A Study on the Network Text Analysis about Oral Health in Aging-Well

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Background: Oral health is an important element of well aging. And oral health also affects overall health, mental health, and quality of life. In this study, we sought to identify oral health influencing factors and research trends for well−aging through text analysis of research on well−aging and oral health over the past 12 years.

Methods: The research data was analyzed based on English literature published in PubMed from 2012 to 2023. Aging well and oral health were used as search terms, and 115 final papers were selected. Network text analysis included keyword frequency analysis, centrality analysis, and cohesion structure analysis using the Net−Miner 4.0 program.

Results: Excluding general characteristics, the most frequent keywords in 115 articles, 520 keywords (Mesh terms) were psychology, dental prosthesis and Alzheimer's disease, Dental caries, cognition, cognitive dysfunction, and bacteria. Research keywords with high degree centrality were Dental caries (0.864), Quality of life (0.833), Tooth loss (0.818), Health status (0.727), and Life expectancy (0.712). As a result of community analysis, it consisted of 4 groups. Group 1 consisted of chewing and nutrition, Group 2 consisted oral diseases, systemic diseases and management, Group 3 consisted oral health and mental health, Group 4 consisted oral frailty symptoms and quality of life.

Conclusion: In an aging society, oral dysfunction affects mental health and quality of life. Preventing oral diseases for well−aging can have a positive impact on mental health and quality of life. Therefore, efforts are needed to prevent oral frailty in a super−aging society by developing and educating systematic oral care programs for each life cycle.

Key Words: Cognitive dysfunction, Dental care for aged, Frailty, Network analysis, Quality of life

Introduction

1. Background

As the global elderly population increases, interest in healthy aging is increasing. Physical disabilities in the elderly make it difficult to access dental care, and inactivity creates financial barriers to dental care. And taking medications for chronic diseases causes dry mouth and oral diseases[1]. Health and oral health influence each other. Therefore, maintaining oral health is important in order to age well.

The experience of oral problems increases with age. Dental caries, periodontal disease, dry mouth, and oral cancer contribute to tooth loss. And tooth loss increases temporomandibular joint symptoms in older adults[2]. Also pain-free chewing is important for maintaining general health as it relates to food selection and nutritional intake[3]. When masticatory function is reduced, cognitive function and mental health are also affected[4]. Therefore, maintaining teeth can delay oral frailty.

Recently, the rate of tooth loss has been decreasing. However, poor oral care and the prevalence of oral diseases are still high[5]. Therefore, preventive management of oral frailty is necessary for aging well.

The rate of oral frailty varies from person to person. Factors such as number of retained teeth, number of functional teeth, and oral muscle strength play a role[6]. Maintaining 20 teeth is important for successful oral frailty[7],

Maintaining a nutritious diet is important to avoid decreased salivary gland function, wound healing ability, and sarcopenia[8]. Additionally, the oral cavity is responsible for digestive functions, and the microbiome increases digestive ability and is involved in regulating immune system function. Therefore, oral health also affects metabolism and regenerative capacity in old age[9].

The effects of oral diseases and systemic diseases have been presented in various studies. Tooth loss and diabetes accelerate cognitive decline in old age[10], and Stress from dental treatment in patients with high blood pressure and orthostatic hypotension, and cough reflex in patients with lung disease are factors that avoid treatment[11]. The musculoskeletal system is necessary to hold a toothbrush and perform oral hygiene procedures[12]. Therefore, the need for oral health care for aging well is emphasized.

Oral problems that frequently affect older adults, such as tooth loss, dry mouth, and chewing limitations, are associated with poorer quality of life[13]. Poor oral health impairs self-esteem and social interaction, which has a negative impact on aging well and mental health[14]. Poor oral health has a negative impact on aging well by impairing self-esteem and social interaction[15]. As such, oral health is essential for cognition, social interaction, and aging well. If oral problems are not resolved, poor health can accelerate[13]. Maintaining teeth enables well-being and social connection. And oral care education reduces the risk of social isolation in older adults[16].

In previous research, studies on the impact of each factor related to oral health have been conducted, comprehensive exploration to determine the direction of oral health research for aging well is insufficient. Therefore, it is necessary to review the research topic through analysis of the main keywords of the study using existing research data.

