

# **Digital Accessibility and Assistive Technology for Autism Spectrum Disorder in Dental Setting: Interactive Communication, Treatment, Referral, and Follow-Up**

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**Abstract:** This paper aims to highlight the connection between oral health and ASD and aims to make dental care more accessible for autistic people. It was proven by multiple studies that autistic individuals are more prone to dental problems, yet they are less likely to seek dental care, and when they do, there are often gaps that prevent them from getting proper care. It is important to address the issues ASD individuals face in order to provide better oral care and improve oral health and awareness in the individuals, parents, and caretakers.

**Keywords-** autism spectrum disorder, disability, Dentistry, Assistive technology.

## **1. Introduction**

Autism Spectrum disorder (ASD) is defined according to the Fifth Edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as the complicated neurodevelopmental disorder characterized by:

- Continuous difficulties with social interactions and communication.
- Interests, activities, and behaviors that are limited, restricted, and repetitive.
- Day to day life is affected by the symptoms.

The word “spectrum” describes the variation and severity of the symptoms experienced by different individuals. Some autistic individuals experience very mild symptoms which cause them to be diagnosed later in life and in some cases never diagnosed. In recent years, the number of children diagnosed with autism has risen to reach a prevalence of 1 in 54 children, this is according to a paper published in 2020 by Como DH. et al. Como DH. et al. pointed to the fact that autism used to be rare, but numbers of diagnoses have increased significantly in the last half century. Dentists must be alerted to this major surge in ASD diagnoses, because nowadays they are more likely to encounter autistic individuals in their practice. Autism impacts various areas when considering overall health, which in turn affects oral health as well.

This paper will highlight how oral health and autism are related and propose solutions to bridge the gap between ASD individuals and receiving proper dental care.

## **2. Methodology**

The study employs a qualitative approach, using a combination of literature review and analysis of case studies to explore existing challenges faced by individuals with ASD in dental settings and identify opportunities to enhance accessibility through digital tools and assistive technologies.

Limitations include the reliance on secondary data which may introduce bias to this paper, in addition to the limited technologies that are currently implemented in dental setting for ASD individuals.

### 3. Discussion

#### 3.1. Association between dental health and autism

In this section, a brief description of some issues individuals with ASD experience and are related to oral and dental health will be mentioned.

- **Sensory Processing Disorder:** Sensory processing disorders are sensory modulation issues in which the affected person does not respond appropriately to a stimulus. People affected by sensory processing disorders can struggle with over- or under-responsiveness to a stimulus, which can result in poor coordination, seeking sensory stimulation, or avoiding sensory stimulation.

TVisual and auditory stimuli at the dental office can be unbearable for individuals with ASD. This leads to individuals with ASD avoiding dental visits which leads to escalation of the issue and needing more invasive procedures, often, they get referred for conscious sedation or general anesthesia (which is more expensive) for procedures that are usually treated by simple local anesthesia.

It has been suggested in a study by Cermak et al. that dental treatments carried out for children with autism in a sensory-adapted dental environment were more effective than treatments carried out in regular dental environment. In 2015, a review carried out by Nelson et al. suggested that children with autism are less likely to be triggered by sensory input when the environment is familiar.

Another aspect of sensory processing disorders and autism is sensory over-responsivity during toothbrushing. A cross-sectional observational study was conducted in 2020 by Khrautiego et al. that suggested that individuals with ASD are less cooperative when it comes to toothbrushing, especially at the dental office. This leads to an increased risk of dental caries and tooth loss. A study done by Jaber M. also found that autistic individuals have poorer oral hygiene and an increased caries risk. In conclusion, individuals with ASD struggle to get dental treatment due to sensory processing disorders and negative sensory input during dental visits, and to minimize this, the dental environment should be familiar to them. In addition to that, they have an increased caries risk due to sensory over-responsivity during tooth brushing which makes them perform oral hygiene measures poorly.

- **Avoidant/ Restrictive Food Intake Disorder (ARFID) Associated with ASD:** Avoidant Restrictive Food Intake Disorder (ARFID) is defined as a feeding and eating disorder in which the individual lack interest in eating and avoid food due to sensory characteristics (taste, smell, texture, etc.) or out of fear of the negative reaction of eating. Some consequences include weight loss, failure of children to meet weight milestones, nutritional deficiencies, depending on supplements and/or enteral feeding, disruption with psychosocial functioning.

It has been estimated that ARFID and ASD co-occur in 12.5%- 33.3% of cases in a study done by Kozak A. and published in 2023.

