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Keyword Network Analysis of Global Trends in Oral Health Research

Yun-Jeong Kim

Associate professor, Department of Dental Hygiene, Kwangju Women's University (tokyj@kwu.ac.kr)

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ABSTRACT

This research aimed to identify shifts in international research trends related to oral health and to investigate potential research directions. An analysis of keyword frequency and centrality was conducted using Textom 6.0 on 2,565 author keywords extracted from 415 articles sourced from Web of Science. The most commonly used keywords included 'health', 'disease', 'risk', 'HIV', and 'Cell'. The degree centrality was notably high for keywords such as 'health', 'disease', 'risk', 'factor', 'gingivitis', 'cell', 'control', 'periodontitis', 'cancer', and 'review'. Additionally, the betweeness centrality was elevated for 'health', 'disease', 'risk', 'cancer', 'factor', 'analysis', 'therapy', 'food', 'cell', and 'gingivitis'. These results suggest that future research in oral health could be enhanced and directed by concentrating on the most central keywords.

1. Introduction

Oral health refers to the condition of being free from oral diseases, having mental well-being, and maintaining healthy teeth and the oral and maxillofacial area, which does not disrupt social interactions (Park et al., 2011). Oral health is a crucial aspect of overall physical health and plays a vital role in digestion and nutrition. It significantly contributes to one's quality of life, as good oral health is necessary for a person to be deemed healthy (Song, 2008). Oral health issues are linked to various factors, such as overall health conditions, daily routines, social interactions, and levels of life satisfaction (Albandar et al., 1999).

Dental diseases are among the most prevalent and expensive health issues, with out-of-pocket costs for dental care exceeding those for general medical care (Australia Government, 2019). Significant oral diseases present a substantial public health issue on global, regional, and national scales, characterized by a burden and disparities that are unmatched by other non-communicable diseases. These conditions have considerable effects on health, well-being, healthcare systems, and economies, and they add to the overall burden of non-communicable diseases. The majority of oral diseases can be prevented through self-care or public health initiatives, necessitating efforts to address broader social, economic, and political factors that influence health in order to alleviate the disease burden and mitigate its adverse effects (World Health Organization, 2023).

Untreated oral health issues impact almost 50% of the global population, with cases rising by

1 billion over the last three decades. This indicates that a significant number of individuals lack sufficient oral healthcare. The repercussions of neglecting oral diseases are serious, leading to physical discomfort, functional challenges, and negative impacts on emotional, mental, and social health. For at-risk groups, obtaining treatment can be expensive, resulting in a financial strain (World Health Organization, 2022). Considering the nature of dental care, which involves significant expenses and specialized treatment tools, there is an ongoing necessity for the creation of affordable and accessible oral health programs (World Health Organization & International Telecommunication Union, 2021). Furthermore, the increasing elderly population and the use of multiple medications are leading to a neglect of oral care, which in turn is causing a decline in health-related quality of life. This decline is associated with various symptoms and oral health issues, including dry mouth, gum disease, bad breath, mouth inflammation, and age-related illnesses (Lee et al., 2015) both individuals and society must take action to enhance oral health care and overall quality of life across all stages of life (Lee et al., 2019). Consequently, it is essential to conduct a study on the dynamics of oral health to assess if academic research in this area has been addressing these needs and to explore the various directions of research aimed at enhancing oral health.

Keyword network analysis goes beyond merely counting how often keywords appear; it also examines the structural connections between concepts. This method investigates the relationships among keywords within a network created by the frequency and co-occurrence of these keywords. As a result, it facilitates the identification of trends or patterns within a field and allows for an analysis of the overall yearly trends. Additionally, it offers a structured approach to understanding abstract concepts (Lee, 2012). In this instance, the keywords provided by the author in the research are appropriate for network analysis, as the researcher has identified the terms that most effectively convey the subject and substance of the study (Park & Jang, 2021), Analyzing networks using author keywords is effective for identifying the main subjects and current state of a research area (Park & Han, 2021). Centrality is an indicator of how central a node is within the overall network (Lee, 2012), and can be utilized to assess the interconnections of important concepts and keywords. It is the most frequently employed metric in network analysis for evaluating the impact and connectivity of particular keywords (Lee, 2018). There are four kinds of centrality: degree centrality, betweeness centrality, closeness centrality, and eigenvector centrality. In this research, we focused on connection centrality and mediation centrality. Connection centrality helps us comprehend the influence of direct links with other keywords, while mediation centrality enables us to assess the extent of mediation or intermediary roles among keywords (Seo, 2021).

