Review Article

Emergence of artificial intelligence in dentistry across global regions: focus on Africa and the West African subregion

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Abstract

Background: Artificial intelligence (AI) is transforming diagnostic and therapeutic pathways in dentistry, although the pace and extent of its adoption vary significantly across regions.
Aim: This article compares the development and implementation of AI in dental practice across major global regions and identifies strategic priorities for accelerating responsible and equitable AI adoption in West Africa.
Methods: A structured search of the global literature was conducted to identify English-language publications on AI applications in dentistry from 2015 to the present. Searches were performed across major scholarly databases using combinations of keywords related to AI and dentistry. Retrieved publications were screened using predefined eligibility criteria and subjected to narrative review to extract information on domains of AI application, stages of implementation, digital infrastructure readiness, regulatory context, and regional adoption patterns. A comparative thematic synthesis was then conducted to categorize regions by stage of AI emergence and to identify key drivers and barriers to adoption.
Results: The initial search yielded 1,125 publications. After abstract screening and eligibility filtering, 109 publications remained, and full-text review identified 16 core articles for analysis. High-income regions demonstrate rapid progression from proof-of-concept models to clinically integrated AI tools. In contrast, West Africa remains at an early stage of adoption, characterized by significant oral health needs, limited digital infrastructure, scarce research, and minimal clinical deployment.
Conclusion: Bridging this gap will require investment in digital infrastructure, context-appropriate AI applications, local data development, capacity building, and ethical governance frameworks.

Keywords: Artificial intelligence, dentistry, oral health, diagnostic imaging, orthodontic planning, oral cancer screening, digital dentistry, West Africa

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Received: 24-02-2026, **Accepted:** 15-03-2026

Access this article online	
Quick Response Code:	Website: www.phmj.org.ng
	DOI: https://doi.org/10.60787/phmj.v20i1.257

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How to cite this article: Akadiri OA, Yarhere KS. Emergence of artificial intelligence in dentistry across global regions: focus on Africa and the West African subregion. Port Harcourt Med J 2026;20(1):3-10.

INTRODUCTION

Artificial intelligence (AI) is rapidly emerging as a transformative tool in dentistry, influencing diagnostic processes, treatment planning, healthcare delivery, and dental education, particularly, in high-income countries.[1] While North America, Europe and parts of Asia–Pacific report a rapid adoption of AI-enhanced imaging, predictive models and digital workflows, evidence from Africa, particularly West Africa, shows a much earlier stage of engagement, constrained by structural barriers in oral health systems and digital infrastructure.[1,2] This study aims to analyze and compare the emergence, scope, and maturity of artificial intelligence (AI) applications in dentistry across major world

subcontinents, with particular emphasis on Africa and the West African subregion. The specific objective is to identify contextual drivers, barriers, and strategic priorities required to accelerate responsible and equitable AI adoption in West African dental practice.

METHODOLOGY

A structured literature search through the electronic databases of PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, as well as web resources containing market intelligence reports, policy documents, WHO regional oral health reports and other Institutional and regulatory bodies' publications was conducted. The search strategy comprises a wide range of search terms combined using Boolean operators such as "Artificial intelligence" AND "dentistry"; "AI in oral health"; "Machine learning" AND "dental imaging"; "AI" AND "oral cancer screening", "Digital dentistry" AND "Africa"; "AI adoption" AND "West Africa". The search period was limited to 2015–2026 to capture AI evolution in dentistry within the last decade. Citation tracking was performed primarily through backward citation searching, with additional manual screening of related references where relevant. To streamline the scope of the review, the following eligibility criteria were defined: publications in English language; articles addressing AI applications in diagnostics and therapeutic dentistry, including but not limited to orthodontics, endodontics, oral oncology, workflow management, or dental education; and publication types including systematic reviews, narrative reviews, observational studies, market reports, adoption reports, or regulatory policies related to AI in dentistry.

Selected publications were then subjected to narrative review to extract relevant information, including domains of AI application in dentistry, stages of implementation, digital infrastructure readiness, regulatory contexts, and regional adoption patterns. Articles that sparsely contributed to the information of interest were further excluded leaving only 16 articles which form the core evidence base for this narrative review. A comparative thematic synthesis was subsequently performed to categorize regions according to their stage of AI emergence and to identify key drivers and barriers influencing adoption. The findings of the narrative review are discussed in the subsequent subsections.

