental teeth disorder	Description	Causes	Prevalence in ASD	Consequences
Enamel hypoplasia	Thin, pitted, or discolored enamel due to defective enamel formation	Genetic mutations (*e.g.*, *AMELX*, *ENAM*), prenatal stressors (maternal infections, nutritional deficiencies), postnatal nutrient deficits (low calcium/vitamin D)	Higher prevalence compared to neurotypical peers	Increased cavities, tooth sensitivity, rapid decay
Delayed tooth eruption	Primary/permanent teeth emerge later than typical timelines	Systemic developmental delays, endocrine imbalances (*e.g.*, hypothyroidism), nutritional deficiencies from selective eating	More common in ASD, especially with comorbid growth/hormonal disorders	Misalignment, crowding, chewing/speech difficulties
Malocclusion	Misaligned teeth or jaws (*e.g.*, overbite, crowding)	Oral motor dysfunction (hypotonia), persistent habits (thumb-sucking, pacifier use), bruxism (teeth grinding)	Higher rates reported in ASD	Difficulty chewing, speech impediments, increased risk of dental trauma
Supernumerary/Missing teeth	Extra teeth (*supernumerary*) or congenital absence of teeth (*hypodontia*)	Genetic syndromes overlapping with ASD (*e.g.*, Smith-Magenis syndrome)	Occurs more frequently in syndromic ASD cases	Crowding, impaction, functional gaps requiring prosthetics
Taurodontism	Molars with enlarged pulp chambers and shortened roots ("bull-like" teeth)	Associated with neurodevelopmental disorders; exact cause unclear	Observed more frequently in ASD	Structural weakness, increased fracture risk, challenges during root canals

ASD: Autism spectrum disorder.

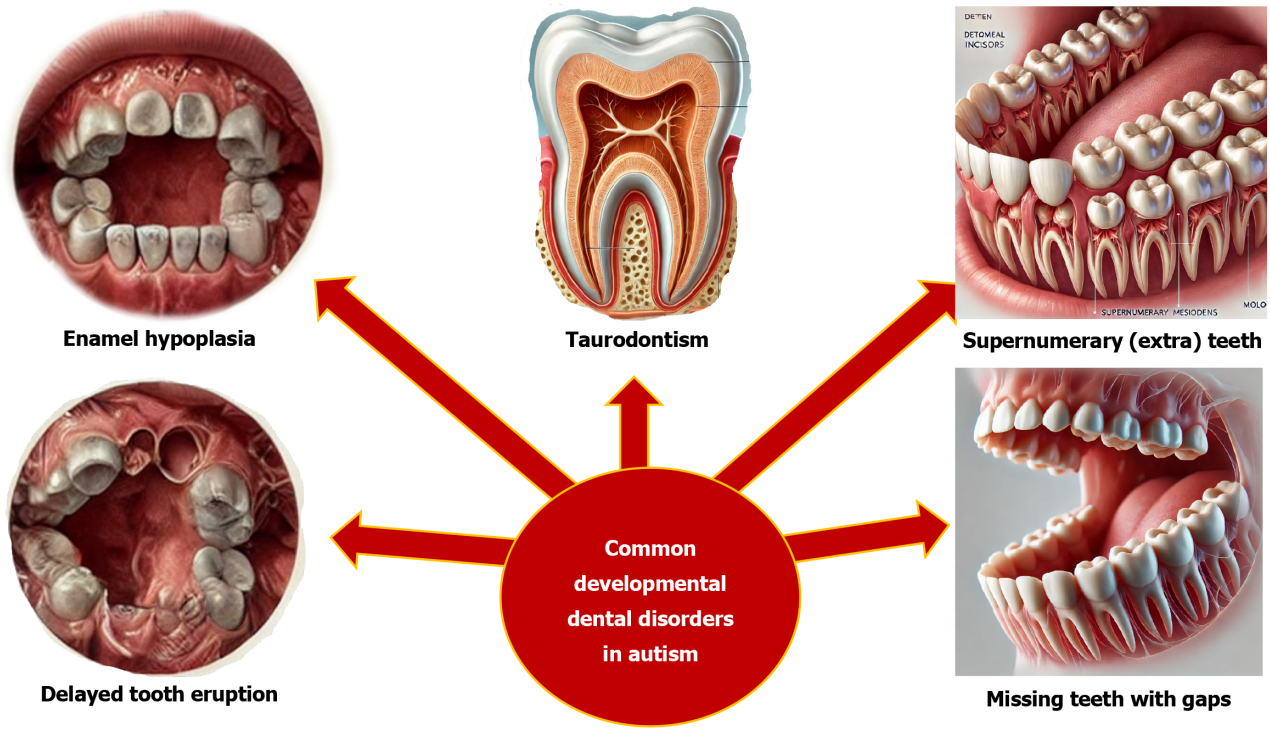

Figure 2 Common developmental dental disorders in children with autism spectrum disorder.

infections, while self-injurious behaviors (*e.g.*, cheek biting) create open wounds vulnerable to secondary infections[96]. Communication barriers often delay diagnosis, as non-verbal children may not express pain, allowing infections to advance unnoticed until they manifest as facial swelling, fever, or refusal to eat[97]. Furthermore, dental anxiety and sensory overload during clinical visits may lead to avoidance of professional care, increasing the likelihood of untreated infections progressing to emergencies requiring invasive interventions[7]. These infections not only compromise oral health but also exacerbate behavioral challenges, as pain and discomfort may intensify sensory sensitivities, agitation, or self-injurious habits, creating a cyclical decline in both physical and emotional well-being[98]. Addressing these infection-related risks necessitates proactive strategies, such as tailored oral hygiene routines, dietary modifications, and early intervention by dental professionals experienced in autism care, to mitigate their profound impact on health and quality

of life.

