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USO DA INTELIGÊNCIA ARTIFICIAL APLICADA AO DIAGNÓSTICO BUCAL

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USO DA INTELIGÊNCIA ARTIFICIAL APLICADA AO DIAGNÓSTICO BUCAL

USE OF ARTIFICIAL INTELLIGENCE APPLIED TO ORAL DIAGNOSIS

Dissertação apresentada ao Programa de Pós-Graduação em Odontologia, da Universidade Federal da Paraíba (UFPB), como parte dos requisitos para obtenção do título de Mestre em Odontologia – Área de Concentração Ciências Odontológicas.

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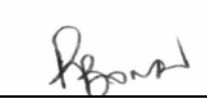

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RESUMO

O objetivo desta dissertação foi abordar e elucidar o uso da Inteligência Artificial no diagnóstico de lesões bucais e, para isso, foram desenvolvidos dois planos de trabalho. O primeiro plano consistiu em elaborar e desenvolver uma revisão bibliométrica com o objetivo de quantificar, analisar e avaliar a produção acadêmica científica sobre o uso da Inteligência Artificial para o diagnóstico de lesões bucais. As bases de dados escolhidas para conduzir a revisão foram: Medline via PubMed, Scopus, Web of Science e Cochrane Library. Para todas as bases de dados, foi definida uma estratégia de busca baseada nos termos do Medical Subject Headings, sinônimos e termos livres relevantes, combinando-os com os operadores booleanos. Os resultados das buscas nas bases de dados foram exportados para a realização da análise bibliométrica através dos softwares R e RStudio, utilizando o pacote Bibliometrix. Ao todo, foram obtidos 3.858 estudos nas bases de dados. Foram removidos 902 arquivos duplicados, restando 2.956 publicações para avaliação de conteúdo. Após a aplicação dos critérios de elegibilidade e a exclusão dos estudos que não estavam de acordo com a temática de interesse, restaram 334 artigos para análise bibliométrica. No segundo plano de trabalho, foi realizado um estudo para avaliar o desempenho do assistente virtual AI Oral Diagnosis Helper (AODH), desenvolvido utilizando-se a plataforma ChatGPT™ (versões 4 e 4o). Foram selecionados 30 casos clínicos para avaliação por dois especialistas em Estomatologia e pelo AODH. Os diagnósticos e sugestões de tratamento foram comparados a um especialista padrão-ouro. As taxas de concordância e a precisão foram calculadas usando o Kappa de Fleiss com um intervalo de confiança de 95%, utilizando o RStudio. O AODH com a versão 4 diagnosticou corretamente 22 de 30 casos (73,3%), enquanto o AODH baseado na versão 4o identificou corretamente 24 casos (80%). O kappa de Fleiss indicou confiabilidade substancial entre o AODH e os especialistas (K = 0,79). Com o desenvolvimento dos planos de trabalho, é possível concluir que a integração da Inteligência Artificial na área do diagnóstico bucal pode enriquecer o aprendizado e a prática clínica, desde que utilizada de forma cautelosa e consciente, servindo de apoio aos estudantes e profissionais.

Palavras-chave: Inteligência Artificial; Diagnóstico Bucal; ChatGPT.

ABSTRACT

The objective of this dissertation was to address and elucidate the use of Artificial Intelligence in the diagnosis of oral lesions and, for this purpose, two work plans were developed. The first plan consisted of preparing and developing a bibliometric review with the objective of quantifying, analyzing and evaluating the scientific academic production on the use of Artificial Intelligence for the diagnosis of oral lesions. The databases chosen to conduct the review were: Medline via PubMed, Scopus, Web of Science and Cochrane Library. For all databases, a search strategy was defined based on the terms of the Medical Subject Headings, synonyms and relevant free terms, combining them with Boolean operators. The results of the searches in the databases were exported for bibliometric analysis through the R and RStudio software, using the Bibliometrix package. In total, 3,858 studies were obtained in the databases. 902 duplicate files were removed, leaving 2,956 publications for content evaluation. After applying the eligibility criteria and excluding studies that were not in line with the topic of interest, 334 articles remained for bibliometric analysis. In the second work plan, a study was carried out to evaluate the performance of the AI Oral Diagnosis Helper (AODH) virtual assistant, developed using the ChatGPT™ platform (versions 4 and 4o). Thirty clinical cases were selected for evaluation by two specialists in Stomatology and the AODH. The diagnoses and treatment suggestions were compared to a gold standard specialist. Agreement rates and accuracy were calculated using Fleiss's Kappa with a 95% confidence interval, using RStudio. The AODH with version 4 correctly diagnosed 22 of 30 cases (73.3%), while the AODH based on version 4o correctly identified 24 cases (80%). Fleiss's kappa indicated substantial reliability between the AODH and the specialists (K = 0.79). With the development of work plans, it is possible to conclude that the integration of Artificial Intelligence in the area of oral diagnosis can enrich learning and clinical practice, as long as it is used cautiously and consciously, serving as support for students and professionals.

Keywords: Artificial intelligence; Oral Diagnosis; ChatGPT.

SUMÁRIO

1. INTRODUÇÃO

O uso da Inteligência Artificial no campo da saúde tem sido amplamente explorado. Na medicina, diversos estudos estão sendo publicados sobre o quanto as ferramentas de Inteligência Artificial podem contribuir para o diagnóstico precoce de algumas doenças, além de ajudar no processo de trabalho a partir da automatização de tarefas (Jiang et al., 2017; Ferrante et al., 2021; Borges et al., 2021; Yingjie et al., 2023; Stoneham et al., 2023). Algumas áreas da Odontologia já estão fazendo uso em larga escala da Inteligência Artificial, como é o exemplo da Radiologia, Ortodontia e Implantodontia, que se destacam no que refere ao diagnóstico e planejamento do tratamento baseados na possibilidade de visualização do resultado final permitido pelo uso da Inteligência Artificial (Heo et al., 2021; Fawaz, El Sayegh, Vannet, 2023; Morais et al., 2015; Revilla-León et al., 2023).

Na área do diagnóstico bucal, as pesquisas avançam na investigação do desempenho das ferramentas de Inteligência Artificial no diagnóstico precoce do câncer de boca (García-Pola et al., 2021), mas também aplicada ao diagnóstico de outras doenças como Osteoporose e Cistos na região maxilo-mandibular, além da identificação de outras condições como reabsorções ósseas alveolares (Kolarkodi, Alotaibi, 2023). Também se têm investigado como modelos baseados em Inteligência Artificial e métodos de visão computacional podem auxiliar no diagnóstico e na predição prognóstica, fazendo análise de informações clínicas e/ou histopatológicas, que pode melhorar o tratamento e resultados prognósticos (Araújo et al., 2023).

Dentre as variadas ferramentas de Inteligência Artificial disponíveis atualmente, o ChatGPT® vem ganhando destaque devido a facilidade no uso e acesso desta ferramenta. O desempenho do ChatGPT® já vem sendo testado, e apesar de alguns resultados serem promissores, ainda é necessário o desenvolvimento de mais estudos com o teste e treinamento da ferramenta com variadas informações, devido a limitação de informações fornecidas (Stoneham et al., 2023, Yingjie et al., 2023; Mago, Sharma, 2023; Mehnen et al., 2023).

Portanto, tendo em vista a identificação dos aspectos relacionados à temática e das lacunas ainda existentes, o objetivo da dissertação foi abordar e elucidar o uso da Inteligência Artificial no Diagnóstico das lesões de boca e, para

isso, foram desenvolvidos dois planos de trabalho. O primeiro plano de trabalho consistiu em elaborar e desenvolver uma revisão bibliométrica com o objetivo de quantificar, analisar e avaliar a produção acadêmica científica sobre o uso da Inteligência Artificial para o diagnóstico das lesões de boca. No segundo plano de trabalho, foi realizado um estudo para avaliar o desempenho de um assistente virtual desenvolvido na plataforma ChatGPT™ comparado a especialistas em Diagnóstico Bucal envolvendo diferentes lesões na região de cabeça e pescoço.

2. REVISÃO DA LITERATURA

Panorama do diagnóstico bucal no Brasil

Segundo os dados do Instituto Nacional de Câncer, é estimado para o Brasil, para cada ano do triênio de 2023 a 2025, mais de 15.000 novos casos registrados de câncer de boca (INCA, 2023). Em aspectos globais, o câncer de boca é considerado como a 11ª doença maligna mais comum (Ghantous et al., 2017). Epidemiologicamente, os homens estão mais susceptíveis e faixa etária comum está entre 40 e 50 anos de idade. A incidência dos novos casos de câncer está associada a fatores de estilo de vida, como tabaco e álcool, mas também a fatores emergentes, como infecções virais, incluindo infecções por papilomavírus humano (HPV) e vírus Epstein-Barr (EBV) (Sung et al., 2021; Barsouk et al., 2023).

A detecção precoce do câncer bucal no Brasil ainda enfrenta desafios significativos. Embora a infraestrutura de saúde e as campanhas estejam melhorando, os pacientes ainda são diagnosticados mais tarde do que deveriam ser (Miranda et al., 2019). Vários fatores contribuem para esse fato, como a falta de acesso a serviços de saúde, desinformação e a falta da capacitação profissional para reconhecer e identificar as lesões potencialmente malignas (Gómez et al., 2010). Entre os profissionais, uma das principais dificuldades é a semelhança clínica entre as lesões, como também a ineficiência do exame clínico em analisar todas as regiões da boca e não somente os dentes. Dentre as consequências, têm-se o atraso no diagnóstico, além dos encaminhamentos inadequados (Miranda et al., 2019), o que esclarece a importância no investimento e capacitação profissional para o diagnóstico das lesões de boca (Bandeira et al., 2017; Soto el al., 2020).

Vale ressaltar que, a especialidade Estomatologia, responsável por identificar e tratar as doenças da boca, também enfrenta vários problemas. Um dos principais é o baixo número de especialistas que atuam na área, principalmente nas áreas rurais ou em locais distantes dos grandes centros urbanos, como também o baixo número de programas de residência no Brasil nesta área (Silva et al., 2022). Além disso, existe uma disparidade em relação aos níveis de apoio à capacidade diagnóstica nas diferentes partes do Brasil, o que dificulta ainda mais o acesso aos serviços especializados (Lima et al., 2017).

Algumas alternativas estão sendo exploradas e implementadas atualmente no Sistema Único de Saúde (SUS) para enfrentar esses desafios e acelerar o processo de diagnóstico, que incluem o uso da Telemedicina/Teleodontologia, o desenvolvimento de Programas de Treinamento e Campanhas de saúde pública e Unidades móveis de atendimento de saúde. As ações desenvolvidas atualmente no SUS são de grande valia, mas ainda não são suficientes para eliminar os desafios que o sistema enfrenta, principalmente após o desmonte da Pandemia da COVID-19 que provocou uma diminuição alarmante no número de consultas especializadas e de biópsias realizadas (Marques et al., 2022).