Global development of AI in dentistry

Recent systematic and anecdotal literature reviews indicate that the utilization of AI in dentistry is garnering heightened focus on caries diagnosis, periodontal assessments, endodontic evaluation, orthodontic planning, oral cancer screening, educational interventions, and orthodontic care instruments.[3,4] Machine learning approaches including deep learning (DL), convolutional neural networks (CNNs), and related models have demonstrated diagnostic performance comparable to or exceeding that of human experts.[5,6] Market analyses indicate rapid expansion of the digital dentistry sector. This was worth about USD 6 billion in 2024 and is expected to be worth more than USD 19 billion by 2034, with a Compound Annual Growth Rate CAGR of about 12–13%. [1] There is wide variation in AI adoption and investment rates in correlation to the socioeconomic conditions, existing regulatory policies, and digital maturity of the various region/subcontinents.[1,2]

Regional adoption overview

According to a 2024 summary of usage statistics and market trends,[1] approximately 35% of dentists worldwide have adopted some form of AI or digital automation in practice with varying degrees of coverage across regions. North America accounts for the largest market share and clinical adoption, with an implied 18% of U.S. dental professionals using AI modules as part of their workflows, especially in imaging and diagnostics.[1] Asia–Pacific has mixed but increasing penetration, notably in Australia and New Zealand with intraoral scanner penetration greater than 50%, to underpin AI-powered digital workflows.[1] Europe is said to be seeing slow and steady development, especially in countries with better health

systems, though fine quantitative uptake data is scarce.[1]

On the other hand, the extent of adoption for the Middle East and Africa is underexplored and studies indicate that AI use in dentistry remains largely investigational rather than part of routine clinical practice.[1,7] This discrepancy highlights a global "AI divide" in oral health similar to wider digital health inequalities.[2,7] Current state of AI development and practice integration globally by regions and subcontinents are summarized in Table 1 and the current emergence curve in figure 1 demonstrates the current development trajectory.

AI in dentistry: North America, Europe, and Asia-Pacific

Systematic literature review and the evidence base show that the vast bulk of published AI dental applications originate in North America, Europe and East Asia.[1,4,5] AI applications in these regions have evolved from proof-of-concept models to clinical decision-support systems embedded into radiology platforms, orthodontic planning software, and oral cancer screening tools. [1,3,4,5,8]

Diagnostic and clinical decision-support functions represent only part of the expanding spectrum of AI applications in dentistry. These applications include the automated detection of dental caries and radiographic lesions through the analysis of dental imaging (periapical, bitewing and panoramic), enhancing accuracy during diagnostic assessment.[4,8] Artificial intelligence (AI) is being applied to screen the periodontal bone defects and periapical aberrations that contribute in diagnosis and intervention early.[9] AI is also being used for cephalometric landmarking and the classification of malocclusions when working in the orthodontics field.[10-12] Other AI tools assist in the early detection of oral cancer and malignant disease, by analyzing photographic and histological images thereby supporting prompt intervention.[4,5,13] In addition to diagnosis, AI is used for workflow optimization for dental practices; the organization of schedules and risk triage (which are possible with predictive analysis) and this results in improved efficacy for the quality of patient care.[5,14]

Table 1. Indicative regional emergence of AI in dentistry

Region/Sub continent	Evidence of AI use in dentistry	Market/adoption signal
North America	Widespread AI imaging, diagnostics, practice-management tools.	Largest AI-in-dentistry market share; ~18% U.S. dentists using AI modules.
Europe	Integration in diagnostics, imaging, education; multiple trials.	Gradual uptake; strong regulatory and research ecosystem.
Asia–Pacific	Rapid rise of digital dentistry growth; AI in imaging, planning, education.	High scanner penetration (>50% in Australia/NZ).
Latin America	Emerging research; limited quantitative data.	Early adoption; localized pilots and academic projects.
Middle East	Growing interest; AI in imaging and oral cancer screening.	Early market growth; pockets of high-tech adoption.
Africa (overall)	Scattered pilots in oral cancer screening and digital tools.	Very limited adoption; nascent, exploratory stage.
West Africa (subregion)	Virtually no routine AI in dental practice reported; major service gaps.	No dedicated AI-dentistry market data; structural constraints dominate.