Medical comorbidities-related teeth disorders in children with autism

Children with ASD often experience medical comorbidities that directly or indirectly contribute to oral health challenges, compounding the risk of dental disorders (Table 12). Gastrointestinal issues, such as acid reflux or chronic vomiting, are prevalent in ASD and expose teeth to stomach acids, leading to enamel erosion, tooth sensitivity, and increased susceptibility to decay[1]. Epilepsy, another common comorbidity, often requires long-term use of anticonvulsant medications (*e.g.*, phenytoin), which can cause gingival hyperplasia (overgrowth of gum tissue), creating pockets where plaque accumulates and elevating the risk of periodontal disease[99]. Genetic syndromes linked to autism, such as Fragile X or Down syndrome, frequently include inherent dental anomalies like enamel defects, delayed eruption, or malocclusion, further complicating oral health. Sleep disorders, including disrupted sleep patterns, may exacerbate bruxism (teeth grinding), accelerating enamel wear, jaw pain, and tooth fractures[100]. Additionally, immune dysregulation or chronic inflammation associated with ASD may impair the body's ability to combat oral pathogens, increasing vulnerability to infections like gingivitis or periodontitis[101]. Nutritional deficiencies stemming from restricted diets—common in children with autism due to sensory aversions—can weaken enamel development (*e.g.*, calcium or vitamin D deficits) or reduce saliva production, diminishing its protective role against cavities[102]. Psychotropic medications (*e.g.*, antipsychotics, antidepressants) often prescribed for ASD-related behaviors frequently cause xerostomia (dry mouth), fostering bacterial overgrowth, halitosis, and rampant caries[96]. Furthermore, metabolic disorders (*e.g.*, mitochondrial dysfunction) may impair tissue repair, delaying healing of oral injuries or infections[100]. These comorbidities interact synergistically with ASD-related sensory sensitivities and behavioral challenges, creating a cycle where systemic health issues exacerbate dental problems and untreated dental conditions worsen overall health[69]. Addressing these interconnected risks necessitates a holistic approach that integrates medical, dental, and nutritional care to mitigate their collective impact on oral and systemic well-being.

They may also experience a higher prevalence of certain dental issues than their neurotypical peers. The most commonly reported dental problems include dental caries, acid erosion, gingivitis and periodontal disease, malocclusion, bruxism, and non-nutritive oral habits[10]. Studies indicate that children with ASD have a higher prevalence of dental caries, often due to difficulties in maintaining oral hygiene, dietary habits favoring sugary and soft foods, and challenges with professional dental care visits[103]. Poor oral hygiene, combined with difficulties in tolerating brushing and flossing, increases the risk of gingivitis and periodontal disease. Children with ASD have an increased risk of acid erosion due to dietary habits, such as consuming acidic foods and beverages, leading to enamel erosion[104]. Oral trauma is more common in children with ASD due to self-injurious behaviors and accidents, necessitating careful monitoring and intervention. Dry Mouth (Xerostomia) is also frequently observed as a side effect of medications used to manage ASD symptoms, increasing the risk of tooth decay and gum disease[69].

Challenges facing parents in dental care for children with autism

Parents of children with ASD navigate a labyrinth of interconnected challenges when managing their child's oral health, many of which stem from the unique sensory, cognitive, and behavioral profiles associated with autism. Sensory sensitivities are a primary barrier, as everyday oral care tools—such as toothbrushes with stiff bristles, mint-flavored toothpaste, or the vibrations of electric brushes—can trigger overwhelming distress, leading to refusal of brushing or gagging[79]. These aversions are compounded by tactile defensiveness, where even the sensation of water or foam in the mouth feels intolerable, making basic hygiene routines fraught with resistance[89]. Communication barriers further complicate care, particularly for non-verbal or minimally verbal children, who may lack the ability to articulate dental pain, leaving parents to decipher subtle signs of discomfort (*e.g.*, changes in behavior, sleep disturbances, or refusal to eat) that could indicate cavities, abscesses, or gum inflammation[97]. Behavioral challenges, including rigidity to routines, meltdowns, or hyperfocus on specific activities, disrupt consistency in oral care, as children may reject new tools (*e.g.*, fluoride rinses) or resist transitions to brushing times[105]. Dental visits introduce additional stressors, as the clinical environment—bright lights, loud equipment, unfamiliar smells, and physical touch—can provoke intense anxiety or sensory overload, leading to uncooperative behavior or complete refusal to enter the dental office[106]. This avoidance often delays preventive care, allowing minor issues to escalate into emergencies requiring invasive treatments under sedation, which carries its own risks and emotional toll[107].

Dietary preferences common in autism, such as a strong inclination toward soft, carbohydrate-heavy, or sugary foods (*e.g.*, crackers, juices, or pureed snacks), coupled with oral motor difficulties that prolong food retention in the mouth, create a high-risk environment for rapid tooth decay and enamel erosion[108]. Parents face an uphill battle in balancing nutritional needs with sensory acceptance, often struggling to introduce healthier alternatives that their child rejects due to texture or taste. Medical comorbidities prevalent in ASD, including gastrointestinal disorders (*e.g.*, acid reflux), epilepsy, or genetic syndromes (*e.g.*, Fragile X), exacerbate oral health risks through mechanisms like enamel-eroding stomach acids, medication-induced dry mouth (xerostomia), or drug-related gingival overgrowth[109]. These systemic issues demand constant vigilance, as parents must reconcile the side effects of essential medications with their impact on dental health. Financial and logistical burdens add another layer of difficulty, as accessing dentists trained in autism care—who often require longer appointments, behavioral support, or specialized sedation—can be prohibitively expensive or geographically inaccessible. Insurance limitations and out-of-pocket costs for therapies, adaptive tools (*e.g.*, silicone brushes), or repeated treatments further strain family resources[32].

Emotionally, parents grapple with chronic stress, guilt, and helplessness, particularly when societal misconceptions about autism lead to judgment over their child's oral health or behavior in public settings. The relentless demands of caregiving, coupled with a lack of respite or tailored support systems, can lead to burnout, while the fear of long-term consequences—such as tooth loss, chronic pain, or social stigma tied to dental appearance—weighs heavily on their

Table 12 Medical comorbidities and associated dental disorders in children with autism spectrum disorder

Medical comorbidity	Associated dental disorder(s)	Impact on oral health
Gastrointestinal Issues (*e.g.*, acid reflux, vomiting)	Enamel erosion, tooth sensitivity, increased risk of decay	Exposure to stomach acids leads to weakened enamel and increased vulnerability to cavities
Epilepsy (and anticonvulsant medications)	Gingival hyperplasia (gum overgrowth), periodontal disease	Plaque buildup in gum pockets due to overgrowth increases the risk of periodontal problems
Genetic syndromes (*e.g.*, Fragile X, Down syndrome)	Enamel defects, delayed eruption, malocclusion	Inherent dental anomalies complicate oral health and require specialized dental care
Sleep disorders (*e.g.*, disrupted sleep patterns)	Bruxism (teeth grinding), enamel wear, jaw pain, tooth fractures	Grinding leads to accelerated wear on teeth, causing damage and sensitivity
Immune dysregulation/chronic inflammation	Gingivitis, periodontitis	Reduced ability to combat oral pathogens, leading to infections and gum disease
Nutritional deficiencies (*e.g.*, calcium, vitamin D)	Weakened enamel, reduced saliva production	Deficiencies compromise enamel development and the mouth's natural defense against cavities
Psychotropic medications (*e.g.*, antipsychotics)	Xerostomia (dry mouth), bacterial overgrowth, halitosis, rampant caries	Dry mouth fosters bacterial growth, increasing risk of tooth decay and gum disease
Metabolic disorders (*e.g.*, mitochondrial dysfunction)	Delayed healing of oral injuries, infections	Impaired tissue repair, leading to prolonged healing times for oral wounds or infections
Dental issues common in ASD	Dental caries, acid erosion, gingivitis, periodontal disease, malocclusion, bruxism, non-nutritive oral habits	Poor oral hygiene, sugary diets, medication side effects, and sensory sensitivities elevate the risk of these issues

