Oral Health Linked to Declining Cognition-A Literature Review

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ABSTRACT

Aim: This review article aims to update and consolidate the scientific data available regarding the link between cognition and oral health in the elderly population.

Background: A study was conducted to review the articles that focused on the link between oral health and specific cognitive abilities with contributing factors such as cardiovascular disease, inflammatory markers and socioeconomic status in older adults.

Method: A review was undertaken in May 2020. From many potentially relevant articles and literatures, 25 were identified that assessed oral health and at least one of the specific cognitive domains along with at least one cofactor in an older adult cohort study.

Results: The foremost consistent relationships were identified with learning and memory, complex attention, and executive function. For each of those cognitive domains, most studies identified significant unadjusted associations with oral health; where adjustments for covariates were made, a minimum of one among the associations with oral health was present in almost all the studies. In addition, poorer oral health status as determined by clinical examinations was negatively associated with frequency of dental visits. In presence of cardiovascular disease and inflammatory markers in geriatric patients, oral health status has shown poor results.

Conclusions: This review literature mediates evidence of an association between cognitive functions with oral health in old age along with other cofactors like associated systemic disease and socioeconomic status. Thus, understanding that life expectancy is impacted by systemic health and the 'Geriatric Giants', the dental professional's role is to make the individual comfortable and maintain function as best possible.

Clinical Significance: The present article will help clinicians better understand the role of cognitive functions in oral health conditions in elderly. Thus, it establishes the opinion that oral health management of the elderly cannot proceed in isolation and requires a multidisciplinary approach.

Keywords: Geriatric Dentistry, Periodontal Health, Edentulous

Abbreviation: DSST: Digital symbol substitution test; MMSE: Mini-Mental State Examination; DWR: Delayed word recall; WF: Word Fluency; HR: High Risk; aHR: Adjusted high risk; OHI-S: Simplified oral hygiene Index

BACKGROUND

Cognition is critical for functional independence as people age, irrespective of whether a person is independent or dependent. Cognitive abilities can be divided into several specific cognitive domains including attention, memory, executive cognitive function, language, and visuospatial abilities. Prospective memory, specifically remembering to perform intended action in the future (e.g., taking medication after breakfast). Whereas, executive cognitive function is particularly important for novel tasks. These are not associated with a habitual response necessarily, but depends critically on the prefrontal cortex [1]. Cognitive dementia,

according to WHO, is a syndrome in which there is deterioration in memory, thinking, behavior, and the ability to perform everyday activity. According to a report published by WHO in September 2019, around 50million of the population have dementia [2]. this is the major reason behind dependency and disabilities during the old age.

As per the last census report (2011), 104 million (53million female & 51 million male) of population belong to the senior citizens in India. Ageing is a natural biological process which is primarily influenced by our genetic makeup. However, in recent centuries it has become more heavily influenced by social, environmental, economic and medical changes as well as physical and mental health [3]. Age related disabilities and immunodeficiency is related to under-nutritional status in the population below the poverty line [4].

Sir Bernard Isaacs coined the term 'Geriatric Giant' in the 1960s to describe categories of impairments in the elderly. Falls were associated with frailty which in turn were associated with neurocognitive decline and delirium as an older person became less agile and in deteriorating health [3]. As dental and oral health issues are a newly recognized burden on the health of the elderly, only scant regard for the implications of overt dental caries and active periodontal infection has occurred [5]. However, as health issues are interconnected, maintaining poor oral health can have consequences that are not immediately evident.

Thus, the present review aims to understand & update the scientific literature regarding the link between cognition and oral health in the elderly population. Different cofactors like cardiovascular disease, diabetes, lifestyle habits are also considered and their roles in the deterioration of the oral health is mentioned.

METHOD

The PRISMA guidelines were followed for a methodological approach and various articles supporting the databases were searched and included. Various articles based on topics cognitive dementia; oral health and aging were assessed and screened. After excluding duplication and studies that could not establish an empirical assessment between cognitive function and oral health, 25 articles were identified for this review.

Inclusion and Exclusion Criteria

1) The selected databases are based on Cohort studies that have studied the cognitive function of the older age group (>50years) by standardized DSST (Digital Symbol Substitution test), Mini-Mental State Examination (MMSE), Delayed word recall (DWR) and Word fluency (WF).