Dental hygiene involves the study of preventive care for oral health, focusing on managing behaviors within the community to prevent oral diseases and enhance overall health (Bae et al., 2022), and trends in oral health can be deduced by examining the research trends in dental hygiene.

Recent research on domestic trends in dental hygiene has utilized methods such as content analysis (Jang et al., 2017; Kang et al., 2010; Kim, 2018; Kim, 2019), network analysis (Kim, 2023), and topic modeling (Kim, 2022). However, there is a lack of sufficient international research trends in dental hygiene when compared to other academic disciplines. Therefore, we would like to explore potential research topics in the field of dental hygiene and analyze current research trends by examining international studies related to oral health. Therefore, this study was conducted to extract and compare keywords with high connectivity and mediation centrality in international research within the field

of oral health. By utilizing keyword network analysis, we aim to identify changes in research trends and explore future directions in dental hygiene.

2. Methods

2.1 Research subjects

To analyze international research trends in oral health, this study gathered data from the Web of Science (WoS), the largest database of academic articles, focusing on publications from the past decade (2014-2023) that include the terms ‘oral health’, ‘oral hygiene’, and ‘dental hygiene’ in their titles and abstracts. The search expression is oral health (subject) or dental hygiene (all disciplines) or oral hygiene (all disciplines). The search yielded 415 articles, with the highest number of publications coming from Oral Diseases (28 articles), Journal of Clinical Periodontology (18 articles), and International Journal of Dental Hygiene (13 articles).

2.2 Data analysis

In the analysis process of this study, a total of 2,565 author keywords were extracted and refined using Textom (Textom 6.0, TheIMC, Korea). The terms ‘oral health’, ‘oral hygiene’, and ‘dental hygiene’, which were included in the article collection, were excluded from the analysis. In the preprocessing stage, we converted all words to lowercase and standardized them with singular notations to ensure that words with similar meanings, such as ‘Health’ and ‘health,’ from being interpreted differently. The secondary cleaned data was reviewed for any unspecified words and extraneous spaces, which were then removed, resulting in the selection of the final dataset.

To better understand research trends, the keyword frequency calculation and network analysis were organized into two groups: Analysis 1 and Analysis 2. For the periods 2014-2018 and 2019-2023, keyword frequency and centrality analyses were conducted on 1,542 and 858 author keywords, respectively, by selecting the top 100 keywords and constructing a 1-mode network matrix. The centrality analysis focused on degree centrality and betweenness centrality. For link centrality and mediation centrality, normalized centrality values were utilized, indicating that a value closer to 1 signifies greater involvement of the keyword (Kawhk, 2017).

3. Results

3.1 Publication of oral health-related papers by year

Figure 1 illustrates the release of 415 articles related to oral health from 2014 to 2023. From 2015 to 2020, approximately 50 papers on oral health were published, with a minimum of 14 papers being released annually during that period.

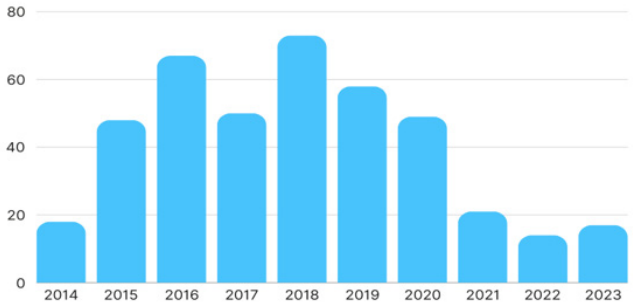

Fig. 1. Number of article by year

3.2 Frequency of keywords in oral health-related studies

A total of 2,565 keywords from 415 articles were examined, with the primary keywords listed in Table 1. Our analysis revealed that oral health research focuses on terms like ‘health’, ‘disease’, ‘risk’, ‘HIV’, and ‘Cell’. The frequency of these keywords was as follows: ‘health’ appeared 100 times, ‘disease’ 60 times, ‘risk’ 43 times, among others.