2. Objectives

Accordingly, this study sought to identify research trends through text analysis of studies related to oral health and aging over the past 12 years. In addition, we aim to identify factors related to oral health in aging well through frequent text and text-to-text correlation analysis and provide basic data needed to prevent oral senescence in aging well.

Materials and Methods

1. Ethics statement

This study utilizes existing data published in PubMed and has low research ethics risk. The collected data is secondary data and does not contain personal information. The study was conducted after Konyang University IRB exemption approval (IRB KYU NON2023-012).

2. Study design

The research data was analyzed based on English literature published in PubMed from 2012 to 2023 aging well and oral health search terms were used. The research period was selected over the past 12 years, starting with the year when aging oral health research increased. There were 201 papers, including reviews and clinical trials, excluding books, documents, and abstracts.

When organizing keywords and MeSH terms in Excel, 115 papers were finally selected, excluding basic experimental research related to aging well oral health. The literature was organized by author, title, journal, volume, year of publication, and keywords. Two people cross-examined the keywords and combined similar keywords (Table 1).

Table 1. Research Procedure and Contents

Research procedure	Contents	Details of research
Research data collection	Data collection	•Aging-well oral health research literature search : Author, title, journal, volume, year of publication, keyword summary
Analyze	Key word analysis	• Key word extraction, frequency analysis
	Network analysis	• Core node subject cluster analysis, central structure analysis, cohesive structure analysis
Result	Result interpretation	• Result interpretation

3. Statistical methods

Network keyword analysis used the Net-Miner 4.0 program. Keyword frequency analysis, degree centrality analysis, and cohesive structure analysis were performed.

Key word frequency analysis was conducted to identify important key words in aging well oral health research. Degree centrality analysis can confirm organic connectivity through the degree of connection between keywords. The narrower the spacing between keywords, the higher the correlation[17]. Cohesive structure analysis constructs a community of texts with strong cohesion, analyzed clustered keywords to identify the close connection between keywords. Cohesive structure analysis is a group of subject words with more intra-group links than inter-group links. The modularity value, an indicator calculated from this analysis, determines group suitability[18]. Through cohesive structure analysis, the interrelationship of key words was identified and clustered concepts were derived. In this study, group 4, Step 70, modularity value was 0.17. If the modularity value is a positive number, it is judged to be modular.

Results

1. Key word frequency analysis of the study subjects

There were 520 keywords presented in 115 academic papers related to aging well oral health. There were a total of 70 key keywords. As for the main keywords 15 keywords with a frequency of 3 or more were identified. Table 2 shows the frequency and ratio of the relevant keywords. The most frequently appearing keyword in aging well oral health research was psychology in 31 articles (26.96%). Next is Adults 19 (16.52%), Sex Factor 17 (14.78%), Adolescent 13 (11.30%), Dental Prosthesis and Alzheimer Disease 11 (9.57%), Dental caries 8 (63.96%), Cognitive. Dysfunction and Bacteria were 7 (6.09%) (Table 2).

2. Study subjects' results of degree centrality analysis

The results of the degree centrality analysis are shown in Table 3. Research keywords with high degree centrality included Sex factors (0.909), Dental caries (0.864), Quality of life (0.833), Tooth loss (0.818), Health status (0.727), and Life expectancy (0.712). This shows that various studies related to aging well oral health are conducted focusing on the above keywords.

The structural analysis of degree centrality is shown in Fig. 1. In the center of the degree centrality map, there are key keywords with high frequency of occurrence: Sex factors (0.909), Dental caries (0.864), Quality of life (0.833), Tooth loss (0.818), Health status (0.727), and Life expectancy (0.712). Over the past 12 years, research on aging well oral health has focused on various keywords such as Sex factors, Dental caries, Quality of life, Tooth loss, Health status, Life expectancy, Diabetes, Saliva, Memory disorders, Social support, and Periodontal diseases. It was confirmed that it was performed properly.

