Review Article

Effect of Cognitive ability on Oral Health Status – A Scoping Review of Observational Studies

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Abstract

This review article aims to update and consolidate the scientific data available regarding the link between cognition and oral health in the elderly population. This review was undertaken in May 2020. A rigorous data search and selection strategy in accordance with the PRISMA guidelines were employed. The population (P) considered was "elderly" (more than 50 years of age), exposure (E) was cognitive difficulty, compared (C) with healthy individuals (in few studies), and the outcome (O) assessed was oral health status. English language articles published from January 1990 to May 2020 were searched. Twenty five articles 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. For every cognitive domain such as learning and memory, complex attention, and executive function, most studies identified significant associations with oral health (when covariates were not adjusted for). In addition, clinical determined poorer oral health status was associated with less frequent of dental visits. In the presence of cardiovascular disease and inflammatory markers in geriatric patients, oral health status has shown to be poor. The present review incorporated longitudinal, prospective cohort studies along with cross-sectional studies. This review mediates evidence of an association between cognitive functions with oral health in old age along with other cofactors such as associated systemic disease and socioeconomic status. The present article will help clinicians better understand the role of cognitive functions in oral health conditions in elderly.

Keywords: Geriatric dentistry, Periodontal health, Edentulous.

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 responses necessarily, but depends critically on the prefrontal cortex.[1] Cognitive dementia, according to the 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 the WHO in September 2019, around 50 million 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 (53 million female and 51 million male) of population belong to the senior citizens in India. Aging 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 are related to undernutritional 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

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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 and update the scientific literature regarding the link between cognition and oral health in the elderly population. Different cofactors such as cardiovascular disease (CVD), diabetes, and lifestyle habits are also considered and their roles in the deterioration of the oral health are mentioned.

Methods

The PRISMA guidelines were followed for a methodological approach to include and various articles from the relevant databases. Various articles based on topics of cognitive dementia, oral health, and aging were assessed and screened.

A systematic literature search was carried out in the following databases: PubMed, WHO, Medline, and ScienceDirect. The keywords used were "cognitive psychology," "Alzheimer," "diabetes," "aging," "oral health," "periodontal therapy," CVD, 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 May 28, 2020, to ensure that 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 were included in the review. Figure 1 depicts PRISMA flowchart for the selection strategy employed for selecting studies.

Inclusion and exclusion criteria

1. The selected databases are based on Cohort studies that have studied the cognitive function of the older age group (>50 years) by standardized digital symbol substitution test (DSST), Mini-Mental State Examination (MMSE), and delayed word recall and word fluency
2. Covariates have been considered like associated disease such as CVD and diabetes, mental health issue such as depression, socioeconomic status and education background, nutrition, and demography. The participants were either dependent or community dwellers
3. Oral health assessment scales such as OHI-S index, periodontal index, DMFT index, self-assessment, and dental follow-ups at specific time span were included in the study.
4. The date of publication of the articles was between 1990 and 2020. The study designs were Cohort cross-sectional and/or longitudinal with at least one above-mentioned covariates.

Data sources, search strategy, and study selection

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 healthcare. Therefore, descriptive analysis was administered in most sections and data were pooled to calculate mean percentage, wherever studies had similar outcome items to match.

Results

Tables 1 and 2 show the results of various studies which were reviewed. Social cognitive theory and oral health implication have presented its results in one study, with covariates of socioeconomic background and tobacco smoking. Covariates such as associated disease and risk factor, education and socioeconomic background, smoking and tobacco abuse, and 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 $n = 209{,}806$ and participant age ranged 50 years and above were compiled.

Cognitive tests using DSST (12 articles) and standardized MMSE (ten articles) were used. Cognitive functions of key six 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 and memory (16 articles), executive function (13 articles), complex attention (eight 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 were recorded and considered as standard.

Self-assessment technique was used for one study by preparing a questionnaire according to the Geriatric Oral Health Assessment Index (GOHAI) survey. Sample size ($n = 141$) was subjected to 16 questions (four on physical functions, five on psychological, and three on pain and discomfort) with consent.