2) Covariates have been considered like associated disease like cardiovascular disease and diabetes, mental health issue like depression, socioeconomic status and education background, nutrition, demography. The participants were either dependent or community dwellers.

3) Oral health assessment scales like OHI-S Index, Periodontal Index, DMFT Index, self-assessment and dental follow-ups at specific time span were included.

4) The date of publication of the articles were between 1990-2020. The study designs were Cohort cross-sectional and/or longitudinal with at least one above mentioned covariate.

Data Sources, Search Strategy and Study Selection

A systematic literature search was carried out in the following databases: PubMed, WHO, Medline, ScienceDirect. The keywords used are cognitive psychology, Alzheimer, diabetes, ageing, oral health, periodontal therapy, cardiovascular disease, dementia, attitude, tooth loss, denture problem, and dry mouth. The filter applied in the search included the language (English) and date of publication (1990-2020). A final search was carried out on 28 May 2020 to ensure the most recent literature was included in this review. In addition, the reference lists and bibliographies of all relevant studies were looked for additional sources. The results from the search were organized and duplicate references were removed using the Mendeley bibliographic software. The title and abstract of the remaining studies were assessed by authors independently using the inclusion and exclusion criteria for suitability. In the case where it was difficult to make a decision on the basis of the title and abstract only, the full text was obtained for further assessment. A total of 25 studies which met the inclusion criteria and were included in the review.

Data Extraction

A data extraction form was developed and piloted independently by two authors and modified as required. The information including author, year of publication, country, characteristics of sample/questionnaire and key outcome items was extracted by two authors and checked by one author for accuracy and completeness of the results. There was clear heterogeneity among the studies in their approaches to measuring and reporting the knowledge, attitudes, and practices in reference to oral health care. Therefore, descriptive analysis was administered in most sections and data was pooled to calculate mean percentage wherever studies had similar outcome items to match (**Figure 1**).
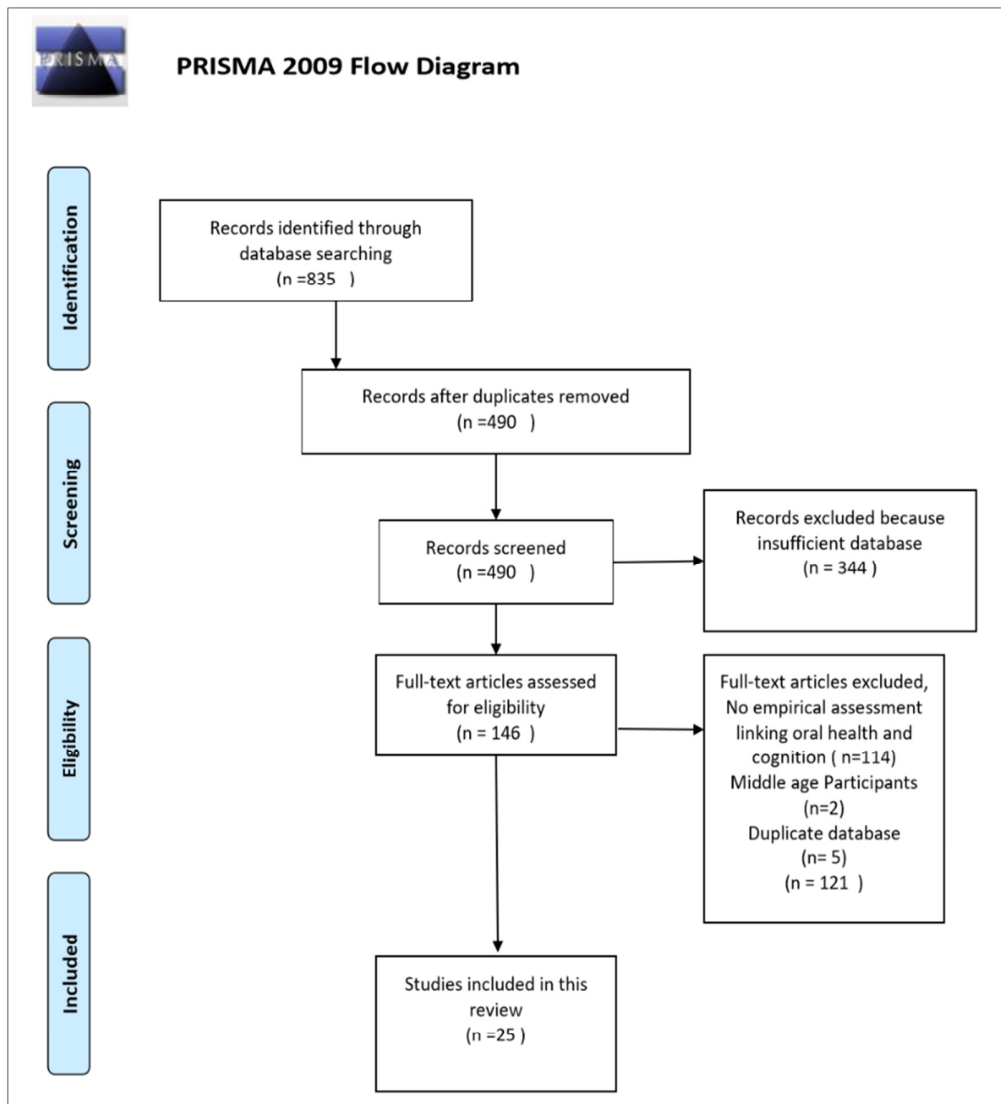
Figure 1. PRISMA 2009 flow diagram.