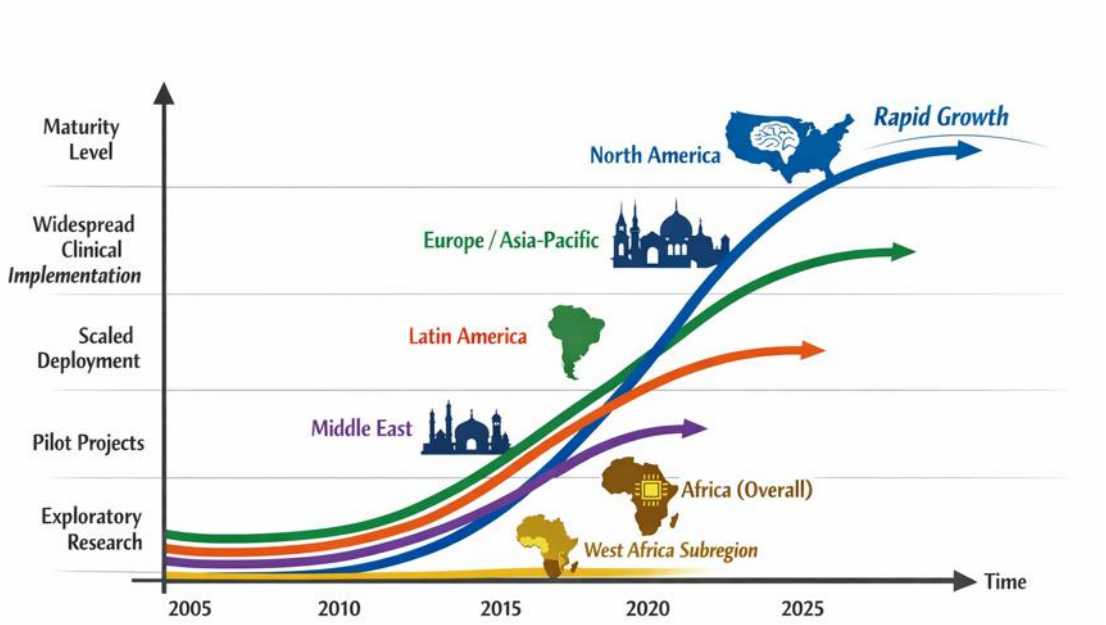

Fig. 1. AI Emergence Profiles in Dentistry across World Subcontinents

These are increasingly being integrated into commercial software, helped by a strong regulatory journey (FDA and CE, etc.) as well as a lot of venture capital.[1] Moreover, educational applications are also rapidly expanding, including AI-enhanced simulation tools such as virtual training environments, radiographic interpretation systems, and simulation platforms used for clinical training and skill development. [1,5]

AI in oral health and dentistry in Africa

Unaddressed oral disease continues to be a significant burden across Africa as well as a serious shortage of both oral health professionals and facilities. A narrative review[15] of dentistry in West Africa identified low dentist-to-population ratios, uneven service distribution, and limited training capacity, all of which contribute to restricted access to dental care. In the context of this, digital health tools – inclusive of AI– are perceived as accelerators for public oral health of the community, however, the evidence base so far is limited.[7] Using global AI–oral cancer literature as a reference, the authors argue that AI models have demonstrated sensitivity and specificity scores of ≥ 90% for detecting oral cancer and potentially malignant lesions,[5,16,17] offering comparable (and potentially better) results than experienced humans. They do note that most of these models originated outside the continent, and were not widely used or validated in African conditions. This same review emphasizes the potential implications of AI-assisted diagnostic tools in areas with limited access to radiologists, pathologists, and dental surgeons, where those on the frontline can take photographs and provide decision support via mobile devices to community health workers. However, there are very few fully operational AI based dental systems in African primary or specialist care, therefore the continent remains at the theoretical stage of an aspirational, piloting, (not on a large scale) project .[1]

The current status and gap in the West African subregion

West Africa typifies the structural barriers to deploying AI in dentistry. A review of regional dentistry describes the changes in services, persistent high burdens of caries and periodontal disease, finite provision of specialists and limited numbers of specialists and poorly resourced training academy.[11] Digital health infrastructure, although expanding, remains fragmented and uneven, with most countries still lacking adequate electronic health record systems and routine

digital imaging infrastructure within public dental health service areas.[1,6,18]

There have been no large-scale reviews in the indexed literature of AI based dental diagnostics/practice management tools or apps, using AI-enhanced dental tools and related practices in West Africa in West African dental medicine, in this regard .[1] The vast majority of innovation work in the region is centered on broadening basic preventive and restorative dental services, integrating oral health within universal health coverage and enhancing the capacity for dental professional training, rather than the development or implementation of sophisticated AI tools.[6,11] The vast majority of digital tools when mentioned exist include teledentistry, mHealth, and simple decision-support systems but not AI models fully trained as part of imaging analysis or practice management environment.[6] This underscores a deficiency in West Africa when compared to the wider western world (North America and Europe),one that comes from various stratified gaps such as, but not limited to, basic service coverage, digital infrastructure, research, capital, and regulatory. Key drivers and barriers influencing AI adoption in dental care worldwide are shown in Table 2.

What aspects are required for accelerating the evolution of AI in West African dentistry?

