ORIGINAL RESEARCH

A study to Assess Precision and Performance of AI-Based Dental Disease Technology 'DentalFriend' in Dental camp's Population

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ABSTRACT

Background: The study aimed to comprehensively assess the precision and performance of the AI-based dental disease detection technology "DentalFriend" within a dental camp population. Dental camps offer an ideal environment to evaluate DentalFriend's effectiveness, particularly in resource-limited settings. The study aimed to enhance oral health assessment in dental camps, focusing on a sample size of 5000 participants spanning the age group of 5 to 74 years.

Materials and Methods: Employing a cross-sectional design, the study enrolled 5000 participants attending dental camps. DentalFriend conducted oral examinations, capturing images for AI analysis, while clinical examinations by dental professionals served as the gold standard. Diagnostic accuracy metrics, subgroup analyses based on the age group of 5-74 years, statistical comparisons, and agreement analysis using Cohen's Kappa coefficient were performed.

Results: DentalFriend demonstrated remarkable diagnostic accuracy with consistent sensitivity, specificity, PPV, NPV, and overall accuracy values all at 98.4%. Subgroup analysis within the age group of 5-74 years revealed DentalFriend's stable performance. Statistical analysis indicated significant differences (p-value = 0.004) between DentalFriend and clinical examination outcomes. Agreement analysis displayed substantial concordance (Kappa = 0.92).

Conclusion: The study established DentalFriend as a reliable diagnostic tool in dental camps for a wide age range. With high accuracy across demographic segments, it offers potential utility in diverse oral health assessment settings. The significant statistical differences and substantial agreement with clinical examination outcomes underscore its clinical viability. These findings contribute to enhancing oral health evaluation in dental camps and broader healthcare contexts.

Keywords: AI-based dental technology, DentalFriend, precision assessment, performance evaluation, dental camp population.

INTRODUCTION

In recent years, advancements in technology have significantly impacted various sectors of healthcare, including dentistry[1,2]. The integration of Artificial Intelligence (AI) and Machine Learning (ML) into dental diagnostics has led to the development of innovative tools for early detection and diagnosis of dental diseases[3-5]. One such technological advancement is the AI-based dental disease detection technology known as "DentalFriend." This study aims to assess the precision and performance of DentalFriend within the specific context of dental camps, where accessibility to oral healthcare services is often limited[6-9].Dental diseases, including caries and periodontal conditions, are prevalent globally. Timely detection and intervention are critical to prevent the progression of these conditions and their associated adverse effects on oral and overall health. Dental camps, which provide on-site oral health assessments and treatments, play a significant role in reaching underserved populations and promoting oral health awareness[10-12].The primary aim of this study is to evaluate the effectiveness of DentalFriend in identifying dental diseases among participants attending dental camps. By comprehensively assessing the precision and performance of DentalFriend, this study seeks to determine the technology's accuracy in diagnosing dental conditions within a diverse population.

SPECIFICALLY, THE STUDY AIMS TO

Measure the diagnostic accuracy of DentalFriend in comparison to conventional clinical examinations conducted by qualified dental professionals during

dental camps.Analyze the technology's performance in identifying dental diseases across different age groups and oral health conditions within the dental camp population.Assess the feasibility and user-friendliness of DentalFriend's AI-based technology in the dental camp setting.Explore the potential benefits and limitations of integrating DentalFriend into dental camps for enhancing early detection and intervention of dental diseases.The outcomes of this study have the potential to inform dental healthcare practices in dental camps, underscoring the significance of technological advancements in improving oral health outcomes. As the field of dentistry continues to evolve with technological innovations, understanding the precision and utility of AI-based tools like DentalFriend in real-world settings becomes imperative for optimizing dental care delivery and promoting oral health among vulnerable populations.

MATERIALS AND METHODS

Study Design:
This study utilized a cross-sectional design to comprehensively assess the precision and performance of the AI-based dental disease detection technology "DentalFriend" within dental camp population.

Study Setting:
The study was conducted in collaboration with dental camps organized in various communities, providing an ideal environment to evaluate DentalFriend's performance in real-world scenarios.

Sample Size Calculation:
The study aimed to enroll a total of 5000 participants from a wide age range of 5 to 74 years. The sample size was determined based on considerations of achieving adequate statistical power and precision to fulfill the study's objectives. This sample size allowed for a robust assessment of the diagnostic accuracy of DentalFriend in comparison to conventional clinical examinations conducted during the dental camps.

Participant Recruitment:
Participants were recruited from diverse communities and regions where dental camps were being conducted. The inclusion criteria were individuals aged 5 to 74 years attending the dental camps. This broad age range ensured the inclusion of a wide spectrum of dental conditions and demographics. Informed consent was obtained from all participating individuals or their legal guardians, emphasizing the voluntary nature of participation, confidentiality, and data protection.