O diagnóstico bucal no SUS deve ser caracterizado, principalmente, por esforços da integração da saúde bucal na atenção primária. Embora em alguns locais os serviços voltados ao diagnóstico sejam eficientes, existem regiões que atrasam a integração com outros níveis de atenção, como também lidam com a falta de recursos apropriados (Bandeira et al., 2017). Dessa forma, novas abordagens devem ser adotadas para melhorar o diagnóstico precoce das doenças em boca, como a adoção de melhores práticas voltadas à Teleodontologia ou a adoção da Inteligência Artificial.

História da Inteligência Artificial

O conceito de Inteligência Artificial (IA) refere-se à atuação de uma máquina de acordo com o comportamento humano, de modo que a mesma seja capaz de tomar decisões e realizar tarefas de maneira autônoma (Van Assen et al., 2022). O termo “Inteligência Artificial” foi proposto pela primeira vez no Dartmouth Conference de 1956 por John McCarthy (Li et al., 2024), sendo considerado o marco no campo de estudo sobre a IA. Os primeiros projetos conhecidos voltados a IA são Logic Theorist e General Problem Solver (GPS) (Rupert, 2016), e, desde então, a pesquisa e o interesse sobre esse tema cresce, principalmente, devido ao foco na possibilidade de economizar tempo e aumentar a produtividade do trabalho (Mughal, Wahid, Khattak, 2021).

A importância da IA resulta da sua capacidade central de imitar funções cognitivas humanas, como o aprendizado, o raciocínio e a resolução de problemas, em uma escala e velocidade que excede em muito as capacidades humanas (Dwivedi et al., 2021). De fato, essa capacidade não apenas tornou várias

operações mais eficientes, como também abriu novos caminhos para a inovação em vários campos. Hoje, a IA está presente em diversos setores do cotidiano humano. Na área da saúde, as ferramentas de IA permitem o auxílio no diagnóstico de doenças, na previsão dos resultados cirúrgicos de pacientes e na personalização de planos de tratamento individualizado (Sawar et al., 2019; Castagno, Khalifa, 2020; Chen et al., 2022). Na indústria automobilística, a IA impulsiona o desenvolvimento de veículos autônomos, melhorando a segurança e a eficiência no transporte (Ravagnani, Junqueira, Pugliesi, 2023). No âmbito do atendimento ao cliente, *chatbots* alimentados por IA fornecem assistência 24 horas por dia, melhorando a experiência do cliente e a eficiência operacional (Kushwaha, Kumar, Kar, 2021). Esses exemplos demonstram como a IA tem-se integrado ao dia a dia, destacando sua importância não apenas como uma ferramenta para automação, mas também como um mecanismo de inovação e qualidade de vida.

Conforme a IA se torna cada vez mais disseminada e evolui em termos de sofisticação e complexidade, os benefícios são reconhecidos como maior eficiência, segurança e comodidade em um nível pessoal e profissional. Embora o desenvolvimento da IA seja encarado com entusiasmo, os possíveis desafios envolvidos com o uso devem ser considerados, tais como a reconfiguração de empregos, preocupações com a privacidade e o potencial viés nos processos de tomada de decisão (Dwivedi et al., 2021). Portanto, compreender a história e as aplicações contemporâneas de IA e as projeções futuras do uso da IA pode auxiliar a maximizar as vantagens, permitindo que os desafios sejam superados.

Uso da Inteligência Artificial na Saúde e na Odontologia

Atualmente, a IA vem revolucionando o setor da saúde a partir do uso de suas diferentes ferramentas e aplicabilidades que podem promover uma melhora no diagnóstico, planejamento de tratamentos, monitoramento dos pacientes e automatização das tarefas administrativas (Naveed, 2023). Os sistemas de IA ajudam os profissionais a fornecerem suporte para tomada de decisão clínica, incluindo sugestões de diagnóstico, plano de tratamento e prognóstico. Do ponto de vista operacional, o uso da IA na medicina acarreta uma série de benefícios a partir do momento em que aumenta a eficiência e diminui o tempo gasto em tarefas administrativas (Panch, Szolovits, Atun, 2018).

No entanto, o uso da IA também requer que os profissionais estejam familiarizados com as ferramentas e desenvolvam novas habilidades e destrezas, como o reconhecimento da interpretação e limitações dos sistemas de IA, principalmente no que se refere a confiabilidade dos dados (Briganti, Le Moine, 2020). Existem ainda outros desafios relacionados à incorporação da IA na saúde, como as questões éticas e de regulamentação, além da resistência dos profissionais ao uso, devido ao receio com a confiabilidade da IA e da insegurança relacionada a substituição de empregos (Abdullah, Fakieh, 2020).

Na Odontologia, em específico, a IA está sendo utilizada para agilizar processos relacionados ao diagnóstico, planejamento de tratamentos e a gestão dos cuidados odontológicos. Uma das principais áreas da Odontologia que utiliza a IA é a Radiologia. Vários processos estão quase que 100% automáticos, devido a incorporação da IA, onde se é possível, a partir de exames radiográficos bidimensionais, tomografia computadorizada de feixe cônico e fotos intra-orais, reconhecer lesões de cáries, doenças gengivais, inflamações na região apical e outras anormalidades (Heo et al., 2021).

A Ortodontia e Implantodontia são duas outras especialidades da Odontologia que também utilizam amplamente os recursos da IA. Na Ortodontia, os softwares estão sendo utilizados para simulação do tratamento ortodôntico, envolvendo casos de extração ou até mesmo casos cirúrgicos, sendo possível prever os resultados de todas as ações necessárias. Isso não só aumenta a precisão dos tratamentos, mas também melhora a satisfação dos pacientes, que podem visualizar o resultado final antes mesmo de iniciar o tratamento (Fawaz, El Sayegh, Vannet, 2023). Na Implantodontia também se faz uso da IA para simulação do tratamento de reabilitação com implantes, mas um dos grandes avanços obtidos com a IA nessa área foi o reconhecimento do tipo de implante e seu fabricante por meio de radiografias periapicais e panorâmicas (Morais et al., 2015; Revilla-León et al., 2023).

A IA também está sendo usada de forma associada com as tecnologias de impressão 3D ou fresagem CAD/CAM na área da Odontologia Restauradora. Com essa integração é possível gerar projetos de fabricação de coroas, restaurações indiretas e próteses que apresentam um melhor resultado em relação ao ajuste e a naturalidade (Revilla-León et al., 2022). Na área do diagnóstico bucal, as pesquisas estão voltadas ao diagnóstico das desordens potencialmente malignas e do câncer

bucal (Ilhan, Guneri, Wilder-Smith, 2021), sendo uma promissora área para desenvolvimento de pesquisas, visto que, com a incorporação e uso a IA para o diagnóstico, a prática clínica e a identificação precoce de lesões de boca podem melhorar consideravelmente (GARCÍA-POLA et al., 2021).

3. ARTIGO 1

O manuscrito a seguir será submetido para publicação no periódico "***Digital Dentistry Journal - ISSN: 2950-6433***".

Use of Artificial Intelligence for Oral Diagnosis: A Bibliometric Analysis

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ABSTRACT

Objective: This study aims to provide a comprehensive bibliometric analysis of the current status and trends in the scientific literature on the use and applicability of Artificial Intelligence in the Oral Diagnosis field. **Methods**: The study utilized a quantitative bibliometric approach, extracting data from major databases including Medline via PubMed, Scopus, Web of Science, and Cochrane. The inclusion criteria targeted studies that discussed the use of AI for diagnosing oral lesions in multiple languages. A total of 3,858 publications were initially retrieved, and after removing duplicates and applying eligibility criteria, 334 articles were selected for detailed bibliometric analysis. **Results**: The selected 334 articles underwent a comprehensive analysis, highlighting the evolution of research trends over the years. The first study on the subject was published in 1995. The majority of studies originated from China and India and the journals with the most publications on the topic were Journal Cancers, Journal of Oral Pathology and Medicine, and Journal Oral Oncology. **Conclusion**: The results demonstrate a significant increase in research publications on AI in oral diagnosis, especially in recent years. The findings emphasize the need for broader research to explore AI's potential for applicability and reliability.

Keywords: Artificial Intelligence, Oral Diagnosis, Bibliometric Analysis, Oral Cancer, Potentially Malignant Disorders.

Introduction

Diseases affecting the oral mucosa are the most common worldwide, impairing various functions of the body and the overall health of individuals[1]. The most common are potentially malignant disorders such as leukoplakia, erythroplakia, cheilitis, and lichen planus, which are proliferative processes with the potential to become neoplasms and exhibit common characteristics such as white and red patches with varied patterns[2]. The main difficulty in precise oral diagnosis is the clinical similarity between the characteristics of potentially malignant lesions and non-malignant lesions, necessitating knowledge of the distinguishing features and associated risk factors such as alcoholism and smoking[3-9].

Oral cancer, the primary neoplasm affecting the oral cavity, can affect the tongue, lips, oropharynx, and lymph nodes in the head and neck region through the proliferation of malignant cells via the lymphatic system, developing metastases and being the 13th most prevalent cancer worldwide[10]. It is estimated that there were 377,713 new cases and 177,757 deaths in 2020 according to the World Health Organization[11]. Squamous cell carcinoma (SCC), which accounts for 90% of annual oral cancer cases, is extremely aggressive and lethal in more advanced stages[12,13].

Early diagnosis is extremely important for a good cancer prognosis and for recommending less invasive treatments with fewer side effects. When diagnosed in the early stages, the survival rate is 80%; if diagnosed in more advanced stages, the survival outlook is 20%, making early and accurate diagnosis essential for patient survival and better treatment conditions[12,14].

The use of Artificial Intelligence as a diagnostic tool for oral cavity diseases is growing and represents one of the major technological advancements in dentistry[15]. Artificial intelligence software, powered by a database that mimics the human brain and stores information about fundamental aspects and characteristics of the associated lesions and imaging software, increases the chances of early cancer diagnosis and reduces error rates[12,15,16,17].

Currently, artificial intelligence operates in various fields, among which the largest are commerce, medicine, entertainment, navigation software, and product recommendation systems based on feedback systems. Among these, the use of AI to create competitive commerce strategies stands out[18]. The application of artificial intelligence in medicine and dentistry is relatively more recent than in the commercial market.

