COMPARISON BETWEEN PERIODONTAL DISEASE DIAGNOSTIC PERFOMANCE OF GENERAL DENTAL PRACTITIONERS AND AN AI TOOL (EBHnow)

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ABSTRACT

Objective: *To compare the periodontal disease diagnostic performance between general dental practitioners and an AI tool (EBHnow).*

Methodology: *This comparative observational study was conducted in Islamabad from October 2023 to August 2024 with a sample of 100 general dental practitioners. General dental practitioners working in private dental clinics of Islamabad were included through cluster sampling. Four standard periodontal disease cases accompanied with radiographs and brief clinical histories were used to evaluate and compare the diagnostic performance between the general dental practitioners and EBHnow. Data analysis was done using SPSS 26 and summarized through descriptive statistics including frequencies and percentages. McNemar test and chi-square analysis, were applied to assess diagnostic agreement and associations.*

Results: *Out of the 100 participating general dental practitioners, only 42% made the correct diagnosis. The highest diagnostic accuracy among general dental practitioners (66.7%) observed for the highest confidence level (5) in contrast, the lowest accuracy (23.1%) was observed for confidence level 2. McNemar test revealed statistically significant difference between the diagnosis made by the dentist and EBHnow across all four cases (p<0.05).*

Conclusion: *This study concluded that the periodontal disease diagnostic accuracy of the AI tool EBHnow was higher compared to general dental practitioners.*

Keywords: *periodontal EBHnow software, 2018 Periodontal disease classification, Diagnostic accuracy, gingivitis, periodontitis, artificial intelligence*

INTRODUCTION

Periodontitis is an inflammatory disease of the tooth supporting tissues. It is multifactorial and leads to loss of periodontal tissue support. It is also a primary cause of tooth loss in adults[1]. Periodontitis is the sixth most prevalent disease worldwide[2]. From a clinical standpoint, the accurate recognition and diagnosis of periodontitis presents challenges. Examination and evaluation methodologies are inconsistent and often suffer from lack of reliability from operator to patient and in between operators.

Artificial intelligence (AI) refers to the simulation of human intelligence processes by machines, especially computer systems[2]. A more technocratic definition of AI states, "the capability of a device to perform functions that are normally associated with human intelligence such as reasoning, learning, and self-improvement." Application of AI into medicine is fast paced making diagnostics and treatment safer, personalized and efficient[3]. In dentistry AI applications include dental image analysis, classifying oral mucosal lesions, dental implant types, dental caries and cephalometric land-

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marks[4]. Artificial Intelligence based models have much potential as a complement to periodontal diagnostics[5].

EBHnow is a free Artificial Intelligence based software. It stands for "Evidence Based Healthcare now". It provides instant answers to medical problems via its one entry point and fast access. This software has several applications in its catalogue each of which is created by utilizing the analysis of many articles. The relevant healthcare literature required in the making of this catalogue was extracted using both their scientific experts and AI. The results of any particular medical problem are presented through user friendly web applications that are peer reviewed to ensure scientific rigor. The periodontal disease diagnosis application of EBHnow was made according to the World Workshop on the Classification of periodontal and Peri-implant diseases and conditions (2018). It was developed as a collective research project between Dalhousie University, Qatar University and Concordia University. Moreover decision making algorithms using Interactive decision Tree plugin by Dan Smith form the basis of this application as well[6].

A number of Artificial Intelligence based tools have been generated, innovated and tested. Their results have shown considerable promise with further optimization. A Support Vector Machine based decision-making system was tested and revealed an accuracy rate of 88.7%[7]. Simultaneously, another assessment tool was developed to detect peri-apical periodontitis. The results showed an F1 score of 0.828, proving that the automated tool outpaced the diagnostic acumen of young dentists[8]. A Convolutional Neural Network assisted detection mechanism and identified periodontal compromised teeth with a diagnostic precision of 81.0% and 76.7% for premolars and molars respectively[9]. A research comparing four caries risk assessment tools amongst 26 hypothetical patients (divided equally into two separate age groups) was carried out. It concluded that all tools were almost equally useful but the final decision depends on the healthcare provider and the respective patient[10].