The results of grouping keywords with high cohesion based on the modularity value presented in the community

Table 2. Key Word Frequency Analysis of the Study Subjects (n=115)

Key word	Number	%	Key word	Number	%
Psychology	31	26.96	Deglutition	4	3.48
Adult	19	16.52	Health policy	3	2.61
Sex factors	17	14.78	Muscle	3	2.61
Adolescent	13	11.30	Frailty	2	1.74
Dental prosthesis	11	9.57	Attitude to health	2	1.74
Alzheimer disease	11	9.57	Caregivers	2	1.74
Dental caries	8	6.96	Quality of life	2	1.74
Cognitive dysfunction	7	6.09	Dementia	1	0.87
Bacteria	7	6.09	Dental care	1	0.87
Diet	5	4.35	Periodontal diseases	1	0.87
Cause of death	5	4.35	Dental plaque	1	0.87
Bite force	4	3.48	Medicare	1	0.87

Table 3. Study Subjects' Results of Degree Centrality Analysis (n=115)

| Key word	Degree centrality	Key word	Degree centrality
Sex factors	0.909	Oral hygiene	0.500
Dental caries	0.864	Preventive	0.500
Quality of life	0.833	Epidemiology	0.470
Tooth loss	0.818	Diagnosis	0.455
Health status	0.727	Diet	0.455
Life expectancy	0.712	Root caries	0.455
Diabetes	0.697	Smoking	0.455
Saliva	0.682	Psychology	0.455
Memory disorders	0.621	Biological	0.455
Social support	0.621	Attitude to health	0.455
Periodontal diseases	0.621	Bite force	0.455
Independent living	0.591	Deglutition	0.455
Health behavior	0.591	Esthetics	0.455
Health services	0.591	Dental care	0.439
Cognitive dysfunction	0.576	Nutrition	0.409
Microbiology	0.576	Adolescent	0.379
Dentition	0.576	Child	0.364
Taste	0.561	Socioeconomic	0.364
Personal satisfaction	0.545	Professional role	0.348
Eating	0.545	Frailty	0.318
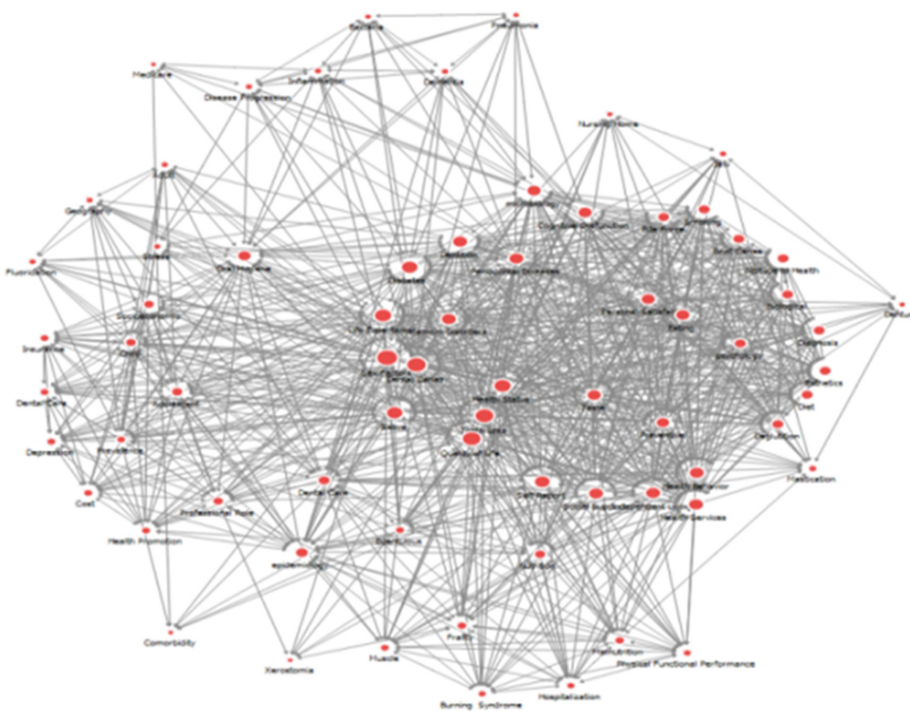
Fig. 1. Structural analysis of degree centrality.

analysis are shown in Fig. 2. Modularity value ranges from −1 to 1, and if it appears as a positive number, it means that modularity is appropriate.

