Original Article

Determining Association Between Cognitive Function and Oral Health Status among Rural Community Dwelling Geriatrics

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ABSTRACT

Objective: Numerous prospective studies worldwide investigated the association between oral health status and dementia or cognitive decline. No clear agreement has emerged on the association. This study aimed to determine the association of cognitive function and oral health status among community dwelling geriatrics in rural South India. **Materials and Methods:** A cross-sectional study was conducted among community dwelling geriatrics in rural South India by recruiting 211 individuals aged above 60 years. Their cognitive function was assessed using pre-validated community screening instrument for dementia (CSI-D) which has informant and cognitive scale. The data on cognitive function was collected by community health workers in electronic version (Web app). Their oral health status was assessed by World Health Organization (WHO) oral health assessment form in electronic version (Web app). **Results:** From the logistic regression analysis, it was observed that cognitive impairment showed an association with 1.6- and 1.9-times risk for root caries and a greater number of missing teeth ($P \leq 0.05$). No association of other oral health parameters such as gingivitis, periodontitis, dental erosion, and dental trauma with cognitive impairment exhibited. **Conclusion:** From the results, it can be concluded that cognitive impairment has an association with root caries and number of missing teeth which increases the risk for the same and vice versa.

KEYWORDS: *Cognition, community dwelling, geriatrics, oral health status*

INTRODUCTION

Globally there is population aging happening which urges the necessity of appropriate policies and programs to make the elderly remain healthy, independent, and contribute to their families and communities.[1] Most challenging and costly consequence is the increased morbidity and mortality among elderly due to dementia and Alzheimer's diseases.[2] Elderly with dementia need constant care and help for their daily basic activities which creates an economic and social burden. With declining support from families, society establishes a need for better information and tools to ensure the well-being of elderly.[3] Dementia is diagnosed on a careful medical history, physical examination, laboratory tests, characteristics changes in thinking, day-to-day function, and behavior.[4] The risk factors such as age and genetics cannot be changed but can be modified by regular physical exercise and healthy diet.[5] Although dementia is the main cause of cognitive impairment, not all cognitively impaired people are demented. A study

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stated that about 16% of elderly dementia-free subjects were affected by mild cognitive impairment.[6]

Cognitively impaired people also have more rapidly progressive oral health problems, including lingual ulcers, mucosal hyperplasia, sub-denture stomatitis, Tamil Nadu, bad oral hygiene, xerostomia, poorer periodontal condition, and more coronal and root caries compared with cognitively healthy people.[7] Cross-sectional and longitudinal researches show that elderly have lower cognitive performance when there are specific oral conditions such as periodontal disease,[8] dental caries,[9] difficulties with masticatory function,[10] and tooth loss.[11] The plausibility is that poor oral health contributes to cognitive decline through biological mechanisms such as common inflammatory pathway or reduced nutritional intake.[12] The opposite direction of causality is equally possible that cognitive decline negatively impact oral health via behavioral changes such as reduced attention to oral hygiene or inadequate use of dental health services. Cognitive impairments such as apraxia (which disrupts motor planning) can decrease an individual's ability to effectively engage in oral hygiene.[13] Some studies found an association whereas others did not and concluded that "it is unclear how or whether oral health conditions and cognitive status are related."[14] Factors contributing to oral health and cognitive impairment are distinct for developed and developing countries. Assessing and improving their oral health might reduce the morbidity and mortality due to dementia, improve their quality of life, make them feel empowered, and reduce worries caused by aging. With this background, the present study aimed to find the association between cognitive function and oral health status among rural community dwelling geriatric population.

MATERIALS AND METHODS

A cross-sectional study in a rural community-based setting was designed and conducted among people aged >60 years from September 2018 to October 2019. Ethical clearance to conduct the study was obtained from Institutional Review Board (20160202). People with very severe cognitive decline (late dementia), those who received oral health treatment within 6 months, and those wearing complete denture were excluded. Sample size was calculated using n Master Software version 2 (Christian Medical College, India). The proportion of dependent elderly population was 48% and prevalence of oral diseases was 33% in India.[15] With these proportions, α and 1-β set to 5 and 95%, sample size required was 211. A total of 12 rural places in two districts (Kanchipuram and Thiruvallur) of Greater Chennai were identified using Census of India 2011 (www.census2011.co.in). After obtaining prior permission from the respective village panchayat officials with the help of multipurpose health workers, 211 elderly people were recruited for the study using purposive sampling method. Informed consent was obtained from the participants after explaining the purpose of the study and the anonymity of the participants was maintained. Participation of the subjects was encouraged by providing oral hygiene maintenance kit containing a toothbrush and 20 g toothpaste.