Periodontitis has high prevalence in Pakistan. A Meta analyses was conducted to check the prevalence of periodontitis which showed that at the national level the total estimate of periodontitis was 56.62% (95% Confidence Interval)[11]. The dentist-to-population ratio in Pakistan is low (1:10,850) compared with the WHO-recommended level of 1:7500[12]. The accurate diagnosis of periodontal disease is vital for correct treatment planning and patient wellbeing. However, in spite of the high prevalence of periodontal disease there is a dearth of periodontists in Pakistan. Therefore, it is important to equip the general dental practitioner when it comes to diagnosing periodontitis. According to a study published in BMC Oral Health journal, dental practitioners from Baltimore and California diagnosed periodontitis using the 2018 classification with fair to moderate agreement. The accuracy of diagnosis was not satisfactory. The diagnostic inaccuracy was attributed to difficulty in identification of risk factors and grading of periodontitis[13]. Moreover, a local study by Journal of Khyber College of Dentistry concluded that general dentists have deficient knowledge with regards to diagnosing periodontal disease as well[14].

The objective of this research study was to compare the periodontal disease diagnostic performance between general dental practitioners and EBHnow along with assessing any factors that affect the diagnostic performance of general dental practitioners.

METHODOLOGY

This cross-sectional study was conducted on a sample of 100 general dental practitioners working in private clinics across Islamabad. Only practitioners registered with the Pakistan Medical and Dental Council were included.

To ensure a representative sample, we employed a cluster sampling technique using Python software. Islamabad was divided into 18 residential clusters, from which private dental clinics were selected. The sample size 100 was determined using a formula that incorporated key statistical parameters: anticipated effect size (0.8), intraclass correlation coefficient (ICC) specific to the population (0.9), average cluster size (3), design effect to account for bias and variance (2.7), desired statistical power (0.8), and an alpha level of 0.05.

Out of the 18 defined clusters, 10 were randomly selected (D-12, E-11, F-6, F-7, F-8, F-10, G-6, G-7, G-8, and I-8 sectors), and responses—both written and online—were gathered from 53 private dental clinics within these clusters. This approach ensured a diverse and representative sample while accounting for variability within different residential sectors.

In order to conduct this study, consent from the Institution Review Board of Islamabad Medical and Dental College was taken. (Ref#IMDC/DS/IRB/259). Data was collected through a proforma made using Google forms. A total of four different proformas were designed using four standard periodontal disease cases from department of Periodontology, Islamabad Dental Hospital. Each proforma included a brief description of one clinical case along with summarized clinical and radiographic findings. Complete digital periodontal charting, full mouth orthopantomogram (OPG) and peri-apical radiograph were also attached. Options were given to diagnose the periodontal disease case in accordance with the 2018 Periodontal Disease Classification. The 2018 Periodontal Disease Classification

is attached as annexure.

These proformas were made available to the participants in person and online. Each dentist was given one of the four cases for diagnosis and requested to review the information given in the proforma, state their diagnosis and give a numerical value to how confident they were with their answer. Incomplete proformas were excluded from this study. The same periodontal disease cases were diagnosed by EBHnow as well. These cases were also reviewed by a consultant periodontologist and the diagnosis was matched with EBHnow and participants' diagnosis.

The compiled data was entered into Statistical Package for Social Sciences 26 (SPSS) for analysis.

RESULTS

A total of 100 general dentists participated in the study. The study sample consisted of 55% female and 45% male participants. Nearly half of the respondents (49%) were within the age range of 26–35 years. 69% of participants had between 0 and 5 years of clinical experience, 15% had 6 to 10 years of clinical experience while the rest (16%) had >10 years of clinical experience.

Regarding their educational background, the majority of participants graduated from Islamabad Medical and Dental College (28%), followed by CMH Lahore (20%), De 'Montmorency College of Dentistry (13%), Army Medical College (9%), Ayub Medical and Dental College (8%), Fatima Memorial Hospital (7%), Islamic International College (Riphah) (6%), Frontier Medical and Dental College (5%), and Margalla Dental College (4%). These institutions represent the complete set of alma maters among the participants.