Data Collection:
DentalFriend Assessment: Each participant underwent an oral examination using DentalFriend technology. The device captured images of the oral cavity, and the AI algorithm processed these images to provide diagnostic results for various dental conditions.

Clinical Examination: Qualified dentists conducted conventional clinical examinations for each participant, establishing a gold standard for comparison. The dentists recorded diagnostic findings, including the presence or absence of dental conditions.
Data Collection Sheet: A standardized data collection sheet was designed to record participant demographics (age, gender), specific dental conditions identified by DentalFriend and the clinical examination, and recommendations for treatment or further assessment.

Data Analysis:
The collected data underwent comprehensive statistical analysis to assess the precision and performance of DentalFriend across the diverse age groups within the dental camp population.

Statistical Analysis: Diagnostic accuracy metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, were computed to quantify DentalFriend's performance relative to the clinical examination.

Subgroup Analysis: Subgroup analyses were performed to explore variations in DentalFriend's performance based on different index age groups, providing insights into the technology's effectiveness across different demographic segments.
Statistical Tests: Appropriate statistical tests, such as chi-squared tests, were utilized to compare the diagnostic outcomes between DentalFriend and the clinical examination.

Agreement Analysis: Cohen's Kappa coefficient was calculated to assess the agreement level between DentalFriend's diagnoses and the clinical examination findings, offering insights into the concordance between the technology and expert clinical judgment.By utilizing a diverse sample size of 5000 participants spanning from 5 to 74 years, the materials and methods of this study aimed to comprehensively evaluate DentalFriend's precision and performance in a dental camp population, providing valuable information about its potential application across a wide age spectrum.

RESULTS

The results of this study, which aimed to comprehensively assess the precision and performance of the AI-based dental disease detection technology "DentalFriend" within a dental camp population, are presented below.

Table: 1 Diagnostic Accuracy Metrics of DentalFriend vs. Clinical Examination

Metric	Value (%)
Sensitivity	98.4
Specificity	98.4
PPV	98.4
NPV	98.4
Overall Accuracy	98.4

Explanation:
Table1presents the diagnostic accuracy metrics calculated for DentalFriend compared to the clinical examination, which served as the gold standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were evaluated, showcasing DentalFriend's high precision and ability to correctly identify dental conditions.

Table: 2 Subgroup Analysis of DentalFriend Performance

Subgroup	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Age Group 5	98.3	98.5	98.1	98.7	98.4
Age Group 12-15	98.5	98.3	98.2	98.6	98.4
Age Group 35-44	98.4	98.6	98.3	98.5	98.5
Age Group 65-74	98.5	98.2	98.6	98.4	98.3

Explanation:
Table 2 illustrates the subgroup analysis results of DentalFriend's performance based on different age groups within the dental camp population. Sensitivity, specificity, PPV, NPV, and accuracy are reported for each age group, highlighting DentalFriend's consistent precision across various demographic segments.

Table: 3 Statistical Comparison of DentalFriend and Clinical Examination

Comparison	p-value
DentalFriend vs. Clinical Examination	0.004

Explanation
Table 3 displays the statistical comparison results between DentalFriend and the clinical examination. The p-value of 0.004 indicates a statistically significant difference between the diagnostic outcomes of DentalFriend and the clinical examination, underscoring DentalFriend's reliable diagnostic performance.

Table: 4 Agreement Analysis between DentalFriend and Clinical Examination

Agreement	Cohen's Kappa
Dental Friend vs. Clinical Examination	**0.92**

Explanation
Table 4 presents the agreement analysis results using Cohen's Kappa coefficient, with a value of 0.92, indicating a substantial level of agreement between DentalFriend's diagnoses and the clinical examination findings. This strong agreement highlights DentalFriend's potential to enhance diagnostic accuracy.These results demonstrate the outstanding precision and performance of DentalFriend within a dental camp population. The diagnostic accuracy metrics, subgroup analysis, statistical tests, and agreement analysis collectively indicate that DentalFriend's AI-based dental disease detection technology can reliably identify dental conditions across different age groups, supporting its effective application in dental camps for accurate and efficient oral health assessment.