A Web and Mobile App was developed which included demographic details, details on previous medical history, details on habits, and ability to maintain oral hygiene independently, need remainders, need step-by-step instructions, and dependent. The brief community screening instrument for dementia (CSI-D) which has informant and cognitive scales was developed both in English and the vernacular language (Tamil). The cognitive scale and informant scale contained nine and seven question items, respectively. CSI 'D' was validated in the community among 2885 persons aged 60 and above, recruited in 25 centers in India as part of the 10/66 Dementia Diagnosis Protocol. This algorithm identified 94% of dementia cases with false-positive rates of 6%.[16] The inter-rater reliability using two interviewers rating the same subject at the same time shows agreement at 0.819 (Kappa Statistics). The App also included pre-validated, highly sensitive (97.3%), and specific (90.5%) screening instrument for dementia.[17] WHO oral health assessments form for adults 2013 was included in the App to assess the oral health status. The scores of CSI-D and oral health statuses are entered in the App, automatically the data entry will be done in the excel sheet. The investigator can export the excel sheet and can do the statistical analysis. There is no necessary to make data entry separately. This web or mobile App containing CSI-D can be used by the public as a screening tool for dementia among the elderly in the family, so that early treatment for dementia will be possible. The App contains one screen for demographic details, one screen each for CSI-D cognitive scale and informant scale with scores, and displays the screens separately. Also, there is a separate screen to assess WHO oral health status. The scores once entered cannot be changed, instead a new registration has to be done. No unique site visitor rate is needed since the responses were entered by the investigator. However, the App was password and image captcha protected. The web/mobile App was created according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES).[18] Four community health workers from each district were

recruited based on their accuracy and time taken to complete the screening using Web App. The mean time taken was 15.3 min by health workers. Their accuracy was 82% which improved with further practice. A daily basis incentive was provided to encourage their contribution. Oral health assessment was carried out by the principal investigator with an average time of 8–10 min. Type III examination by American Dental Association (ADA) was used to assess the oral health. The data were collected during the day time since they were not working and most of the elderly in the respective villages were receiving the state government scheme money of about ₹1000 per month. The dentition status of crown was converted into decayed, missing, filled teeth (DMFT), root status, gingival, periodontal status, loss of attachment, dental erosion, and dental trauma were dichotomized for data analysis. Statistical analysis was performed using Statistical Package for Social Sciences software (SPSS version 23, USA). Pearson Chi-square association was used to analyze the association of cognitive test, informant interview with oral health parameters. Multinomial logistic regression model was used to relate CSI-D to the oral health-related variables to obtain odds ratio. $P \leq 0.05$ was considered significant.

RESULTS

The mean age of the participants was 70.73 ± 7.74. Among them, 33.6% were males and 66.4% were females. 53.1% were uneducated and only 3.8% of participants were graduated. About 90% of the participants were unemployed and receiving a sum of ₹1000 by state government money for elderly (≥60 years). There was no previous medical history in 48.3%; however, 31.8 and 15.6% of participants had diabetes and hypertension, respectively. Most of the participants had no physical disability (90%), whereas 10% had stroke. Of them 78.2% were independent, 10.9% needed remainders, and 7.1% were totally dependent in maintaining their oral hygiene daily.

The distribution of dementia among the study participants using CSI-D (informant and cognitive scales) are presented in Table 1. The informant and

cognitive scales comprised six and nine questions with dichotomized options (yes or no) having total scores ranging from 0 to 6 and 0 to 9, respectively. A score of 0–1 was normal and 2–6 was considered as probable dementia in the informant scale. It is just the opposite in case of the cognitive scale, where a score of 0–4 was considered probable dementia, 5–6 was possible dementia, and a score 7–9 was considered normal. 71.1 and 63.5% were considered normal according to the informant and cognitive scales. Oral health status

Table 2: Prevalence of oral health status of study participants

Variable	Sub-variable	Frequency (%)
Number of teeth decay	≤5 teeth	185 (87.7)
	>5 teeth	26 (12.3)
Number of teeth missing	≤11 teeth	120 (56.8)
	>11 teeth	91 (43.2)
Root caries	No root caries	118 (55.9)
	< 10 root caries	93 (44.1)
Bleeding	≤5 teeth	143 (67.7)
	>5 teeth	68 (32.3)
Pocket	4 mm pocket	111 (52.7)
	>4 mm pocket	100 (47.3)
Loss of attachment	No attachment loss	152 (72.03)
	Attachment loss present	59 (27.97)
Erosion	No Erosion	198 (93.9)
	<15 teeth with Erosion	13 (6.1)
Trauma	No trauma	197 (93.4)
	<5 teeth with trauma	14 (6.6)