RESULTS

Social cognitive theory and oral health implication have presented its results in 1 study, with covariates of socioeconomic background and tobacco smoking. Covariates like associated disease and risk factor, education and socioeconomic background, smoking and tobacco abuse, nutrition have been considered. Various articles published from the year 1990 to 2020 with a sample size ranging from a minimum of n= 8 to maximum of n=2, 09,806 and participant age ranged 50years and above were compiled.

Cognitive tests using Digit Symbol Substitution Test (DSST) (12 articles) and standardized mini-mental state examination (SMMSE) (10 articles) were used. Cognitive functions of key 6 domains, according to the

DSM-5 classification system, were considered for the examination. However, all the 25 articles established a link between cognitive domains of learning & memory (16 articles), executive function (13 articles), complex attention (8 articles) and their implication on the deterioration of oral health.

The participants selected in 23 studies had their oral health assessed by examinations that were conducted in a time interval of 6 months to a year in each of the studies. Periodontal health assessment and number of missing teeth was recorded and considered as standard.

Self- assessment technique was used for 1 study by preparing a questionnaire according to the GOHAI (Geriatric Oral Health Assessment Index) survey. Sample size (n=141) were subjected to 16 questions (4 on

physical functions, 5 on psychological, 3 on pain and discomfort) with consent **(Table 1)**.

Table 1. Data extracted from various articles.

Article	Sample Size (n)	Study Design	Co variates	Result
Kweider [6]	(n=50)	Cross-sectional	Associated Cardiac Disease Age (>50)	Fibrinogen and WBC count was established as a mediator between cardiac and inflammatory dental disease.
Saxe [7]	(n=129)	Cross- section	Demography Age (>50)	Cavity filling using amalgam has no impact on cognitive impairment.
Cohen-Mansfield [8]	(n=80)	Cross-sectional	Age (>59)	The findings reveal that the MDS (Minimum Data Set, a comprehensive functional assessment) underreports pain in cognitively impaired residents. Participants reported excruciating pain of oral soft tissue lesions and decreased pain threshold.
Kim [4]	(n= 1,204)	Cross-sectional	Nutritional status; chronic inflammatory condition Age (>65)	Fewer teeth were associated with and increased risk of incident dementia along with marked reduction in nutritional status.
Wu [9]	(n= 1984)	Cross- sectional	Socio-demography Associated disease Age (>60)	Higher cognitive level & higher sociodemographic level were associated with frequent dental visit Poor health status is associated with poor oral health
Gagliardi [10]	(n= 253)	Longitudinal	Socioeconomic condition Age (> 75)	Oral health related quality of life improved with increased state funded health care.
Yu and Kuo [11]	(n=803)	Cross-sectional	Demography Associated disease Age (>60)	Better periodontal health is associated with higher DSST scores (unadjusted).
Lexomboon [12]	(n= 557)	Cross- sectional	Associated disease	Adjusted for sex, age,