One of the many complications of ARFID is gastroesophageal reflux and vomiting. Acidic substances cause the pH level of the oral environment to drop significantly which cause erosion, this is a type of tooth surface and enamel loss due to acid attacks. Another manifestation of acid attacks is soft tissue symptoms like burning and sensitivity.

- **Ehlers-Danlos syndromes (EDS) and its' relationship with autism and dental health:** Ehlers-Danlos Syndromes (EDS) are a group of hereditary connective tissue disorders that affect collagen and extracellular matrix synthesis and maintenance. Individuals with EDS have marked skin fragility and hyperextensibility, hypermobile joints, and tendency of bruising.

EDS impacts many areas of the body; however, the focus here will be on the orofacial area. Before detailing how EDS affects oral health, it is necessary to mention the role of collagen and how vital it is to maintain the overall health of the teeth and periodontium. In teeth, the collagen forms a matrix for the mineralization of mineral platelets in dentin where it is the major component, so it provides a scaffold for mineralized tissue formation. When compared to enamel, which is the outer layer of the tooth, the dentin underlaying is less mineralized and less brittle, it can withstand high compressive forces and masticatory load due to the abundance of collagen. Therefore, any tooth with dentin abnormality is a weak tooth that fractures easily even under masticatory forces.

The teeth are supported and held into their place by the periodontal ligaments which are bundles of collagen fibers. They can withstand masticatory forces and heavy occlusal loads. An easy analogy to that would be a trampoline, as a person jumps on it, the frame and jumping mats do not break as they are held firmly by flexible springs that can slightly extend and redistribute forces, and any issue with these springs will affect the strength the trampoline can tolerate, and in severe cases it will make the components detach from each other.

**Negligence and disregard of oral hygiene:** A descriptive cross-sectional study was conducted in Chennai and published in 2022 by Suresh S. et al. showed increased instances of poor oral hygiene among disabled individuals due to negligence by parents, caretakers, and even dentists. People with mild instances of autism are capable of maintaining good oral hygiene, while others are unable to do that, therefore, they rely on caretakers or parents to assist them in performing oral hygiene measures. The level of functioning of autistic individuals and performance of oral hygiene were correlated according to a survey done by Weil TN et al.

The level of cooperation in ASD individuals correlated strongly with how severe autism is, and the level of functioning such as talking, listening, ability to perform self-care, etc. of each individual, as people who have more ability to speak, listen, and converse showed better ability to perform oral hygiene practice independently, while autistic individuals with lower functioning abilities struggle to do so, and their caretakers must assist them to brush and floss their teeth. Sometimes, caretakers struggle to do so due to decreased cooperation or sensory issues so many of them give up on oral hygiene.

Challenges individuals with ASD face at the dental clinic:

It has been highlighted that autistic people suffer from various oral implications, so it is logical that special care should be available for them. Unfortunately, many of their needs remain unmet.

### **3.2. Inexperienced dentists:**

Special care dentistry (SCD) is a part of dentistry that focus on providing treatments for people with disabilities and preventing the emergence or progression of dental diseases. Early recognition and prevention of disease is a big part of SCD. Another part of SCD includes providing care for people with complex additional needs.

The lack of special needs dentistry curricula in dental colleges and schools has been recently demonstrated in a study published in 2024 by Scepanovic T. et al. This study is one of its kind as it was carried out globally in 1265 dental schools across 180 countries. The results were astonishing and concluded that there is a lack in dental schools curricula that focus on providing care for people with disabilities even among the G7 countries which are considered the world's most economically advanced countries.

The study also pointed out that knowledge and education regarding SCD and providing dental care for disabled people should be crucial for both general and specialized dentists.

General and specialized dentists must be well versed in SCD so they can provide preventive care and perform minimally invasive procedures for patients with mild to moderate autism who have the potential for being cooperative instead of referrals and extra costs for the individual.

### **3.3.Inaccessible dental clinics**

Inaccessibility in dental clinics for individuals with ASD is a multifactorial issue as suggested by Parry JA. et al. some of the issues will be discussed in this section.

