UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

ANTONIA TAIANE LOPES DE MORAES

ANALYSIS OF SCIENTIFIC PUBLICATIONS ON ORAL CANCER: A BIBLIOMETRIC STUDY OVER 36 YEARS

ANÁLISE DAS PUBLICAÇÕES CIENTÍFICAS EM CÂNCER ORAL: UM ESTUDO BIBLIOMÉTRICO AO LONGO DE 36 ANOS

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Dissertação apresentada à Faculdade de Odontologia de Piracicaba da Universidade Estadual de Campinas como parte dos requisitos exigidos para a obtenção do título de Mestra em Estomatopatologia, na Área de patologia.

Dissertation presented to the Piracicaba Dental School of the University of Campinas in partial fulfillment of the requirements for the degree of Master in Stomatopathology, in Pathology area.

Orientador: Prof. Dr. Jacks Jorge Júnior

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PROF. DR. JACKS JORGE JUNIOR

PROF. DR. JOÃO DE JESUS VIANA PINHEIRO

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RESUMO

Introdução: As análises bibliométricas são essenciais na pesquisa da ciência da informação e na avaliação do impacto acadêmico das publicações científicas. O método bibliométrico permite esclarecer rapidamente as características da literatura, analisa o processo de desenvolvimento e identifica os pontos críticos dos campos de pesquisa. Uma análise bibliométrica da temática de câncer oral no Brasil pode fornecer uma visão abrangente e atualizada do panorama científico, identificando tendências, áreas de pesquisa promissoras e contribuições científicas relevantes a cerca do tema, contribuindo dessa forma para avanços no conhecimento científico e auxiliando na identificação de áreas de pesquisa prioritárias e no estabelecimento de parcerias, possibilitando o desenvolvimento de estratégias mais efetivas de prevenção, diagnóstico e tratamento dessa doença. **Objetivo:** A presente dissertação teve como finalidade fornecer informações tanto quantitativas quanto qualitativas, sobre a produção científica relacionada ao câncer oral no Brasil ao longo dos últimos 36 anos. **Métodos:** O banco de dados eletrônico Web of Science foi acessado e uma pesquisa avançada, com critérios rigorosos, foi conduzida no período de janeiro de 1986 a dezembro de 2022, com o objetivo de identificar estudos na área de câncer oral. Para os artigos selecionados, os seguintes parâmetros foram avaliados: produção anual, número total de publicações no período estudado, autores, periódico de publicação, instituição de origem, países colaboradores, tópicos de destaque, palavras-chave mais utilizadas e número de citações. Os dados adquiridos foram analisados por meio de estatística descritiva e mapeamentos gráficos, utilizando o software Bibliometrix, Microsoft Excel 2016, RAWGraphs 2.0 e o Datawrapper**. Resultados:** Durante o processo de triagem, foram identificadas 2516 publicações. Em seguida, foi conduzida uma análise de citação por ano, revelando que o ano de 2015 apresentou o maior índice. Em termos de periódicos, o Journal of Oral Pathology & Medicine se destacou ao publicar a maioria dos artigos relacionados ao câncer oral. A Universidade de São Paulo foi a instituição de pesquisa brasileira que possuía a maior quantidade de publicações em termos de produção científica. No que diz respeito aos autores mais produtivos, o autor Kowalski LP destaca-se como um dos autores mais produtivos, tanto pelo maior número de citações recebidas quanto pelo maior número de publicações. **Conclusões:** A análise bibliométrica do câncer bucal no Brasil revelou tendências emergentes na pesquisa, como o estudo da biologia molecular e genética do câncer oral. Além disso, essa análise

permitiu identificar pesquisadores ativos e instituições proeminentes na área, oferecendo uma compreensão abrangente sobre o desenvolvimento ao longo do tempo. Esses resultados fornecem insights valiosos para direcionar estudos futuros e promover colaborações científicas.

Palavras-chave: Câncer oral; indicadores bibliométricos; levantamento.

ABSTRACT

Introduction: Bibliometric analyzes are essential in information science research and in evaluating the academic impact of scientific publications. The bibliometric method makes it possible to quickly clarify the characteristics of the literature, analyze the development process and identify the critical points of the research fields. A bibliometric analysis of the topic of oral cancer in Brazil can provide a comprehensive and up-to-date view of the scientific landscape, identifying trends, promising research areas and relevant scientific contributions about the topic, thus contributing to advances in scientific knowledge and helping to identify priority research areas and the establishment of partnerships, enabling the development of more effective strategies for the prevention, diagnosis and treatment of this disease. **Objective:** The purpose of this dissertation was to provide both quantitative and qualitative information about the scientific production related to oral cancer in Brazil over the past 36 years. **Methods:** The Web of Science electronic database was accessed and an advanced search, with strict criteria, was conducted from January 1986 to December 2022, with the aim of identifying studies in the area of oral cancer. For the selected articles, the following parameters were evaluated: annual production, total number of publications in the studied period, authors, journal of publication, institution of origin, collaborating countries, highlighted topics, most used keywords and number of citations. The acquired data were analyzed using descriptive statistics and graphic mappings, using the Bibliometrix software, Microsoft Excel 2016, RAWGraphs 2.0 and Datawrapper. **Results:** During the screening process, 2516 publications were identified. Then, a citation analysis by year was conducted, revealing that the year 2015 presented the highest index. In terms of journals, the Journal of Oral Pathology & Medicine stood out by publishing most of the articles related to oral cancer. The University of São Paulo was the Brazilian research institution that had the most publications in terms of scientific production. With regard to the most productive authors, the author Kowalski LP stands out as one of the most productive authors, both for the highest number of citations received and the highest number of publications. **Conclusions:** The bibliometric analysis of oral cancer in Brazil revealed emerging trends in research, such as the study of molecular biology and genetics of oral cancer. In addition, this analysis allowed us to identify active researchers and prominent institutions in the area,

providing a comprehensive understanding of the development over time. These results provide valuable insights to direct future studies and promote scientific collaborations.
Keywords: Mouth neoplasms; Bibliometric Indicators; Surveys.

SUMÁRIO

1 INTRODUÇÃO

O câncer oral é uma doença maligna que afeta diversas áreas da boca, como os lábios, a língua, a mucosa jugal, as gengivas e o palato duro e mole (Montero PH & Patel SG., 2015). Sua incidência e impacto na saúde pública são preocupantes, devido aos graves efeitos na qualidade de vida dos pacientes e às altas taxas de mortalidade associadas a essa condição (Jemal A et al., 2011). O uso de tabaco é amplamente reconhecido como o principal fator de risco associado ao câncer oral. Seja por meio do consumo de cigarros, charutos, cachimbos ou produtos de tabaco sem fumaça, a exposição a essas substâncias aumenta significativamente as chances de desenvolvimento dessa doença maligna. Além disso, o consumo excessivo de álcool desempenha um papel importante, especialmente quando combinado com o uso de tabaco. Estima-se que mais de 90% dos casos de câncer oral estejam diretamente relacionados ao uso dessas substâncias (Chamoli A et al., 2021).

Além disso, a infecção pelo vírus do papiloma humano tem emergido como um fator de risco crescente para o câncer oral, especialmente entre indivíduos mais jovens (Giraldi L et al., 2021; Varoni EM et al., 2021; Yete S et al., 2018). Outros fatores de risco incluem a exposição excessiva ao sol, má higiene bucal, deficiências nutricionais e histórico familiar de câncer oral (Karaca IR & Ozturk DN., 2019).

De acordo com as estimativas globais mais recentes do relatório de 2020 do GloboCan, o câncer oral ocupa a 17ª posição entre as neoplasias malignas mais comuns em todo o mundo, com uma incidência de 377,713 novos casos (Sung H et al., 2021). Mais de 90% dos casos de câncer oral são carcinomas de células escamosas, e cerca de dois terços dos casos ocorrem em países em desenvolvimento em comparação com os países desenvolvidos (Vos T et al., 2019).

