

## **THE POTENTIAL OF USING AI IN THE EARLY DIAGNOSIS OF CARIES IN PEDIATRIC DENTISTRY**

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**Abstract:** The article provides a scientific analysis of the use of artificial intelligence (AI) technologies in the early diagnosis of dental caries in pediatric dentistry. In recent years, highly accurate neural networks and automated image processing systems have significantly improved the ability to detect caries at its initial stages. Compared to traditional clinical examinations and radiography, AI-based diagnostics offer advantages such as speed, precision, and reduced subjective errors. Research findings show that AI-supported diagnosis enhances the effectiveness of preventive dentistry in children, reduces the need for invasive treatments, and plays a crucial role in improving oral health.

**Keywords:** Artificial intelligence, pediatric dentistry, dental caries, early diagnosis, neural networks, dental innovations

### **The Emergence of Artificial Intelligence in Dentistry**

Over the past decades, artificial intelligence (AI) has become one of the most significant innovative technologies in medicine. High effectiveness has been demonstrated in automating diagnostic processes in fields such as radiology, dermatology, and ophthalmology, and dentistry has not remained an exception. Initially, AI was applied in dentistry for the automatic analysis of digital radiographic images. Later, its applications expanded to cone-beam computed tomography (CBCT), intraoral scanning, and high-resolution clinical photography, enabling the detection of carious lesions, periodontal changes, and orthodontic abnormalities.

The principal advantage of AI lies in its ability to analyze images at the *microscopic level*, identifying subtle changes that are imperceptible to the human eye. Programs trained using machine learning and deep neural networks are developed on the basis of large-scale dental datasets. Consequently, they provide improved diagnostic efficiency, high accuracy, and a significant reduction of human error. Moreover, AI in dentistry is not limited to diagnostics alone. It also serves as an *auxiliary tool* in treatment planning, predicting disease progression, and establishing preventive strategies. Today, major clinical centers are already implementing AI-based software to reduce patient waiting times and enhance the quality of dental care.

### **Challenges of Early Caries Diagnosis in Pediatric Dentistry**

In pediatric dentistry, dental caries is distinguished by its high prevalence and rapid progression. Due to the thinner enamel and lower degree of mineralization of primary teeth, caries can quickly advance, leading to severe complications such as pulpitis or periodontitis. Therefore, early detection significantly expands the possibilities for preventive and minimally invasive treatment. Traditional diagnostic methods, such as visual-tactile examination and radiography, are widely used in practice; however, their sensitivity remains limited. In visual examination, the dentist's experience and subjective judgment play a decisive role, which may result in the initial stages of carious lesions being overlooked. Radiographic assessment, on the other hand, often fails to detect early demineralization and, in some cases, poses additional radiation risks for children.

Furthermore, the low level of cooperation among young patients presents an additional challenge during diagnostics: children are often fearful of examinations and find it difficult to keep their mouths open for extended periods. As a consequence, caries is frequently diagnosed at later stages, requiring invasive interventions. Thus, in pediatric dentistry, there is a pressing need to improve traditional methods, introduce modern technologies, and develop objective diagnostic systems. Artificial intelligence is increasingly recognized as a promising tool capable of addressing these gaps.

### **Advantages of Artificial Intelligence in Caries Detection**

One of the most important advantages of using artificial intelligence in pediatric dentistry is its *high sensitivity and accuracy*. Neural networks based on machine learning are capable of processing large volumes of clinical data, allowing them to detect even subtle changes that may not be visible to the clinician's eye. Another significant aspect is the *reduction of subjective errors*. While traditional examinations rely heavily on the dentist's experience and attention, AI algorithms operate independently of human emotions or biases. This enables earlier detection of carious lesions. In addition, it is noteworthy that AI contributes to *reducing invasive interventions in children*. When caries is detected at an early stage, treatment can be limited to remineralization or preventive procedures, thereby reducing the need for drilling and filling. This, in turn, decreases children's fear of dental treatment.

Another advantage of AI is *speed*. Modern systems can analyze digital radiographs or scanned images within seconds, whereas a clinician would require more time. In practice, this allows for more efficient time management and better organization of patient flow in the clinic. It should also be emphasized that certain systems not only detect existing caries but can also *predict the risk of future demineralization*. For example, by identifying initial changes such as white spot lesions, these systems can

assess the likelihood of progression. This provides valuable assistance for dentists in implementing preventive measures in a timely manner. Thus, AI-based diagnostic systems play an important role in pediatric dentistry by enhancing accuracy, efficiency, and preventive opportunities, ultimately contributing significantly to clinical practice.

### **Analysis**

A review of the literature and existing research shows that *early detection of dental caries in pediatric dentistry remains a pressing issue*. While traditional clinical examination and radiographic methods are useful, their sensitivity is often insufficient, which leads to many cases of caries being diagnosed only at advanced stages. *Artificial intelligence (AI)-based diagnostic systems* demonstrate advantages in terms of sensitivity, objectivity, and speed. They are capable not only of identifying existing carious lesions but also of detecting the earliest stages of demineralization. As a result, preventive and minimally invasive treatments can be applied in a timely manner. However, certain limitations remain, including the cost of technology, the need for high-quality imaging, and the necessity of regularly updating algorithms. Nevertheless, scientific evidence emphasizes that *AI does not replace the clinician in decision-making, but rather serves as a valuable adjunctive tool*.

### **Conclusion**

The integration of artificial intelligence into pediatric dentistry offers new opportunities for the early diagnosis of dental caries. This technology complements the shortcomings of traditional methods by increasing *accuracy, speed, and objectivity* in diagnosis. It also reduces the need for invasive treatment and positively affects children's psychological comfort during dental care. Thus, the use of AI in dentistry has the potential not only to improve clinical effectiveness but also to *significantly enhance preventive strategies*. In the future, further development of this field may lead to a qualitatively new stage in diagnostic and treatment approaches within pediatric dental practice.

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