Review:
Artificial Intelligence in pediatric dentistry: A Narrative review

Jaya Chandra Bhumireddy, Anpam Saha, Mahesh Nunna, Anil Kumar Patil

[1]Department of Pediatric and Preventive Dentistry, Government Dental College and Hospital, Kadapa, Andhra Pradesh, India.

[2]Pediatric Dentistry, Sairam Dental Hospital, Calcutta 700012, West Bengal, India.

[3]Mahesh Speciality Dental Care, Dharmavaram, Andhra Pradesh, India.

[4]Department of Pediatric and Preventive Dentistry. Aditya Dental College, Beed, Maharashtra, India

Corresponding Author: Email: dr.jayachandra2509@gmail.com

Dr. Jaya Chandra Bhumireddy

Abstract

The most common chronic childhood illnesses are oral ones, a severe public health concern for children of all ages in developing and industrialized nations. Early detection and treatment of these disorders are essential for a child's dental health and overall well-being. Recently, the area of pediatric dentistry has made extensive use of artificial intelligence (AI). This systematic review aims to evaluate the effectiveness of artificial intelligence models created for use in pediatric dentistry (PD).

Introduction

Dental diseases impact kids of every generation and are a severe public health problem worldwide. They constitute a large percentage of chronic childhood ailments. Diagnosing and treating these conditions early ensures a kid's dental and overall health. [1-4] Detection of danger in its earliest stages can prove to be enormously beneficial in developing cost-effective approaches to avoid oral diseases, which are, by necessity, avoidable. [2-5] Plaque on teeth is thought to be a contributing factor in the development of most oral illnesses, including gingivitis and dental caries. As a result, preventing plaque deposition on the dental soft and hard tissues is highly important for keeping children's dental health in good condition.[4-8] When used on children, the traditional approach of detecting dental plaque using an exploration is inconvenient. Because the procedure requires the use of a revealing agent, it had been reported in the literature that several advanced methods, including precision photoluminescence spectroscopy and digital imaging assessment, had been developed; however, their significant drawbacks included the high cost of the necessary equipment and the difficulty in standardizing their procedures. [9-17] AI is gradually expanding across various industries, and the healthcare industry is no exception. [11-17]

The application of AI in PD is highly relevant since not only does it require the ability to execute operations, but it also requires the ability to guide patients' behaviors appropriately.[1-3] The field of PD is currently undergoing several innovations that will assist in the following areas: the identification of a patient's behavioral pattern; the management of anxiety; the management of data; investigations; the diagnosis; the appropriate treatment planning; the prediction of a patient's prognosis; and patient education.[7-9] Clinicians stand to benefit from improved patient care and the simplification of complex protocols brought about by the provision of a predicted outcome.[7] AI is a new technology swiftly becoming popular in the scientific and technological communities. Imaging, which serves to a significant degree as a foundational component in dentistry, is an essential component of AI. Continuous health monitoring, understanding treatment's long-term consequences, and being prepared for potential health risks are all made easier with the help of AI.[8-13] AI can entirely do away with the long work hours put in by dental experts. In addition, it is possible to enhance people's health while simultaneously reducing associated expenses, providing individualized, preventative, and predictive dental care, and integrating healthcare for all

Individuals. AI has the potential to enhance dental care by improving the precision and effectiveness of diagnosis, creating better treatment visuals, simulating outcomes, and predicting oral diseases and health. The employment of AI models as additional tools that improve the precision and accuracy of diagnosis has also garnered much interest in recent years. The medical sciences have made substantial use of AI technology, and the results have been impressive in several patient care areas. Disease diagnosis and determining a patient's susceptibility to disease are just two examples of the many responsibilities of a pediatric dentist. Hence, the objective of the study was to conduct a comparative analysis of the published papers pertaining to the application of artificial intelligence in the field of pediatric dentistry.