The modularity value of this study was 0.175 and there were 4 community groups. Aging Well Oral Health Research Results: Group 1 was mastication and nutrition, Group 2
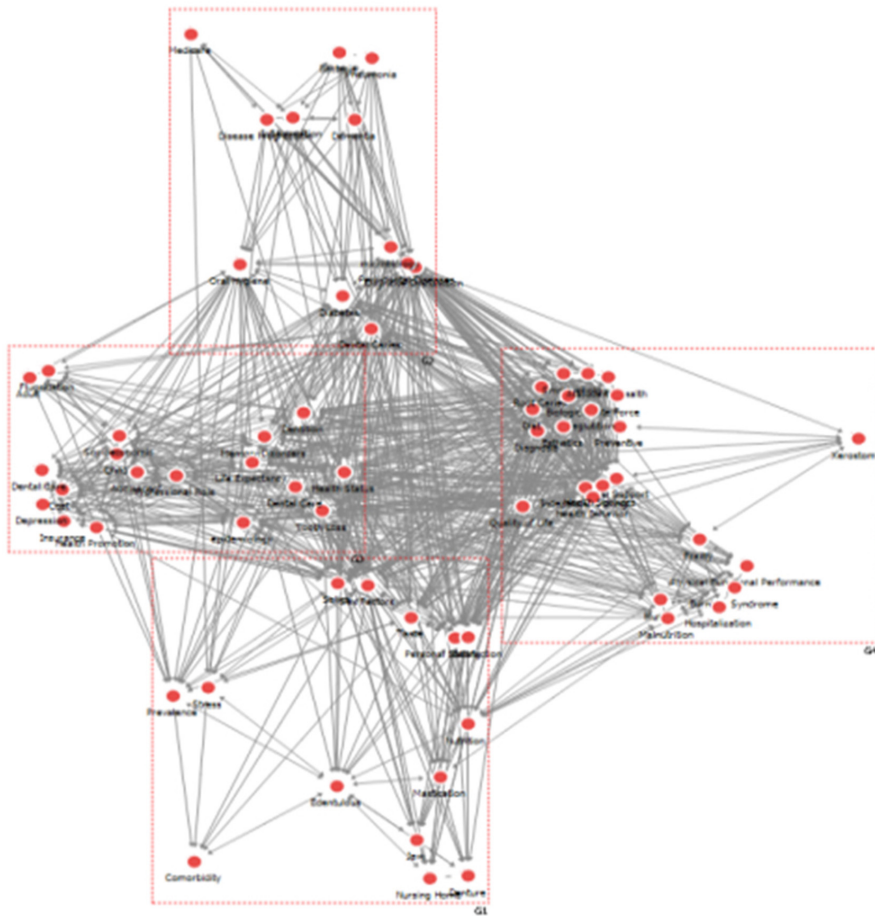
Fig. 2. Cohesive structure analysis of university-linked education.

Table 4. Group 1 (Mastication and Nutrition) Network Map Keyword

Key word	Degree centrality
Eating	0.545
Saliva	0.682
Taste	0.561
Nutrition	0.409
Edentulous	0.258
Denture	0.152
Mastication	0.227
Jaw	0.182
Stress	0.167
Personal satisfaction	0.545
Prevalence	0.258
Nursing home	0.152
Comorbidity	0.091
Sex factors	0.909

Fig. 3. Group 1 network map keyword.

was research on oral diseases, systemic diseases and management, Group 3 was research on oral health, mental health and costs by life cycle, and Group 4 was oral frailty and quality of life. It consisted of research.

Group 1, there were 14 keywords, and the average degree centrality index was 0.367. Key keywords consisted of Saliva (0.682), Taste (0.561), Eating (0.545), Nutrition (0.409), Edentulous (0.258), Prevalence, Mastication (0.227), and personal satisfaction (0.545). This was grouped into research on chewing and nutrition related to aging well oral health (Table 4, Fig 3).