O câncer oral é uma questão de saúde pública de grande importância no Brasil, com uma incidência relevante em todo o país (Galante ML et al., 2020). De acordo com informações do Instituto Nacional do Câncer, é estimado, para o triênio de 2023 a 2025, que ocorram 11 mil novos casos de câncer oral a cada ano no Brasil. Esses números ressaltam a necessidade de medidas efetivas de prevenção, diagnóstico precoce e tratamento adequado para combater essa doença e reduzir seu impacto na saúde da população brasileira (INCA, 2022).

A análise bibliométrica é uma abordagem quantitativa e qualitativa que utiliza métodos estatísticos e computacionais para examinar a produção científica em uma área específica de estudo. Seu objetivo é identificar e avaliar características dos documentos

científicos, como artigos, livros, teses e outros, a fim de obter insights sobre a produção, disseminação e impacto da pesquisa nessa área (Donthu N., 2021). Essas análises são amplamente utilizadas em estudos científicos para identificar lacunas de pesquisa, áreas emergentes, colaborações acadêmicas, influência de pesquisadores e instituições, bem como oferecer uma visão geral da evolução e tendências da pesquisa ao longo do tempo em um determinado campo (Grosser M et al., 2022; Blažun H et al., 2012; Liu W et al., 2020).

Essa análise requer a coleta de dados bibliográficos provenientes de fontes confiáveis, como bases de dados científicas, por exemplo, a Web of Science, Scopus ou PubMed (Snyder H., 2019). Em seguida, são utilizadas técnicas estatísticas e de visualização de dados para extrair informações relevantes, como a quantidade de publicações, tendências ao longo do tempo, autores mais produtivos, instituições de destaque, colaborações entre pesquisadores e países mais ativos no campo de estudo em questão (Aria M et al., 2017).

Essas análises também podem investigar métricas bibliométricas, como o índice de impacto das revistas científicas e o número de citações recebidas pelos artigos, para avaliar a influência e o impacto dos trabalhos científicos. Essas métricas permitem uma avaliação da qualidade e visibilidade da pesquisa em um determinado campo, oferecendo uma indicação do alcance e relevância dos estudos realizados (Waltman L., 2016).

Uma análise bibliométrica sobre o câncer bucal no Brasil é importante, visto que o câncer bucal é considerado um problema crítico de saúde pública devido ao seu impacto significativo na qualidade de vida dos pacientes e suas altas taxas de mortalidade. Compreender a produção científica nessa área é fundamental para identificar lacunas de pesquisa e direcionar esforços para áreas que necessitam de maior atenção.

Além disso, o Brasil apresenta uma incidência crescente de câncer bucal, o que reforça a necessidade de avaliar a produção científica relacionada a essa doença. Sabendo-se disso, uma análise bibliométrica dessa temática pode fornecer uma visão abrangente e atualizada do panorama científico, identificando tendências, áreas de pesquisa promissoras e contribuições científicas relevantes.

Outro ponto importante é a avaliação da qualidade científica das publicações. A análise bibliométrica pode considerar indicadores como o fator de impacto das revistas e o número de citações recebidas pelos artigos, fornecendo insights sobre a influência e visibilidade da pesquisa realizada. Os resultados obtidos podem servir como base para o

direcionamento de recursos, estabelecimento de prioridades e promoção de estudos que contribuam para o avanço no diagnóstico, tratamento e prevenção do câncer bucal.

Desse modo, esse trabalho teve como objetivo principal fornecer uma visão abrangente e detalhada da produção trazendo informações quantitativas e qualitativas, sobre a produção científica, na temática de câncer oral, no Brasil desde 1986, ano no qual os trabalhos começaram a ser indexados na plataforma Web of Science, até o ano 2022, explorando aspectos como tendências temporais, distribuição geográfica, colaborações entre pesquisadores e instituições, e qualidade das publicações. Esses resultados são fundamentais para orientar futuras investigações, identificar lacunas de pesquisa e promover avanços significativos no combate a essa doença.

2 ARTIGO: Artigo: Bibliometric analysis of scientific publications on oral cancer in brazil: a 36-year study.

Artigo submetido para publicação no Journal of Oral Pathology & Medicine. (Anexo 1)

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ATLM and ACNN: Conceptualization; Data curation; Formal analysis; Methodology; JJJ: Supervision; Funding acquisition; Validation; Visualization; Writing - review & editing ATL: Roles/Writing - original draft; Writing - review & editing; MSM: Conceptualization; Data curation; Writing - review & editing.

Abstract

Background: Oral cancer is considered a public health problem due to its high mortality rates. Brazil has a growing incidence of this disease, which highlights the importance of assessing scientific production in the area and identifying possible gaps. A bibliometric analysis of this theme in Brazil can provide a comprehensive and updated view of the scientific landscape, allowing the identification of promising research areas, academic collaborations and prominent institutions. Therefore, the objective of this work is to provide a bibliometric view, bringing qualitative and quantitative information about the scientific production on oral cancer in Brazil in the last 36 years. **Material and Methods:** The Web of Science database was used for an advanced search using strict criteria from January 1986 to December 2022 for studies in the area of oral cancer. Data were analyzed using descriptive statistics and graphical mapping using Bibliometrix software, Microsoft Excel 2016, RAWGraphs 2.0, and Datawrapper. **Results:** A total of 2516 publications were identified. In the analysis of citation per year, the year 2015 showed the highest index. The *Journal of Oral Pathology & Medicine* published most of the articles related to the theme in terms of journals. The University of São Paulo has the most publications in terms of research institutions in Brazil, the author Kowalski, LP received the highest number of citations. **Conclusions:** This bibliometric analysis provided an original and comprehensive view of the progress and advances of the oral cancer theme in Brazil allowing an in-depth understanding of the development process in this field over the past 36 years.

Keywords: Oral cancer; oral squamous cell carcinoma; bibliometric analysis; bibliometric indicators; survey.

INTRODUCTION

Oral cancer, a set of malignant neoplasms affecting the oral cavity, is associated with multifactorial etiology, such as genetic, epigenetic, microbial, and environmental factors, such as tobacco, areca nut, cigarette smoking, and alcohol, which usually vary with geographic regions or ethnic groups [1]. A number of histopathological changes have been documented in the oral mucosa that precede oral cancer. The process of carcinogenesis, or cancer formation, usually occurs gradually, and it can take many years for a cancer cell to multiply and give rise to a visible tumor [2, 3].

The Globocan 2020 report highlighted cancer as a significant cause of premature death among oral diseases, when addressing the overall burden of incidence and mortality from this condition. On a global scale, lip and oral cavity cancers are estimated to have accounted for 377,713 incident cases and 177,757 deaths in 2020. These figures highlight oral cancer as a critical health problem given its ability to pose a significant life-threatening risk and, as a result, it is one of the main barriers to increasing life expectancy worldwide [4, 5].

Bibliometric analyses have emerged as one of the most widely used methods to assess the credibility, quality and impact of academic work [6]. Bibliometrics is a specific field in the areas of librarianship and information science, dedicated to the analysis of scientific publications [7]. These studies aim to quantify, describe and predict the process of written communication, with a central focus on analyzing and building quantitative and qualitative indicators of publications, using statistical and mathematical methods [8,9].

The relevance of bibliometric studies lies in the need to understand and evaluate the productivity and quality of research, enabling the identification of patterns of dispersion and citation behavior in scientific productions [10]. The demand and use of bibliometric studies have grown significantly, both for the quantification of scientific production and for other purposes. For example, these studies are employed in the analysis of diseases in the health field, allowing to identify critical research areas, to investigate the most recent trends, and to direct the scientific community and public policies towards more effective approaches [11,12].

Therefore, a bibliometric analysis on oral cancer in Brazil plays an essential role in understanding the current scientific scenario. It will allow the identification of the most

frequently addressed themes, as well as the most productive geographic areas, institutions, and authors in this area of research. In addition, this analysis can contribute to the identification of research gaps and trends, providing valuable insights for future studies and directing efforts in the search for advances in the diagnosis, treatments, and prevention of this disease.