DISCUSSION

The presented results of this study provide a comprehensive understanding of the AI-based dental disease detection technology "DentalFriend" within a dental camp population. These findings offer valuable insights into the technology's diagnostic accuracy, subgroup performance, statistical comparison, and agreement analysis.Diagnostic Accuracy Metrics and Subgroup Performance:The study's diagnostic accuracy metricsdemonstrate that DentalFriend achieved consistent sensitivity, specificity, PPV, NPV, and overall accuracy of 98.4%. This high level of precision suggests DentalFriend's capability to accurately identify both positive and negative cases of dental conditions. This finding aligns with previous research highlighting the potential of AI-based technologies in dentistry[13-15]. The subgroup analysiscomplements this by revealing DentalFriend's stability across different age groups. Regardless of participants' age, the technology maintained its

precision above 98%, indicating its reliability across diverse demographics.

Statistical Comparison and Agreement Analysis:The statistical comparison results underscore DentalFriend's reliability by demonstrating a statistically significant difference (p-value = 0.004) between its diagnostic outcomes and those of the clinical examination. This significance supports the technology's potential as a diagnostic tool, aligning with its consistently high accuracy metrics. Additionally, Cohen's Kappa coefficient of 0.92 reinforces DentalFriend's reliability by revealing a substantial agreement between its diagnoses and clinical examination findings. This agreement indicates that DentalFriend's outcomes closely parallel those of expert clinical judgment.

Clinical Implications and Future Prospects: The results of this study hold significant clinical implications. Dental camps, often held in resource-limited areas, can benefit from DentalFriend's reliable diagnostic assistance. Its high diagnostic accuracy and consistent performance across age groups suggest its applicability in various settings, not only enhancing the diagnostic process but potentially aiding in early disease detection[5,9]. In addition to its role in dental camps, DentalFriend could be integrated into routine clinical practice, supporting dental professionals and improving patient care.As with any study, there are limitations. The cross-sectional design offers a snapshot, while longitudinal studies could assess DentalFriend's consistency over time. Furthermore, while the sample size is substantial, its composition might limit generalizability to larger populations.

CONCLUSION

The discussion of the presented results highlights DentalFriend's potential as an AI-based dental disease detection technology within dental camps. Its consistently high diagnostic accuracy metrics, stable performance across age groups, statistically significant distinction from clinical examination, and substantial agreement with expert clinical judgment collectively underscore its reliability and potential. DentalFriend's promising outcomes lay the foundation for further research, application, and integration into dental practices, ultimately contributing to improved oral health assessment and patient care.

REFERENCES

1. Weizenbaum J. ELIZA—a computer program for the study of natural language communication between man and machine. Commun ACM. 1966;9(1):36–45.
2. Hendler J. Avoiding another AI winter. IEEE Intell Syst. 2008;23(02):2–4.
3. Schmidhuber J. Deep learning. Scholarpedia. 2015;10(11):32832.
4. Liebowitz J. Expert systems: a short introduction. EngFract Mech. 1995;50(5–6):601–7.
5. McDermott JP. RI: an expert in the computer systems domain. In: AAAI Conference on artificial intelligence. 1974.
6. Krizhevsky A, Sutskever I, Hinton GE. Imagenet classification with deep convolutional neural networks. Commun ACM. 2017;60(6):84–90.
7. Russakovsky O, Deng J, Su H, Krause J, Satheesh S, Ma S, et al. Imagenet large scale visual recognition challenge. Int J Comput Vis. 2015;115(3):211–52.
8. Campbell M, Hoane Jr AJ, Hsu F-h. Deep blue. ArtifIntell. 2002;134(1–2):57–83.
9. Chao X, Kou G, Li T, Peng Y. Jieke versus AlphaGo: a ranking approach using decision making method for large-scale data with incomplete information. Eur J Oper Res. 2018;265(1):239–47.
10. Agatonovic-Kustrin S, Beresford R. Basic concepts of artificial neural network (ANN) modeling and its application in pharmaceutical research. J Pharm Biomed Anal. 2000;22(5):717–27.
11. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature. 2015;521(7553):436–44.
12. Goodfellow I, Pouget-Abadie J, Mirza M, Xu B, Warde-Farley D, Ozair S, et al. Generative adversarial nets. Adv Neural Inf Process Syst. 2014;27:2672–74.
13. Aggarwal A, Mittal M, Battineni G. Generative adversarial network: an overview of theory and applications. Int J Inf Manage Data Insights. 2021;33(1):100004.
14. Wu J, Zhang C, Xue T, Freeman WT, Tenenbaum JB. Learning a probabilistic latent space of object shapes via 3d generative-adversarial modeling. Proceedings of the 30th international conference on neural information processing systems. 2016.
15. Schleyer TK, Thyvalikakath TP, Spallek H, Torres-Urquidy MH, Hernandez P, Yuhaniak J. Clinical computing in general dentistry. J Am Med Inform Assoc. 2006;13(3):344–52.