Out of all participants, only 42% were able to make the correct diagnosis. Fig.1 presents the percentage of correct diagnoses for each case as reported by the dentists. Confidence levels were measured using a Likert scale ranging from 1 to 5, with 5 indicating the highest level of confidence. Chi-square test was applied to assess the association between years of clinical experience and confidence levels; however, the result was statistically insignificant (p = 0.06), indicating no strong relationship between these two variables. Notably, 40% of participants selected a confidence score of 3 (neutral). Table 1 illustrates the relationship between accuracy and confidence levels, with the highest accuracy (66.7%) occurring at confidence level 5 and the lowest accuracy (23.1%) occurring at confidence level 2. The McNemar test was applied to assess the relationship between the diagnoses made by EBHnow and those made by the dentists. The p-values for cases 1, 2, 3, and 4 were 0.00, 0.00, 0.00, and 0.031, respectively, indicating statistically significant differences in diagnoses for all four cases. Table 2 presents a case-wise comparison

of diagnostic accuracy of general dental practitioners (GDPs), EBHnow (AI tool), and a periodontist reference standard. Notably, generalized plaque-induced gingivitis emerged as the condition with the lowest diagnostic accuracy among GDPs.

DISCUSSION

The results of the present study reveal critical insights into the relationship between clinician experience, confidence, and diagnostic precision. The diagnostic accuracy demonstrated by the participants was only 42%. These findings align with a previous study assessing periodontal diagnosis according to the 2017 classification system, which found that 49.2% of GDPs correctly diagnosed one of two periodontitis cases, while 43% were unfamiliar with the updated classification criteria[15]. A possible explanation for the incorrect diagnosis could be the limited practical exposure of the classification of periodontal diseases among dental students which can be improved by making necessary changes in the teaching methodology or emphasizing on the practical application of periodontal classification. The integrated curriculum for the Department of Periodontology of Shaheed Zulfiqar Ali Bhutto Medical University states that the third year undergrad dental
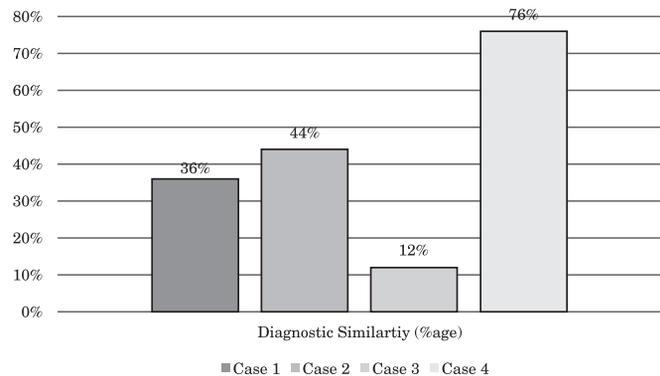

Fig 1: Case-wise Diagnostic Similarity, e.g., in case 1, 36% participants matched their diagnosis with that of EBHnow

TABLE 1: DISTRIBUTION OF CORRECT AND INCORRECT DIAGNOSIS PERCENTAGES ACROSS LEVELS OF CONFIDENCE WITH 1 INDICATING LEAST CONFIDENT TO 5 INDICATING MOST CONFIDENT

		Diagnosis		
Level of confidence	1	50.0	50.0	100.0
	2	23.1	76.9	100.0
	3	40.0	60.0	100.0
	4	39.3	60.7	100.0
	5	66.7	33.3	100.0
	Total	42.0	58.0	100.0

TABLE 2: COMPARISON OF DIAGNOSTIC AC-CURACY OF EBHNOW AND GDPS (GENERAL DENTAL PRACTITIONERS) WITH THE DIAGNO-SIS MADE BY A PERIODONTIST.

