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Association between Oral Health Status and Cognitive Function among Geriatrics - A Cross Sectional Study

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Abstract

Background
Oral health disorders such as loss of teeth, periodontitis, root caries are associated with cognitive impairment in a group of elders.

Objective
This study was designed to assess the association between oral health status and cognitive function among a community-dwelling geriatric population in Chennai.

Materials and Methods
This was a cross sectional study involving 150 elderly from two geriatric institutions and two day care centers, who were interviewed and examined for oral health status and screened for cognitive function using Montreal cognitive assessment test (MoCA).

Results
Among 150 participants 53 (35.3%) had mild cognitive impairment (MCI) with a mean cognitive score of 22.17 (SD = 1.7), 73 (48.7%) had severe cognitive impairment (Dementia) with a mean cognitive score of 10.81 (SD = 5.4) and about 24 (16%) had normal cognition with a mean score of 27.08 (SD = 1.4). It was found that of the indices assessed, Russell's periodontal index had a negative association with cognitive function (R = - 0.212). In the linear regression model, adjusted for age and education, Russell's periodontal index was a predictive factor for cognitive function among older adults.

Conclusion
Periodontitis may serve as an early risk predictor for cognitive impairment among geriatrics.

Keywords
Oral health status; Cognitive function; Geriatrics; Association; Periodontal disease

Introduction
The world is on the brink of demographic milestone with the proportion of older and their life span increasing globally. It is estimated that the number of people in the age of 65 and above will grow from 524 million in 2010 to approximately 1.5 billion in 2050, particularly in developing countries [1]. With this emerging growth pattern, there arises a key question: will population ageing be accompanied by a longer period of good health, a sustained sense of well - being and extended periods of social engagement and productivity or will be associated with more illness, disability and dependency [2] Numerous studies have associated old age to diseases such as Dementia, frailty, heart disease, stroke, diabetes,

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and cancer, advocates' efforts to be taken to prevent the risk associated with the same.

Among those diseases affecting geriatrics, dementia is found to be the fifth common cause of fatality. It has been estimated that about 46.8 million elderly are affected with dementia globally. The scenario is also same in India: among 100 million of geriatric population, dementia is prevalent about 4.1 million in the year of 2015. By 2030, this incidence is expected to increase exponentially [3].

Dementia is a chronic syndrome characterized by progressive, global detrition in the intellect including memory, learning, orientation, comprehension and judgment. It occurs in association with certain diseases such as cardiovascular disease, stroke etc. and usually rare in persons under age 60 [4]. It has a significant impact on individual's disability and mortality and it also diminishes the quality of life both for the patients and their caregivers.

Among various types of Dementia (vascular, Lewybody, fronto-temporal, Alzheimer's diseases), neurodegenerative dementia (Alzheimer's) accounts for about 50% - 70% of the cases. The specific age for prevalence of Alzheimer's disease (AD) increases logarithmically in an interval of 5 years in people above 60 years.

There are numerous risk factors for Alzheimer's disease. The sporadic, late onset of AD is most likely due to the complex interaction of environmental, vascular and genetic factors. Only about less than 15% of attributable risk has been found to be associated with these factors and approximately half of the risk remains unexplained. Thus there is a need for the research on additional and potential risk factors for AD [5].

Cognitive impairment in old age is an early sign of clinical dementia. Mild cognitive impairment (MCI) is a condition where people have mild but measurable changes in thinking abilities that are noticeable to the person affected, to the family members and friends. A number of studies have reported that people with MCI, especially involving memory problems are more likely to develop Alzheimer's and other dementias compared to the people with normal cognition [6]. Many observational studies conducted in various developed countries suggests that oral health disorders such as loss of teeth, periodontitis, root caries may be associated with cognitive impairment in older adults. However, these factors contributing to oral health and cognitive impairment are distinctly different for developed and developing countries [7]. Hence, this cross sectional study was designed to assess the association between oral health status and cognitive function among a community-dwelling geriatric population in Chennai city, India.

Materials and Methods

This cross sectional study was conducted to assess the association between oral health status and cognitive function among a community – dwelling geriatric population at Chennai city. Ethical clearance for this study was obtained from Institutional Review Board, Ragas Dental College and Hospital, Chennai, India. A written informed consent both in English and in vernacular (Tamil) was obtained from all participants and/or their legal guardian. Prior permission to conduct the study was obtained from the concerned authorities of study places included in the study.

The study population consisted of geriatrics living in two private institutions and two day care centers in Chennai. There are about 45 geriatric private institutions and 5 day care centers in Chennai mostly situated in the eastern and northern part of Chennai respectively. Among them two institutions and two day care centers were selected randomly and all the inmates who fulfilled the inclusion criteria were included as study participants. In this study geriatric institutions are referred to as nursing homes, a multi – residential housing facility for senior citizens whereas day care centers are the places where a life service for frail, physically or cognitively impaired seniors were provided during day time.