However, its increasing use in the field of dentistry, especially in the diagnosis and prognosis of oral cavity pathologies, has motivated various studies[10-17]. Most publications are related to the diagnosis of oral cancer through Artificial Intelligence[10-13,17]. In this context, this research aims to quantify, analyze, and evaluate the academic scientific production, through the bibliometric method, on the use of Artificial Intelligence for the diagnosis of oral lesions, mainly for Oral Cancer, identifying the characteristics of relevant scientific publications.

Methodology

This is a bibliometric analysis with a quantitative approach. This method aims to analyze a specific scientific field and assist researchers in identifying research changes and existing gaps within a given topic[19]. To conduct the study, a review protocol was developed, structuring and determining the necessary methodological steps for the scientific investigation[20,21].

The databases eligible for the study were Medline via PubMed, Scopus, Web of Science, and Cochrane. For eligibility, studies discussing the use of Artificial Intelligence for the diagnosis of oral lesions in English, Portuguese, and Spanish were considered. No time limit was set due to the need to identify and map all the scientific productions published on the topic. Articles in editorial processing, student theses, dissertations, letters, and book chapters were excluded from the study.

A search strategy was developed with the assistance of a library specialist using a combination of Boolean operators and controlled search terms taken from the Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH). For each database, the initial strategy was adapted according to specific truncations.

The results of the searches in the databases were exported for bibliometric analysis in Bibliometrix[22] through R and RStudio software[23]. Using these tools, it was possible to remove duplicate publications and generate a spreadsheet with all the data, in which the existence of duplicates was manually checked and removed.

The data from the studies in the spreadsheet configured by RStudio were analyzed to detect possible publications that did not correspond to the study's thematic interest. The selected articles were analyzed based on bibliometric data related to publication trends over the years, journals with the highest number of publications on the topic, authors with the most publications, the number of articles distributed by the country of origin of the main authors, and the ten most cited articles. The collected bibliometric data were used to foster the aspects presented in the discussion.

Results

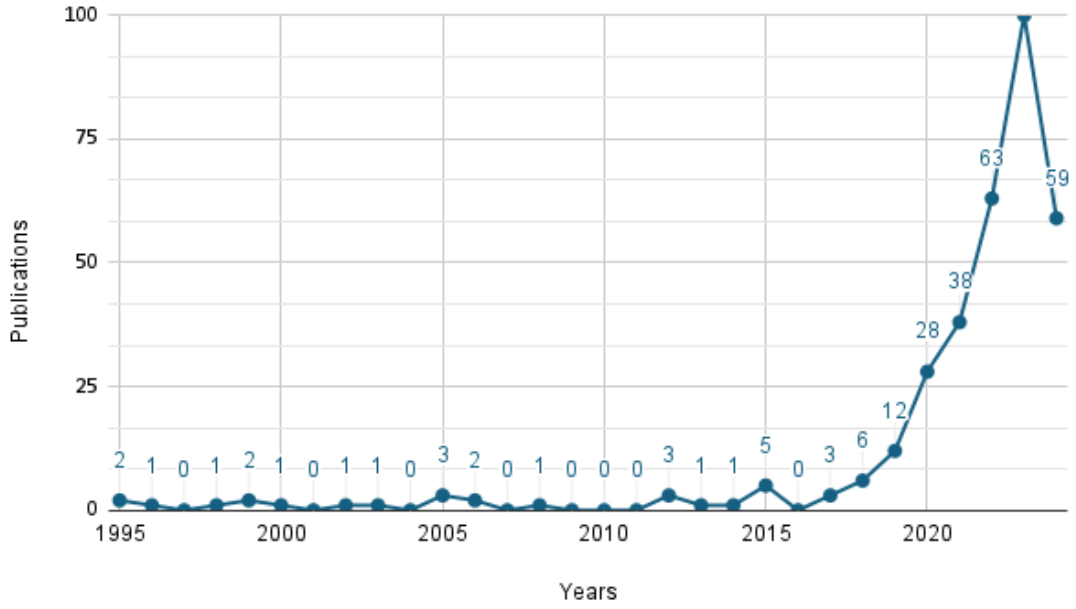
From the application of the search strategy in the databases, a total of 3,858 publications were obtained, with 2,222 in MedLine via PubMed, 1,141 in Scopus, 482 in Web of Science, and 13 in Cochrane. All publications were exported to

RStudio, where 902 duplicate publications were identified and removed. After this step, the final spreadsheet generated in the software was manually analyzed, identifying and excluding 25 duplicate articles that were not automatically detected, leaving a total of 2,931 publications for analysis.

The 2,931 publications were analyzed in terms of title and abstract, to include only those articles that were consistent with the theme and eligibility criteria in the bibliometric analysis. As a result, a total of 2,597 publications were excluded, leaving only 334 articles for bibliometric analysis using Bibliometrix.

The first studies addressing the theme were published in 1995. In the following years, there was low production related to the theme until 2019, when 12 publications (3.59%) were recorded. Subsequently, the number of publications increased exponentially, reaching a peak in 2023 with 100 publications, representing 29.9% of the studies included (Figure 1).

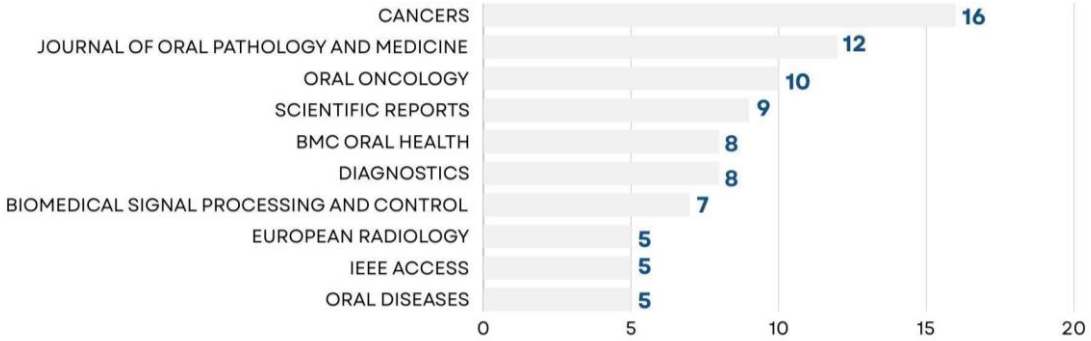
Figure 1. Distribution of publications over the years on the use of Artificial Intelligence in oral diagnosis.



In Figure 2, the top 10 journals that published articles on the applicability of Artificial Intelligence in Oral Diagnosis are presented. The Journal Cancers stands out in first place with 16 articles (4.79%), launched in 2009, which publishes various studies on all types of tumors. In second place is the Journal of Oral Pathology and Medicine with 12 publications (3.59%), which are focused on oral pathology and oral

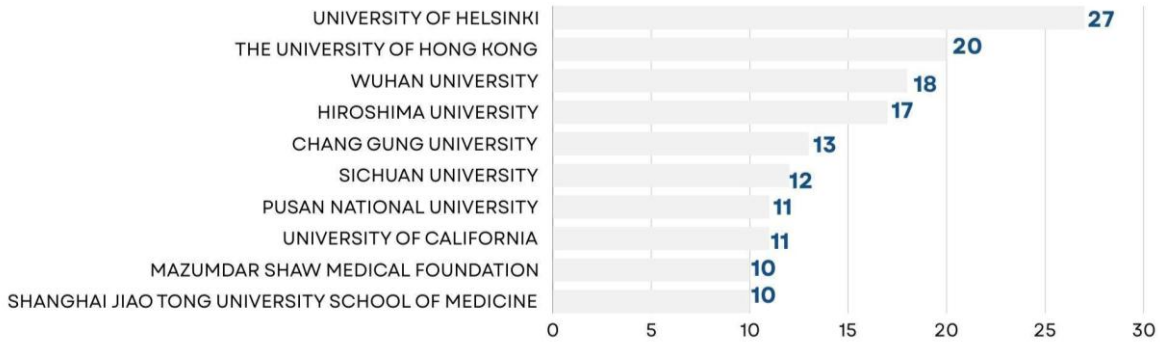
medicine. The third place is occupied by the Oral Oncology Journal with 10 publications (2.99%). This journal is dedicated to publishing studies on head and neck neoplasms and related aspects. The impact factors for the Journal Cancers, Journal of Oral Pathology and Medicine, and Journal Oral Oncology are 5.2, 3.3, and 8.6, respectively.

Figure 2. Ranking of the top 10 relevant journals with more publications on Artificial Intelligence in oral diagnosis.



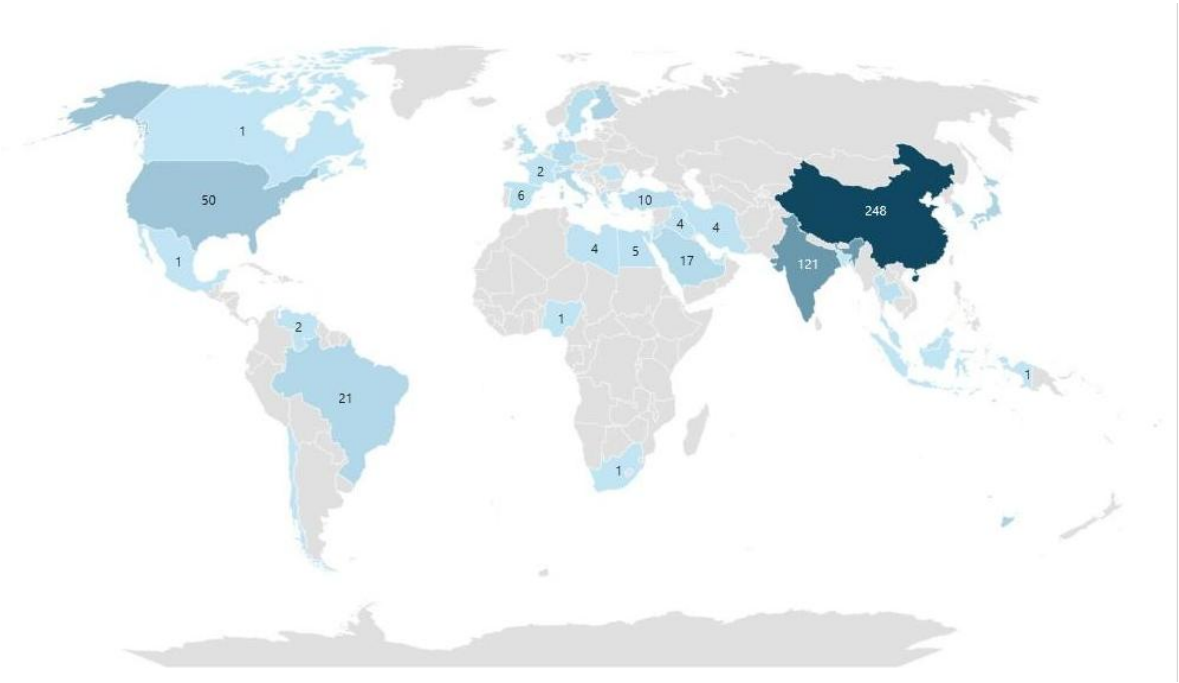
The main affiliations in terms of the number of publications on the use of Artificial Intelligence applied to oral diagnosis are presented in Figure 3. The top three affiliations with the highest number of publications are the University of Helsinki (Helsinki, Finland, n=27, 8.08%), The University of Hong Kong (Hong Kong, China, n=20, 5.99%), and Wuhan University (Wuhan, Hubei, China, n=18, 5.39%).