Table 1. Frequency of key words

Rank	Key word	N(%)	Rank	Key word	N(%)	Rank	Key word	N(%)
1	Health	100(3.90)	11	Assessment	16(0.62)	14	Aid	12(0.47)
2	Disease	60(2.34)		Infection	16(0.62)		Patient	12(0.47)
3	Risk	43(1.67)		Outcome	16(0.62)	15	Nutrition	11(0.43)
4	HIV	30(1.17)	12	Care	15(0.58)		Loss	11(0.43)
5	Cell	24(0.94)	13	Therapy	13(0.51)		Hygiene	11(0.43)
6	Cancer	23(0.90)		Gingivitis	13(0.51)		Prevention	11(0.43)
7	Factor	21(0.82)		Plaque	13(0.51)		Child	11(0.43)
8	Food	19(0.74)		Analysis	13(0.51)		Caries	11(0.43)
9	Review	18(0.70)		Microbiome	13(0.51)		Gut	11(0.43)
10	Surgery	17(0.66)		Vitamin D	13(0.51)		Exposure	11(0.43)

HIV: human immunodeficiency virus

3.3 Changes in main keywords over the years

Figure 2 illustrates the annual frequency of the top 10 keywords in oral health research. The keyword ‘risk,’ which ranks third in frequency, saw a decline after 2019, whereas ‘HIV,’ the fourth most common keyword, experienced an increase from its baseline between 2016 and 2020, but has since become less frequent. In general, the top 10 keywords showed an upward trend in frequency from 2015 to 2020, but have since remained at lower levels.

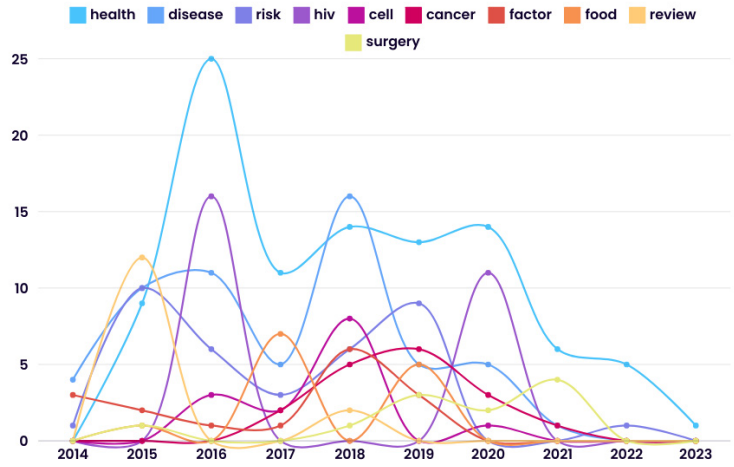

Fig. 2. Changes in top keywords over the years

3.4 Changes in keywords over time in oral health-related research

Table 2 illustrates the evolution of keywords in oral health research over time. The top ten keywords for each period were listed, revealing that from 2014 to 2018, the most common terms were ‘health’, ‘disease’, and ‘risk’, along with ‘gingivitis’, ‘plaque’, and ‘assessment’. In the period from 2019 to 2023, ‘health’, ‘risk’, and ‘cancer’ emerged as the most prevalent keywords, followed by ‘nutrition’, ‘quality of life’, and ‘child’.