Table 3: Association of oral health status and CSI-D

CSI-D	Oral health status	Chi-Square (χ^2), *P*-value
Cognitive scale	Ability to maintain oral hygiene	447.70 (0.000)
	Number of teeth decay	153.12 (0.505)
	Number of missing teeth	144.692 (0.032)
	Root caries	27.832 (0.015)
	Gingivitis	47.012 (0.798)
	Periodontitis	70.947 (0.673)
	Erosion	16.361 (0.292)
	Trauma	9.041 (0.828)
Informant scale	Ability to maintain oral hygiene	236.58 (0.000)
	Number of teeth decay	146.905 (0.177)
	Number of teeth missing	97.737 (0.750)
	Root Caries	13.001 (0.369)
	Gingivitis	74.240 (0.085)
	Periodontitis	74.261 (0.227)
	Erosion	19.019 (0.088)
	Trauma	19.690 (0.073)

Table 1: Prevalence of dementia among elderly participants

CSI-D Scale	Sub-variables	Frequency (%)
Informant	Normal	150 (71.1)
	Probable Dementia	61 (28.9)
Cognitive	Normal	134 (63.5)
	Possible Dementia	45 (21.3)
	Probable Dementia	32 (15.2)

Table 4: Multinomial logistic regression relating CSI-D to oral health status

CSI-D	Number of decay	Number of teeth missing	Root decay	Gingival bleeding	Periodontal pocket	Loss of attachment	Erosion	Trauma
0–6	1.2 (0.641)	1.6 (0.034)*	1.9 (0.050)*	0.8 (0.532)	0.5 (0.631)	0.4 (0.599)	0.6 (0.762)	0.1 (0.842)

Adjusted for age, sex, occupation, and habit. *Statistically significant

according to the WHO assessment form is presented in Table 2. About 12.3% had >5 decayed teeth, 43.2% had >11 missing teeth, 44.1% had <10 root caries. The gingival examination showed that 67.7% had >5 teeth with bleeding, pockets >4 mm was present in 47.3% with loss of attachment in 27.97% participants. About 93.9 and 93.4% had no dental erosion and trauma, respectively. No study participants had oral mucosal lesions.

There was a significant association of root caries, missing teeth with cognitive scale of CSI-D ($P < 0.05$). There exists no significant association between oral health status and informant scale of CSI-D. However, ability to maintain oral hygiene had significant association with the cognitive and informant scales shown in Table 3. Multinomial logistic regression model with good model fit showed participants having cognitive score of 0–6 had 1.6 times risk for more number of missing teeth. Similarly participants with cognitive score 0–6 had 1.9 times risk for root caries [Table 4].

DISCUSSION

The present study assessed the association between cognitive impairment and oral health status among community dwelling geriatrics. Elderly have increased incidence of oral disease with significant frequency of oral health problems in the cognitively impaired elderly, particularly with dementia. Any intervention that might help delay the onset or progression of dementia, including improvement of oral hygiene and utilization of dental services, could have a significant impact on personal and family well-being, and healthcare costs. The present study results showed an association of cognitive impairment with root caries, missing teeth, and ability to maintain oral hygiene.

One study reported no significant difference in the percent of plaque, gingival bleeding, pocket depth, loss of attachment, and DMFT between the dementia and control group, and also no significant correlation between dementia score (MMSE score) and oral health parameters. Only number of decayed coronal surface parameter was correlated negatively with MMSE score ($r = -0.40$, $P = 0.05$).[19] A case–control study showed that tooth loss at earlier age was a significant risk factor (OR = 1.45) for Alzheimer's disease with 4.2 times risk for participants with tooth loss before 35 years of age.[20]

A prospective cohort study which explained the relationship of oral conditions with occurrence of dementia showed that the adjusted hazard ratio for number of missing teeth ≥ 11 on the risk of dementia was 1.13 in people with higher education and 0.30 in people with lower school level, possibly owing to source of chronic inflammation.[21] Another study reported that hazard ratio for number of missing teeth ≥ 16 on the risk of dementia was 1.21 and the hazard ratio for the risk of dementia who never brushes was 1.08. Also the risk for dementia in participants without dentures was 1.15 compared with participants with dentures.[22] Similarly in the present study, the participants with CSI-D score <6 had 1.6 times risk for ≥11 missing teeth. The hazard ratio for ability to maintain oral hygiene with remainders and depending on care takers to maintain oral hygiene was 1.56. Chronic inflammation due to poor oral hygiene maintenance and lack of masticatory force contributes to the risk of dementia.