ASD: Autism spectrum disorder.

mental health[110]. Systemic barriers, including insufficient training for general dentists in ASD-specific care and a scarcity of interdisciplinary collaboration between dental professionals, occupational therapists, and pediatricians, leave many families navigating these challenges in isolation[92]. Ultimately, the cumulative effect of these obstacles creates a cycle where unmet oral health needs exacerbate behavioral and sensory challenges, hindering effective care and underscoring the urgent need for compassionate, individualized strategies and systemic advocacy to support these families[111].

Ideal routine home dental care for children with autism

Establishing a dental home for children with ASD involves creating a consistent, predictable, and supportive environment that integrates tailored oral hygiene practices, caregiver education, and professional collaboration to address the unique challenges these children face[4]. Daily oral care routines must prioritize sensory accommodations, such as using ultra-soft or silicone toothbrushes, unflavored or mildly flavored toothpaste, and non-foaming alternatives if sensory aversions exist[74]. Brushing should be structured around the child's preferences, incorporating visual schedules or timers to provide predictability and gradual desensitization—starting with brief brushing sessions and incrementally increasing duration as tolerance develops. Positive reinforcement (*e.g.*, praise, stickers, or preferred activities post-brushing) reinforces cooperation, while choice-based empowerment (*e.g.*, selecting a toothbrush color) fosters autonomy [79]. Adaptive tools like finger brushes, electric toothbrushes with vibration settings, or antimicrobial wipes can serve as interim solutions for children with oral motor difficulties or extreme resistance[112].

Dietary management is critical, as selective eating habits often favor cavity-promoting foods. Caregivers should be guided to limit sugary or sticky snacks, offer crunchy vegetables (*e.g.*, carrots) to naturally clean teeth, and encourage water intake to combat dry mouth caused by medications[113]. Collaboration with occupational therapists can address sensory aversions to textures or tastes, while speech therapists may assist with oral motor exercises to improve chewing and swallowing efficiency[114]. At home, desensitization techniques—such as gentle gum massages or introducing oral care tools during play—help reduce tactile defensiveness. Regular professional dental visits are essential, ideally at a clinic experienced in ASD care, where preventive measures like fluoride varnishes or sealants are applied to protect vulnerable teeth[43]. Dentists should work with families to create a "dental passport"—a personalized document detailing the child's triggers, communication methods, and calming strategies—to ensure continuity of care across visits. Emergency preparedness includes training caregivers to recognize signs of dental pain (*e.g.*, facial swelling, refusal to eat) and establishing a clear action plan for urgent issues[115]. Ultimately, the dental home model thrives on caregiver empowerment through ongoing education, access to resources (*e.g.*, social stories about dental visits), and emotional support to navigate setbacks[42]. By embedding flexibility, patience, and interdisciplinary collaboration into every aspect of care, the ideal dental home transforms oral health from a source of stress into a manageable, empowering routine that safeguards both physical well-being and the child's sense of security[10].

Challenges facing dentists during dental care of children with autism

Dentists encounter significant challenges when providing care to children with ASD, stemming from the unique sensory,

behavioral, and communication needs of these patients[92]. Sensory sensitivities often make the dental environment overwhelming, as bright lights, the sound of dental instruments, tactile sensations (*e.g.*, the feel of gloves or probes), and even the taste of dental materials can trigger anxiety, meltdowns, or refusal to cooperate[116]. Communication barriers pose another major hurdle, particularly for non-verbal children or those with limited expressive language, as dentists struggle to explain procedures, gauge pain levels, or gain trust. Behavioral challenges, such as rigidity to routines, impulsivity, or repetitive movements, can disrupt examinations and treatments, requiring dentists to adapt techniques in real-time to avoid triggering distress[75]. Resistance to physical touch or unfamiliar positioning (*e.g.*, reclining in the dental chair) further complicates procedures, often necessitating physical restraint or sedation, which carries ethical and safety concerns[117]. Dental anxiety, already common in children, is amplified in those with autism due to difficulties in processing novel experiences, leading to prolonged appointments, incomplete treatments, or cancellations. Dentists must also navigate the child's sensory-seeking behaviors, such as oral fixation (chewing on instruments) or sudden movements, which risk injury to the child or dental staff[118].

Limited training in ASD-specific care exacerbates these challenges, as many general dentists lack expertise in behavioral management, sensory adaptations, or techniques for desensitizing autistic patients to dental visits[119]. The need for interdisciplinary collaboration—coordinating with occupational therapists, pediatricians, or behavioral specialists—adds complexity, requiring time and resources often unavailable in standard practice settings. Environmental modifications, such as creating sensory-friendly waiting areas or using noise-canceling headphones, may be necessary but are not always feasible due to cost or space constraints[120]. Additionally, time and financial pressures arise from the extended duration of appointments, the potential need for multiple visits to complete simple procedures, or the use of sedation, which requires specialized staffing and equipment[121]. Dentists must also balance parental expectations with clinical realities, as families may feel frustrated by delays or perceive insufficient empathy for their child's needs. Ultimately, providing effective care demands patience, creativity, and a willingness to individualize approaches, from using visual aids (*e.g.*, picture schedules) to incorporating gradual desensitization protocols[37]. Without adequate support, training, or systemic accommodations, dentists risk perpetuating disparities in oral health outcomes for children with autism, underscoring the urgent need for specialized education, policy reforms, and accessible resources to empower dental professionals in this critical aspect of care[10].