Literature review:

An artificial intelligence system is a new technology that has gained popularity in science and technology. Imaging is crucial to artificial intelligence, which is emerging in dentistry. Artificial intelligence could help assess and monitor a patient's health, understand a treatment's long-term effects, and anticipate health issues. [12-14] Artificial intelligence may eliminate dentists' excessive hours. Health can be improved at a lesser cost, tailored, preventative, and predictive dentistry provided, and healthcare integrated for everybody. First and foremost, artificial intelligence can improve dental care quality, diagnostic accuracy and efficiency, treatment visualizations, therapy outcomes, and oral health. [7, 9, 17] Additionally, artificial intelligence models may improve diagnostic precision and accuracy. Artificial intelligence has been widely employed in medical sciences and performed effectively in many patient-care tasks. There are various researchers focused on AI intelligence in pediatric dentistry and the studies identified were summarised in Table 1. [13-16, 18-27]

Nevertheless, the study cohort was small and unrepresentative because it was limited to high-risk kids from low-income households in a US state. [15] The model's sensitivity was 96.0 percent, and specificity was 96.0 percent, 88.1 and 97.1% for proximal caries, 95.8 and 99.0% for caries without cavities, and 99.0% for caries with holes. Another ML-based model for dental caries prediction was described. [19] This model performed admirably, on par with human dentists, and showed tremendous promise for detecting dental cavities in young patients. The study had limitations, such as relatively few kids with severe cavities and a small sample size. There is a potential for social

desirability bias because parents were asked to respond to questions regarding their children's oral treatment. Deep learning in radiograph analysis reduces observer fatigue and bias, handles large samples quickly, and speeds diagnostic and clinician efficiency. [1, 14]In contrast to manual interpretation, conflict between Observers is removed, and findings are independent of abilities and experience. As technology advances, new CNN architectures are created, improving deep learning model performance. They should become more successful and widely used in medical image analysis due to this improved performance [31-40].

Table 1: A description of the AI-based approaches in pediatric dentistry

Ref no	Study Factor	The objective of the study	Findings	Conclusion
[13]	Dental Plaque	To assess the efficacy of an AI-based system for detecting plaque on baby teeth	Comparing the CNN-based approach to a pediatric dentist, it showed excellent accuracy in identifying plaque.	Children's dental health could be improved with the use of this approach.
[14]	DC lesions	Prediction of early childhood infections using machine learning-based AI systems.	ML-based methods performed well in terms of forecasting DC.	can be beneficial for determining high-risk populations and putting into practice preventative measures
[15]	Dental Caries (DC)	Deep learning-based technique for identifying dental cavities in images.	The capacity to identify DC was established.	AI systems might correctly verify many forms of DC.
[16]	Oral health status and treatment needs	XGBoost's effectiveness in identifying OHS and treatment needs (TN) will be evaluated.	The algorithms performed well in forecasting OHS and TN.	This concept can be beneficial for school-based oral health initiatives.
[18]	Tooth and bone parameters	A technique using Deep learning (DL) for determining age.	Deep learning (DL) models have better efficacy on the initial iteration of learning the network	The collection of indications utilized in the initial phase of the study ought to be used to create deep neural networks.
[19]	Dental caries	Random forest machine learning technique for questionnaire item identification and DC prediction.	The capacity of this equipment for DC scanning.	This approach can test children for DC.
[20]	Tooth	A deep-learning method for automatically identifying and counting the deciduous teeth on panoramic radiography.	A practical method for automatically documenting panoramic dental radiography.	It will benefit doctors by sparing them time.
[21]	Dental age and chronological age	To provide accurate artificial neural network-based tooth maturation ratings for age estimate.	It increased the accuracy of the age estimate.	Appropriate to forensic & clinical situations.
[22]	DC lesions	AI approach for DC prediction using specified polymorphisms.	This algorithm was very accurate in forecasting DC.	The ability to create oral hygiene and dietary habits for patients with information on their prospective risk status might be helpful.
[23]	Microbial analysis	A Silver diamine fluoride (SDF) therapy non-response predicting model based upon MI.	Only these algorithms are viable candidates for use in forecasting non-response.	Predictions must be made in more significant, impartial databases.
[24]	Dental age	To create machine learning techniques to forecast a child's dental age.	The ML techniques were substantially more accurate than the two reference approaches.	These findings support the usage of ML algorithms instead of conventional population databases.
[25]	DC lesions	ML model for predicting the risk of caries using genetic and environmental variables.	This approach may successfully pinpoint those with severe and highly high risk.	An effective method for identifying those with a high risk of developing cavities at the societal level.
[26]	Mesiodens	Deep-learning algorithms Mesiodens are automatically classified as belonging to the primary or blended dentition using SqueezeNet, ResNet-18, ResNet-101, & Inception-ResNetV2.	In the presence of mesiodens in heterogeneous dental panoramic radiography, these algorithms provided good accuracy.	Clinical professionals with limited clinical expertise may benefit from DL technology for even more rapid and accurate diagnosis.
[27]	Dental age	Predicting children's dental ages using "random forest (RF), support vector machines (SVM), and linear regression (LR)" based on the Cameriere method	For determining dental age, ML techniques based on the phases of Cameriere development were much more precise than the Cameriere formula.	ML models are more precise than the conventional Cameriere formula.