Figure 3. Ranking of the top 10 affiliations that publish the most on the use of Artificial Intelligence in oral diagnosis.



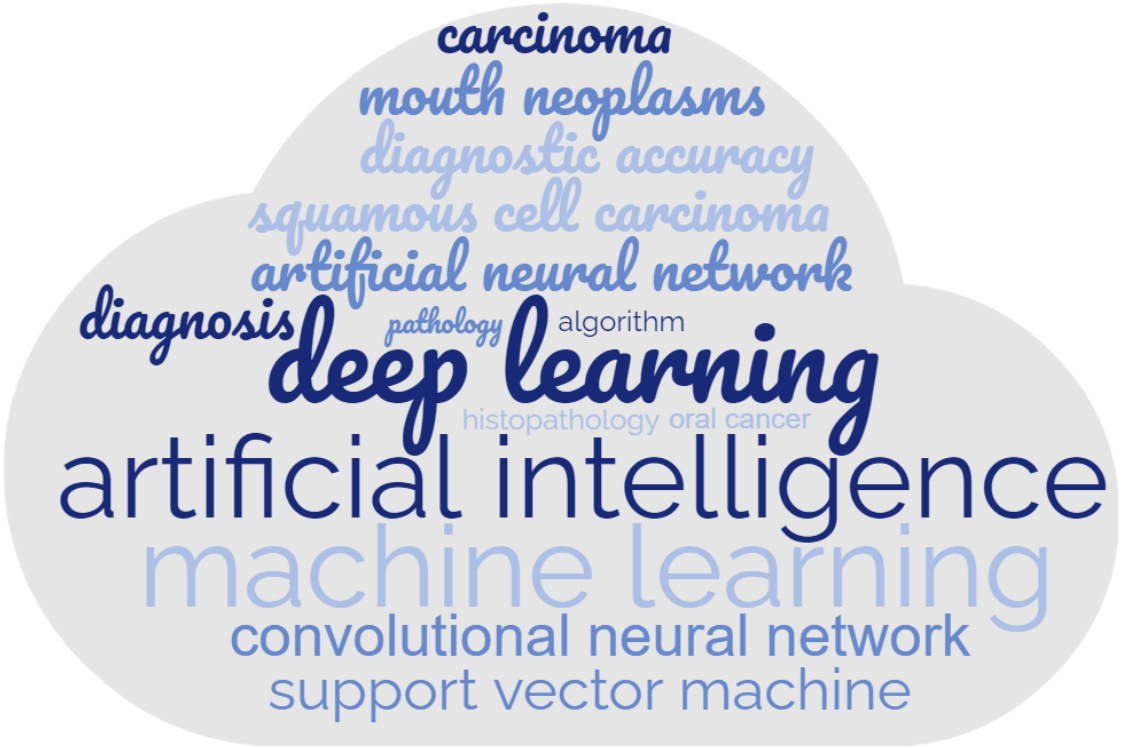
Regarding the geographical distribution of the scientific publications on the theme, the diversity of countries contributing to the field stands out. China leads with 248 (35.3%) publications, followed by India with 121 (17.2%), demonstrating intense academic and research activity in these Asian countries. The United States holds the third position with 50 (7.1%) publications in the area (Figure 4).

Figure 4. Countries with the most significant influence based on the number of publications.



In Figure 5, it is possible to observe the most commonly used terms in the studies, which represent the theme of the articles included in the bibliometric analysis. The terms that are most highlighted in the word cloud, such as "deep learning," "artificial intelligence," "machine learning," "convolutional neural network," "support vector machine," and "squamous cell carcinoma," are the keywords of the included articles.

Figure 5. Word cloud.



The ten authors and their works with the highest number of citations on the topic are indicated in Table 1, specifying the institution of affiliation, journal, and number of citations.

Table 1. Most relevant articles on the topic.

Ranking	Author	Affiliation	Citations	Journal	DOI
1	JJ Sciubba	Long Island Jewish Medical Center	245	Journal of The American Dental Association	10.14219/jada.archive.1999.0055
2	Jeyaraj e Nadar	Mepco Schlenk Engineering College	210	Journal of Cancer Research and Clinical Oncology	10.1007/s00432-018-02834-7
3	Kim et al.	Yonsei University College of Dentistry	198	Scientific Reports	10.1038/s41598-019-43372-7
4	Welikala et al.	Kingston University	140	IEEE ACCESS	10.1109/ACCESS.2020.3010180

5	Shaban et al.	University of Warwick	113	Scientific Reports	10.1038/s41598-019-49710-z
6	Chang et al.	University of Malaya	110	BMC Informatics	10.1186/1471-2105-14-170
7	Ariji et al.	Aichi-Gakuin University School of Dentistry	107	Oral Surgery, Oral Medicine, Oral Pathology, and Oral Radiology	10.1016/j.oooo.2018.10.002
8	Das, Hussain e Mahanta	India National Institute of Technology	103	Neural Networks	10.1016/j.neunet.2020.05.003
9	Fu et al.	Wuhan University	101	eClinicalMedicine	10.1016/j.eclinm.2020.100558
10	Song et al.	The University of Arizona	100	Biomedical Optics Express	10.1364/BOE.9.005318

Discussion

The present bibliometric analysis highlights a significant growth in publications utilizing Artificial Intelligence for the diagnosis of oral lesions, with a significant increase in research from 2019 and reaching a peak in 2023. The growth in the number of publications on the topic can be explained by the growing global interest in the use of Artificial Intelligence in healthcare, reflecting the maturation of technology and its expansion of practical applications[24-26].

Studies included in the bibliometric analysis emphasize the improved accuracy and efficiency that Artificial Intelligence offers in diagnosing Potentially Malignant Disorders, as well as the early diagnosis of oral cancer, including the implementation of less invasive and more effective treatments[27-29]. Deep learning algorithms associated with predictive models are also being used for processing imaging exams such as computed tomography and magnetic resonance imaging, allowing for the prediction of metastasis in hidden cervical lymph nodes that often go unnoticed in clinical examinations[30,31], which reinforces the importance of further research and application of Artificial Intelligence in this area.

It is observed that a large portion of the publications originated from China and India, countries considered major hubs for development and technological innovation in Artificial Intelligence[32,33], This fact is also noted in the study by Tu et al. (2021)[34]. Nevertheless, it is evident that the scientific production on the topic still has a wide geographic distribution, suggesting good international collaboration and knowledge sharing in different parts of the world that drive innovations in this field.

The most influential journals in publishing research on Artificial Intelligence and oral diagnosis, particularly oral cancer, have high impact scores, which may validate the importance of the published studies. It is worth noting that, according to Bradford's Law[19,35,36], the main journals in a scientific area publish about one-third of all relevant articles on a given topic. This is because authors always aim to publish articles in line with the scope of the journals while considering previously published works to maximize the visibility of their research.

Despite the advances in implementing Artificial Intelligence in oral diagnosis, the literature points to several challenges, including clinical validation, integration with existing healthcare systems, and ethical issues involving the use of Artificial Intelligence, such as patient data privacy and the limited decision-making capacity of algorithms. Therefore, there is a recognized need for the creation of appropriate regulations and guidelines regarding the use of Artificial Intelligence to ensure that this tool is used responsibly, without causing harm to professionals and patients[37,38]. The Food and Drug Administration (FDA), Health Canada, and the United Kingdom's Medicines and Healthcare Products Regulatory Agency (MHRA) have proposed guiding principles to professionals regarding good practices in the use of Machine Learning[39].

As for research gaps and future directions, the present bibliometric analysis suggests the need to develop more longitudinal studies on the long-term efficacy and safety of Artificial Intelligence tools, which aligns with the general conclusions already existing in the literature. Additionally, a significant limitation in the use of Artificial Intelligence in healthcare is the lack of transparency, applicability, and explicability of the deep learning models mentioned in the studies, which often use robust methods that are not always reproducible.

Conclusion

The bibliometric analysis of the articles demonstrated an increasing number of publications, as well as an evolution in the sophistication of the methodologies used. There are still aspects that need to be explored regarding the applicability of Artificial Intelligence, particularly concerning the reliability of the information produced and data security.

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Contributions of the Authors

EGOA: conceptualization, writing–original draft, writing–review, and editing. LIMC: conceptualization, writing–original draft, writing–review and editing. BESS: conceptualization, writing–original draft, writing–review and editing. HDDM: validation, supervision, and writing–review and editing. HBPS: validation, supervision, and writing–review and editing. CBM: validation, supervision, and writing–review and editing. LAR: validation, supervision, and writing–review and editing. LMRPD: project administration, validation, supervision. EHGL: project administration, validation, supervision. CSDP: project administration, validation, supervision. PRF: project administration, validation, supervision.

Conflict of interests

The authors declare no conflicts of interest.

Ethics statements

All bibliographic references eligible for inclusion in this study were made publicly available, eliminating the need for submission and the scheduled schedule of the Research Ethics Committee.

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4. ARTIGO 2

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Virtual assistant based on artificial intelligence for oral diagnosis: a help for clinicians

AI Oral Diagnosis Helper

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Abstract

Objective: This study aimed to evaluate the performance of the AI Oral Diagnosis Helper (AODH), developed using ChatGPT^{TM} (versions 4 and 4o), in the diagnosis and management of oral diseases. Methods: Thirty clinical cases were evaluated by two specialists in oral diagnosis and the AODH. Diagnosis and treatment suggestions were compared with those of a gold standard specialist. Agreement and accuracy rates were

calculated using Fleiss' Generalized Kappa with a 95% confidence interval, using RStudio. Results: AODH using ChatGPT™ 4 (AODH4) correctly diagnosed 22 out of 30 cases (73.3%), while AODH based on version 4o (AODH4o) correctly identified 24 cases (80%). Expert 1 and Expert 2 correctly diagnosed 27 (90%) and 26 (86.7%) cases, respectively. Fleiss' Kappa indicated substantial reliability among AODH and experts (K = 0.79). AODH4 recommended appropriate diagnostic tests in 21 cases (70%), while AODH4o did so in 26 cases (86.7%). For biopsy recommendations, Specialist 1 was accurate in 27 cases (90%), Specialist 2 in 26 cases (86.7%), AODH4 in 17 cases (56.7%), and AODH4o in 26 cases (86.7%). Conclusion: AODH demonstrated high diagnostic accuracy comparable to human specialists and can assist in oral diagnosis, especially where access to specialists is limited. AODH4o showed superior performance compared to AODH4. Further research is needed to define the role of AI in enhancing clinical decision-making.