			Age (>77)	education, depression, and mental illness, odds of cognitive impairment significantly higher for persons with chewing difficulty
Naorungroj [13]	(n= 10,050)	Longitudinal	Age, socioeconomic condition, demography, habit, associated disease Age (> 56)	Tooth loss and periodontal problems shows close association with decline in memory domain of cognition.
Stewart [14]	(n= 1,053)	Cross-sectional	Age, Demography, Poor mental health. Age (>70)	Decline complex attention is associated with poor oral health. Lower DSST scores are associated with poor Gingival Index results.
Asai [15]	(n= 8,124)	Cross- sectional	Associated disease (Cardiac Disease, diabetes, etc) Age (>75)	The study suggests a linear relationship between tooth loss and degree of arterial stiffness that is sex dependent.
Foltyn [3]	(n=8)	Longitudinal	Age, habit, socioeconomic condition Age (>50)	The contributing factors for poor oral health & reduced motor function, declining cognition led to an increase in both morbidity and mortality also impacting the quality of life.
Tsakos [16]	(n=3,166)	Longitudinal	Depression, socioeconomic condition and Comorbidities Age (>60)	Tooth loss is a potential early marker of decline in older age. Edentulous participants recalled 0.88% less words at 0.09 m/s slower speed than dentulous participants (adjusted for time & demography)
Supawadee Naorungroj [17]	(n=911)	Prospective cohort study	Cardiovascular Disease Age (>52)	Mean decline in scores of Digit Symbol Substitution Test (DSST), Delayed word recall (DWR) and Word fluency (WF) was associated with tooth loss

				and poor Periodontal health.
Kamer [18]	(n=152)	Cross-sectional	Alzheimer's Disease Periodontal inflammation Age (> 60)	Participants with existing periodontal inflammation showed lower Digital Symbol test scores. Also no. of missing teeth was more.
Komiyama [19]	(n=834)	Prospective cohort study	Habit, depression, Education Age (>70)	Participants with less than 20 teeth showed higher chances of developing functional disability. Thus, tooth loss was associated is greater risk of functional disability.
Kundapur [20]	(n=141)	Cross-sectional	Demography Age (>60)	With loss of multiple teeth and declining motor skills prosthetic denture wear is difficult to adapt. Leading to rapid bone loss.
Li [21]	(n= 8,153)	Longitudinal	Socioeconomic Condition Age (> 60)	More teeth were associated with better cognitive function. Mean baseline teeth number-17.5, the mean of baseline cognitive function-27.3
Nangle [22]	(n=64)	Oral Health Intervention	Age (>65)	The cognitive test scores showed positive results after regular oral health intervention.
Saito [23]	(n=140)	Longitudinal	Associated disease (Cardiac Disease, diabetes) Age (>65)	Multiple tooth loss significantly increased the risk of developing cognitive impairment. Association between Chronic inflammatory systemic disease and periodontal disease. Mini-Mental State Examination (MMSE) score were less in participants with 0-9 teeth in oral cavity.
Yoo [24]	(n= 2,09,806)	Longitudinal	Dementia, Demography Age (> 60)	Individuals with tooth loss had a higher risk for dementia than

				those without tooth loss. Incidence of dementia decreased with periodontal treatment.
Yoo [25]	(n= 10,215)	Retrospective Cohort study	Diabetes Age (>65)	Diabetic individuals had a higher risk of tooth loss, due to periodontal problem than nondiabetic individuals (HR = 1.298)
Kato [26]	(n= 210)	Longitudinal	Objective Dementia Age (>60)	Individuals with a total of 20 teeth or more, including both natural and artificial teeth, had significantly higher MMSE scores
Thomson [27]	(n=818)	Prospective cohort study	Socioeconomic Condition, education Age (> 50)	IQ test scores were highest with better DMFT Index and OHI-S Index.
Nangle [22]	(n=341)	Cross-sectional	Age (>65) Demography	Around 129 participants with dementia showed poor DMFT score and poor toothbrushing habits.