Thus, the main objective of this research was to provide a bibliometric view, bringing quantitative and qualitative information about the scientific production on oral cancer in Brazil since 1986, the year in which the studies began to be indexed in this platform, until the year 2022. In addition, this work also sought to analyze the temporal trends of scientific production, identifying whether there was an increase or decrease in the number of publications over the years; to evaluate the geographical distribution of scientific production, identifying the regions of Brazil with the greatest contribution and highlighting possible regional disparities; To investigate the collaboration between authors and institutions, identifying relevant academic and scientific partnerships in the field of oral cancer in Brazil and to carry out an analysis of the scientific quality of the publications, considering indicators such as the impact factor of the journals and citations received by the articles.

MATERIAL AND METHODS

Database Search

A broad advanced search was performed on the Web of Science (WoS) electronic database (Clarivate Analytics, London, UK), within the Web of Science Core Collection. The following descriptors were used: “Oral cancer” OR “Mouth Neoplasms” OR “Carcinoma, Squamous Cell” OR “Tongue Neoplasms” OR “Salivary Gland Neoplasms” OR “Lip Neoplasms” combined with the Boolean operator “AND” and the term “Brazil” was inserted into the Country/Region filter, as was the term "Dentistry, Oral Surgery & Medicine" has been inserted into the field “Categories of Web of Science”. The results were refined using the "Years of publication" filter, including publications from 1986 to 2022.

Inclusion and exclusion criteria

The titles and abstracts of the records were examined. Inclusion criteria were defined as any original work or review on oral cancer in the field of oral pathology originating

from Brazil. On the other hand, papers from other dental fields, and studies related to cancer in animals (veterinary field) were excluded.

Data extraction and mapping

The Biblioshiny R-package- Bibliometrix (https://www.bibliometrix.org/home/; K-Synth Srl Inc., Nápoles, Itália) was used to analyze and extract the following data: type of publication, amount of production per year, number of citations per year, research institutions that publish the most, most relevant journals in the area, impact factor of the journals, most relevant authors along with their *h*-index and citation index, most cited papers, most used words, and Brazil's international collaboration network.

The Microsoft Excel (versão 2016, Microsoft corporation, USA, Redmond) was also used to organize and analyze the data.

Complementarily, the total number of records obtained in the database search was imported into the Bibliometrix software tool, which allows the construction and visualization of bibliometric networks.

To construct graphs, interaction networks and the other visual presentations of the data, the software's RAWGraphs 2.0 beta e o Datawrapper.

RESULTS

Using the search strategy algorithm, a total of 2,516 articles related to oral cancer originating from Brazil were obtained, covering the period from 1986 to 2022. As shown in figure 1A, a significant increase in scientific production is observed from the 2000s onwards, remaining in constant growth until 2020, with a slight decrease in 2022. Figure 1B shows the average number of citations over the past 36 years. It can be seen that there have been four citation peaks during this period, with the first occurring in 1989, followed by a second peak in 1994. The third peak, the largest of all, was recorded in 2005, while the last peak occurred in 2018.

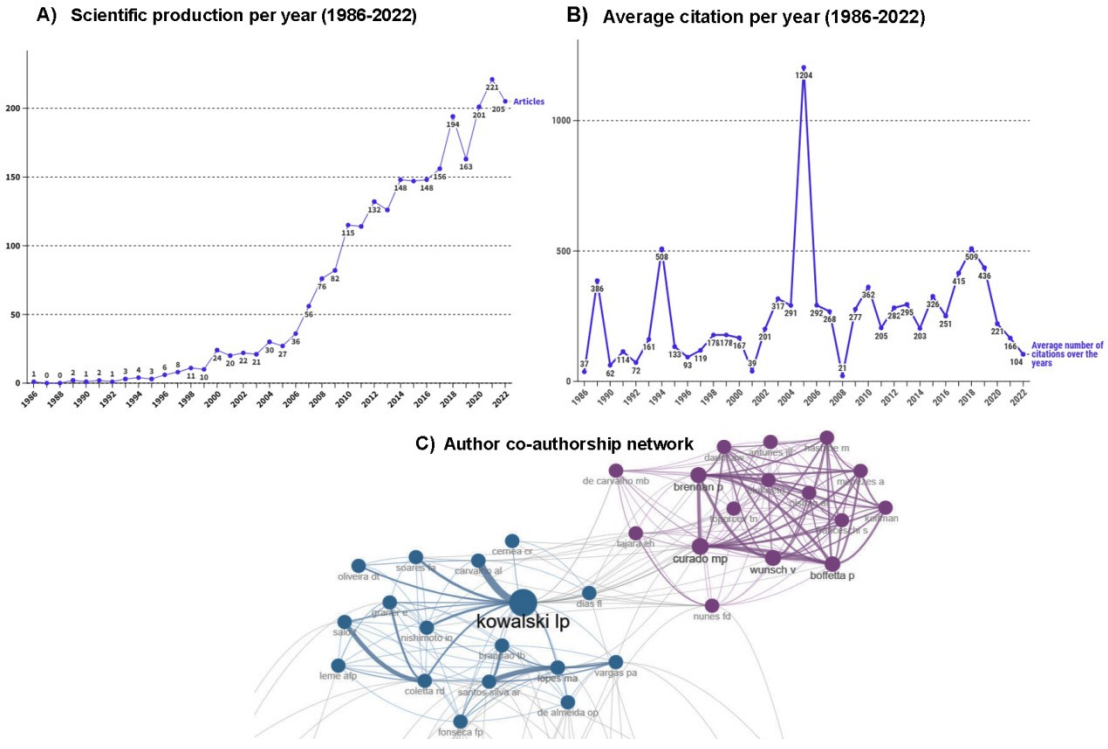
A total of 12,385 authors have contributed to published research on oral cancer in Brazil. Among these authors, 10 have more than 40 records, while only one author has more than 200 articles. Table 1 presents the list of the 10 most productive authors, along with the number of citations received and the *h*-index of each, from the combined data obtained from the Web of Science.

Table 01. The 10 most productive authors, the *h*-index and number of citations.

Authors	Number of works	*h* -index	Number of citations
Kowalski, LP	218	69	22.243
Coletta, RD	70	43	6.577
Lopes, MA	63	35	4.077
Carvalho, LA	61	31	3.143
Santos-Silva, AR	54	25	2.485
Curado, MP	50	54	13.368
Gomez, RS	49	37	9.569
Nunes, FD	46	26	2.301
Batista, AC	42	25	2.235
Martins, MD	40	26	2.177

Figure 1C illustrates the distribution of authors who publish the most in coauthorship networks, with the participation of at least five authors from at least two different institutions. Within this collaboration network, authors Kowalski LP and Coletta RD stand out as those with the largest collaboration network and publications.

Figure 1. . Graph illustrating annual production, number of citations over the years and Network of co-authorship of the main authors from 1986 to 2022.