Case number	Diagnosis by perio-dontist	Diagnostic accuracy of EBHnow (AI tool) (%)	Diagnostic accuracy of GDPs (%)
1	Generalized Plaque Induced Gingivitis	100	36
2	Localized periodontitis stage II grade A	100	44
3	Generalized plaque induced gingivitis	100	16
4	Generalized periodontitis stage II grade B	100	76

students should be able to classify periodontal diseases both theoretically and on a clinical basis[16]. On the other hand, a case-control study conducted in Canada demonstrated that the use of flowcharts developed for periodontal classification significantly enhanced the diagnostic accuracy of dental students compared to those who relied solely on the curriculum (73.5% vs. 50.0%, respectively)[17] Along with the introduction of curriculum reinforcement, diagnostic AI tools like EBHnow incorporated in clinical settings have the potential to aid correct diagnoses particularly in complex cases. Additionally, literature suggests that dentists are generally more confident and accurate when diagnosing periodontitis than gingivitis, owing to the more distinct clinical and radiographic features of periodontitis, a comparison further validated by Alogaibi et al[18]. The low accuracy can also be explained by the experience gap as 69% of participants had ≤5 years of experience, potentially contributing to diagnostic challenges. However, no statistically significant relationship was found between years of experience and confidence level. This study also highlights a confidence-accuracy paradox, revealing that a significant proportion of participants (40%) selected a confidence level of 3—representing a neutral stance—when rating their diagnostic certainty. This choice may reflect uncertainty or indecisiveness in clinical judgment. However, only 40% of those who selected this neutral confidence level made a correct diagnosis, suggesting a potential disconnect between perceived and actual diagnostic competence. The highest accuracy (66.7%) was observed at confidence level 5 (most confident), while the lowest (23.1%) occurred at confidence level 2.

Periodontal disease remains a significant public health concern in Pakistan, with a reported prevalence of 70.4% for gingivitis and 25.2% for periodontitis[19]. A key factor contributing to the challenges in periodontal disease management is the low dentist-to-patient ratio in Pakistan, currently estimated at one dentist per 10,850 patients[20]. Additionally, as of January 2025, there are only 59 periodontists in the country[21]. Recently it has been highlighted a critical shortage of periodontal specialists in Pakistan, exacerbating the difficulty in providing specialized care[22]. Given this shortage, general dental practitioners (GDPs) play a pivotal role in diagnosing and managing periodontal diseases, necessitating enhanced diagnostic strategies and treatment planning.

As general dentists are often the first point of contact for patients with periodontal diseases, their ability to diagnose and refer cases appropriately is crucial. The findings of this study underscore the necessity for additional training programs and resources to enhance the diagnostic capabilities of GDPs and improve periodontal health awareness among the general population. Recent literature has demonstrated that AI-based diagnostic tools can enhance diagnostic reliability in dentistry, particularly in radiographic interpretation[23]. These tools can serve as valuable aids in periodontal disease diagnosis, assisting early career clinicians in making more accurate assessments ultimately enhancing patient care. The integration of AI in private dental clinics if validated in clinical settings, could improve diagnostic consistency, optimize treatment planning, and ultimately enhance patient care.

This study utilized a proforma, including a brief description of the clinical case along with radiographs. Therefore, the lack of clinical examination is a limitation to accurate diagnosis. Furthermore, the confidence levels in this study were self-reported which do not reflect the actual competence of the clinician. Future research should explore the effectiveness of AI-based diagnostic systems in improving periodontal disease detection and clinical decision-making.

CONCLUSION

EBHnow significantly outperformed GDPs in periodontal diagnosis across all cases, demonstrating perfect concordance with specialist judgment. While AI shows promise for enhancing diagnostic accuracy, educational initiatives reinforcing the 2018 Classification and periodontal screening protocols remain essential for GDPs. Strategic integration of validated AI tools could

mitigate diagnostic variability and improve patient care, particularly in regions with specialist shortages.