Discussion

Chronic periodontitis is a widespread peripheral immune-inflammatory condition. It is postulated to play an important role in the aggravation of dementia. An association between peripheral inflammation and dementia was hypothesized by an article published by Kim *et al*. in the International

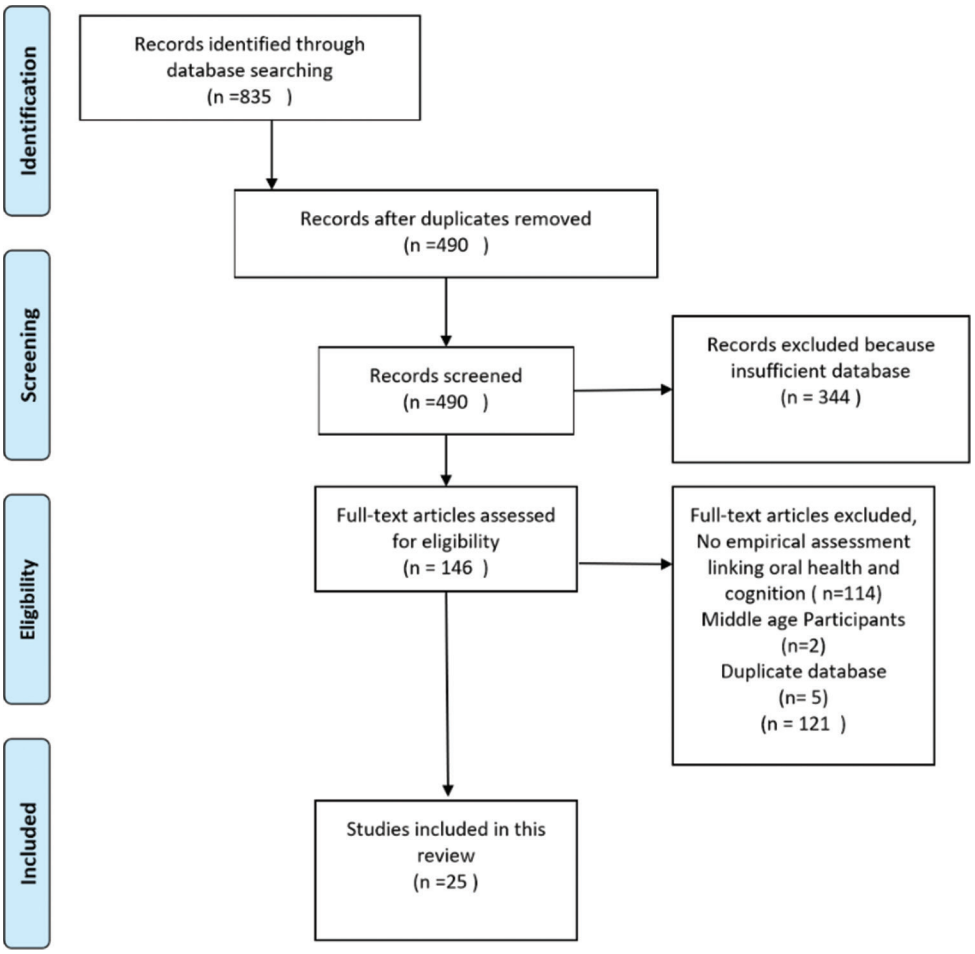

Figure 1: PRISMA flow diagram depicting selected studies

Journal of Geriatric Psychiatry (2007). It was suggested that chronic systemic inflammation aggravated the inflammatory response in the brain. This can be due to increase in the levels of pro-inflammatory mediators such as tumor necrosis factor-α, interleukin-1, interleukin-6, and in the plasma.[5] The contributing factors for poor oral health such as dental caries, acute and chronic periodontal infections, and compromised systemic health causing xerostomia, reduced fine motor function.[6] Thus, the declining cognition and motivation may not only lead to both morbidity and mortality but also impact on quality of life (QoL).

Associated health problems such as CVD, diabetes, and other chronic inflammatory systemic disease have shown unfavorable outcomes such as plaque accumulation and periodontal disease followed by tooth loss. Oral health in later life is one of the significant determinants of QoL and life satisfaction as well as a key health status indicator related to functional limitations and limited daily activities.[7] 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 QoL.[29,30]

With age, changes in biological and physiological aspects are inevitable. There are ample of evidences that show alterations in brain structure and performance which are intimately tied to alterations in cognitive function. Crystallized intelligence refers to skills, ability, and knowledge that is overlearned, well-practiced, and familiar. Crystallized abilities such as vocabulary and general knowledge remain stable or gradually improve at a rate of 0.02–0.003 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, and attend to and control one's environment. Post the third decade of life, that is., the peak, fluid cognition, especially psychomotor ability, and processing speed declines at an estimated rate of −0.02 standard deviations per year.[31]