Although the evaluated studies have yielded excellent findings, this particular study has several limitations. For instance, the literature's quality ranking acknowledges the potential presence of bias. Take into account the intricacy of a system or mechanism, its expense, and the required instruments for each specific situation. Additionally, it is crucial to consider the requisite amount of training for any AI model. Further research, increased visibility, and greater utilization are necessary. The dearth of adequate, precise data has impeded the attainment of favorable results thus far. Essentially, there are issues pertaining to both technology and ethics. The research [22] published further information on an AI system for tooth decay predictions based on a particular polymorphism. The total accuracy of this model was 93%, with a sensitivity of 90% and a specificity of 96%. The authors [25] tested the hypothesis that an AI-based ML model might use environmental and genetic data to forecast caries risk. With an AUC of 0.73, this model accurately separated individuals into those at high risk for caries and those at very high risk. However, the study's findings may have been skewed because researchers relied on the cariostatic score—a metric that can be impacted by microbiome markers—to assess the contained components of dental plaque. Because the source was limited, sample sizes were small. XG Boost, random forest, and Lite GBM were among the ML-based AI models revealed in the study [14] for predicting preschool cavities. These models' accuracy in predicting dental caries will help focus prevention efforts on the people most likely to benefit from them. The creation of the model using only 2D photos presents a potential drawback. They also reported on the development of the artificial intelligence (AI) model. [21] The model's predictive accuracy for age was 93.8%, making it suitable for use in forensics. The researchers published a prediction of a child's dental age using ML algorithms. This model performed satisfactorily; these ML techniques were noticeably more precise than the two reference techniques. We also used AI models to automatically detect and classify them, following the Cameriere approach.[22] Supernumerary teeth are defined as those that exist in addition to the typical 32. The only way to avoid these issues is to have any supernumerary teeth removed as soon as possible. The researchers reported on the automatic categorization of mesiodens in primary or mixed dentitions using deep learning models. [26] The classification accuracy of these models was perfect. Unfortunately, this study also suffered from issues that plagued the use of radiographs in a single medical center. There could be specific limitations on this

Review's scope. Despite conducting a thorough search For primary research publications, we may have overlooked some relevant studies. Second, there may be differences in how people evaluate the potential for bias due to individual perceptions. We need to speed up the approval process for selling AI models, which can enhance doctors' daily functions and decision-making based on these models' overall performance. AI has seen many applications in pediatric dentistry due to its ability to aid less-practiced dentists in making more diagnoses. These models effectively recognize and classify children into different risk categories, individually and in groups. Additionally, they support creating preventive measures, such as creating dental care routines and encouraging individuals to adopt healthy dietary practices. These models can be beneficial when planning and assessing school-based dental health projects. Children's incentives could rise due to their increased awareness of and appreciation for their dental health. However, there are some drawbacks associated with the datasets used for training and validation in these described models. It is possible to prevent this by mixing information from several organizations, data obtained by various persons, and tools produced by diverse manufacturers.

Conclusion:

Studies suggest that artificial intelligence is frequently employed in pediatric dentistry to aid pediatric dentists in generating informed clinical judgments, formulating preventive approaches, and devising appropriate treatment protocols. The AI in pediatric dentistry has been focused in recent years. Still, there is a lot of scope to establish the role of AI In pediatric dentistry.

The Author:

Dr. Anupam Saha

Dr. Anil Kumar Patil

Dr. Mahesh Nunna

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