1. Basic digital and data infrastructure

AI systems need high-quality, digital, well-annotated clinical data. Because of this, dental offices need to enhance their equipment and technology for digital radiography as well as appropriate facilities to store data without risk, such as basic EHRs. De-identified regional and national image repositories (for disease-related factors such as caries, periodontal disease, and oral potentially malignant disorders) would generate training and validation datasets with a focus on West African settings.

2. Context-appropriate AI use-cases

Because resource constraints exist in West African dentistry, AI adoption ought not at first to mimic complex use cases as seen in Western countries but rather should aim at high-impact, feasible applications. Specific focus areas for AI are mobile triaging tools with emphasis on early detection of oral cancer and severe dental infections, at a community level.

Table 2. Key drivers and barriers influencing AI emergence in dentistry by region

Factor	High-income regions (NA/EU/EA)	Africa/West Africa
Baseline dental infrastructure	High specialist density, widespread imaging and EHR.	Low workforce density, limited imaging and records.
Digital readiness	Mature broadband, cloud, and cybersecurity frameworks.	Variable connectivity; limited secure health IT.
Research and industry	Strong academia–industry partnerships; VC funding.	Sparse local AI-dentistry research; minimal industry.
Regulation and policy	Active pathways for AI device approval.	Emerging digital health policies; limited AI-specific rules.
Financing	High per-capita health spending; insurance coverage.	Out-of-pocket dominance; constrained public budgets.
Data availability	Large, annotated image repositories.	Fragmented, non-digitized records; few datasets.

Moreover, basic radiographic decision-support systems can guide general practitioners in interpreting digital radiographs, which may be especially valuable in contexts where specialists are scarce. Predictive tools for community risk stratification can deepen the range of activities that can be targeted for educational outreach, in order that school-based oral health programs may prosper in school-based services. These use cases are suitable for the region's disease burden and the availability of skilled workers and can complement existing mobile health (mHealth) and telehealth programs.

3. Capacity building and South–South/North–South collaboration

Educating dental professionals, policymakers, and informatics teams on AI literacy is critical to enable them to critically evaluate tools, co-design implementations, and prevent dependence on "black boxes". Coherently, collaborative research networks connecting West African dental schools with AI research clusters both in Africa and abroad can facilitate collaborative model building, transfer learning on African datasets, and skill sharing.

4. Governance, ethics, and equity by design

Good governance frameworks will need to deal with data protection, consent, algorithmic bias, liability, and sustainability. They will also need to be more complete so that they don't make existing inequalities worse. AI systems that utilizes only Western datasets are likely to make inaccurate classifications and unsafe suggestions because West African patients would have some nuanced differences from patients in different parts of the world. This underscores the importance of consistent audits and human oversight.

5. Financing and innovation ecosystems

We need specific funding sources from governments, development partners, and impact investors to pay for pilot projects, infrastructure improvements, and local health-tech startups that work on dental AI. Embedding AI elements into current oral health and primary care programs (not standalone "AI projects") could increase sustainability and integration.

Limitations of the Study

This study has several limitations that should be considered when interpreting the findings. First, the review was conducted as a narrative synthesis rather than a formal systematic review or meta-analysis. Although a structured search strategy and eligibility criteria were applied, the final evidence base was limited to 16 core articles. As a result, the findings primarily provide a conceptual overview of global AI development in dentistry rather than a quantitative assessment of adoption patterns. The relatively small number of included studies may also limit the generalizability of conclusions regarding regional implementation trends.

A second limitation relates to the restriction of the literature search to English-language publications and the limited availability of indexed research on AI applications in dentistry within Africa and the West African subregion. Important studies, pilot projects, or policy documents published in local languages, institutional reports, or non-indexed sources may therefore not have been captured. This constraint reflects the broader scarcity of documented AI implementation in African dental systems and may result in an underrepresentation of emerging regional initiatives.

CONCLUSION

AI in dentistry is evolving rapidly in North America, Europe, and certain regions of Asia-Pacific, advancing from pilot studies to clinically relevant diagnostic, clinical and educational tools and supported by robust markets and regulatory environments.

AI-related activity in dentistry within Africa and West Africa in particular, is largely exploratory and limited to scattered pilot studies and research initiatives, with very limited routine clinical deployment. Regulatory frameworks for AI in healthcare are still emerging across many African countries, and comprehensive AI-specific

policies remain under development in most jurisdictions.

Closing this gap will take strategic investment in digital infrastructure, context-appropriate use-cases, regional access to data, capacity building, and ethical governance, such that AI will be a tool to diminish, rather than exacerbate, oral health inequities in the subregion.

Financial Support and Sponsorship:

Nil

Conflict of Interest:

There are no conflicts of interest.

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