For the present study the sample size was derived as 114 subjects using the formula [DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1)+p*(1-p)]. For the sample size calculation the prevalence of Alzheimer's disease was calculated as 60% based on the study done by Mathuranath et al, 2012 [8]. Further the sample size was approximated as 150 subjects by setting 95% confidence interval and β error of 20%.

Subjects with age 60 and above and having at least 10 natural teeth were included in the study. Also subjects with loss of vision, hearing, speaking and difficulty to participate in the cognitive evaluation were excluded from the study. A total of 400 subjects from the 4 study areas (institutions and day care centers) were approached and screened. On the basis of inclusion criteria 250 subjects were excluded from the present study. About 150 subjects who fulfilled the above inclusion criteria were selected to include in the study.

The cognitive function of the participants were assessed using Prevalidated Montreal cognitive assessment test (MoCA – Basic), a routine cognitive screening tests rated on a 30 point scale (Ziad Nasreddine, 1996) which was translated into vernacular (Tamil). The medical history and education of the participants were obtained as a part of this cognitive assessment test and also been confirmed with participants medical record. For the administration of cognitive assessment test the principle investigator underwent online paper test training: www.mocatest.org/. The principle investigator efficiency has also been monitored by the clinical psychiatrist and the investigator was calibrated with kappa value of 0.80 which was substantial.

Oral health status for the participants were assessed using Oral hygiene index simplified (OHIs) developed by Green & Vermillion in 1964, Periodontal index (PI) developed by Russell's in 1956, 1967 and Decayed – Missing – Filled Teeth index (DMFT Index) developed by Henry T. Klein, Carrole E. Palmer and Knutson J.W in 1938. The principle investigator administered the above mentioned indices in the Department of Public Health Dentistry, Ragas Dental College and Hospital, Chennai before eliciting them for the study participants. The investigator calibration was assessed using kappa statistics was k = 0.90.

The cognition function and oral health status for each study participants were assessed on the same day. The time taken to complete the cognitive function evaluation was about 10 – 12 minutes and for oral health examination was about 15 minutes for each participants. These examinations were done in the above mentioned study places during 9.00 am to 12.30 pm on the two week days. The study was conducted from May to August 2016 by the principle investigator.

The data obtained were entered in Microsoft Excel sheet 2013. The entered data were statistically analyzed using Statistical Package for the Social Science (SPSS), version 20. The data obtained from the participants were divide into three groups based on MoCA scores as normal (>26), mild cognitive impairment (26-19) and severe cognitive impairment (<19). Pearson's correlation was done to find the association between the oral health status and cognitive function. Multiple linear regression was run to obtain the regression equation. A p value less than 0.05, estimated in two – tailed manner was considered statistically significant.

Results

The present study assessed 150 community dwelling geriatrics aged 60 and above to detect the association between oral health status and cognitive function. Among the participants examined, 124 (83%) were female and 26 (17%) were male. The mean age of the participants was 74.03 years (SD = 8.4). Majority of the study participants have completed their middle school (39.3%). Most of the participants had normal medical history (49.3%). Among 150 participants 53 (35.3%) had mild cognitive impairment (MCI) with a mean cognitive score of 22.17 (SD = 1.7), 73 (48.7%) had severe cognitive impairment (Dementia) with a mean cognitive score of 10.81 (SD = 5.4) and about 24 (16%) had normal cognition with a mean score of 27.08 (SD = 1.4) according to Montreal cognitive assessment test. The characteristics such as age and education were found to be significantly different for the participants among three groups (cognitive normal, MCI and dementia). Table 1 gives the descriptive statistics for the study variables.

Table 2 showed the association of oral health status and cognitive function made using bivariate analysis. It was found that of the three indices score, Russel's periodontal index alone had a negative association with cognitive function R = - 0.212 with a significant p value of 0.009.

In the linear regression model, adjusted for age and education, only periodontal index by Russell's remained as a predictive variable for cognitive function among older adults with a regression equation of MoCA score = 19 – 0.77 (Russell's score).

Discussion

In this study the association between the oral health status and cognitive function among older population in Chennai city was assessed. Severe periodontal destruction was found to be negatively associated with cognitive function after controlling of the confounders, age, education, general disease. This is the first epidemiological study using MoCA test to assess the cognitive function in older Indian population.