Keywords: Artificial Intelligence, Oral Diagnosis, ChatGPT, decision support.

Introduction

Oral cancer is considered one of the most aggressive forms of cancer involving the head and neck region, due to its rapid progression and potential for metastasis. It is considered the 13th most common malignant neoplasm, and 90% of oral cancer cases are squamous cell carcinomas [1]. Given the seriousness of this condition, the need for early identification and continuous monitoring is emphasized in order to effectively manage this disease and mitigate its consequences [2].

The incidence of oral cancer varies between different regions and populations, and is influenced by factors such as tobacco and alcohol consumption, as well as infections with the human papillomavirus (HPV) and the Epstein-Barr virus (EBV) [3]. Despite

sophisticated surgical and radiotherapeutic treatment modalities, oral cancer is still characterized by a poor prognosis and low survival rates. Although variable based on clinical and pathological stages, HPV status, ethnicity and age data, in general, estimates from the National Cancer Institute (2012-2018) suggest that a five-year survival rate is only possible in 68% of cases [4]. In the study by CHI et al. (2015) [5], the authors highlighted the public health challenge posed by the growing numbers of oral cancers and the importance of epidemiological data for defining preventive strategies and treatment modalities.

It should be noted that, despite advances in diagnostic methods, early detection of oral cancer and other diseases affecting this region in general remains a challenge. Common barriers include the lack of specific symptoms in the early stages, as well as socio-economic factors that affect patients' access to healthcare. However, one of the most serious problems that can be considered is the general lack of knowledge among health professionals for the identification of oral lesions and, consequently, the early detection of oral cancer [6].

Therefore, some strategies should be adopted to improve this scenario. Currently, with the expansion of digital technologies, some studies have already carried out tests related to the application of various resources, such as the use of Artificial Intelligence and Computer-Assisted Imaging [7-9]. Artificial Intelligence, in particular, is being widely explored mainly due to its ability to evaluate large amounts of data accurately and quickly. It has been shown that Artificial Intelligence tools can not only improve the capabilities of existing diagnostic tools, but also create new methodologies applicable to early diagnosis. However, studies are still needed to address some issues related to the use of Artificial Intelligence, such as data privacy and the reliability of the information provided [10].

Studies are already underway testing different artificial intelligence interfaces, but their results are average in terms of diagnostic accuracy. There is an ongoing discussion about the need to improve these models for health education and information [11]. Despite

these results, strategies can be developed, such as the development of specific prompts that generate assistants focused on specific tasks, resulting in a more reliable and accurate tool. In this context, this study aimed to evaluate the performance of the AI Oral Diagnosis Helper (AODH) virtual assistant based on artificial intelligence using ChatGPT™ in defining the diagnosis and management of different oral pathological processes.

Materials and Methods

Research Design

This is a cross-sectional, quantitative and experimental study that evaluates the performance of the artificial intelligence-based Oral Diagnostic Helper (AODH) developed from ChatGPT™. Clinical cases from a referral hospital were used, the study received prior approval from the Research Ethics Committee (CAAE number: 72314323.0.0000.5188) and complies with the Declaration of Helsinki.

Oral Diagnosis Helper (AODH)

The artificial intelligence-based virtual assistant was developed using the ChatGPT™ (OpenAI) MyGPT platform. AODH was trained using official documents as a basis, such as the new classification of Potentially Malignant Oral Disorders [12], as well as the book Oral and Maxillofacial Pathology [13]. To develop the resource and provide support in answering questions about oral diseases, the virtual assistant was instructed by a structured prompt to analyze the clinical characteristics of each lesion, such as surface type, insertion, topography, time of evolution, color, symptoms, regularity and texture. Instructions were also given on the different diseases based on the clinical characteristics and the management of the cases, including the prescription of tests. The analysis of all this

data was necessary to simulate the diagnostic method of a specialist, allowing the production of a detailed diagnostic report suitable for clinical review and discussion with the patient. The analysis was carried out by means of a brief summary and uploading the clinical images of the cases to the AODH chatbox. The ADOH development process is described in Figure 1.

[insert Figure 1.]

Figure 1. Development process ADOH.

Case Selection

Thirty clinical cases were selected from an outpatient clinic at a referral hospital, based on the study by Hirosawa et al. (2023) [14]. Each case was structured with a detailed description of the clinical findings, including the patient's demographic data, medical history, history of the presenting disease, chief complaint and clinical and radiographic images of the lesions. Diagnoses included malignant conditions, potentially malignant diseases, non-neoplastic proliferative processes, viral and bacterial infections, among others.

AODH in Oral Diagnosis

To evaluate AODH's performance, clinical cases with a summary including initials, age, gender, brief history, habits and clinical images were submitted one at a time to the AODH chatbot, and the virtual assistant was asked to provide information on diagnosis and management. The cases were tested using the ChatGPT^{TM} platform in versions 4.0 and 4o (AODH4 and AODH4o). Versions 4.0 and 4o were the most recent versions of OpenAI, where more intelligent responses are produced based on the advancement in accuracy of both versions. This study aims to test whether there is a difference between version 4 and version 4o in solving clinical cases.

AODH versus Experts in Oral Diagnosis

In order to compare the opinions issued by the AODH, the selected cases were also referred to two specialists in oral diagnosis, who issued their opinions on the diagnosis, presenting clinical hypotheses and approaches to reach the final diagnosis, in a blind manner, without prior knowledge of the diagnostic conclusions of the cases. The specialists could propose various diagnostic hypotheses, and the accuracy score was considered valid as long as the correct option was included among the diagnostic possibilities. Likewise, the diagnostic approach was analyzed, including the request for complementary exams and biopsies. For scoring purposes, the specialists and the AODH had to order at least one of the complementary tests indicated by the gold standard and correctly identify the type of biopsy (incisional or excisional) required for the case.

These experts were not allowed to use any AI-based tools to help solve the cases. The two oral diagnostics experts are both PhDs in Oral Diagnostics, with more than 10 years of clinical experience. The cases were evaluated independently and blindly by the two experts.

A senior specialist who was considered the gold standard. The gold standard for comparing the opinions of the AIs with those of specialists was the diagnosis issued by an oral diagnostician (30 years' experience), who was responsible for diagnosing the cases, including providing the results of histopathological examinations when these were indicated.

Data Analysis

The data was analyzed by calculating the frequency of correct diagnoses and the conduct of the AODH and the specialists. Inter-examiner agreement was assessed by comparing the diagnoses of AODH4 and AODH4o with those of the specialists and AODH with the gold standard, using Fleiss' Generalized Kappa. Both tests adopted a 95%

confidence interval, using RStudio statistical software (version 2023.12.1 - Massachusetts, Posit PBC). For the statistical analysis of the variables of interest, the Z-test for two proportions was used, with a p-value of less than 0.05 being considered significant.

Results

With regard to the clinical hypothesis, AODH4 correctly identified 22 (73.3%) cases, while AODH4o identified 24 (80%) cases. In comparison, Experts 1 and 2 obtained 27 (90%) and 26 (86.7%) correct cases, respectively (Table 1).

Table 1. Performance of agreement with the gold standard considering the clinical hypothesis.

Performance	AODH4	AODH4o	Specialist 1	Specialist 2
Correct	22 (73.3%)	24 (80%)	27 (90%)	26 (86.7%)
Incorrect	8 (26.7%)	6 (20%)	3 (10%)	4 (13.3%)
Total	30 (100%)	30 (100%)	30 (100%)	30 (100%)

Table 2 shows a comparison of the diagnoses provided by AODH4, AODH4o, the specialists and the gold standard for all cases.

Table 2. Comparison of the diagnoses provided by the AODH Models, specialists and the gold standard.

Case	AODH4	AODH4o	Specialist 1	Specialist 2	Gold standard
1	Cat-Scratch Disease	Cat-Scratch Disease	Cat-Scratch Disease	Cat-Scratch Disease	Cat-Scratch Disease
2	Vascular Malformation	Vascular Malformation	Vascular Malformation	Vascular Malformation	Vascular Malformation
3	Syphilis	Syphilis	Syphilis	Syphilis	Syphilis
4	Leukoplakia	Leukoplakia	Leukoplakia	Leukoplakia	Leukoplakia
5	Hemangioma	Hemangioma	Mucoepidermoid Carcinoma	Mucoepidermoid Carcinoma	Mucoepidermoid Carcinoma
6	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma
7	Lipoma	Lipoma	Lipoma	Lipoma	Lipoma
8	Ranula	Ranula	Ranula	Ranula	Ranula
9	Candidiasis	Candidiasis	Candidiasis	Candidiasis	Candidiasis
10	Lichen Planus	Lichen Planus	Lichen Planus	Lichen Planus	Lichen Planus

11	Pyogenic Granuloma	Pyogenic Granuloma	Pyogenic Granuloma	Pyogenic Granuloma	Pyogenic Granuloma
12	Lipoma	Lipoma	Lipoma	Lipoma	Lipoma
13	Pyogenic Granuloma	Pyogenic Granuloma	Pyogenic Granuloma	Fibrous Hyperplasia	Pyogenic Granuloma
14	Papilloma	Papilloma	Papilloma	Papilloma	Papilloma
15	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma
16	Mucocele	Mucocele	Mucocele	Pyogenic Granuloma	Mucocele
17	Squamous Cell Carcinoma	Squamous Cell Carcinoma	PCM*	PCM*	PCM*
18	Leukoplakia	Actinic Cheilitis	Actinic Cheilitis	Actinic Cheilitis	Actinic Cheilitis
19	Fibrous Hyperplasia	Fibrous Hyperplasia	Fibrous Hyperplasia	Fibrous Hyperplasia	Fibrous Hyperplasia
20	Reactive Gingival Hyperplasia	Reactive Gingival Hyperplasia	Pyogenic Granuloma	Localized juvenile spongiotic gingival hyperplasia	Localized juvenile spongiotic gingival hyperplasia
21	Candidiasis	Candidiasis	Candidiasis	Candidiasis	Herpes
22	Bacterial or viral infection	Traumatic injury	Traumatic Ulcer	Traumatic Ulcer	Traumatic Ulcer
23	Oral melanosis	Oral melanosis	Oral melanosis	Oral melanosis	Oral melanosis
24	Fibroma	Fibroma	Fibroma	Fibroma	Fibroma
25	Papilloma	Papilloma	Papilloma	Papilloma	Papilloma
26	Nicotine Stomatitis	Erythroleukoplakia	Nicotine Stomatitis	Nicotine Stomatitis	Nicotine Stomatitis
27	Sialolithiasis	Sialolithiasis	Sialolithiasis	Sialolithiasis	Sialolithiasis
28	Leukoplakia	Frictional Leukoplakia**	Oral Lichenoid Lesion	Oral Lichenoid Lesion	Oral Lichenoid Lesion
29	Leukoplakia	Focal epithelial hyperplasia	Focal epithelial hyperplasia	Focal epithelial hyperplasia	Focal epithelial hyperplasia
30	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Squamous Cell Carcinoma

* PCM stands for Paracoccidioidomycosis.