Group 2, there were 12 keywords, and the average degree centrality was 0.400. Key keywords include Dental caries (0.864), Periodontal Diseases (0.621), Microbiology (0.576), Bacteria (0.152), Inflammation (0.197), Oral Hygiene (0.500), Diabetes (0.697), Dementia (0.182), Pneumonia (0.152), Cognitive Dysfunction (0.576), Disease Progression (0.197), and Medicare (0.091). It was confirmed that this consists of research on oral diseases and serious diseases and management related to aging well oral health (Table 5, Fig. 4).

Table 5. Group 2 (Oral diseases, Systemic Diseases and Management) Network Map Keyword

Key word	Degree centrality
Dental caries	0.864
Periodontal diseases	0.621
Microbiology	0.576
Bacteria	0.152
Inflammation	0.197
Oral hygiene	0.500
Diabetes	0.697
Dementia	0.182
Cognitive dysfunction	0.576
Pneumonia	0.152
Disease progression	0.197
Medicare	0.091

Table 6. Group 3 Network (Oral Health, Mental Health) Map Keyword

Key word	Degree centrality
Life expectancy	0.712
Child	0.364
Adolescent	0.379
Adult	0.182
Socioeconomic	0.364
Epidemiology	0.470
Tooth loss	0.818
Dental care	0.439
Fluoridation	0.182
Professional role	0.348
Depression	0.273
Memory disorders	0.621
Dentition	0.576
Health promotion	0.288
Health status	0.727
Cost	0.273
Insurance	0.273

Fig. 4. Group 2 network map keyword.

Fig. 5. Group 3 network map keyword.

Group 3 had 17 keywords, and the average degree centrality was 0.429. Key keywords are Life Expectancy (0.712), Child (0.364), Adolescent (0.379), Adult (0.182), Socioeconomic (0.364), Epidemiology (0.470), Tooth loss (0.818), Dental care (0.439), Fluoridation (0.182), Professional role (0.348). It was composed of Depression (0.273), Memory disorders (0.621), Dentition (0.576),

Health promotion (0.288), Health status (0.727), Cost (0.273), and Insurance (0.273). It was confirmed that this consists of studies related to oral health, mental health, and costs by life cycle (Table 6, Fig. 5).

Group 4 had 23 keywords, and the average degree centrality was 0.434. Key keywords are Quality of life (0.833), Frailty (0.318), Root caries (0.455), Burning syndrome (0.242), Xerostomia (0.106), Deglutition (0.455), Muscle (0.273), Bite force (0.455), Diet (0.455), Malnutrition (0.288), Esthetics (0.455), and Diagnosis (0.455). And psychology (0.455), Biological (0.455), Preventive (0.500), Smoking (0.455), Social support (0.621), Health behavior (0.591), Health services (0.591), Attitude to health (0.455), Independent living (0.591), Hospitalization (0.242), and Physical functional performance (0.242). It was confirmed that this consists of oral frailty symptoms and quality of life (Table 7, Fig. 6).

Table 7. Group 4 (Oral Frailty and Quality of Life) Network Map Keyword

Key word	Degree centrality	Key word	Degree centrality
Quality of life	0.833	Psychology	0.455
Frailty	0.318	Biological	0.455
Root caries	0.455	Preventive	0.500
Burning syndrome	0.242	Smoking	0.455
		Social support	0.621
Xerostomia	0.106	Health behavior	0.591
Deglutition	0.455	Health services	0.591
Muscle	0.273	Attitude to health	0.455
Bite force	0.455	Independent living	0.591
Diet	0.455	Hospitalization	0.242
Malnutrition	0.288	Physical functional performance	0.242
Esthetics	0.455		
Diagnosis	0.455		

Discussion

1. Interpretation and comparison to previous studies

As a result of analyzing keywords in research related to

Fig. 6. Group 4 network map keyword.

oral health, which is an essential factor for aging well, the keywords with the highest frequency were general characteristics of research subjects, oral factors, and mental factors.

Oral factors included Bacteria, Dental caries, and Dental Prosthesis, and mental factors included Psychology, Cognitive dysfunction, and Alzheimer Disease. It has been confirmed that many studies on cognitive influencing factors related to oral health have been conducted for aging well over the past 12 years.