DISCUSSION

Chronic periodontitis is a widespread peripheral immunoinflammatory condition; it has been proposed to play a significant role in the aggravation of Dementia. An association between peripheral inflammation and dementia was hypothesized by an article published by Kim [4] in the International Journal of Geriatric Psychiatry (2007). It was suggested that chronic systemic inflammation worsened the inflammatory processes in the brain. This was mainly attributed to increased levels of pro-inflammatory mediators, such as interleukin-1, interleukin -6 and tumor necrosis factor-α in the plasma [5]. The contributing factors for poor oral health like dental caries, acute and chronic periodontal infections and compromised systemic health causing xerostomia, reduced fine motor function [28]. Thus, the declining cognition and motivation may not only lead to both morbidity and mortality but also impact on quality of life.

Associated health problems like cardiovascular disease, diabetes and other chronic inflammatory systemic disease have shown unfavorable outcomes like plaque accumulation, periodontal disease followed by tooth loss.

Oral health in later life is one of the significant determinants of quality of life (QoL) and life satisfaction as well as a key health status indicator related to functional limitations and limited daily activities [29]. When elderly become care dependent, their oral health often deteriorates due to neglect of oral (self) care. Socioeconomic factor also plays a key factor amongst this population that forms a contributing factor. The lack of attention for oral care can lead to poor oral health and can be considered a hidden health hazard as dental awareness and oral health has been shown to significantly contribute to general health and quality of life.

With age, changes in biological and physiological aspects are inevitable. There are ample of evidences that show alterations in brain structure and performance are intimately tied to alterations in cognitive function. Crystallized intelligence refers to skills, ability, and knowledge that are overlearned, well-practiced, and familiar. Crystallized abilities like vocabulary and general knowledge remain stable or gradually improve at a rate of 0.02 to 0.003 standard deviations per year through the sixth and seventh decades of life. Fluid cognition is a person's natural ability to process and

learn new knowledge, solve problems, attend to and control one's environment. Post the third decade of life i.e., the peak, fluid cognition, especially psychomotor ability and processing speed declines at an estimated rate of - 0.02 standard deviations per year [30].

Just as age-related changes in brain structure and performance aren't uniform across the entire brain or across individuals; age-related changes in cognition aren't uniform across all cognitive domains or across all older individuals. The basic cognitive functions most suffering from age are attention and memory. Attention is that the means by which we actively process a limited amount of data from the big amount of data available through our senses, our stored memories, and our other cognitive processes. A decline in the domain of attention can have widespread effects on one's ability to function adequately and efficiently in their daily life.

The prevalence of cardiovascular disease (CVD) is increasing rapidly in the growing aging population. Cardiovascular disease contributes to morphological alteration of the brain that leads to cognitive decline, dementia and cerebrovascular disease. The cognitive decline during this condition is especially a result of the formation of amyloid deposits that provoke neuroinflammation, ultimately leading to necrobiosis [31]. Associations between high blood pressure (BP) and poor performance on neuropsychological tests are well described in the neuropsychological literature particularly in the areas of memory, attention, and executive function. Metabolic-related conditions such as diabetes and obesity have also been associated with cognitive impairment. Periodontal disease, a local inflammatory process is a common oral problem of the older population leading to loss of natural teeth. This local inflammatory process may induce a systemic inflammatory reaction. Therefore, periodontitis could trigger and/or exacerbate an inflammatory condition especially in elderly subjects, resulting in memory impairments, contributing to accelerate the progression of neurodegenerative diseases.

Each of these articles, through cross section analysis (10 studies) and longitudinal studies (8 studies) has established satisfactory results supporting the hypothesis positively. However, none of the articles has considered all the covariates altogether. The database was collected through National health surveys or self-reported. Thus, the uniformity in the measurement is lacking.

CONCLUSION

This review literature mediates evidence of an association between cognitive functions with oral health in old age along with other cofactors like associated systemic disease and socioeconomic status. Elderly with complex care needs experience significantly more oral health problems and are more often edentulous than robust elderly. Moreover, elderly with few teeth and elderly with implant-supported overdentures reported less frailty and better quality of life [32]. However, frequent oral health check-ups for dependent as well as independent aged population can be incorporated for better oral health status. Policies at community level for population of lower socioeconomic background can achieve better quality of life.

ACKNOWLEDGMENT

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