Features and criteria of the ideal dental clinic for children with autism

An ideal dental clinic tailored to children with ASD prioritizes sensory-friendly design, adaptive communication strategies, and individualized care to mitigate anxiety and promote cooperation[81]. Sensory-friendly environments are foundational, featuring adjustable lighting (*e.g.*, dimmable LEDs or natural light), noise-reduction measures (*e.g.*, sound-absorbing panels, quiet HVAC systems), and a calming color palette to minimize sensory overload[122]. Waiting areas should include quiet zones with sensory toys, weighted blankets, or visual barriers to reduce stimuli, while treatment rooms should be equipped with adaptive dental chairs that allow gradual reclining and tactile-friendly surfaces. Visual supports, such as picture schedules, social stories, or video modeling, are integrated to prepare children for procedures, demystify tools (*e.g.*, "show-tell-do" demonstrations), and establish predictable routines[123]. Clinicians and staff must undergo specialized training in autism care, including behavioral management techniques (*e.g.*, positive reinforcement, distraction strategies), non-verbal communication skills (*e.g.*, using gestures, AAC devices), and desensitization protocols to build trust over multiple visits[5] (Figure 3).

The clinic's operational flexibility is critical, offering extended appointment times to accommodate breaks, staggered steps for procedures, and options for gradual acclimation (*e.g.*, "pre-visit tours"). Tools and techniques are adapted to sensory needs, such as non-foaming, flavor-free toothpaste, silicone or ultra-soft toothbrushes, and alternatives to traditional drills (*e.g.*, laser dentistry)[124]. Interdisciplinary collaboration with occupational therapists, behavioral therapists, and pediatricians ensures holistic care, addressing co-occurring issues like oral motor dysfunction or medication-related dry mouth. Technology plays a role through noise-canceling headphones, virtual reality distraction systems, or apps that gamify oral care[125].

Parental involvement is encouraged, with private consultation spaces for caregivers to discuss concerns and receive tailored guidance on home care. The clinic also prioritizes safety and accessibility, including clear pathways for mobility aids, emergency protocols for medical comorbidities (*e.g.*, seizures), and sedation options administered by pediatric anesthesiologists in a controlled setting[126]. The clinic fosters a culture of empathy and patience, where staff are trained to interpret non-verbal cues, avoid punitive measures, and celebrate small victories to build long-term rapport. Combining these elements, the ideal clinic transforms dental care from a traumatic experience into a structured, supportive process that respects neurodiversity. It ensures equitable access to oral health for children with autism[127].

Strategies for effective management

Behavioral and sensory adaptations: Managing dental care for children with ASD requires a personalized approach that prioritizes behavioral and sensory adaptations to reduce anxiety and foster cooperation. Central to this strategy is desensitization, which involves introducing dental care elements incrementally—such as letting the child touch or hold a toothbrush before brushing or arranging non-treatment clinic visits to familiarize them with the environment[123]. Gradual exposure builds on this foundation by slowly increasing the complexity of interactions, starting with brief, non-invasive sessions (*e.g.*, sitting in the dental chair) and progressing to full procedures as comfort grows. To address sensory sensitivities, accommodations like noise-canceling headphones, weighted blankets, or comfort objects (*e.g.*, a favorite toy) help minimize overwhelming stimuli. At the same time, alternatives such as silicone toothbrushes or unflavored toothpaste cater to tactile and taste aversions[128]. Visual and social supports, including picture guides, storyboards, or video models, pre-teach each step of the dental visit, demystifying tools and routines to enhance predictability. Clinics can further reduce stress by customizing schedules, offering extended appointment times or booking visits during low-

Figure 3 Artificial intelligence generated ideal dental clinic suitable for children with autism spectrum disorder. This ideal dental clinic for children with autism spectrum disorder (ASD) is designed to provide a calm, sensory-friendly, and supportive environment. The space features soft pastel colors, dimmable lighting, and noise-reducing walls to minimize sensory overload. Visual aids, picture schedules, and tablet-based communication tools help ease anxiety and improve understanding. Private treatment rooms with adjustable dental chairs, weighted blankets, and sensory toys ensure comfort. The waiting area includes a sensory play zone, quiet music, and flexible seating to create a stress-free experience. Trained staff uses the Tell-Show-Do method, gentle communication, and short, flexible appointments to enhance cooperation. This clinic prioritizes predictability, comfort, and specialized care, ensuring a positive dental experience for children with ASD.

traffic hours to limit sensory overload[81]. Crucially, parental involvement reinforces success, as caregivers help maintain consistent oral hygiene routines at home, use positive reinforcement (*e.g.*, praise, rewards), and collaborate with clinicians to tailor strategies to their child's evolving needs[129]. By integrating these adaptive techniques, dental care becomes a structured, reassuring experience that respects the child's sensory profile and promotes lifelong oral health.

Pharmacological and non-pharmacological interventions: For children with ASD who face extreme anxiety, sensory overload, or behavioral challenges during dental care, a combination of pharmacological and non-pharmacological interventions may be necessary to ensure safe and effective treatment[32]. Non-pharmacological approaches are often prioritized first, such as behavioral therapy techniques like ABA to reinforce positive behaviors, cognitive-behavioral therapy to address dental phobias, or distraction strategies (*e.g.*, music, interactive apps) to reduce stress[130]. However, when these methods prove insufficient—particularly for invasive procedures, severe dental needs, or profound sensory aversion—pharmacological interventions become essential. Sedation (*e.g.*, nitrous oxide or oral sedatives) can help moderate anxiety while allowing the child to remain responsive[117]. In contrast, general anesthesia may be required for extensive treatments or children with extreme behavioral resistance, ensuring procedures are completed safely and efficiently[131]. These approaches are carefully balanced against risks, such as side effects or recovery challenges, and require thorough pre-procedural assessments by pediatric anesthesiologists. Importantly, pharmacological strategies are most effective when paired with preparatory behavioral interventions (*e.g.*, desensitization to masks for nitrous oxide) and post-procedural support to minimize trauma[132]. Collaboration among dentists, behavioral therapists, and medical professionals ensures that interventions are tailored to the child's needs, prioritizing safety, dignity, and long-term oral health outcomes. This dual approach acknowledges the spectrum of needs in ASD care, offering flexibility to address both routine and complex cases with compassion and clinical rigor[4].