The potential mechanism for the association between oral health and cognitive function is that inflammatory mediators produced in response to the periodontal pathogens, produce chronic systemic inflammation and neuropathology, increasing the risk of stroke and cerebrovascular disease [9, 10]. Periodontitis is associated with a raised serum pro-inflammatory state

Table 1: Descriptive statistics of study variables (n = 150)

Variables		n %	Mean(SD)
Age		150	74.03 (8.4)
Gender	Male	26 (17)	
	Female	124 (83)	
Education	Profession/Honors	2 (1.3)	
	Graduate/Post Graduate	20 (13.3)	
	Intermediate/Diploma	7 (4.7)	
	High School	12 (8.0)	
	Middle School	59 (39.3)	
	Primary School	43 (28.7)	
	Illiterate	7 (4.7)	
General Disease	Normal	74 (49.3)	
	Diabetes	30 (20.0)	
	Hypertension	7 (4.7)	
	Diabetes & Hypertension	12 (8.0)	
	Heart Disease	27 (18.0)	
	Dependent	12 (8.0)	
MoCA Score	Normal	24 (16.0)	27.08 (1.4)
	Mild cognitive impairment	53 (35.3)	22.17 (1.7)
	Severe cognitive impairment (Dementia)	73 (48.7)	10.81 (5.4)

Table 2: Correlation coefficient of oral health indices score with cognitive function scores

	Oral health Indices	Correlation coefficient (r)	P value
MoCA score	OHIs	-0.412	0.083
	Russell's	-0.212	0.009
	DMFT	0.019	0.814

wherein there is an increase in C reactive protein (CRP) and pro-inflammatory cytokines (eg: Tumor Necrosis Factor α (TNFα)) along with a reduction in anti-inflammatory markers (eg: interleukin 10 (IL 10)), leading to higher amyloid precursor protein expression [11]. Studies by Kubota et al, 2014 and Kamar AR et al, 2015 suggested that periodontitis is associated with higher amyloid precursor protein expression and higher amyloid loads in the elderly, leading to neuronal degeneration [12, 13]. The oral gram negative bacteria in periodontitis may disseminate to brain via transient bacteremia and neuronal pathways, leading to neuronal degeneration [14]. This was explained by Riviere and colleagues who detected the antigens of oral treponemes more often in the samples from participants with Alzheimer's disease (14 out of the 16 participants) than in the ones from the control (4 out 18) [15].

The other possible mechanism may be the tooth loss, due to severe periodontal destruction. Mastication, besides its primary functions of food intake and digestion has shown to promote general health, especially the cognitive function [16, 17, 18]. Research on aging and mastication have shown that the decrease in the number of teeth and the impairment of jaw muscle activity due to aging cause a reduction in sensory input activity to the central nervous system. Functional magnetic resonance imaging (MRI) and positron emission topography (PET) revealed that mastication increases cortical blood flow and widely activates various cortical areas (Hippocampal center – Cognitive center) of the somatosensory, supplementary motor, and insular cortices, as well as the striatum, thalamus and cerebellum [19-21].

Elderly people are at risk factors for cognitive impairment and for developing Alzheimer's disease (AD), which is one of the most common subtypes accounting for 50 – 70% of dementia[5]. Among the risk factors including ageing, illiteracy, lower level of education,

lower socioeconomic status, head trauma, genetic factors, cardiovascular risk factors, overweight, smoking, hypertension and diabetes mellitus, an inactive lifestyle, loss of teeth (commonly due to periodontitis and dental caries) has shown to be significantly important [22-25].

As a cross-sectional study, our finding on the significant association between periodontitis and cognitive impairment is consistent with the previous observation and review studies. A cohort study conducted in 60 Southampton elderly people, United Kingdom, by Mark Ide, 2016, showed that periodontitis was associated with an increase in cognitive decline in Alzheimer's disease [26]. Iwasaki M et al, 2015, in Japanese older adults reported for low MMSE score associated with periodontal disease and edentulous [27]. A Systematic review and Meta-analysis by Cerutti-Kopplin et al, 2016, studied the association between periodontal disease and cognitive status showed conflicting results [28]. Few studies have found association between tooth loss (periodontitis and dental caries) and cognitive impairment. A cross- sectional study by Jianfeng Luo, 2015 among 3063 Chinese older adults showed that tooth loss of >16 were significantly associated with dementia with an OR of 1.56 (95%CI 1.12-2.18)[5]. A study conducted by Lexomboon D et al, 2012, in Swedish old people reported that Persons with multiple tooth loss and persons with difficulty chewing hard food had significantly higher odds of cognitive impairment (OR = 1.82; P = 0.01) [29]. Bei wu et al, 2008 conducted a study among U.S old population reported that the predicted number of decayed teeth increased by 0.01 with each 1-point decrease in the Digit Symbol Substitution Test score; the number of missing teeth increased by 0.02; and the percentage of sites with periodontal disease increased by 0.02 [30]. Batty D et al, 2013 reported that relative to the group with the greatest number of teeth (>=22), having no teeth was associated with the highest risk of both dementia and cognitive decline [31].

The limitation of the present study was the lack of temporality due to its design. Further this results has to be extrapolated with caution as this study was conducted on a sample population in Chennai and risk factors for AD may vary with different population and place.

Conclusion

Based on the present study results, geriatric population in Chennai with cognitive impairment had significantly poor periodontal health than their cognitively normal counterpart. Thus, periodontitis could serve as an early risk predictor for cognitive impairment among geriatrics. However a follow up data would make the results more valid and this would benefit the cognitively impaired older people.

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