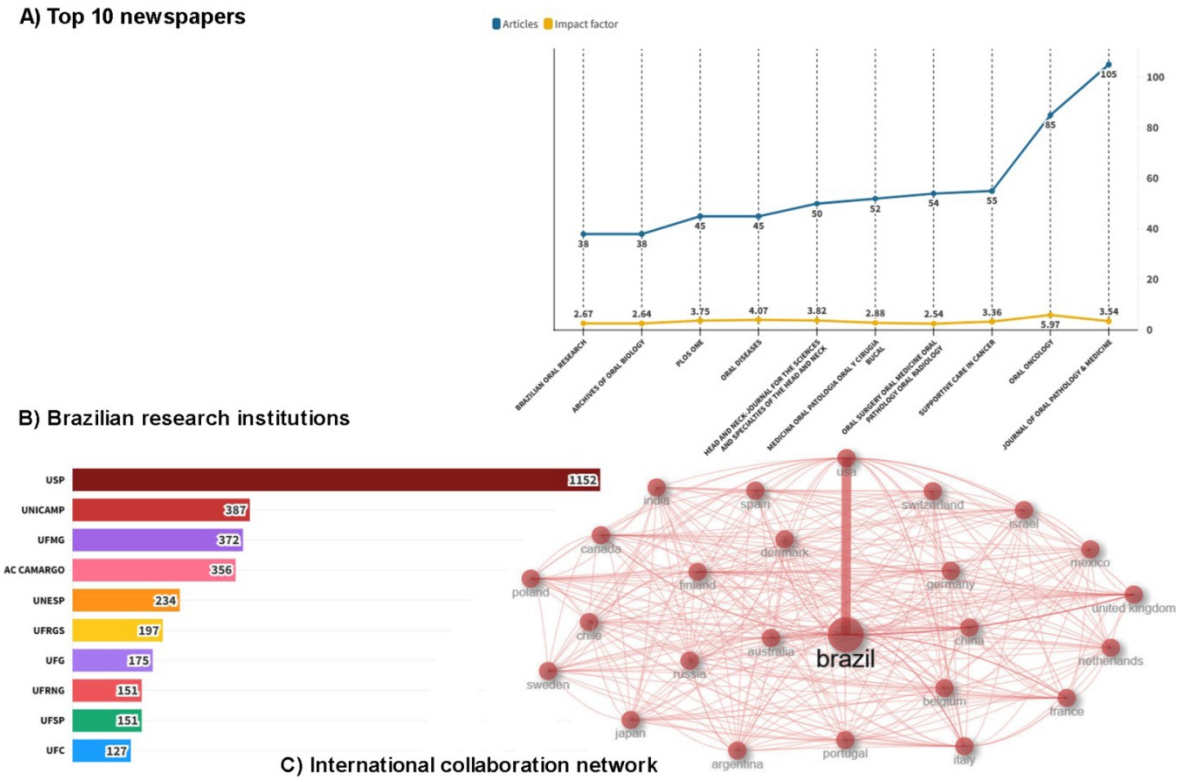


A total of 700 publication sources (journals) were identified using the Web of Science tool. Figure 2A shows the top 10 publication sources in oral cancer, along with their impact factors, according to Journal Citation Reports (JCR) data. The JCR is an annual publication by Clarivate Analytics that provides a systematic and objective evaluation of the world's leading research journals. According to the figure, the Journal of Pathology & Medicine is the journal with the highest number of publications in the area of oral cancer.

A total of 571 institutions were involved in producing research in the area of oral cancer. Figure 2B illustrates the 10 institutions with the highest production of research in this field. The University of São Paulo tops the list, with a total of 1,152 publications, withthe State University of Campinas and the Federal University of Minas Gerais with 387 and 372 publications, respectively.

In addition, an international collaboration network was established between Brazilian institutions and several countries, as illustrated in Figure 2C**.** It can be seen that the highest rate of collaboration occurred among United States and Brazil, indicating a significant scientific partnership between these nations.

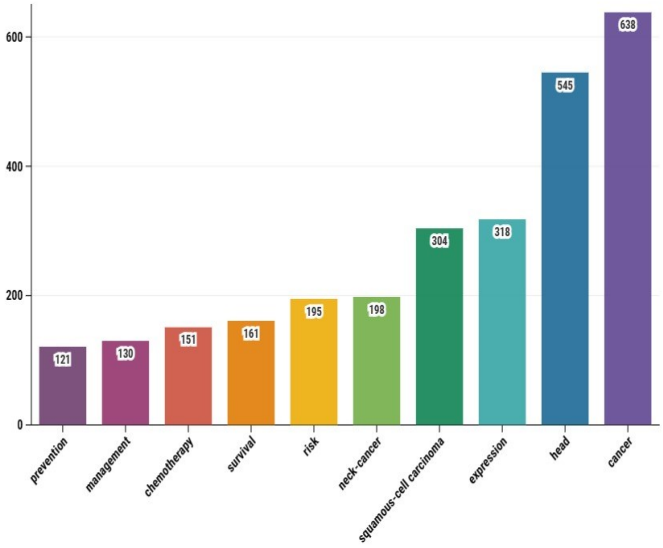
Figure 2. The top 10 newspapers according to their publication numbers Brazilian, research institutions according to their publication numbers and interntional collaboration network.



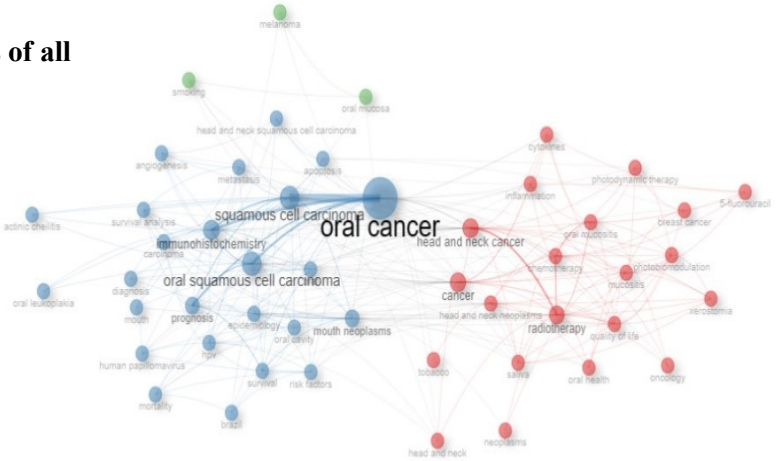
From the total of 2,516 records retrieved and screened, 5,708 keywords were identified, as illustrated in Figure 3A. The terms "Cancer" and "Head" had the highest occurrence, with 638 and 545 times, respectively. This was followed by the terms "expression", "squamous cell carcinoma", and "neck cancer", with 318, 304, and 198 occurrences, respectively. In Figure 3B, in the cluster analysis of the most used keywords, we found that "oral cancer" appeared most frequently, occurring 638 times, followed by "squamous-cell carcinoma" (545 times), which is a type of cancer of epithelial origin that occurs in about 95% of oral cancer cases.

Figure 3. The 10 most commonly occurring keywords and co-occurrence analysis of all keywords in publications on oral cancer.

A) The 10 most commonly

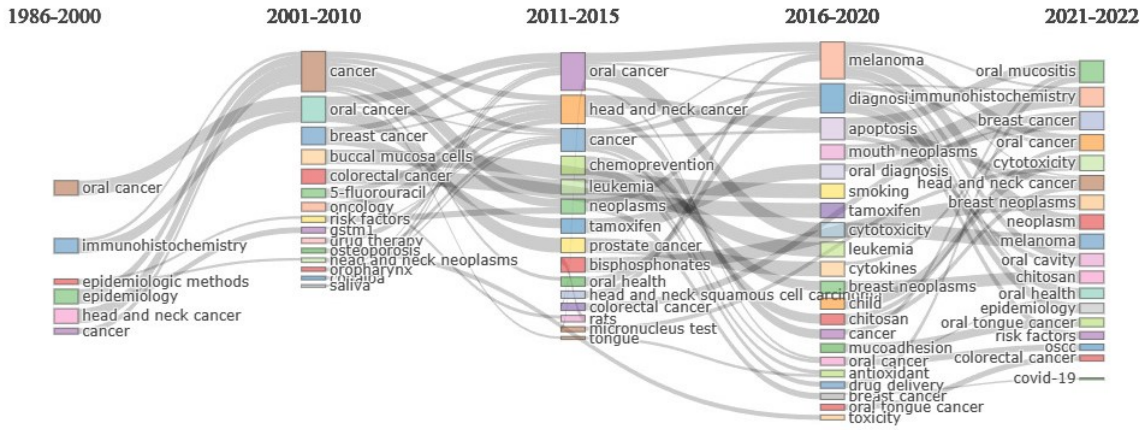


B) co-occurrence analysis of all



Using the Bibliometrix tool, we created a map, in figure 4, to assess the evolution and emergence of terms over time, providing a comprehensive view of the trends and development of research in the area of oral cancer.

Figure 4. . Thematic evolution map.



The 10 most cited articles on oral cancer, based on Web of Science data, are presented in Table 2.

Table 2. Top 10 most cited articles on oral cancer.