Role of caregivers and education

Caregivers play a pivotal role in ensuring consistent oral hygiene for children with autism, acting as daily advocates and collaborators in both home care and clinical settings. Effective management begins with involving caregivers in dental routines by training them to adapt techniques to their child's sensory and behavioral needs—such as using visual schedules to structure brushing times, introducing sensory-friendly tools (*e.g.*, flavored floss, vibrating toothbrushes), or

incorporating rewards to motivate participation[119]. Education empowers caregivers to recognize early signs of dental issues (*e.g.*, tooth grinding, food pouching) and reinforces preventive practices, such as fluoride use or diet modifications [133]. Equally critical is training dental professionals to understand ASD-specific challenges, including communication styles (*e.g.*, using simple language and visual aids), sensory triggers (*e.g.*, avoiding sudden touch), and behavioral cues (*e.g.*, identifying non-verbal pain signals)[5]. Workshops, online modules, or partnerships with autism advocacy groups can equip clinicians with skills like patience-driven desensitization or trauma-informed care. Collaborative efforts—such as joint consultations between dentists, occupational therapists, and caregivers—ensure continuity between home and clinic, while resources like social stories or video tutorials standardize expectations[134]. By fostering caregiver confidence and professional competence, this dual focus on education bridges gaps in care, transforming oral health routines into shared, sustainable practices that prioritize the child's comfort, autonomy, and long-term well-being[135].

Preventive measures

Preventive dental care is paramount for children with ASD, as proactive strategies reduce the likelihood of complex, invasive treatments that may trigger anxiety or sensory overload. Central to prevention is dietary counseling, which addresses the preference for sugary, sticky, or carbohydrate-rich foods common in selective eaters[136]. Caregivers are guided to offer tooth-friendly alternatives (*e.g.*, crunchy vegetables, cheese) and limit snacks that promote decay, while hydration is emphasized to combat dry mouth caused by medications[137]. Fluoride treatments—applied as varnishes or gels during routine visits—strengthen enamel and inhibit bacterial growth, offering a quick, non-invasive defense against cavities[138]. Dental sealants on molars provide an additional barrier for vulnerable teeth. Regular check-ups (every 3–6 months) allow early detection of issues like enamel hypoplasia or gingivitis, enabling timely intervention before problems escalate[139]. These visits also serve as opportunities to desensitize the child to clinical environments through brief, positive interactions. By integrating preventive care into home routines (*e.g.*, supervised brushing with fluoride toothpaste) and clinical protocols, caregivers and dental teams collaboratively minimize risks, ensuring oral health is maintained with minimal stress—a critical step in fostering lifelong well-being for children with ASD.

Role of oral (dental) probiotics in managing dental disorders in children with ASD

Children with ASD often exhibit altered microbiome profiles, not just in the gut but also in the oral cavity. This dysbiosis can increase susceptibility to dental caries, periodontal disease, and oral infections, necessitating alternative or adjunctive therapeutic strategies such as probiotics. Traditional dental care methods, including regular brushing, flossing, and professional cleanings, can be challenging for children with ASD due to sensory sensitivities, communication barriers, and behavioral difficulties. As a result, oral (dental) probiotics have emerged as a promising adjunctive approach to improving oral health by balancing the oral microbiome, reducing pathogenic bacteria, and promoting overall dental and gum health[140]. Oral probiotics consist of beneficial bacteria that help maintain a healthy microbial balance in the mouth. Unlike traditional probiotics that primarily target gut health, oral probiotics modulate the composition of the oral microbiota, inhibit harmful bacterial colonization, reduce inflammation, and enhance the protective functions of saliva and oral tissues[141]. Commonly studied probiotic strains for dental health include *Lactobacillus reuteri, Lactobacillus paracasei, Lactobacillus rhamnosus, Streptococcus salivarius,* and *Bifidobacterium* species. These probiotics exhibit antimicrobial properties by competing with pathogenic bacteria, such as *Streptococcus mutans* and *Porphyromonas gingivalis*, which are associated with dental caries and periodontal disease, respectively[142] (Tables 13 and 14).

One of the key benefits of oral probiotics is their ability to reduce dental caries (tooth decay), which is particularly relevant for children with ASD who often have a preference for soft, sugary foods that increase their risk of cavities. Probiotic strains help by competing with *S. mutans* for adhesion sites on teeth, producing antimicrobial compounds that inhibit its growth, and lowering the pH of the oral environment, making it less hospitable for cariogenic bacteria[143]. Additionally, oral probiotics contribute to better gum health by reducing inflammation and preventing periodontal disease, a condition exacerbated in children with ASD due to difficulties in maintaining consistent oral hygiene practices. Specific probiotic strains such as *L. reuteri* and *S. salivarius* have been shown to inhibit *P. gingivalis*, decrease pro-inflammatory cytokines, and enhance immune responses within the oral cavity, thereby reducing gum inflammation and periodontal disease progression[67].

Another significant concern in children with ASD is halitosis (bad breath), which often results from poor oral hygiene, medication-induced xerostomia (dry mouth), or microbial imbalances in the oral cavity. Probiotic strains such as *S. salivarius K12* and *L. reuteri* help reduce bad breath by inhibiting odor-producing bacteria and neutralizing volatile sulfur compounds responsible for halitosis[144]. Moreover, frequent acid exposure due to gastroesophageal reflux disease or acidic dietary habits can contribute to enamel erosion, further complicating oral health management in ASD. Certain probiotic strains play a protective role by stimulating saliva production, which provides natural buffering agents such as bicarbonate, calcium, and phosphate to counteract acid damage and maintain enamel integrity[145].

Xerostomia, a common side effect of medications prescribed for ASD symptom management, further predisposes children to cavities and gum disease due to reduced saliva flow. Some probiotics, particularly *L. reuteri* and *Bifidobacterium* species, have been found to stimulate salivary gland function, increasing saliva secretion and enhancing the mouth's natural defense against bacterial overgrowth and tooth decay[146]. Additionally, children with ASD who are prone to oral Candida infections (oral thrush) may benefit from probiotics, as strains such as *L. reuteri* and *Bifidobacterium* exhibit antifungal properties by inhibiting the overgrowth of *Candida albicans* and reducing the incidence of fungal infections[147]. While probiotics do not directly prevent bruxism (teeth grinding), they can play a supportive role in oral tissue repair and inflammation reduction, potentially minimizing the damage associated with excessive grinding and improving periodontal health[148]. Table 14 summarizes key probiotic strains used in preventing or treating dental caries, highlighting their mechanisms of action and associated oral health benefits.