Just as age-related changes in brain structure and performance are not uniform across the entire brain or across individuals, age-related changes in cognition are not uniform across all cognitive domains or across all older individuals. The basic cognitive functions most suffering from age are attention and memory. Attention is the means by which we actively process a limited amount of data from the big amount of data available

Table 1: Data extracted from various articles

Article	Sample size (*n*)	Study Design	Covariates	Result
Kweider *et al*. (1993)[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 *et al*. (1995)[7]	(*n*=129)	Cross-section	Demography age (>50)	Cavity filling using amalgam has no impact on cognitive impairment.
Cohen-Mansfield (2004)[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 *et al*. (2006)[4]	(*n*=1204)	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 *et al*. (2007)[9]	(*n*=1984)	Cross-sectional	Socio-demography associated disease age (>60)	Higher cognitive level and higher socio-demographic level were associated with frequent dental visit Poor health status is associated with poor oral health
Gagliardi *et al.* (2008)[10]	(*n*=253)	Longitudinal	Socioeconomic condition age (>75)	Oral health related quality of life improved with increased state funded health care
Yu and Kuo (2008)[11]	(*n*=803)	Cross-sectional	Demography associated disease age (>60)	Better periodontal health is associated with higher DSST scores (unadjudted)
Lexomboon *et al*. (2012)[12]	(*n*=557)	Cross- sectional	Associated disease age (>77)	Adjusted for sex, age, education, depression, and mental illness, odds of cognitive impairment significantly higher for persons with chewing difficulty
Naorungroj *et al*. (2013)[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 *et al*. (2013)[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 *et al*. (2015)[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 (2015)[3]	(*n*=8)	Longitudinal	Age, habit, socioeconomic condition Age (>50)	The contributing factors for poor oral health and reduced motor function, declining cognition lead to an increase in both morbidity and mortality also impacting the quality of life
Tsakos *et al*. (2015)[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 and demography)
Supawadee Naorungroj *et al*. 2015[17]	(*n*=911)	Prospective cohort study	Cardiovascular disease Age (>52)	Mean decline in scores of digit symbol substitution test, delayed word recall and word fluency was associated with tooth loss and poor periodontal health
Kamer *et al*. (2016)[18]	(*n*=152)	Cross-sectional	Alzheimer's disease periodontal inflammation age (> 60)	Participants with existing periodontal inflammation showed lower Digital Symbol test scores. Furthermore, number of missing teeth were more
Komiyama *et al*. (2016)[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

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.

Table 2: Data extracted from various articles

Article	Sample Size (*n*)	Study design	Covariates	Results
Kundapur *et al*. (2017)[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 *et al*. (2017)[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
Tominaga *et al*. (2018)[22]	(*n*=64)	Oral Health Intervention	Age (>65)	The cognitive test scores showed positive results after regular oral health intervention
Saito *et al*. (2018)[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 score were less in participants with 0–9 teeth in oral cavity
Yoo *et al*. (2019)[24]	(*n*=209,806)	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 *et al*. (2019)[25]	(*n*=10,215)	Retrospective Cohort study	Diabetes Age (>65)	Diabetic individuals had a higher risk of tooth loss, due to periodontal problem than non-diabetic individuals (HR=1.298)
Kato *et al*. (2019)[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 mini-mental state examination scores
Thomson *et al*. (2019)[27]	(*n*=818)	Prospective cohort study	Socioeconomic condition, education Age (> 50)	IQ test scores were highest with better DMFT index and OHI-S index
Ren *et al*. (2020)[28]	(*n*=341)	Cross-sectional	Age (>65) Demography	Around 129 participants with dementia showed poor DMFT score and poor tooth-brushing habits

The prevalence of CVD is increasing rapidly in the growing aging population. CVD contributes to morphological alteration of the brain that leads to cognitive decline, dementia, and cerebrovascular disease. The cognitive decline occurs due to the formation of amyloid deposits that provoke neuroinflammation, finally resulting in necrobiosis.[32] Associations between high blood pressure 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 (ten studies) and longitudinal studies (eight studies), have 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 scoping review mediates evidence of an association between cognitive functions with oral health in old age along with other cofactors such as 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. Elderly with complex care needs experience significantly more oral health problems and is more often edentulous than robust elderly. Moreover, elderly with few teeth and elderly with implant-supported overdentures reported less frailty and better QoL. 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 the lower socioeconomic background can achieve better QoL.

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