** Although this term was cited by ChatGPT, it is not a term recognized by the World Health Organization.

When it came to recommending the appropriate complementary tests, AODH4 correctly identified the necessary tests in 21 cases (70%), while AODH4o performed even better, indicating the correct tests in 26 cases (86.7%). Specialist 1 and Specialist 2 performed similarly, correctly identifying the necessary tests in 20 cases (66.7%) (Table 3).

Table 3. Performance in ordering appropriate complementary tests.

Performance	AODH4	AODH4o	Specialist 1	Specialist 2
Correct	21 (70%)	26 (86.7%)	20 (66.7%)	20 (66.7%)
Incorrect	9 (30%)	4 (13.3%)	10 (33.3%)	10 (33.3%)
Total	30 (100%)	30 (100%)	30 (100%)	30 (100%)

The various complementary tests indicated by the gold standard include: serology (for Bartonella, Toxoplasmosis, Syphilis, Tuberculosis, Leishmaniasis), microbiological culture, treponemal test, imaging tests (panoramic, periapical and occlusal radiographs, conventional and cone beam computed tomography, ultrasound, magnetic resonance imaging) and complete blood count. Serological testing was indicated by the gold standard in two cases, and only Specialist 2 agreed, indicating this complementary test in one case. Microbiological culture was requested in two cases by the gold standard and by AODH4. AODH4o indicated microbiological culture in three cases. The treponemal test was indicated in one case by the gold standard, and the only one who agreed and also indicated the same test was AODH4.

With regard to imaging tests, occlusal radiography was requested by the gold standard in one case, in which only AODH4o also agreed. Ultrasound was indicated in only one case by the gold standard, while AODH4 and AODH4o indicated it in four cases. Computed tomography was indicated in one case by the gold standard and by Specialist 2. The gold standard also indicated a chest X-ray for one case, but this complementary test was not indicated by the specialists or the AODH.

In terms of recommending incisional or excisional biopsies for cases, Specialist 1 showed the best performance, with correct indications in 27 cases (90%). Expert 2 followed closely behind with 26 correct indications (86.7%). AODH4 obtained 17 correct indications (56.7%), while AODH4o performed significantly better, correctly recommending biopsies in 26 cases (86.7%) (Table 5).

Table 4. Relative performance in requesting adequate biopsies compared to the gold standard.

Performance	AODH4	AODH4o	Specialist 1	Specialist 2
Correct	17 (56.7%)	26 (86.7%)	27 (90%)	26 (86.7%)
Incorrect	13 (43.3%)	4 (13.3%)	3 (10%)	4 (13.3%)
Total	30 (100%)	30 (100%)	30 (100%)	30 (100%)

The Fleiss Kappa coefficient calculated to assess the agreement between AODH4, AODH4o and the experts in classifying the cases is shown in Table 5.

Table 5. Evaluation of agreement between the AODH, expert and gold standard models using Fleiss' Kappa Coefficient.

Evaluation	Fleiss' Kappa (K)	95% CI	Z	p-value	Agreement (%)
AODH4, AODH4o, and experts	0.79	0.75 - 0.82	47.3	<0.001	66.7%
AODH4, AODH4o, and gold standard	0.74	0.69 - 0.78	32.2	<0.001	70%

The statistical analysis using the Z-test for two proportions shown in Table 6 revealed that there were no statistically significant differences in the performances compared in terms of the agreement of the AODH and the specialists with the gold standard considering the clinical hypotheses, as well as for the appropriate complementary tests. Thus, although AODH4o had a higher proportion of correct answers than AODH4 and was closer to the experts' performance, this difference was not statistically significant. Regarding the request for appropriate biopsies, specifically, the comparison between AODH4 and AODH4o resulted in a p-value of 0.010, indicating a significant difference in the indication of correct biopsies. In addition, the comparisons between AODH4 and Specialist 1 ($p = 0.004$) and between AODH4 and Specialist 2 ($p = 0.010$) also showed significant differences (Table 6).

Table 6. Statistical analysis using the Z-test for the AODH, expert and Gold Standard models.

Comparison	Clinical hypothesis.		Complementary tests		Biopsies	
	Z	p-value	Z	p-value	Z	p-value
AODH4 vs AODH4o	-0.354	0.724	-1.577	0.116	-2.586	0.010
AODH4 vs Specialist 1	-1.674	0.096	0.275	0.784	-2.918	0.004
AODH4 vs Specialist 2	-1.301	0.194	0.275	0.784	-2.586	0.010
AODH4o vs Specialist 1	-1.087	0.278	1.834	0.068	-0.398	0.692
AODH4o vs Specialist 2	-0.691	0.490	1.834	0.068	0	1.000
Specialist 1 vs Specialist 2	0.398	0.692	0	1.000	0.398	0.692

Discussion

This is the first study to address the use of an AI-based virtual assistant on the ChatGPT™ platform created specifically for the diagnosis of oral lesions. The results indicated that AODH has considerable accuracy in diagnosing oral lesions, reaching an accuracy rate of 80%, which is comparable to the performance of Oral Diagnosis specialists. As a differential, the virtual assistant was developed on the ChatGPT™ platform, and other studies have already been carried out using this specific platform, where results similar to those of the present study have been observed [15-17]. These studies involved not only the field of Dentistry, but also Dermatology, with a focus on the preliminary diagnosis of diseases.

The results show that while AODH does not replace expert clinical analysis and consultation, it can serve as a supportive tool, especially in regions where access to specialists is unfortunately limited [18]. In fact, AODH's ability to provide almost immediate accurate diagnoses can still be beneficial and exploited in screening scenarios, where early detection of malignant lesions is necessary to initiate a patient's treatment plan. In medicine, version 4.0 of ChatGPT™ has already been tested in the screening rooms of an emergency department for prostate cancer, showing promising performance in accurately categorizing patients based on the severity of their condition [19].

Although AI has demonstrated a high level of accuracy in diagnostic hypotheses, approaching the performance of human experts, some limitations and considerations need to be explored. One of the main findings of this research regarding the limitation of AODH was related to its not so efficient performance in recommending biopsy procedures. In this situation, experts outperformed Artificial Intelligence, as it is necessary not only to analyze clinical characteristics, but also other aspects related to the lesion, which reinforces the importance of integrating Artificial Intelligence tools with human supervision, especially in the healthcare area, as diagnostic decisions have significant implications for patient management and treatment [20,21].

The ordering of tests is another point of limitation of the AODH that needs to be highlighted. Although AODH aligns well with one of the experts, there is still room for improvement, especially when trying to understand more complex clinical cases that may require a more extensive investigation and, consequently, more test requests. However, it should be noted that the effectiveness of AI systems such as ChatGPT™ depends to a large extent on the diversity and breadth of the training data. In other words, for Artificial Intelligence models to provide a more qualified response, training must be carried out during the learning process of an Artificial Intelligence tool, providing information that increases its accuracy and reliability in decision-making processes [22].

The reliability of the AODH, as measured by Fleiss's Kappa coefficient, proved to be significant, suggesting that the instrument could be a viable complement for Oral Diagnosis specialists. Positive results in relation to the reliability and accuracy of ChatGPT™ responses have also been obtained in other studies, with values above 80% [14,23], especially when using ChatGPT™ version 4.0 [24], which was also used in this study.

As already mentioned, artificial intelligence tools have limitations when it comes to assessing more complex and rare cases. In the study by Mehnen et al. (2023) [25], 10 clinical presentations of rare cases were tested to assess the diagnostic accuracy of ChatGPT™. As expected, ChatGPT™ did not perform well, which was even lower when version 3.5 was used. Therefore, the integration of the use of artificial intelligence tools in healthcare must move forward with an awareness of their limitations, but with a commitment to improvement through the development of research, rather than replacing healthcare professionals [26-29].

As this is a recent area of research, studies on the subject are still incipient, justifying the use of smaller samples to investigate and test AI tools in healthcare. In this study, 30 clinical vignettes were used to evaluate the AODH tool, a similar number to that adopted in the study by Hirosawa et al. (2023) [14]. In that study, the diagnostic accuracy of ChatGPT™ was analyzed in clinical medical cases, where high diagnostic accuracy was observed. In a similar study that evaluated the accuracy of ChatGPT™ in 10 ophthalmology clinical vignettes, promising results were also found in terms of AI accuracy [30]. These results indicate that, even with small sample sizes, it is possible to obtain results that can contribute to the development and improvement of these technologies in the healthcare field.

A limitation of the study is that the content generated by the AODH was not qualitatively assessed to verify the adequacy and relevance of the information. However, the results of this study indicate that future research into the reliability of AI-based virtual assistants still needs to be developed, including more clinical information and a greater number of cases. Although AODH is proving to be a promising tool for supporting clinical practice, its information should be managed by human professionals, given the limitations identified and the unsatisfactory results in some cases.

Conclusion

It was concluded that the AODH virtual assistant performed well in diagnosing oral lesions. The combination of the virtual assistant and ChatGPT™ with healthcare professionals can be a favorable strategy to enrich the diagnostic process with rapid support, as well as to improve the human experience, creating a more robust and accessible healthcare system. Although this technology should be used with caution and always under professional supervision, it represents a promising advance in the integration of artificial intelligence in the field of oral diagnostics.

Conflict of interests

The authors declare no conflicts of interest.

Ethical Approval

The study received prior approval from the Research Ethics Committee of the Health Sciences Center of the Federal University of Paraíba - João Pessoa - Brazil (CAAE number: 72314323.0.0000.5188), and is in accordance with the Declaration of Helsinki.

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Authors' contributions

EGOA: conceptualization, writing - original draft, writing - revision and editing. LIMC: conceptualization, writing - original draft, writing - revision and editing. BESS: conceptualization, writing the original draft, writing-revising and editing. HDDM: conceptualization, writing - original draft, writing - revision and editing. HBPS: conceptualization, writing the original draft, writing-review and editing. CBM: validation,

supervision and writing-review and editing. LAR: validation, supervision and writing-revising and editing. AUDB: validation, supervision, formal analysis and writing-review and editing. LMRPD: project administration, validation, supervision. EHGL: project administration, validation, supervision. PRFB: conceptualization, project management, validation, supervision.