Table 13 Role of oral (Dental) probiotics in managing dental problems in children with autism spectrum disorder

Dental issue	Challenges in children with ASD	Role of oral probiotics	Common probiotic strains
Dental caries (Cavities)	Preference for sugary, soft foods; difficulty in oral hygiene	Inhibits *S. mutans*, lowers oral pH, produces antimicrobial compounds	*Lactobacillus reuteri*, *Lactobacillus paracasei*, *Lactobacillus rhamnosus*
Periodontal disease (Gingivitis & Periodontitis)	Poor brushing & flossing; plaque buildup	Reduces inflammation, inhibits *P. gingivalis*, decreases pro-inflammatory cytokines	*L. reuteri*, *Streptococcus salivarius*
Halitosis (Bad Breath)	Poor oral hygiene, medication-induced dry mouth	Reduces odor-producing bacteria, neutralizes volatile sulfur compounds	*S. salivarius K12*, *L. reuteri*
Enamel erosion	GERD, acidic dietary habits	Increases saliva production, enhances buffering capacity of saliva	*L. reuteri*, *Bifidobacterium* spp.
Xerostomia (Dry Mouth)	Medication side effects reducing saliva production	Stimulates saliva flow, maintains oral moisture	*L. reuteri*, *S. salivarius*
Oral candidiasis (Thrush)	Immune dysregulation, prolonged antibiotic use	Inhibits *Candida albicans* overgrowth, supports oral microbiome balance	*L. reuteri*, *Bifidobacterium* spp.
Bruxism (Teeth Grinding)	Sensory sensitivities, stress, sleep disturbances	Promotes oral tissue repair, reduces inflammation in gum tissues	*L. reuteri*, *L. paracasei*

ASD: Autism spectrum disorder; *L. reuteri*: *Lactobacillus reuteri*; *L. paracasei*: *Lactobacillus paracasei*; *P. gingivalis*: *Porphyromonas gingivalis*; *S. mutans*: *Streptococcus mutans*; *S. salivarius*: *Streptococcus salivarius*; GERD: Gastroesophageal reflux disease.

Table 14 Commonly used probiotics for dental caries prevention and treatment

Probiotic strain	Mechanism of action	Potential benefits in dental health
Lactobacillus reuteri	Inhibits *S. mutans* and *P. gingivalis* growth, reduces inflammation	Reduces dental caries and gum disease[142]
Streptococcus salivarius K12	Produces bacteriocins that inhibit odor-causing bacteria	Reduces halitosis and enhances oral immunity[144]
Lactobacillus paracasei	Competes with *S. mutans* for adhesion sites, modulates pH	Lowers risk of cavities and enamel demineralization [143]
Lactobacillus rhamnosus	Enhances salivary immunity and prevents biofilm formation	Supports gum health and reduces plaque[141]
Bifidobacterium species	Suppresses *Candida albicans* growth and promotes beneficial microbiota	Prevents oral thrush and fungal infections[147]

P. gingivalis: *Porphyromonas gingivalis*; *S. mutans*: *Streptococcus mutans*.

For effective administration, oral probiotics are available in various delivery forms, including lozenges, chewable tablets, probiotic-enriched toothpaste or mouthwash, and probiotic-infused dairy products such as yogurt. Most studies recommend daily use for optimal benefits, with noticeable improvements typically observed after several weeks of consistent administration[149]. However, while oral probiotics offer significant advantages, they should be integrated into a comprehensive dental care plan that includes regular brushing with fluoride or hydroxyapatite toothpaste, daily flossing, dietary modifications to reduce sugar intake, routine dental visits with autism-friendly accommodations, and adequate hydration to maintain saliva flow[67]. Given the unique challenges children with ASD face in maintaining oral hygiene, probiotic therapy serves as a valuable adjunct to traditional dental care, offering a non-invasive and potentially effective strategy to improve oral health outcomes. Future research should focus on establishing standardized probiotic formulations, optimal dosages, and long-term efficacy in children with ASD to enhance clinical recommendations and personalized treatment approaches.

Recommendations for practice and future research

Clinical guidelines for dental practitioners: Children with ASD often experience unique challenges in dental settings due to sensory sensitivities, communication difficulties, and behavioral issues. To ensure a comfortable and effective dental experience, practitioners must adopt tailored strategies that address these challenges.

Pre-appointment preparation is crucial for reducing anxiety and increasing cooperation. Dental practitioners should involve parents and caregivers in gathering medical and behavioral histories, identifying specific triggers, and determining preferred communication methods[37]. Providing structured appointment plans, visual supports, and social stories can help children with ASD become familiar with dental procedures in advance. Additionally, desensitization visits, where children are gradually introduced to dental tools and settings, can be highly beneficial[150].

Sensory considerations in the dental office play a significant role in reducing distress. Environmental modifications such as dimming bright lights, minimizing noise, and eliminating strong smells can help prevent sensory overload[81]. Offering noise-canceling headphones, sunglasses, or weighted blankets can further enhance comfort. Some children may also require modified seating arrangements, such as sitting upright rather than reclining, or alternative positioning techniques like the lap-to-lap method for younger patients[151].

Effective communication strategies are essential in managing ASD-specific challenges. Dentists should use simple, clear language with step-by-step explanations[152]. The "Tell-Show-Do" technique-where a procedure is first explained, then demonstrated, and finally performed-can be particularly effective. Nonverbal communication, such as visual schedules and hand signals, may also be helpful. Providing choices when possible gives children a sense of control, reducing anxiety and increasing cooperation[153].

Behavioral management techniques should focus on positive reinforcement and structured routines. Praising cooperative behavior and offering small rewards, such as stickers or tokens, can encourage compliance. Keeping dental visits predictable by maintaining consistent appointment schedules and minimizing unexpected changes can help children feel more at ease[154]. Since prolonged procedures can be overwhelming, appointments should be kept as short and efficient as possible, with priority given to essential treatments. If necessary, protective stabilization should be used only as a last resort, with parental consent[155].

Pain and anxiety management should be tailored to the child's needs. Non-pharmacological approaches such as guided imagery, deep breathing exercises, and distraction techniques (*e.g.*, playing calming music or videos) can help alleviate stress[156]. For children with severe anxiety, nitrous oxide sedation may be considered, provided they can tolerate a nasal mask. General anesthesia should be reserved for cases requiring extensive dental work when other approaches are ineffective[157].

Collaboration with healthcare providers is essential for comprehensive care. A multidisciplinary approach involving pediatricians, occupational therapists, speech therapists, and behavioral specialists can help address the complex needs of children with ASD. Additionally, dental professionals should receive specialized training in ASD-specific care and stay updated on emerging research to enhance their ability to manage these patients effectively[158].

Practical examples of collaboration with healthcare providers

Collaboration between dentists and speech therapists: Many children with ASD have oral-motor dysfunctions, sensory aversions, or difficulties with swallowing.

Example: A pediatric dentist works with a speech therapist to develop exercises that improve tongue movement and oral coordination, making dental procedures like fluoride application or toothbrushing more tolerable.

Coordination between dentists and occupational therapists: Occupational therapists help desensitize children to oral care routines and improve tolerance for dental procedures.