Table 2. Frequency of key words by period

Rank	2014-2018		2019-2023	
	Key word	N	Key word	N
1	Health	60	Health	40
2	Disease	46	Risk	17
3	Risk	26	Cancer	15
4	Cell	19	Disease	14
5	HIV	18	Surgery	13
6	Review	16	Infection / HIV	12
7	Factor	15	Outcome	10
8	Food / Vitamin D	13	Nutrition	8
9	Gingivitis / Plaque	12	Quality life / Pain / Therapy	7
10	Assessment	11	Patient / Syndrome / Food Factor / Impact / Study / Child	6

HIV: human immunodeficiency virus

3.5 Keyword network analysis of oral health-related research

The findings from the keyword network analysis, which aimed to assess the impact of keywords in oral health research across various timeframes, are presented in. Throughout the entire study

period, the keywords ‘health’, ‘disease’, ‘risk’, ‘factor’, ‘gingivitis’, ‘cell’, ‘control’, ‘periodontitis’, ‘cancer’, and ‘review’ exhibited high degree centrality values. However, from 2014 to 2018, ‘plaque’ and ‘prevention’ had higher values than ‘cancer’ and ‘review’. In the period from 2019 to 2023, ‘outcome’, ‘surgery’, ‘infection’, ‘head and neck’, and ‘patient’ surpassed ‘gingivitis’, ‘cell’, ‘control’, ‘periodontitis’, and ‘review’ in terms of centrality (Table 3). Throughout the entire timeframe, the terms ‘health’, ‘disease’, ‘risk’, ‘cancer’, ‘factor’, ‘analysis’, ‘therapy’, ‘food’, ‘cell’, and ‘gingivitis’ were highly prominent in terms of betweenness centrality. However, when looking specifically at the period from 2014 to 2018, the terms ‘safety’, ‘dysbiosis’, and ‘periodontitis’ gained more prominence compared to ‘cancer’, ‘analysis’, and ‘therapy’. In the subsequent period from 2019 to 2023, the terms ‘infection’, ‘head and neck’, ‘outcome’, ‘surgery’, ‘system’, and ‘metabolism’ became more prominent, replacing ‘factor’, ‘analysis’, ‘therapy’, ‘food’, ‘cell’, and ‘gingivitis’ (Table 4).

Table 3. Degree centrality by period

Rank	2014-2023		2014-2018		2019-2023	
	Key word	DC	Key word	DC	Key word	DC
1	Health	0.737	Health	0.646	Health	0.414
2	Disease	0.727	Disease	0.596	Cancer	0.323
3	Risk	0.616	Risk	0.535	Risk	0.303
4	Factor	0.434	Factor	0.414	Disease	0.263
5	Gingivitis	0.414	Periodontitis	0.404	Outcome	0.263
6	Cell	0.384	Gingivitis	0.394	Surgery	0.242
7	Control	0.374	Control	0.343	Infection	0.242
8	Periodontitis	0.374	Plaque	0.333	Factor	0.182
9	Cancer	0.343	Cell	0.313	Head and neck	0.182
10	Review	0.323	Prevention	0.293	Patient	0.172

DC: degree centrality

Table 4. Betweeness centrality by period

Rank	2014-2023		2014-2018		2019-2023	
	Key word	BC	Key word	BC	Key word	BC
1	Health	0.145	Health	0.208	Health	0.240
2	Disease	0.138	Disease	0.156	Infection	0.151
3	Risk	0.083	Risk	0.091	Cancer	0.132
4	Cancer	0.023	Factor	0.037	Risk	0.077
5	Factor	0.022	Cell	0.026	Head and neck	0.069
6	Analysis	0.020	Safety	0.024	Disease	0.069
7	Therapy	0.019	Dysbiosis	0.019	Outcome	0.052
8	Food	0.018	Periodontitis	0.018	Surgery	0.049
9	Cell	0.016	Food	0.018	System	0.040
10	Gingivitis	0.015	Gingivitis	0.017	Metabolism	0.032

BC: betweeness centrality

4. Discussion

This study involved the selection of 415 research articles published between 2014 and 2023 for analysis. A keyword network analysis was performed to examine the frequency and centrality of keywords, aiming to assess the current landscape of international research in oral health and to encourage future research directions in this area.