Title	publication year	Journal	Total citation
Interaction between Tobacco and Alcohol Use and the Risk of Head and Neck Cancer: Pooled Analysis in the International Head and Neck Cancer Epidemiology Co nsortium	2009	Cancer epidemiology biomarkers & prevention Factor de impact: 5.594	720
Alcohol drinking in never users of tobacco, cigarette s moking in never drinkers,and the risk of head and neck cancer: Pooled analysis in the international head and n eck cancer epidemiology consortium	2007	Journal of the national cancer institute Factor de impact : 13.993	695
Risk-factors for oral-cancer in brazil - a case-control study	1989	International journal of cancer Factor de impact: 6.842	270
Low human papillomavirus prevalence in head and nec k cancer: results from two large case-control studies in high-incidence regions	2011	International journal of epidemiology Factor de impact: 11.653	131
Effects of the tumour necrosis factor-alpha inhibitors pentoxifylline and thalidomide in short-term experimental oral mucositis in hamsters	2005	European journal of oral sciences Factor de impact : 2.932	84
Phase III trial of lowlevel laser therapy to prevent oral mucositis in head and neck cancer patients treated with concurrent chemoradiation	2014	Radiotherapy and oncology Factor de impact: 6.724	75
Clinicopathological prognostic factors of oral tongue squamous cell carcinoma: a retrospective study of 202 cases	2014	International journal of oral and maxillofacial surgery Factor de impact: 3.02	71
Evaluation of low-level laser therapy in the prevention and treatment of radiation-induced mucositis: A double-blind randomized study in head and neck cancer patients	2011	Oral oncology Factor de impact: 5.895	65
Effects of Low-Level Laser Therapy on Collagen Expression and Neut rophil Infiltrate in 5-Fluorouracil-Induced Oral Mucositis in Hamsters	2010	Lasers in surgery and medicine Factor de impact: 3.043	55
Trends and spatial distribution of oral cancer mortality in Sao Paulo, Brazil, 1980-1998	2001	Oral oncology Factor de impact: 5.895	49

DISCUSSION

In recent years, a remarkable increase in the number of articles on oral cancer has been observed. Several factors may have contributed to this increase. One possible explanation is the significant investment in oral cancer research in Brazil, which is related to the rapid development of the national economy, especially since the 2000 [13]. This economic growth drove the increase in funds allocated to the field of oral cancer research, as demonstrated by the total investments in fellowships and research funding granted by the National Council for Scientific and Technological Development (NCSTD). According to NCSTD data, the number of grants offered increased from 431,631 in 1996 to 1,340,289 in 2014. This increase in funding has contributed to the strengthening of research in this area and to the advancement of knowledge about oral cancer in Brazil [14].

A second factor that has contributed to this increase is the improved training and increased number of dental surgeons and researchers, as well as the establishment of new research institutions and improvements in their infrastructure, providing a more favorable environment for the development of studies [15]. As a third factor, the annual growth in the incidence of oral cancer stands out, as verified by data from the National Cancer Institute (NCAI). Between the years 1988 and 1999, NCAI recorded 7,249 cases of oral cancer in men and 2,631 in women. Whereas in the period from 2000 to 2019, 41,503 cases were recorded in men and 14,891 in women. The NCAI also estimates that there will be approximately 11,180 new cases of oral cancer in men and 4,010 in women each year in the triennium 2020-2022. These numbers highlight the worrying trend of increasing incidence of oral cancer in Brazil over the past decades, requiring greater attention and effective measures for prevention, diagnosis and treatment [16].

Another factor for such an increase in publications from the 2000s would be the popularization of the internet, making the publication process in scientific journals faster, more accessible and global. Before the dissemination of the internet, the process of submitting and publishing scientific articles was a more time-consuming, bureaucratic process with geographic limitations, since researchers interested in publishing their articles in scientific journals had to send printed copies of the documents by mail to the journal editors [17].

As highlighted by Dellagostin (2021), there is additional support for the reasons raised above. From the 2000s on, there was an expansion of the National Post-Graduation System with an increase in the number of masters graduated in academic and professional master's programs, as well as PhDs, which brings as a consequence an increase in scientific production, since both are closely related. Moreover, Dellagostin (2021) also highlights the growing and important contribution of federal and state funding agencies in the expansion and support of research [18].

In terms of research institutions, 5 of the 10 most productive institutions are from the state of São Paulo. A reflection of the economic and human capital importance that this state holds in Brazil. Recognized as the largest economic and industrial hub in the Southern Hemisphere, São Paulo figures prominently in the Brazilian economyaccounting for 31.6% of the country's Gross Domestic Product in 2020. This state also concentrates 25% of the total number of higher education institutions in Brazil and the three public universities in São Paulo (USP, UNICAMP and UNESP) are among the best in the country, with international recognition [19].

The journal with the highest number of publications was the *Journal of Pathology & Medicine*, followed by *Oral Oncology*. Both have the highest impact factors, with the *Oral Oncology* factor being the highest of all, which shows that both the quantitative and qualitative factors are going hand in hand. The *Journal of Oral Oncology* and the *Journal of Oral Pathology & Medicine* are two scientific journals that focus primarily on research related to oral oncology and oral pathology. The *Journal of Oral Oncology* covers a wide range of topics related to oral cancer, including etiopathogenesis, epidemiology, prevention, clinical features, diagnosis, treatment, and management of patients with head and neck neoplasms. On the other hand, the *Journal of Oral Pathology & Medicine* focuses specifically on oral pathology, which involves the study of diseases affecting the mouth, the lips and the adjacent region. Considering the themes addressed by both journals and their relevance in the publication of scientific studies, one can obtain an insight into the main areas of research in the field of oral cancer in Brazil, and also the most addressed and relevant topics, which provides insights into the areas of greatest interest and contribution within the scope of this disease.

Regarding the key words, which are terms composed of one or more words that summarize what an article or content is about, the most used were "cancer" and "head"

broad terms that refer to the theme studied, perhaps because they are broad that explains their greater use and can be used in a range of works. In the co-occurrence network of words, a set of points (or nodes) with their own attributes that are connected through lines or links, the words "oral cancer" and "squamous cell carcinoma" are the words with the highest occurrence in the published articles. This is justified by the fact that squamous cell carcinoma is the most common cancer of the oral cavity [20]. Another word that has gained relevance of use is "expression", a term closely related to new trends in oral cancer studies, which are focused on the area of proteomics, studying the expression, interactions and functions of certain proteins in the biological behavior of cancer [21].

Additionally, the annual citation index, the year 2005 had the highest number of citations, with a total of 1204 citations in this year. During this year the publications focused mainly on issues related to trends in the incidence and prognosis of oral cancer, low-power laser therapy, significance of some immunohistochemical markers in the prognosis of oral cancer, and oral complications of cancer therapy such as bisphosphonate-associated osteonecrosis of the mandibular and maxillary bone.

There were three more peaks in the citation graph. One was in 1988 in which the focus at that time was papers related to risk factors for oral cancer. Another peak in citations was in 1994 with papers focusing on surgical treatments for oral cancer. The third and final peak was in 2019 which brought papers related to the themes of biomarker identification, transcriptomics in saliva, oral health policies, impact of cancer mortality, and photobiomodulation in cancer cells.

In this study we show the 10 most cited articles. The mentioned papers share the goal of investigating different aspects of oral and head and neck cancer. Although they are diverse in terms of topics and methodologies, they all have in common the search for a better understanding of risk factors, treatments, prognosis and epidemiology related to oral cancer.

The article with the most citations is an international cooperative study involving several institutions, including Brazilian ones, in which the authors assessed the magnitude of the risk conferred by the interaction between tobacco and alcohol use on the risk of head and neck cancer by analyzing 17 case-control studies. And indeed, the

International Agency for Research on Cancer (IARC) classifies tobacco and alcohol in Group 1 of carcinogens for humans [22].

From the construction of a thematic map divided into five temporal sections, it is possible to analyze how the area has been behaving over time and how the worked themes change. In the first stage of the thematic map the theme "immunohistochemistry" (IHC) gained wide application in pathology at the turn of the 80s-90s to identify the presence of specific antigens in cancer tissue samples. This technique was mainly used for basic and exploratory research studies, and its clinical application was limited [23]. Over time the term has fallen into disuse, but in the 2000s a series of technical developments created more sensitive detection systems, with increased availability of specific antibodies and detection techniques, including automated detection systems and the introduction of immunofluorescence. IHC has also gained an important foothold in personalized cancer therapy, playing an important role in identifying predictive biomarkers of response to specific therapies, such as the expression of target proteins for targeted therapies [24].