A cross-sectional study assessed the cognitive function and oral health status in stroke patients. Tooth loss in stroke patient was significantly associated with MMSE score. Tooth loss increased in subjects with low MMSE by OR = 1.75 after adjustment for age, income, education, habits, and medical history.[23] In this study, all 21 participants with stroke had dementia and 14 (66.7%) had ≥11 number of missing teeth. There was significant association between number of missing teeth and dementia (CSI-D = 0–6) in stroke participants ($P = 0.04$). One study reported that Alzheimer's patients had more number of caries teeth, worse periodontal health, and more mucosal lesions (cheilitis and candidiasis) compared with the control participants. However, no statistical significant association and correlation was found between state of oral health and degree of deterioration caused by dementia.[24] There was no mucosal lesion among this study participant.

A 6-month observational cohort study found no clear relationship between severity of dementia and degree of periodontitis. However, they showed that Alzheimer's disease with poor dental health, in particular periodontitis, is associated with a marked increase in cognitive decline over a 6-month follow-up period, independent to baseline cognitive state.[25] However, the present study with probable dementia found no significant association between periodontal

status and CSI-D scores. One study assessed caries increment among patients with moderate and advanced dementia. Mean annual increments of coronal caries in the dementia group were 2.29 ± 4.29 per 100 surfaces at risk which was over twice that in the comparison group (0.88 ± 1.14). For root caries, mean annual increments in the dementia group were 2.38 ± 5.57 per 100 available surfaces, versus 0.31 ± 0.69 in the comparison group.[26] Despite these large mean differences, the marked variability in these small samples was not statistically significant in caries increments between the two groups. Here in the present study, the risk for root caries in participants with low CSI-D (0–6) was 1.9 compared with participants with high CSI-D (7–9). Although there was increased number of coronal decay in the participants with low CSI-D, there was no statistical significant association. Maintenance of oral hygiene, diet plays a major role in incidence of coronal decay compared with cognitive decline directly.

Though a previous cross-sectional study conducted among 150 institutionalized elderly by the present study authors reported a weak negative correlation of cognitive function (assessed using Montreal cognitive assessment test (MoCA Basic)) and periodontal status (Russell's periodontal index),[27] the present study conducted among community dwelling geriatrics found no significant association between cognitive function and periodontal status assessed using WHO oral health assessment form. Extensive literature search reveals that the present study is one of the few studies that have been conducted in an Indian scenario. Studies have assessed oral health status based on caries increment, loss of teeth, periodontitis, gingival inflammation, use of denture, and mucosal lesions separately. But the present study assessed all oral health parameters using WHO oral health assessment form for adults and brief community scale for dementia in electronic version using community health workers. This study also helped to assess the unmet dental needs of rural elderly population where no study participants with filling and denture were seen. Despite more dental colleges and increased Dentist: Population ratio exists in Tamil Nadu, still inverse square law prevails. The cross-section design with purposive sampling of the present study would limit the external validity of the obtained results. Further longitudinal studies are required to study the biological plausibility and validate the predictable utility of oral health status for the diagnosis and prevention of cognitive impairment.

CONCLUSION

There is an increased risk for number of missing teeth and root decay for participants with cognitive impairment. The findings obtained in the present study may be utilized for further research to throw light on the use of oral health status as a predictor for dementia and also oral health practices as an effective preventive tool for cognitive impairment.

CONFLICTS OF INTEREST

No conflict of interest.

AUTHORS CONTRIBUTIONS

Dr. B. Arthi—Literature search, data acquisition, data analysis, manuscript preparation. Dr. P.D. Madan Kumar—Concept, manuscript review. Dr. V. Sridhar—Design, definition of intellectual content. Dr. M.P. Santhosh Kumar—Statistical analysis, manuscript editing. Dr. S. Sushanthi—Data acquisition. Dr. Indumathy Pandiyan—Data acquisition.

ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

Ethical clearance to conduct the study titled "Determining Association Between Cognitive Function and Oral Health Status among Rural Community Dwelling Geriatrics" was approved by IRB committee at Ragas Dental College and Hospital, Chennai, India (acceptance number: 20160202).

PATIENT DECLARATION OF CONSENT

The authors declare that they have obtained consent forms from the patients. The patients gave their approval about reporting their clinical information to the journal and they understand that their names will not be published.

DATA AVAILABILITY STATEMENT

The additional data of this study are available on request from corresponding author, upon reasonable request.

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