We examined 2,565 keywords from 415 articles to determine the primary keywords. Our analysis revealed that the top five keywords throughout the entire period were ‘health’, ‘disease’, ‘risk’, ‘HIV’, and ‘cell’. During the years 2014-2018, the same five keywords were identified, although ‘HIV’ and ‘cell’ switched places, with ‘HIV’ in fourth and ‘cell’ in fifth. From 2019 to 2023, ‘health’ continues to be the most prominent term, but ‘risk’ and ‘disease’ have swapped places, and ‘cancer’ and ‘surgery’ have replaced ‘HIV’ and ‘cell’. The increased prevalence of ‘cancer’ and ‘surgery’ is likely due to growing research into the connection between oral health and systemic diseases. In the top 10 keywords, ‘gingivitis’, ‘plaque’, and ‘assessment’ were the most common from 2014 to 2018, while ‘nutrition’, ‘quality of life’, and ‘child’ emerged as key terms from 2019 to 2023. This shift in frequently used keywords over time illustrates that trends within any field can change and develop (Ahn & Ko, 2024). While the period from 2014 to 2018 focused on oral health care and assessment, the years 2019 to 2023 have seen research broaden to encompass systemic health throughout the life cycle.

The analysis of degree centrality revealed that ‘health’ had the highest centrality across all time frames, as it was the most commonly used keyword. A keyword with high connectivity has numerous connections, indicating its significance and the attention it garners within the network, as well as its active research status (Moon, 2020). In conclusion, ‘health’ emerges as the most significant keyword throughout the entire period, demonstrating the highest number of connections to other keywords. Conversely, the presence of ‘plaque’ and ‘prevention’ among the top 10 keywords from 2014 to 2018 indicates a strong interconnection among keywords related to effective oral healthcare, mirroring the frequency of the primary keywords. The inclusion of ‘infection’, ‘patient’, and others in the top 10 from 2019 to 2023 can be seen as a reflection of the social context shaped by the COVID-19 pandemic, highlighting a trend that aligns with shifts in social issues.

The betweeness centrality analysis conducted in this study indicates that the keywords ‘health’, ‘disease’, and ‘risk’ are significant in oral health research, ranking highly in both degree centrality and betweeness centrality. A comparison of the betweenness centrality analysis results over time reveals a shift in the top 10 terms: from 2014-2018, the terms ‘safety’, ‘dysbiosis’, and ‘periodontitis’ were prominent, while from 2019-2023, ‘infection’, ‘head and neck’, ‘outcome’, ‘surgery’, ‘system’, and ‘metabolism’ took their place. A keyword with high centrality serves as a bridge between networks and facilitates the overall discussion, whereas a keyword with high betweenness centrality frequently links concepts during the meaning-making process (Lee & Lee, 2021). Given that keywords with high betweeness centrality connect various topics and are important for expanding research in related areas (Lee & Noh, 2022), this study suggests the potential for developing sub-research areas based on the identified keywords.

By examining research trends, we can condense previous studies to grasp the progression and

features of research, as well as propose future research avenues (Woo & So, 2019). Consequently, the importance of this study lies in offering a more objective and systematic evaluation of international research trends in oral health over the last ten years. This will help guide future research and academic efforts in the field of oral health. The limitations of this study include the fact that data was collected solely from the Web of Science (WoS) and that only author keywords were analyzed. In a follow-up study, we will gather data from multiple databases, refine the titles and abstracts, and present the results of our analysis.

Additionally, we suggest performing a topic modeling analysis on the keywords identified in this study to investigate the primary themes.

5. Conclusion

This research performed an analysis of keyword frequency and centrality on 2,565 author keywords from 415 articles sourced from WoS to uncover international research trends in oral health, yielding the following findings.

1. The most commonly occurring keywords included ‘health’, ‘disease’, ‘risk’, ‘HIV’, ‘Cell’, and others.

2. The connection centrality scores were elevated for the terms ‘health’, ‘disease’, ‘risk’, ‘factor’, ‘gingivitis’, ‘cell’, ‘control’, ‘periodontitis’, ‘cancer’, and ‘review’. Meanwhile, the mediational centrality scores were high for ‘health’, ‘disease’, ‘risk’, ‘cancer’, ‘factor’, ‘analysis’, ‘therapy’, ‘food’, ‘cell’, and ‘gingivitis’.

The findings from this analysis suggest that future studies in oral health can be enhanced and advanced by concentrating on the most central keywords.

Notes

ORCID

Yun-Jeong Kim : https://orcid.org/0000-0003-3908-9228

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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