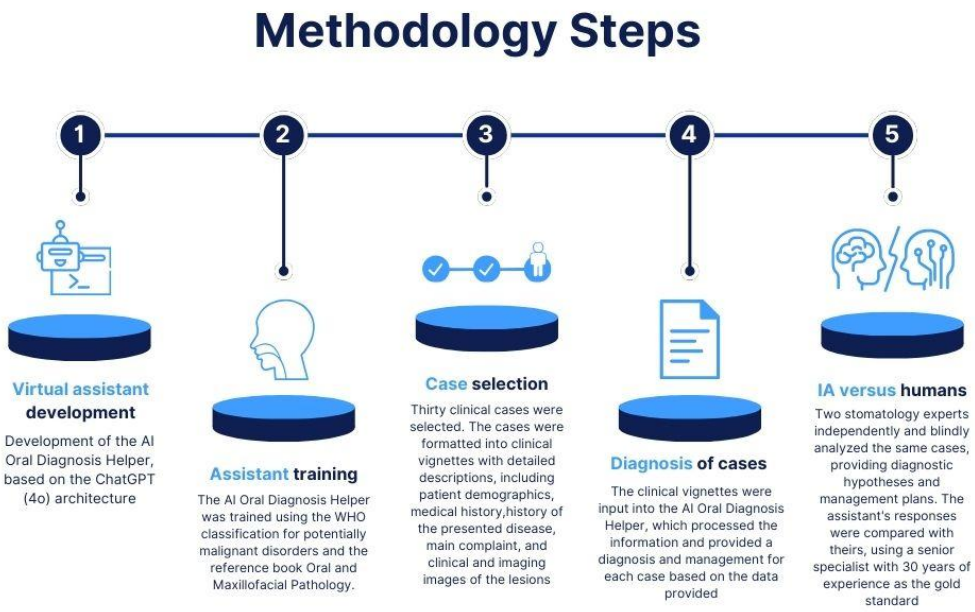

Figure 1. Development process ADOH.

5. CONSIDERAÇÕES FINAIS

De acordo com os resultados do primeiro plano de trabalho foi possível obter uma visão geral sobre as tendências de publicações voltadas para área da Inteligência Artificial aplicada ao diagnóstico bucal. O número de trabalhos com essa temática cresceu principalmente nos últimos anos, mas ainda existem alguns aspectos sobre a Inteligência Artificial que precisam ser estudados, como a confiabilidade e segurança.

No segundo plano de trabalho, foram obtidos resultados promissores sobre o desempenho do assistente virtual desenvolvido na plataforma ChatGPT™, que indica que esta ferramenta possa ser incorporada como apoio aos profissionais. Contudo, ainda é necessário utilizar as ferramentas de inteligência artificial com cautela, pois algumas informações ainda são errôneas e podem comprometer a decisão diagnóstica.

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ANEXOS

ANEXO 1 - NORMAS DE SUBMISSÃO PARA REVISTA "*DIGITAL DENTISTRY JOURNAL*"

About the journal

Aims and scope

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These guidelines are meant as a point of reference to help you identify appropriate language but are by no means exhaustive or definitive.

Reporting sex- and gender-based analyses

There is no single, universally agreed-upon set of guidelines for defining sex and gender. We offer the following guidance:

- Sex and gender-based analyses (SGBA) should be integrated into research design when research involves or pertains to humans, animals or eukaryotic cells. This should be done in accordance with any requirements set by funders or sponsors and best practices within a field.
- Sex and/or gender dimensions of the research should be addressed within the article or declared as a limitation to the generalizability of the research.
- Definitions of sex and/or gender applied should be explicitly stated to enhance the precision, rigor and reproducibility of the research and to avoid ambiguity or conflation of terms and the constructs to which they refer.

We advise you to read the Sex and Gender Equity in Research (SAGER) guidelines and the SAGER checklist (PDF) on the EASE website, which offer systematic approaches to the use of sex and gender information in study design, data analysis, outcome reporting and research interpretation.
For further information we suggest reading the rationale behind and recommended use of the SAGER guidelines.

Definitions of sex and/or gender

We ask authors to define how sex and gender have been used in their research and publication. Some guidance:

- Sex generally refers to a set of biological attributes that are associated with physical and physiological features such as chromosomal genotype, hormonal levels, internal and external anatomy. A binary sex categorization (male/female) is usually designated at birth ("sex assigned at birth") and is in most cases based solely on the visible external anatomy of a newborn. In reality, sex categorizations include people who are intersex/have differences of sex development (DSD).
- Gender generally refers to socially constructed roles, behaviors and identities of women, men and gender-diverse people that occur in a historical and cultural context and may vary across societies and over time. Gender influences how people view themselves and each other, how they behave and interact and how power is distributed in society.

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- Maps: Readers should be able to locate any study areas shown within maps using common mapping platforms. Maps should only show the area actually studied and authors should not include a location map which displays a larger area than the bounding box of the study area. Authors should add a note clearly stating that "*map lines delineate study areas and do not necessarily depict accepted national boundaries*". During the review process, Elsevier's editors may request authors to change maps if these guidelines are not followed.
- Institutional affiliations: Authors should use either the full, standard title of their institution or the standard abbreviation of the institutional name so that the institutional name can be independently verified for research integrity purposes.

Writing and formatting

File format

We ask you to provide editable source files for your entire submission (including figures, tables and text graphics). Some guidelines:

- Save files in an editable format, using the extension .doc/.docx for Word files and .tex for LaTeX files. A PDF is not an acceptable source file.
- Lay out text in a single-column format.
- Remove any strikethrough and underlined text from your manuscript, unless it has scientific significance related to your article.
- Use spell-check and grammar-check functions to avoid errors.

We advise you to read our Step-by-step guide to publishing with Elsevier.

Title page

You are required to include the following details in the title page information:

- Article title. Article titles should be concise and informative. Please avoid abbreviations and formulae, where possible, unless they are established and widely understood, e.g., DNA).
- Author names. Provide the given name(s) and family name(s) of each author. The order of authors should match the order in the submission system. Carefully check that all names are accurately spelled. If needed, you can add your name between parentheses in your own script after the English transliteration.
- Affiliations. Add affiliation addresses, referring to where the work was carried out, below the author names. Indicate affiliations using a lower-case superscript letter immediately after the author's name and in front of the corresponding address. Ensure that you provide the full postal address of each affiliation, including the country name and, if available, the email address of each author.
- Corresponding author. Clearly indicate who will handle correspondence for your article at all stages of the refereeing and publication process and also post-publication. This responsibility includes answering any future queries

about your results, data, methodology and materials. It is important that the email address and contact details of your corresponding author are kept up to date during the submission and publication process.

- Present/permanent address. If an author has moved since the work described in your article was carried out, or the author was visiting during that time, a "present address" (or "permanent address") can be indicated by a footnote to the author's name. The address where the author carried out the work must be retained as their main affiliation address. Use superscript Arabic numerals for such footnotes.

Abstract

You are required to provide a concise and factual abstract which does not exceed 250 words. The abstract should briefly state the purpose of your research, principal results and major conclusions. Some guidelines:

- Abstracts must be able to stand alone as abstracts are often presented separately from the article.
- Avoid references. If any are essential to include, ensure that you cite the author(s) and year(s).
- Avoid non-standard or uncommon abbreviations. If any are essential to include, ensure they are defined within your abstract at first mention.

Keywords

You are required to provide 1 to 7 keywords for indexing purposes. Keywords should be written in English. Please try to avoid keywords consisting of multiple words (using "and" or "of").
We recommend that you only use abbreviations in keywords if they are firmly established in the field.

Tables

Tables must be submitted as editable text, not as images. Some guidelines:

- Place tables next to the relevant text or on a separate page(s) at the end of your article.
- Cite all tables in the manuscript text.
- Number tables consecutively according to their appearance in the text.
- Please provide captions along with the tables.
- Place any table notes below the table body.
- Avoid vertical rules and shading within table cells.

We recommend that you use tables sparingly, ensuring that any data presented in tables is not duplicating results described elsewhere in the article.

Figures, images and artwork

Figures, images, artwork, diagrams and other graphical media must be supplied as separate files along with the manuscript. We recommend that you read our detailed artwork and media instructions. Some excerpts:
When submitting artwork:

- Cite all images in the manuscript text.
- Number images according to the sequence they appear within your article.
- Submit each image as a separate file using a logical naming convention for your files (for example, Figure_1, Figure_2 etc).
- Please provide captions for all figures, images, and artwork.
- Text graphics may be embedded in the text at the appropriate position. If you are working with LaTeX, text graphics may also be embedded in the file.

Artwork formats

When your artwork is finalized, "save as" or convert your electronic artwork to the formats listed below taking into account the given resolution requirements for line drawings, halftones, and line/halftone combinations:

- Vector drawings: Save as EPS or PDF files embedding the font or saving the text as "graphics."

- Color or grayscale photographs (halftones): Save as TIFF, JPG or PNG files using a minimum of 300 dpi (for single column: min. 1063 pixels, full page width: 2244 pixels).
- Bitmapped line drawings: Save as TIFF, JPG or PNG files using a minimum of 1000 dpi (for single column: min. 3543 pixels, full page width: 7480 pixels).
- Combinations bitmapped line/halftones (color or grayscale): Save as TIFF, JPG or PNG files using a minimum of 500 dpi (for single column: min. 1772 pixels, full page width: 3740 pixels).

Please do not submit:

- files that are too low in resolution (for example, files optimized for screen use such as GIF, BMP, PICT or WPG files).
- disproportionally large images compared to font size, as text may become unreadable.

Figure captions

All images must have a caption. A caption should consist of a brief title (not displayed on the figure itself) and a description of the image. We advise you to keep the amount of text in any image to a minimum, though any symbols and abbreviations used should be explained.

Provide captions in a separate file.

Color artwork

If you submit usable color figures with your accepted article, we will ensure that they appear in color online.

Please ensure that color images are accessible to all, including those with impaired color vision. Learn more about color and web accessibility.

For articles appearing in print, you will be sent information on costs to reproduce color in the printed version, after your accepted article has been sent to production. At this stage, please indicate if your preference is to have color only in the online version of your article or also in the printed version.

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Please read our policy on the use of generative AI and AI-assisted tools in figures, images and artwork, which can be found in Elsevier's GenAI Policies for Journals. This policy states:

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- The use of generative AI or AI-assisted tools in the production of artwork such as for graphical abstracts is not permitted. The use of generative AI in the production of cover art may in some cases be allowed, if the author obtains prior permission from the journal editor and publisher, can demonstrate that all necessary rights have been cleared for the use of the relevant material, and ensures that there is correct content attribution.