From 2001 to 2010 the terms "oral cancer" and "breast cancer" are the most prominent. This may be due to the fact that both cancers, although distinct types, have some common factors. Breast cancer and oral cancer share some risk factors, such as smoking, alcohol consumption, exposure to radiation, and genetic predisposition. This may lead to research investigating these associations and possible common mechanisms of carcinogenesis, such as protein expression in both neoplasms and their biological significance. Consequently, breast cancer samples are often used as positive controls in oral cancer studies [25].

In the 2011-2015 time cut, the term "chemoprevention" gained prominence due to some advances in understanding the process of carcinogenesis. These findings have provided a solid foundation for the development of chemoprevention strategies. Research on chemopreventive agents, new chemopreventive substances were being studied, including pharmaceutical compounds, natural products, and dietary supplements [26].

In the mid-2016s, the term "melanoma" was prominent in scientific literature and in studies related to oral cancer, mainly due to a few reasons. The first concerns its clinical importance since it is an aggressive and potentially fatal skin cancer. Also, during this period, there have been significant advances in the diagnosis and early detection of

melanoma. New imaging techniques, such as dermoscopy and confocal microscopy, have been developed and refined to improve the ability to diagnose melanoma non-invasively. Significant advances have also occurred in the development of target therapies and immunotherapy for the treatment of melanoma. Such increased interest in this lesion has resulted in more clinical trials and scientific research dedicated to the topic [27].

A recent focus, which comminuted in the appearance of the term "Covid-19" in the 2021-2022 time cut concerns the outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that marked the beginning of a new pandemic called coronavirus disease 2019 (COVID-19). Previous studies have documented that this disease not only results in respiratory complications and pneumonia, but can also compromise the immune system of affected individuals. In this scenario, oral cancer patients are in a high-risk group during pandemic, as they may encounter severe detrimental outcomes as they were even more susceptible to complications and negative impacts [28].

From the thematic evolution map it is possible to understand how the cancer theme has been behaving. There were significant shifts in the focus of oral cancer research before and after the 2000s, reflecting scientific and technological advances and changes in research priorities. Before the 2000s, the main research focus included oral cancer epidemiology, associated risk factors, diagnosis and staging, treatment and rehabilitation, and patient quality of life. Since the 2000s, there has been a shift toward understanding the molecular and genetic biology of oral cancer, personalized medicine, immunotherapy, molecular targeted therapy, metabolomics and proteomics, and regenerative medicine. These new research focus reflect the search for more targeted, personalized, and innovative approaches to oral cancer prevention, diagnosis, and treatment.

It is worth noting that the graph of publications over the years studied showed a decrease in the year 2022, a fact that can be explained by the negative impact that the pandemic of COVID-19 had on scientific publications, not only nationally but also globally [29].

Regarding the authors with the most publications within the theme, 8 of the 10 most productive authors are from the Southeast region of the country, concentrating the

publications in this region. As for the network of authorial collaboration, it was noted that authors from the same institution tend to collaborate more among themselves, It was also noted that this network is concentrated in the southeastern region, that is, authors from this region tend to collaborate more with authors who also live in the same region, thus denoting a collaborative network between institutions that are close to each other.

The concentration of authors and collaborations in the Southeast region of Brazil on the subject of oral cancer can have different meanings. And some points can be considered. The first concerns infrastructure and resources since the Southeast region concentrates important research centers, universities and health institutions that have an advanced infrastructure and resources available to conduct studies in the area of oral cancer. This concentration may be an indication of a greater availability of laboratories, equipment, and expertise needed for scientific research in the field of oral cancer. In addition, it suggests that this region has had a significant investment in education and research, establishing itself as a reference in this area [30].

Not to mention that such a region has a high population density which could provide access to a larger number of patients and clinical samples related to oral cancer. This may allow more robust data collection and a more representative population for epidemiological and clinical studies [30].

When it comes to international collaboration, Brazil has a greater collaboration with the United States, especially Harvard University, the University of Michigan, the University of Texas, the Massachusetts Institute of Technology, and Stanford University. Among the reasons why Brazilian research institutions collaborate with American universities, the resources and infrastructure are the most pointed, since universities in the United States often have advanced resources and high quality research infrastructure, which can benefit Brazilian researchers. This includes well-equipped laboratories and access to state-of-the-art technologies [31].

A second reason is related to the international recognition of the academic excellence of US universities. Collaborating with researchers from these institutions allows access to expertise and specific knowledge, which can enrich studies and research projects in progress. Taking into the financial realm, collaborations between Brazilian institutions and American universities may, in some cases, involve joint financing of research

projects. This partnership can increase the opportunities to obtain financial resources to support studies and research initiatives. And a final reason would be the visibility of publications, since collaboration with renowned researchers and institutions in the United States can increase the visibility of studies and research conducted in Brazil [30].

We are aware that this bibliometric analysis has some limitations. First, we used only data from the Web of Science database, without including other databases for analysis. Although the Web of Science is considered comprehensive and accurate, the exclusion of other databases may limit the overview of the research landscape in the field. It is important to consider including other data sources in future analyses to gain a more complete and comprehensive understanding of the topic at hand. Second, it is important to note that citation counts do not directly reflect the quality of an article, but provide a quantitative assessment of the scientific impact in a given field.

In summary, this study sought to show, using bibliographic analysis, a general panorama of publications on oral cancer in a qualitative and quantitative way. Showing the most relevant research institutions, the most productive authors and journals, the hots topics of the theme and the international relations that the country maintains. It was observed that there is a significant concentration of research activity in the Southeast and South of the country in relation to oral cancer. This is evidenced by the presence of relevant research institutions and productive authors in these regions. This disparity raises the question about the possible lower productivity in the Midwest, North and Northeast regions. A possible explanation for the lower scientific productivity in these regions is the lack of investment in research. However, it is important that future studies be carried out to investigate and better understand this disparity found, in order to direct efforts and seek solutions to promote scientific development in these areas.

CONCLUSION

The results obtained in this study provide a deeper understanding of the dynamics of oral cancer research over time across the country. The bibliometric approach adopted in this analysis provides information of interest to researchers, helping them to identify trends through emerging topics in the area, such as molecular biology, genetics of oral cancer and immunotherapy, which are gaining increasing relevance in the scientific field of this disease, this information can assist in directing future studies. In addition, this analysis also provides the most active researchers in these areas, which indicates the

scientific community important names in the oral cancer theme for possible collaborations and partnerships. Furthermore, the identification of the most prominent institutions in the publication of papers related to this theme in Brazil can serve as a reference for researchers seeking partnerships and scientific cooperation. These results provide insights into the state of oral cancer research in Brazil, highlighting the areas of greatest focus and indicating possible directions for future studies.

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Informed consente

For this type of study informed consent is not required.

Conflict of interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Ethics

This article does not contain any studies with human participants or animals performed by any of the authors.

Data availability

Data supporting the findings of this study is available on the supplementary material and from the corresponding author upon reasonable request.

Author contribuitions

ATLM and ACNN: Conceptualization; Data curation; Formal analysis; Methodology; JJJ: Supervision; Funding acquisition; Validation; Visualization; Writing - review & editing ATL: Roles/Writing - original draft; Writing - review & editing; MSM: Conceptualization; Data curation; Writing - review & editing.