- **Dental anxiety and phobia:** In an article published by Beaton L. et al. about why people are afraid of the dentist many reasons were explored. Traumatic experiences, learning about bad experiences of other people, and individual personality traits were all reasons to cause dental phobia and/or anxiety. It has been suggested that 50% of those who have dental fear and anxiety acquired it during childhood, and it persisted with them into adulthood. Analysis showed that the number of tooth extractions a child had had is correlated with higher incidents of dental fear and anxiety. It is also important to point out that children reported lower levels of dental fear if they had had more check-up visits before receiving treatments. Studies conducted in the UK showed that people with ASD experience higher anxiety and fear related to dentists compared to other people. This anxiety does not only come from the individual, but also from the dentist, Parry JA et al. mentioned that dentists feel anxious when treating people with autism. Autistic individuals have difficulties when engaging with the dental team due to their anxiety and fear, so challenging behaviors are not uncommon for autistic children. Dentists often find it difficult to deal with these behaviors from neurotypical children, so it is understandable that dealing with autistic patients can often times be challenging. Parry JA et al. also highlighted that many autistic individuals get dental treatments under general anesthesia and suggested that more practical primary dental care strategies must be implemented and considered. Dentists are often very well trained to deal with situations like screaming, crying and decreased cooperation from patients, they use many methods to reassure the patient and provide a more comforting environment.
- **Sensory sensitivity:** As discussed above, people with autism struggle with sensory processing disorders, and this is one issue that causes extreme distress for them when getting dental treatment. Unfortunately, many dental clinics lack the facilities to help autistic people deal with the

issue of increased sensory sensitivity despite the inherent nature of dental clinics to be increasingly stimulating.

One example of that is sensory distress caused by the texture of a material or an item. Parry JA et al. collected data about experiences of autistic individuals at the dentists, parents of one autistic individual reported that their child would accept treatment and is usually laid back, however, the child panics, cries, and sweats when the material used for cleaning is mentioned that it would be used on him, because according to them it feels gritty.

Another aspect of sensory sensitivity is associated with visual stimulation. Lights and reflections during dental treatment could pose an issue with individuals with autism.

Auditory stimulation also causes increased sensory overload for autistic people. At the dental office the sounds of machines running, clocks, handpieces, suctions, etc. are all difficult to tolerate and cope with.

Other stimulations that are difficult for individuals with ASD to tolerate include taste, vibrations, and even the dental team touching them.

- **Difficulties in communication:**

Vogindroukas I. et al. published a study in 2022 titled “Language and Speech Characteristics in Autism”, in which they emphasized that both written and oral linguistic abilities are different for different individuals with ASD. Some of them demonstrated poor linguistic ability while others showed above average ability.

The challenge with communication with the dentist is clearly found in the first group where their limited ability to express written and verbal language prevents them from explaining their symptoms clearly to the dentist. For some people, they can communicate with some assistance.

In addition, ASD individuals can be verbal, minimally verbal, or non-verbal. It is the dentist’s duty to recognize the communication pattern for each person and communicate accordingly in a way that suits their needs and makes it less challenging for them.

- **Challenging behaviors:**

Edelson SM. Mentioned that many people on the spectrum are reported to have challenging behaviors that include hostility and aggression towards people like hitting, biting, or scratching, self-harm like pulling their hair, biting their hands, or slapping themselves, and severe tantrums.

It has been stated since the 1960s that challenging behaviors fall under a paradigm that starts with receiving stimuli that provokes the challenging behavior and depending on how the behavior is reinforced whether negatively or positively the recurrence rate and severity of the same behavior will be less or more likely to re-occur. This is known as operant conditioning paradigm.

Bijou and Baer contributed to this by publishing their research and theories regarding human and child psychology and children development. Their work was referenced in Edelson SM. Article as contributory to the operant conditioning paradigm as they have modified it to include an individual’s internal factors such as physical pain, discomfort, and fatigue, and their external surrounding like light and temperature, and categorized them as setting events. In this case, the flow of events preceding the occurrence of undesired behavior will include internal and external factors.

How an autistic individual display behavior also depends on their interoception. Interoception is internal body sensations that include hunger, thirst, pain, bowel

movements etc. interoception is mediated by parts of the brain and studies have demonstrated that individuals with ASD interoception is poorly regulated. Some people with autism display an increased response while others displayed lower response due to dysregulated interoception.

Interoception comes into play in the display of negative behavior, as high interoception, over-responsiveness, and inability to locate pain and discomfort were all correlated to increased display of undesired behaviors severity and frequency.

Dentists are aware of the concept of negative and positive reinforcement, so they should always make sure to apply these concepts accordingly and in the correct manner all while taking into account the person's nature, setting factors, interoception, and pattern of challenging behavior.