Example: Before a dental visit, an OT works on desensitization exercises using vibrating toothbrushes and textured oral toys. The OT also provides the dentist with sensory preferences and calming strategies tailored to the child.

Collaboration between dentists and behavioral therapists: ABA therapists train children to tolerate dental exams using gradual exposure and positive reinforcement.

Example: A behavioral therapist develops a step-by-step program where the child first practices sitting in a dental chair, then opening their mouth, and eventually allowing the dentist to perform an exam with rewards for cooperation.

Integration of dental care in special education programs: Schools with ASD programs incorporate oral hygiene education into daily routines.

Example: Teachers and school nurses implement a structured brushing program where children practice brushing with visual schedules, and a dentist visits quarterly for check-ups and fluoride application.

Collaboration between dentists and psychologists/psychiatrists: Many children with ASD experience dental anxiety, requiring psychological support.

Example: A psychologist develops a social story explaining a dental visit with pictures and simple language. The dentist then uses the social story to prepare the child before the appointment.

Working with nutritionists to manage diet and oral health: Children with ASD often have selective eating habits that increase their risk for cavities.

Example: A nutritionist and dentist work together to recommend alternative, low-sugar foods and drinks, ensuring proper nutrition without compromising oral health.

Collaboration with anesthesiologists for sedation dentistry:

Some children with severe anxiety or sensory issues require sedation for dental procedures.

Example: A pediatric dentist, anesthesiologist, and child's primary care physician evaluate sedation options, ensuring safety and minimizing stress during treatments.

Parental training and caregiver support: Parents and caregivers are essential partners in ensuring consistent oral hygiene at home.

Example: A dental team holds workshops for parents, demonstrating adaptive toothbrushes, sensory-friendly toothpastes, and strategies for making brushing easier at home.

Training programs for dental professionals

Providing effective dental care for children with ASD requires specialized training for both dentists and their supporting staff. Given the unique challenges posed by ASD—including sensory sensitivities, communication barriers, anxiety, and behavioral issues—dental professionals must be equipped with the knowledge and skills necessary to create a safe, comfortable, and supportive environment[123]. Traditional dental education often lacks a dedicated focus on treating patients with special healthcare needs, leaving many practitioners unprepared to handle ASD-specific challenges. Structured training programs can help dental teams develop essential competencies in behavioral management, communication techniques, sensory adaptations, and interdisciplinary collaboration[5].

One of the fundamental aspects of training is increasing awareness and understanding of ASD. Dental professionals should be educated on the neurodevelopmental characteristics of ASD, including common behavioral patterns, sensory sensitivities, and communication difficulties. Training should emphasize that ASD presents in a highly variable manner, requiring a flexible and patient-centered approach rather than a standardized method[119]. Communication and behavioral management strategies are critical components of training. Since children with ASD often struggle with verbal communication and social interactions, dental professionals should be trained in techniques such as the "Tell-Show-Do" method, visual supports like picture schedules and social stories, non-verbal cues, and positive reinforcement[159]. These strategies can help build trust and reduce anxiety during dental visits. Additionally, behavioral management techniques such as desensitization visits, structured routines, and gradual exposure should be incorporated into training to ensure a smooth and predictable experience for ASD patients[115].

Sensory adaptations in the dental office play a crucial role in making dental visits more tolerable for children with ASD. Training programs should educate dental teams on environmental modifications, such as dimming lights, minimizing noise, and eliminating strong odors, to reduce sensory overload. The use of sensory-friendly tools, including noise-canceling headphones, weighted blankets, and textured oral hygiene products, can also improve patient comfort [81]. Furthermore, alternative positioning techniques, such as allowing children to remain seated upright instead of lying flat, can help alleviate anxiety and increase cooperation. Since some children with ASD may require sedation due to extreme anxiety or difficulty tolerating procedures, training should cover the safe use of nitrous oxide, general anesthesia protocols, and non-pharmacological pain management techniques like guided imagery, deep breathing exercises, and distraction methods[160].

Another critical area of training is emergency preparedness and crisis management. Children with ASD may experience meltdowns or behavioral crises due to heightened anxiety or sensory overload, requiring dental teams to be well-prepared with de-escalation techniques and crisis intervention protocols[161]. Effective collaboration with caregivers is essential, as parents and guardians can provide valuable insights into calming strategies that work best for their child [162]. Additionally, training should emphasize the importance of interdisciplinary collaboration with pediatricians, developmental specialists, occupational therapists, and behavioral therapists to create a holistic, patient-centered approach to dental care[163].

Research gaps and future directions

Despite growing awareness of the oral health challenges faced by children with ASD, significant research gaps remain regarding effective interventions, long-term outcomes, and the role of caregiver involvement in dental care. One of the primary areas requiring further study is the development and evaluation of tailored dental interventions for children with ASD. While various behavioral management techniques, such as desensitization visits, visual supports, and sedation, have been proposed, there is limited evidence on their comparative effectiveness across different ASD severity levels[164]. Future research should focus on identifying the most effective strategies for reducing dental anxiety, improving cooperation during treatment, and enhancing oral hygiene behaviors at home. Additionally, studies should investigate the efficacy of emerging technologies, such as tele-dentistry, mobile health applications, and virtual reality simulations, in improving dental care accessibility and adherence among children with ASD.

Long-term outcome studies are also crucial to understanding the impact of early dental interventions on the lifelong oral health of individuals with ASD. While short-term studies have highlighted increased rates of dental caries, periodontal disease, and malocclusion in children with ASD, there is little data on how these conditions progress into adulthood and their broader implications for overall health. Longitudinal studies could provide valuable insights into how early preventive care, dietary modifications, and behavioral interventions influence long-term oral health outcomes in this population. Additionally, research should examine the long-term effects of repeated sedation and general anesthesia, as children with ASD often require these measures due to heightened anxiety and difficulty tolerating dental procedures.

Caregiver involvement is another critical but underexplored area in ASD dental care research. Parents and caregivers play a vital role in maintaining their child's oral health, yet many report difficulties in implementing effective home care routines due to sensory sensitivities, resistance to toothbrushing, and lack of professional guidance[75]. Future studies should focus on developing and evaluating caregiver education programs that provide practical training on oral hygiene techniques tailored to children with ASD. Research should also explore the psychological burden faced by caregivers in managing their child's dental health and identify supportive strategies to reduce stress and improve adherence to

preventive care.