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3 CONCLUSÃO

Com base nas informações obtidas através do estudo apresentado nesta dissertação, podemos concluir que:

- Os resultados deste estudo oferecem uma compreensão mais profunda da dinâmica da pesquisa sobre o câncer bucal no Brasil ao longo do tempo, abrangendo todo o país.
- A abordagem bibliométrica utilizada nesta análise fornece informações valiosas para os pesquisadores, permitindo a identificação de tendências emergentes na área, como biologia molecular, genética do câncer oral e imunoterapia, que estão se tornando cada vez mais relevantes no campo científico dessa doença. Essas informações podem orientar estudos futuros e direcionar a pesquisa.
- A análise também destaca os pesquisadores mais ativos nessas áreas, com destaque para o pesquisador Kowalski LP, indicando nomes importantes na comunidade científica que podem ser alvos de colaborações e parcerias.
- Além disso, a identificação das instituições mais proeminentes, como a USP e UNICAMP, na publicação de trabalhos relacionados ao câncer bucal no Brasil, serve como referência para pesquisadores que buscam parcerias e colaborações científicas para desenvolvimento de trabalhos dentro dessa temática.
- Esses resultados fornecem insights sobre o estado atual da pesquisa do câncer bucal no Brasil, destacando as áreas de maior foco e apontando possíveis direções para estudos futuros.

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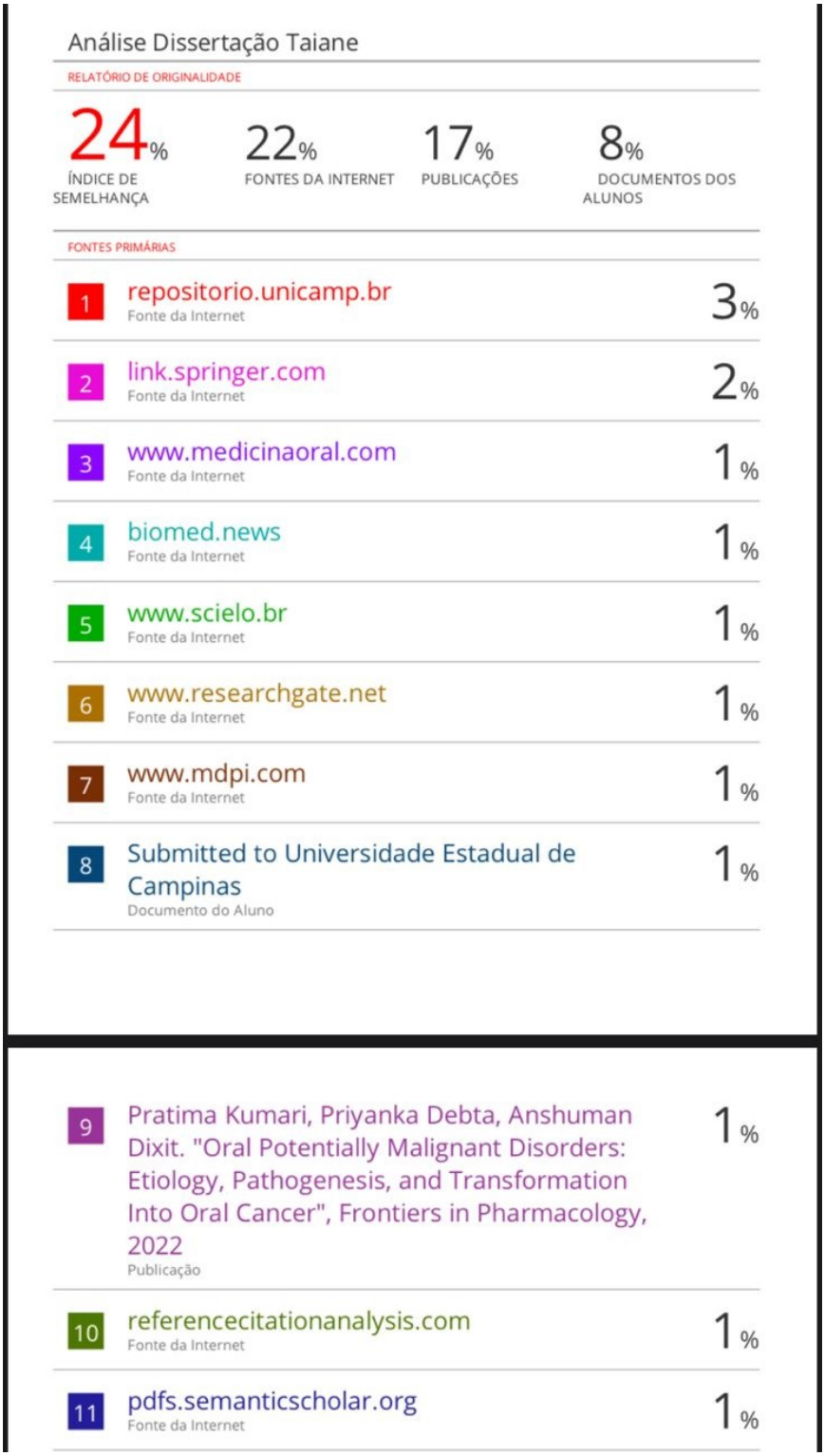
ANEXOS

Anexo 1- Documento de submissão do artigo (print do sistema online de submissão).

Anexo 2- Relatório de similaridade da Plataforma Turnitin.



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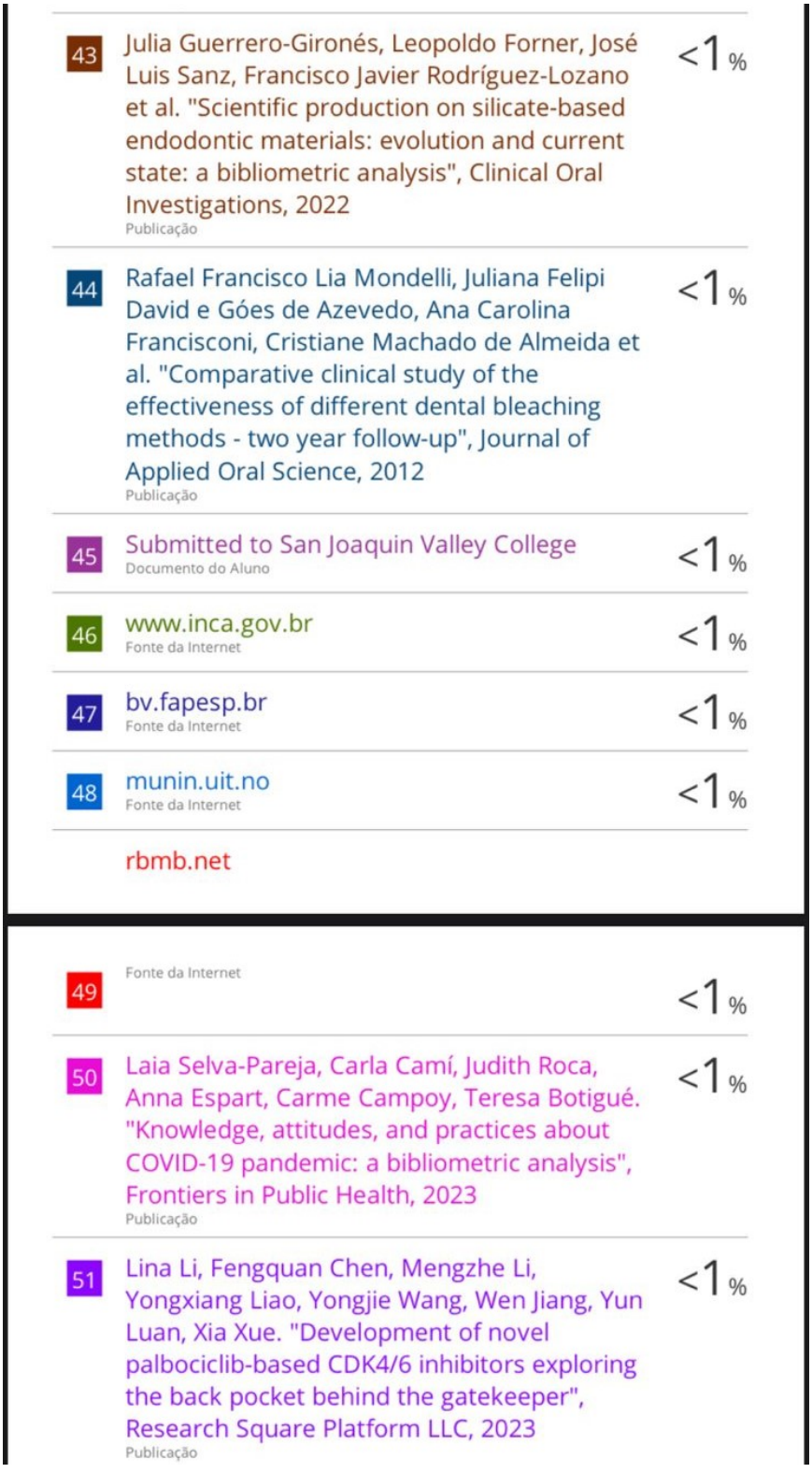