Those were some of the factors that explain why many autistic people struggle with maintaining their oral health which stems from (but not solely) dental clinics lack accessibility for individuals with ASD. Some important points include: inexperienced dentists who have little to no knowledge and experience when dealing with people with autism and lack of dentists who specialize in SCD, the inherent nature of autistic individuals to be sensory- sensitive and the nature of dental clinics to be sensory-stimulating, increased levels of anxiety and phobias that can make communication difficult and result in undesirable behaviors that dentists find difficult to control, and intellectual disability that also affects effective communication.

### **3.4.How to make dental care more accessible for individuals with autism?**

In this section, suggestions will be discussed to make dental care more accessible for autistic individuals.

- **Modification of the environment at dental clinics:** When it comes to taking in sensory input for ASD individuals, it starts right from entering the clinic. Dentists usually start observing the patient right from that moment too, because the moments the patient walks in can give so much information regarding their personality and behavior. Autistic individuals can behave in any of these ways depending on the severity of their autism, setting factors, interoception, and many other factors. The role of the dental team is to be welcoming of the individual from the moment they walk into the clinic. The team should introduce themselves, explain their roles, and the dentist must explain what they will be doing today. This simple gesture could have a significant impact on the autistic person because each time the dental team welcome them and introduce themselves it gives them a sense of familiarity. Next, the dentist observes their patients in the waiting room, because that too can give a clear idea about the person. Autistic individuals behave differently in the waiting room depending on the aforementioned factors. What dental clinics can do to make autistic people dental visits easier is not to let them wait for a long time and to make the environment in the waiting area more comfortable for them.

As previously mentioned, individuals with ASD struggle with sensory issues that can be triggered by light and sounds. It is preferable if the waiting area has dim lights, it is also preferable that treatment rooms doors remain closed so loud sounds do not reach the waiting room. The waiting room must not have any kind of strong smell or fragrance.

Another way to modify waiting areas is to provide a sensory area that has colors, books, cubes, toys, etc. and to provide comfortable chairs. The surfaces should be soft, and lights should be dim. Soft mats and interactive sensory toys or gadgets can also be used.

It is important that the environment is also comfortable for them. Some dental materials contain very strong smells like eugenol or sodium hypochlorite, so the room should be well ventilated or other fragrances that the autistic person prefer can be used to mask the strong scents. It is also crucial that the environment is familiar for the autistic person, so what the dental team can do is arrange for the individual to visit their clinic for a few times while introducing them to the place, let them explore the dental chair, suction, masks, and tools. These visits main aim is to familiarize the autistic individual with the environment, not to provide treatment. In addition to that, these visits are also important for the dentist as they give them an idea about the individual's personality, pattern of behavior, and degree of cooperation.

One of the best ways to deal with anxious patients of all ages is the show, tell, do, technique that all dentists are aware of. One way of implementing it is to show the person the suction or saliva ejector for example, then explaining that this tool suctions the water and saliva from the mouth, a dentist can then proceed to put some water in a cup and suction it and telling them that this is how it works, finally they can try it in their mouths.

Another way of improving the treatment experience and outcomes is to have distractions for the autistic person. A screen can be attached to the dental chair with the remote being with the person. Noise cancelling headphones can be used as well. Modifying dental light is also another way to modify the environment and make it more sensory friendly.

It is also important that autistic individuals are assigned to the same dentist, and they should get to know the dentist very well to be more familiar and comfortable.

- **Modification of dental tools and instruments:**

Many dentists struggle with putting the instruments anywhere near the autistic person mouth. this stems from many reasons, for example the autistic individual believe that this tool will cause them pain. The best way to deal with this is the show, tell, do technique which was discussed previously. Another reason as to why an autistic individual refuses dental instruments is the instruments being unfamiliar for them.

Another way to overcome this is to design dental instruments to look like items they put in their mouths. For example, a dental mirror can be re-designed to look like a spoon, a local anesthesia syringe could be designed to look like a lollipop or other food items, and an ultrasonic scaler can be designed to look like a toothbrush.

It is also critical that the patient's comfort and safety is taken into account, so one thing that can be done is providing bite blocks and tools that help keep the mouth open. These tools can be attached to highspeed handpieces and ultrasonic scalers, and then removed for sterilization. Another suggestion is that the buttons on the dental chair be kept hidden under the chair in a place only the dentist can access easily. Another modification that can be made to dental chairs is adding a voice prompt that informs the patient that the chair will now be raised, or the chair will go down and so on.