As a result of the centrality analysis, the core topics of aging well oral health were Dental caries, Tooth loss, Health status, Quality of life, and Life expectancy. Tooth loss and impaired oral health lead to physical decline and dysfunction, as they contribute to aging[19]. This confirmed that keywords related to oral disease, health, and quality of life were the focus of the study, taking into account life expectancy in a super-aging society.

As a result of the cohesive structure analysis, group 1 was conceptualized as mastication and nutrition. Although masticatory parameters change with age, aging itself does not impair masticatory function. Loss of teeth and lack of saliva in old age are causes of mastication disorders. Food bolus formation for swallowing depends on the number of mastications, muscle strength, and the amount of saliva released. This shows the negative consequences of eating habits and nutrition, confirming the importance of chewing and nutrition for aging well[20].

Group 2 confirmed studies on the effects of oral diseases and systemic diseases such as inflammation, diabetes, dementia, pneumonia, and cognitive dysfunction. These were studies that recognized the importance of oral health contributions such as type 2 diabetes, periodontitis, pneumonia in elderly people with dysphagia, and pathophysiological effects. In order to age healthily, it is important to be aware of the impact of poor oral health[21].

Group 3 consisted of oral health, mental health, and costs by life cycle. Preventing tooth loss is essential for oral care throughout each life cycle[22]. In order to maintain oral health throughout each life cycle, the need for self-management education and the preventive effects of professional care was suggested. In particular, educational programs including oral exercises are effective in improving articulation, functional performance of the tongue, and swallowing func-

tion in older adults without disabilities[23].

Such oral function has an important impact on depression and cognitive health in old age. Depression affects oral health due to neglect of oral hygiene, intake of cariogenic nutrition, and avoidance of necessary dental care. This increases the risk of dental caries and periodontal disease. The severity of depression in older adults increases with the number of missing tooth, number of cavities, and prevalence of dry mouth[24]. And Mastication disorders and cognitive disorders are interrelated[25], Therefore Policy support is needed to improve oral health and health in the age of super-aging.

Some studies have shown that disparities in an individual's oral health are primarily influenced by socioeconomic conditions and the availability and accessibility of oral health services[26]. Therefore, policy support research for oral health promotion is needed to improve this.

Group 4 was conceptualized in terms of oral senescence symptoms and quality of life.

Oral frailty is associated with sarcopenia due to frequent habitual intake of inappropriate food and poor nutritional status. And low tongue pressure reflects frailty and dysphagia in older people [27]. As a result, oral frailty is associated with mastication and swallowing problems and causes nutritional deficiencies. Some studies suggest that sarcopenia is associated with mortality[28].

Masticatory disorders in older adults can lead to decreased nutrition, communication, self-esteem, and quality of life[15]. Many studies are evaluating the impact of various aspects such as self-esteem, social interaction, and school or work performance to evaluate the impact of oral health on quality of life [15].

In summary, Factors affecting oral health with increasing age were investigated including root caries, bite force, burning syndrome, and xerostomia. Research trends on well-aging include chewing and nutrition, oral and systemic diseases, oral health and mental health, oral aging, and quality of life. In order to live a healthy old age in a super-aging society, it was necessary to recognize and manage the importance of oral health.

2. Suggestion

In the results of this study, the aging well oral health

study consisted of chewing and nutrition, oral disease and mental disease, oral health and mental health, oral frailty, and quality of life. As the elderly population has increased worldwide, the development of a systematic intervention program was necessary to improve oral health throughout the life cycle. And oral senescence emphasizes the risk of developing dementia. There is a need for continued research on the impact of oral dysfunction on mental health and quality of life in the super-aging society. Lastly, in order to age well in a super-aging society, exploratory research from various perspectives is needed to improve quality of life by preventing oral senescence.

3. Limitations

In this study, network keyword analysis was conducted on 12 years of literature related to aging and oral health. In future research, it is necessary to expand the period and target research period and conduct big data analysis to increase generalizability.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Data availability

Dataset1. 115 articles searched in PubMed.

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