Moreover, there is a need for studies exploring systemic barriers to dental care for children with ASD. Many families face challenges in accessing specialized dental services due to a lack of trained professionals, inadequate insurance coverage, and long wait times for appointments[165]. Research should assess the effectiveness of policy changes, such as increasing insurance reimbursement for ASD-specific dental care, integrating oral health services into autism care programs, and expanding community-based dental initiatives. Additionally, cross-cultural studies are needed to understand how different healthcare systems and cultural perceptions of ASD influence access to and utilization of dental services worldwide.

Finally, future research should prioritize the integration of interdisciplinary approaches in ASD dental care. Collaboration between dentists, pediatricians, occupational therapists, and behavioral specialists could lead to more comprehensive, patient-centered models of care. Studies should evaluate how interdisciplinary interventions improve both oral health and overall well-being in children with ASD. Advancing research in these areas will not only enhance the quality of dental care for children with ASD but also contribute to a more inclusive and accessible healthcare system that meets their unique needs. Table 15 summarizes the recommendations for improving dental care in children with ASD.

Table 15 Recommendations for improving dental care in children with autism spectrum disorder

Target audience	Key recommendations	Expected benefits
Caregivers	Implement structured oral hygiene routines using visual schedules, sensory-friendly toothbrushes, and non-foaming toothpaste	Improves cooperation, reduces sensory aversions, and establishes consistent oral care habits
	Use positive reinforcement strategies (*e.g.*, rewards, social stories, or gamification) to encourage daily brushing and flossing	Enhances motivation and engagement in oral hygiene
	Seek ASD-trained dental professionals and schedule pre-visit desensitization sessions	Reduces dental anxiety and improves cooperation during clinical visits
	Encourage a balanced diet with limited sugary or acidic foods and promote water intake for oral health	Reduces risk of cavities and acid erosion
	Consider probiotic supplements (if recommended) to support oral microbiota and prevent dental caries	Enhances oral microbial balance and reduces inflammation
Dentists & dental professionals	Adapt the dental environment (dim lights, noise reduction, weighted blankets, sensory-friendly tools)	Minimizes sensory overload and improves patient comfort
	Use visual communication aids (picture schedules, social stories, and modeling videos)	Enhances understanding and predictability for ASD patients
	Implement gradual desensitization protocols and behavioral techniques (Tell-Show-Do method, distraction strategies)	Increases patient cooperation and reduces dental fear
	Provide ASD-specific training for dental staff to enhance communication and behavioral management skills	Improves patient-dentist interaction and treatment success
	Offer shorter, flexible, or split appointments based on patient needs	Reduces stress and increases the likelihood of completing treatment
	Use alternative sedation techniques (if necessary), ensuring safe administration for children with severe anxiety or sensory issues	Enhances safety while ensuring comprehensive treatment completion
Policymakers & healthcare administrators	Increase access to ASD-specialized dental training in dental schools and continuing education programs	Expands the workforce of ASD-trained dental professionals
	Implement insurance policies that cover ASD-specific dental care (*e.g.*, behavioral adaptations, extended visits, sedation if necessary)	Reduces financial barriers to receiving specialized dental care
	Promote interdisciplinary collaboration between pediatricians, occupational therapists, behavioral specialists, and dentists	Creates a holistic approach to ASD dental care and improves patient outcomes
	Support the development of digital applications and tele-dentistry solutions to assist ASD families with home-based oral care	Increases accessibility to oral health education and remote guidance
	Encourage funding for research on ASD dental care interventions, including behavioral adaptations, probiotics, and technology-driven solutions	Drives innovation in evidence-based ASD-specific dental practices

ASD: Autism spectrum disorder.

Limitations

Despite the rigorous methodology applied in this systematic review, several limitations should be acknowledged. First, the included studies exhibited substantial heterogeneity in terms of study design, sample characteristics, and outcome measures. The variations in research methodologies and assessment tools limited our ability to perform a meta-analysis

and draw definitive statistical conclusions. Second, most of the reviewed studies relied on caregiver-reported data, which may be subject to recall bias and social desirability bias. The reliance on parental perspectives, rather than objective clinical assessments, may have influenced the reported prevalence and severity of dental issues in children with ASD. Third, the majority of the included studies were conducted in high-income countries, limiting the generalizability of our findings to low- and middle-income settings. Socioeconomic factors, cultural differences, and variations in healthcare systems may impact the accessibility and quality of dental care for children with ASD in diverse global contexts.

Fourth, the absence of longitudinal studies in our review restricts our ability to assess the long-term effectiveness of various dental interventions. Most of the studies included were cross-sectional or short-term in nature, making it difficult to determine the sustained impact of specific behavioral and sensory adaptations on oral health outcomes. Fifth, there is a lack of standardized guidelines for managing dental problems in children with ASD. The interventions described in the literature varied widely, with no clear consensus on best practices for addressing the unique dental challenges in this population. Future research should focus on developing evidence-based clinical guidelines to optimize dental care for children with ASD. Lastly, publication bias may have influenced our findings, as studies with positive outcomes are more likely to be published compared to those reporting negative or inconclusive results. This may have led to an overestimation of the effectiveness of certain interventions. Despite these limitations, this systematic review provides valuable insights into the challenges and solutions in managing dental problems in children with ASD. Future research should address these gaps by conducting well-designed longitudinal studies, exploring culturally diverse populations, and establishing standardized protocols for ASD-specific dental care.

CONCLUSION

This systematic review highlights the significant challenges faced by children with ASD in maintaining optimal oral health and accessing appropriate dental care. Sensory sensitivities, communication difficulties, behavioral challenges, and limited access to ASD-trained dental professionals contribute to a high prevalence of dental issues such as dental caries, gingivitis, bruxism, and malocclusion in this population. Additionally, parental concerns, financial constraints, and the lack of standardized protocols further exacerbate these challenges, emphasizing the need for tailored interventions. The findings suggest that a multidisciplinary approach, incorporating behavioral adaptation techniques, sensory-friendly dental environments, caregiver education, and interdisciplinary collaboration, can significantly improve dental care outcomes for children with ASD. Strategies such as desensitization programs, visual supports, modified dental tools, and digital interventions have shown promise in reducing dental anxiety and enhancing cooperation during dental visits. Moreover, the role of caregivers in maintaining daily oral hygiene and facilitating positive dental experiences underscores the importance of comprehensive education and support for families. Despite advancements in research, gaps remain in the standardization of ASD-specific dental care guidelines and the long-term effectiveness of various interventions. Future research should focus on developing evidence-based protocols, conducting longitudinal studies, and expanding access to specialized dental care for children with ASD, particularly in underserved populations. By addressing these gaps, healthcare professionals, policymakers, and caregivers can work together to ensure that children with ASD receive the dental care they need, ultimately improving their overall quality of life and well-being.

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