Supplementary material

We encourage the use of supplementary materials such as applications, images and sound clips to enhance research. Some guidelines:

- Cite all supplementary files in the manuscript text.
- Submit supplementary materials at the same time as your article. Be aware that all supplementary materials provided will appear online in the exact same file type as received. These files will not be formatted or typeset by the production team.
- Include a concise, descriptive caption for each supplementary file describing its content.
- Provide updated files if at any stage of the publication process you wish to make changes to submitted supplementary materials.
- Do not make annotations or corrections to a previous version of a supplementary file.
- Switch off the option to track changes in Microsoft Office files. If tracked changes are left on, they will appear in your published version.

Video

This journal accepts video material and animation sequences to support and enhance your scientific research. We encourage you to include links to video or animation files within articles. Some guidelines:

- When including video or animation file links within your article, refer to the video or animation content by adding a note in your text where the file should be placed.
- Clearly label files ensuring the given file name is directly related to the file content.
- Provide files in one of our recommended file formats. Files should be within our preferred maximum file size of 150 MB per file, 1 GB in total.
- Provide "stills" for each of your files. These will be used as standard icons to personalize the link to your video data. You can choose any frame from your video or animation or make a separate image.
- Provide text (for both the electronic and the print version) to be placed in the portions of your article that refer to the video content. This is essential text, as video and animation files cannot be embedded in the print version of the journal.

We publish all video and animation files supplied in the electronic version of your article.

For more detailed instructions, we recommend that you read our guidelines on submitting video content to be included in the body of an article.

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We are committed to supporting the storage of, access to and discovery of research data, and our research data policy sets out the principles guiding how we work with the research community to support a more efficient and transparent research process.

Research data refers to the results of observations or experimentation that validate research findings, which may also include software, code, models, algorithms, protocols, methods and other useful materials related to the project.

Please read our guidelines on sharing research data for more information on depositing, sharing and using research data and other relevant research materials.

Data linking

Linking to the data underlying your work increases your exposure and may lead to new collaborations. It also provides readers with a better understanding of the described research.

If your research data has been made available in a data repository there are a number of ways your article can be linked directly to the dataset:

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- You can also link relevant data or entities within the text of your article through the use of identifiers. Use the following format: Database: 12345 (e.g. TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN).

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Article structure

Article sections

Divide your manuscript into clearly defined sections covering all essential elements using headings.

Glossary

Please provide definitions of field-specific terms used in your article, in a separate list.

Acknowledgements

Include any individuals who provided you with help during your research, such as help with language, writing or proof reading, in the acknowledgements section. Acknowledgements should be placed in a separate section which appears directly before the reference list. Do not include acknowledgements on your title page, as a footnote to your title, or anywhere else in your article other than in the separate acknowledgements section.

Funding sources

Authors must disclose any funding sources who provided financial support for the conduct of the research and/or preparation of the article. The role of sponsors, if any, should be declared in relation to the study design, collection, analysis and interpretation of data, writing of the report and decision to submit the article for publication. If funding sources had no such involvement this should be stated in your submission.

List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants, scholarships and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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We ask you to use the following format for appendices:

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- Give separate numbering to formulae and equations within appendices using formats such as Eq. (A.1), Eq. (A.2), etc. and in subsequent appendices, Eq. (B.1), Eq. (B. 2) etc. In a similar way, give separate numbering to tables and figures using formats such as Table A.1; Fig. A.1, etc.

References

References within text

Any references cited within your article should also be present in your reference list and vice versa. Some guidelines:

- References cited in your abstract must be given in full.

- We recommend that you do not include unpublished results and personal communications in your reference list, though you may mention them in the text of your article.
- Any unpublished results and personal communications included in your reference list must follow the standard reference style of the journal. In substitution of the publication date add "unpublished results" or "personal communication."
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Linking to cited sources will increase the discoverability of your research.

Before submission, check that all data provided in your reference list are correct, including any references which have been copied. Providing correct reference data allows us to link to abstracting and indexing services such as Scopus, Crossref and PubMed. Any incorrect surnames, journal or book titles, publication years or pagination within your references may prevent link creation.
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When listing web references, as a minimum you should provide the full URL and the date when the reference was last accessed. Additional information (e.g. DOI, author names, dates or reference to a source publication) should also be provided, if known.
You can list web references separately under a new heading directly after your reference list or include them in your reference list.

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We encourage you to cite underlying or relevant datasets within article text and to list data references in the reference list.
When citing data references, you should include:

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Add [dataset] immediately before your reference. This will help us to properly identify the dataset. The [dataset] identifier will not appear in your published article.

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Indexed and abstracted in: Science Citation Index Expanded, Journal Citation Reports, Index Medicus, MEDLINE, PubMed, Scopus, Embase and Emcare, Indice Médico Español, IBECS, Dialnet, Latindex

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https://www.ncbi.nlm.nih.gov/pmc/journals/1898/

JOURNAL SECTIONS

1. Oral Cancer and Potentially malignant disorder
2. Oral Medicine and Pathology
Clinicopathological as well as medical or surgical management aspects of diseases affecting oral mucosa, salivary glands, maxillary bones, as well as orofacial neurological disorders, and systemic conditions with an impact on the oral cavity.
3. Medically compromised patients in Dentistry
Articles discussing medical problems in Odontology will also be included, with a special focus on the clinico-odontological management of medically compromised patients, and considerations regarding high-risk or disabled patients.
4. Oral Surgery
Surgical management aspects of diseases affecting oral mucosa, salivary glands, maxillary bones, teeth, implants, oral surgical procedures. Surgical management of diseases affecting head and neck areas.
ts.
5. Implantology
6. Periodontology

Medicina Oral Patología Oral y Cirugia Bucal no longer ADMITS:
1. CASE REPORTS.
2. ARTICLES focus on Prosthesis, Comunity and Preventive Dentistry, Clinical and Experimental Dentistry, Restorative Dentistry, Odontopediatrics, Orthodontics, TMJD Temporomandibular bone disorders and Endodontics,
Cleft lip and Palate & Craniofacial Malformations.
In the above cases, we recommend to submit the paper to:
Journal of Clinical and Experimental Dentistry (ISSN 1989-5488)
Indexed in SCOPUS and accepted in PubMed Central® (PMC) since 2012 http://www.ncbi.nlm.nih.gov/pmc/ **This is an Open Access (free access online)**
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Articles may only be submitted through our web site and in ENGLISH. Log on our web site and we will send you an USER NAME and PASSWORD to submit the article.
http://www.medoral.es

For submitting NEW OR MODIFIED MANUSCRIPTS the description of the process is:

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• Title of the article
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• References
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Articles will normally be included in one of the different journal sections. Authors should indicate the section in which they wish their article to be included, although the Editor may change this upon advice from reviewers. Articles received will always undergo revision by a committee of experts *(peer review process)*. Only original articles will be accepted, authors being responsible for the meeting of this regulation. Authors are also ***RESPONSIBLE*** for all opinions, results and conclusions contained in articles, which will not necessarily be shared by the journal's Editor and reviewers. All accepted articles become the property of Medicina Oral S.L., and their date of reception and acceptance will be reflected; thus, their subsequent publication in other media is not allowed without written permission by the Editor. Authors will transfer IN WRITING the copyright of their contributions to Medicina Oral S.L.

TYPES OF ARTICLES

1. Research articles: Analytical investigations such as cross-sectional surveys, case-control studies, cohort studies and controlled clinical trials will be recommended for publication. For clinical trials, authors must specify legal permissions obtained. Articles should not exceed 12 pages (including references) in DIN A-4 format, 30 lines per page. Not more than four figures and four tables should be included; up to 30 references.

2. Review articles: Articles of special interest and those entailing an update on any of the topics identified as subjects for this journal will be accepted. They should not exceed 14 pages (references included) in DIN A-4 format, with 30 lines per page. We recommend systematic reviews and meta-analysis. They should contain a maximum of four figures and four tables per article; up to 40 references.

ARTICLE STRUCTURE

Articles should include the following:
1. First page: *This should include the title of the article, as well as a running* title, the authors' full name and academic post, and an address for correspondence, including telephone and fax numbers, and e-mail address.
2. Following pages: *These in turn will include the following headings, according* to the type of contribution (research articles, review articles):

Research articles
— Abstract, containing 150-300 words ALWAYS structured as: Background, Material and Methods, Results, Conclusions.- Key words.- Introduction.- Material and Methods: specifying statistical procedures used.- Results.- Discussion.- References.
Review articles
— Abstract: containing 150-300 words ALWAYS structured as: Background, Material and Methods, Results, Conclusions.- Key words. -Introduction. - Material and methods: specifying how the search was made (date base selected, search strategy, screening and selection of the papers and statistical analysis). - Results and Discussion. - References.

REFERENCES

1. We do NOT accept book references.
2. We only admit references of articles INDEXED in PubMed-Medline.
3. The references should be numbered consecutively in order of appearance, being quoted in parentheses in the text. Unpublished observations and personal communications should not be included as references. The Uniform Requirements for Manuscripts Submitted to Biomedical Journals format is required throughout.

http://www.nlm.nih.gov/bsd/uniform_requirements.html

Example: Authors numbering six or less should all be quoted; when more authors are present, first six names will be quoted, followed by et al.

> Halpern SD, Ubel PA, Caplan AL. Solid-organ transplantation in HIV-infected patients. N Engl J Med. 2002;347:284-7.

Ethical requirements regarding human and animal experimentation

Ethical consideration regarding human and animal experimentation
Authorship and contributorship
Privacy and confidentiality
Protection of human subjects and animals in research

Medical Ethics Manual
Ethics in Research

Conflict of interest requirements

A conflicts of interest exists if authors or their institutions have financial or personal relationships with other people or organisations that could inappropriately influence (bias) their actions. Financial relationships are easily identifiable, but conflicts can also occur because of personal relationships, academic competition, or intellectual passion.

AT THE END OF THE MANUSCRIPT all submissions to *Medicina Oral Patologia Oral y Cirugia Bucal* must include:

1. Conflict of interest
Disclosure of all relationships that could be viewed as presenting a potential ***conflict of interest***.
• At the end of the text, under a subheading "Conflicts of interest", all authors must disclose any financial and personal relationships with other people or organisations that could inappropriately influence (bias) their work. Examples of financial conflicts include employment, consultancies, stock ownership, honoraria, paid expert testimony, patents or patent applications, and travel grants, all within 3 years of beginning the work submitted. If there are no conflicts of interest, authors should state that.
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Information
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- *Journal Citation Reports*
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- *Emcare, Embase, SCOPUS*
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