Due to the sensory issues that individuals with ASD experience, some of them might be sensitive to lights, so one thing that can be done is removing the dental light above the patient and replacing it with a smaller light that can be attached and detached from the instruments or modifying each instrument to have its own light source.

- **Providing at least one expert in the field of SCD per clinic:**

This solution is difficult to implement due to the current lack of experts in the field. But what can be done is to gather available human resources and collect data about dentists who have the knowledge, skills, and confidence to deal with mild and moderate autistic patients with the ability to cooperate, then relocate them and assign them to different clinics.

Assigning paedodontists with experience with inhalation or conscious sedation in multiple clinics in various areas is also recommended.

It is also suggested that more investment is to be made to support these dentists and assist them in getting proper education to expand their expertise regarding SCD.

- **Better awareness for parents and caretakers:**

Dental facilities and dentists should do better regarding educating parents and caretakers of the importance of oral health for autistic individuals. They should always emphasize the importance of brushing, flossing, and regular dental visits. They should also make sure that parents and caretakers are aware of the oral health problems that come with autism.

On the other hand, caretakers and parents must not neglect the importance of oral health for their autistic children and individuals. They must be well aware of the oral health implications of autism, and they should always ask for more information from their dentists whenever required.

Moving on to the last section, which is the main and most important aspect of this proposal, I will discuss in detail the main idea on how dentists can contribute to their duty and help people with autism gain more access to dental care.

- **Designing an application for people with autism:**

The idea is to create an application for people with autism to gain more access to dental services. More details below will be highlighted.

Table 1. design and utility of the application for enhancing accessibility in dental care for individuals with ASD.

Aspect	Detail
What is it?	An application for mobile devices that enables autistic individuals to find suitable dentists, book appointments, and review their past appointments.
Who is it designed for?	Individuals with Autism Spectrum Disorder (ASD), their caretakers or parents, dentists, medical doctors, and pharmacists.
How will it help individuals with ASD?	<ul style="list-style-type: none"> <li>- Provides access to dentists' profiles for informed selection.</li> <li>- Enables appointment booking, reducing stress.</li> <li>- Includes personal profiles showing treatment plans, previous treatments, radiographs, and clinical notes.</li> <li>- Sends reminders for appointments.</li> <li>- Allows simple consultations by submitting questions to dentists.</li> </ul>
How will it help dentists?	<ul style="list-style-type: none"> <li>- Supports patient selection by ensuring dentists are familiar with Special Care Dentistry (SCD) are chosen.</li> <li>- Serves as a database for storing patient information, templates, and medical history.</li> <li>- Allows access to past treatments without editing capability.</li> <li>- Enables prescribing medications directly via the app.</li> <li>- Facilitates referrals to specialized colleagues, saving time and reducing patient stress.</li> </ul>
Why are medical doctors and pharmacists included?	<ul style="list-style-type: none"> <li>- Pharmacists: Verify and dispense medications prescribed via the app.</li> <li>- Medical Doctors: Record patient allergies, medications, and health history. Assist with blood work requests and upload results for dentist review.</li> </ul>
What are some other features?	<ul style="list-style-type: none"> <li>- Virtual reality: Allows autistic individuals to simulate dental visits and interact with tools.</li> <li>- Incorporates tawasol symbols for better communication (e.g., dentist, open mouth, rinse mouth).</li> </ul>
How can we improve it in the future?	<ul style="list-style-type: none"> <li>- Expand to include individuals with other disabilities (e.g., Down syndrome, cerebral palsy, visual impairments).</li> </ul>



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- Develop a similar application for the general population.
  - Add a voice recognition feature for visually impaired users.

## 4. Conclusion

This is the end of this proposal that explains how autism and oral health are related and offers many solutions to improve issues ASD individuals face in regard to receiving dental care.

To put everything into perspective, individuals with ASD are often affected by oral complications that can be due to sensory regulation issues, challenging behaviors, intellectual disability, or even due to co-morbid conditions that have a high co-occurrence rate with ASD such as ARFID and EDS.

According to many referenced studies, if dentists do not get enough education and exposure in regards of how to care for disabled individuals, meaning that many dental schools or colleges lack in the curricula of special care dentistry.

In the end, it is important that dentists and authorities come together with their thoughts, ideas, and suggestions on how to be more inclusive of autistic individuals as they are a part of our society and deserve oral care like their neurotypical peers. These ideas must be implemented and carried out accordingly all while making sure that they are useful for individuals with ASD.

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