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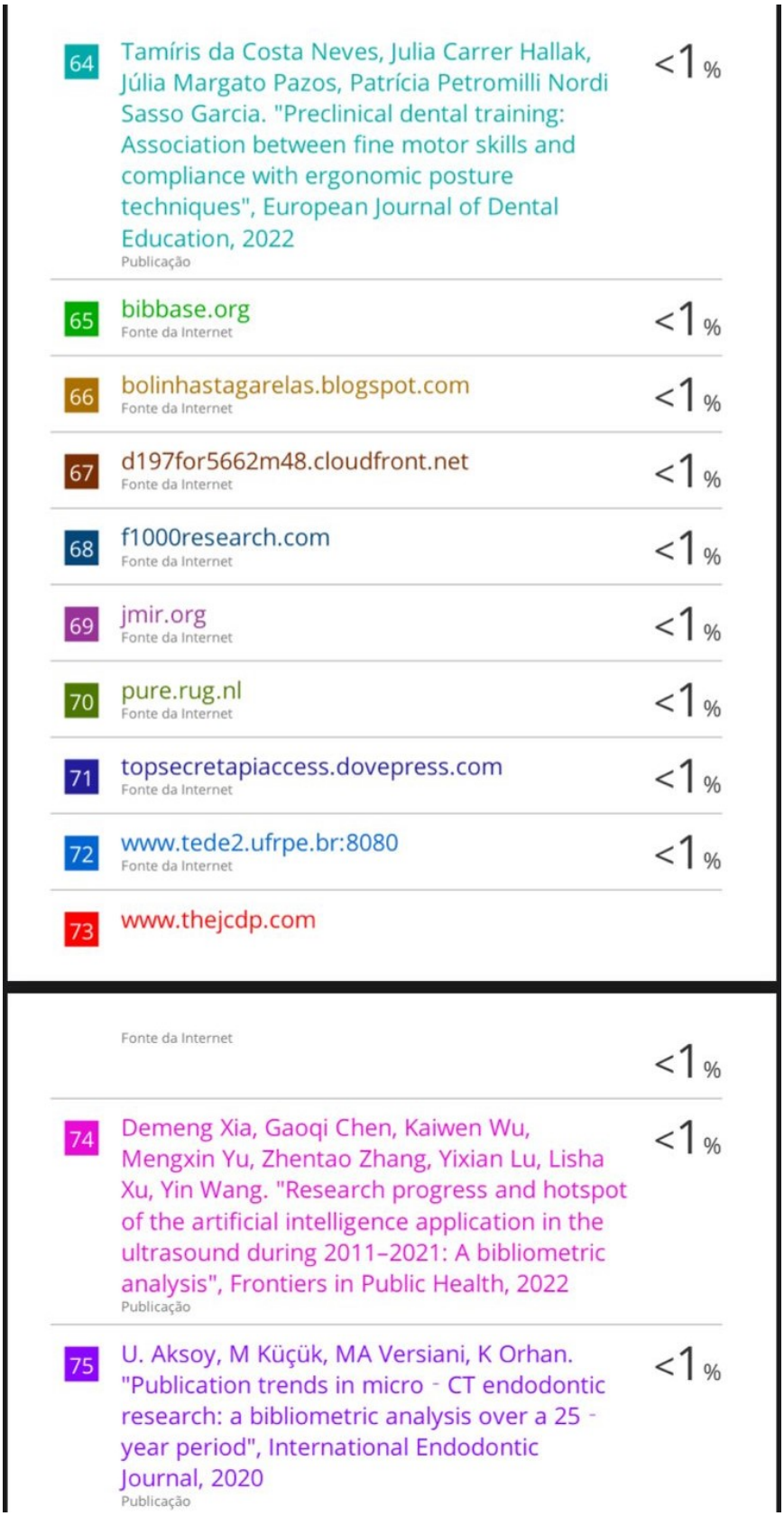

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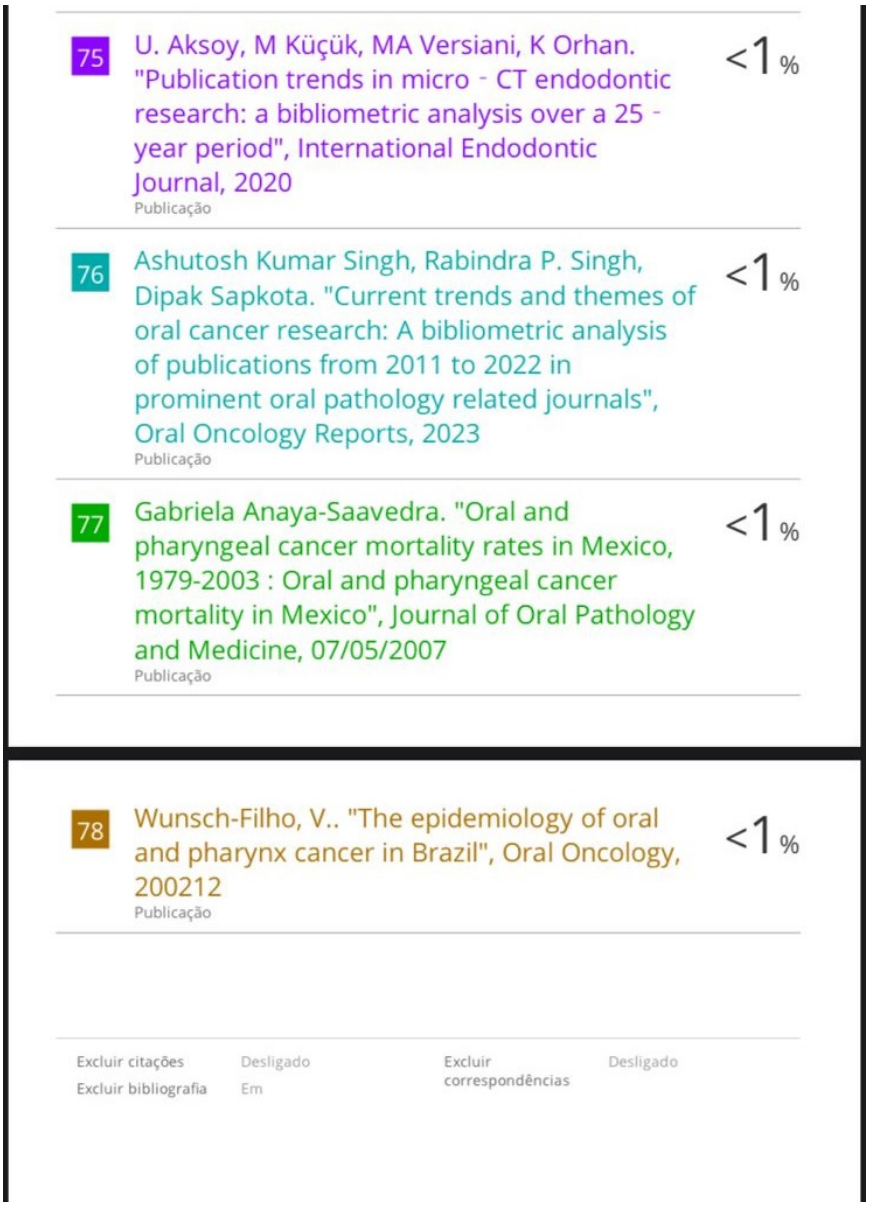

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