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ANNEXURE

PERIODONTAL DISEASE 2018 CLASSIFICATION

Periodontal Diseases and Conditions		
Periodontal Health, Gingival Diseases and Conditions Chapple, Mealey, et al.2018 Consensus Rept link Trombelli et al. 2018 Case Definitions link	**Periodontitis** Papapanou, Sanz, et al.2018 Consensus Rept link Jepsen, Caton et al.2018 Consensus Rept link Tonwetti, Greenwell, Kornman et al. 2018 Case Definitions link	**Other Conditions Affecting the Periodontium** Jepsen, Caton et al.2018 Consensus Rept link Papapanou, Sanz, et al.2018 Consensus Rept link
Periodontal Health and Gingival Health	**Necrotizing Periodontal Diseases**	**Systemic diseases or conditions affecting the periodontal supporting tissues**
Gingivitis: Dental Biofilm-Induced	**Periodontitis**	**Periodontal Abscesses and Endodontic-Periodontal Lesions**
Gingival Diseases: Non-Dental Biofilm-Induced	**Periodontitis as a Manifestation of Systemic Disease**	**Mucogingival Deformities and Conditions**
		Traumatic Occlusal Forces
		Tooth and Prosthesis related Factors
Peri- Implant Diseases and Conditions Berglundh, Armitage, et al.2018 Consensus Rept link		
Peri-Implant Health	**Peri-Implant Mucositis**	**Peri-Implantitis**	**Peri-Implant Soft and Hard Tissue Deficiencies**

STAGING

	Periodontitis	Stage I	Stage II	Stage III	Stage IV
Severity	Interdental CAL (at site of greatest loss)	1 - 2mm	3 – 4mm	≥5mm	≥5mm
	RBL (at site of greatest loss)	Coronal 3rd (<15%) 3mm from CEJ	Coronal 3rd (15 – 33%) 4-5mm from CEJ	Extending to middle 3rd of root and beyond (>33%) >5mm from CEJ	Extending to middle 3rd of root and beyond (>33%) >5mm from CEJ
	Tooth Loss (due to periodontitis)	No tooth loss		≤4 teeth	≥5 teeth
Complexity	Local	- Max. PD ≤4mm - Mostly Horizontal Bone Loss (HBL)	- Max. PD ≤5mm - Mostly Horizontal Bone Loss (HBL)	In addition to Stage II complexity: - PD ≥6mm - Vertical Bone Loss ≥3mm - Furcation Involvment Class II or III - Moderate ridge defects	In addition to Stage III complexity: Need for complex rehabilitation due to: - Masticatory dysfunction - 2nd occlusal trauma (mobility degree ≥2) - Severe ridge defects - Bite collapse, drifting, flaring - <20 remaining teeth (10 opposing pairs)
Extent and Distribution	Add to stage as descriptor	For each stage, descibe extent as: Localized (<30% of teeth involved); Generalized (≥30% of teeth involved); or Molar/Incisor pattern			

GRADING

	Progression		Grade A: Slow rate	Grade B: Moderate rate	Grade C: Rapid rate
Primary criteria Whenever available, direct evidence should be used.	Direct evidence of progression	Radiographic bone loss or CAL	No loss over 5 years	< 2mm over 5 years	≥ 2mm over 5 years
	Indirect evidence of progression	% bone loss/age	< 0.25	0.25 to 1.0	> 1.0
		Case phenotype	Heavy biofilm deposits with low levels of destruction	Destruction commensurate with biofilm deposits	Destruction exceeds expectations given biofilm deposits; specific clinical patterns suggestive of periods of rapid progression and/or early onset disease
Grade modifiers	Risk factors	Smoking	Non-smoker	< 10 cigarettes/day	≥ 10 cigarettes/day
		Diabetes	Normoglycemic/no diagnosis of diabetes	HbA1c < 7.0% in patients with diabetes	HbA1c ≥ 7.0% in patients with diabetes

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3. Hamdia Yumun:	Data Collection, Data Analysis, Article Writing
4. Naveeda Farooq	Data collection, Article Writing
5. Hina Mahmood	Conceptualization, helped in study design and data collection
6. Fatima Khan	Proof reading, Data Analysis