Effect of Tooth Loss and Chewing Ability on Cognitive Function of Community Dwelling Elderly

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ABSTRACT

Tooth loss among older people is highly prevalent worldwide. Reduced number of teeth may be associated with impaired chewing ability and cognitive impairment. This study aimed to assess the association between low number of remaining teeth and cognitive function in a group of elderly in the community. A cross-sectional study was carried out on 152 older adults aged 60 years and above from four elderly activity centres in Kuala Lumpur, Malaysia. Clinical oral examination was conducted to determine the oral health conditions of respondents, which include number of remaining teeth, presence of denture and history of dental caries. The validated Malay version of Mini-Mental State Examination (MMSE) was used to assess their cognitive function. Low cognitive status was defined as having MMSE score of less than 24. The mean number of teeth present was 12.0 ± 9.6, with 23.7% had total tooth loss (edentate). Lower MMSE score (<24) was found in 34.9% of the respondents. A significantly higher percentage of respondents with reduced number of teeth and chewing difficulty had lower MMSE score. Significant positive correlation was also found between number of remaining teeth and MMSE score (r=0.30; p<0.01). Chewing difficulty and reduced number of teeth were significantly associated with cognitive decline among the elderly. Maintenance of optimum number of teeth can be an important factor for cognitive function. Longitudinal studies are needed to further explore the relationship.

1. INTRODUCTION

Oral health plays an important role in the well-being of older people as it is associated with physical, psychological and social function and overall quality of life. However, oral diseases are prevalent among the aged with high prevalence of dental caries and periodontal disease [1]. Severe dental caries and periodontal disease resulted in partial or total tooth loss, which is a common scenario among the older age population. The Malaysian elderly aged 60 years and over were reported to have a mean of 9.8 remaining teeth and about 36.8 percent were edentulous [2]. Partial and complete tooth loss can interfere with the functioning of the aged group, for example in chewing and swallowing, speech and also appearance [3]. The potential association of number of teeth with cognitive decline has been widely studied recently [4], [5]. Various studies have concluded that reduced number of teeth lead to reduced chewing ability and cognitive impairment [6-

8]. It was also suggested that loss of teeth was one of the major risk factors for development of Alzheimer's disease, with fewest teeth may be related to development of dementia later in life [9]. Poor masticatory function may act as a significant risk factor for having cognitive impairment, as mastication stimulates the activity in the cerebral cortex and may be helpful in preventing degradation of a brain function [10]. However, the causality of this association is yet to be established as there are several confounding factors.

In Malaysia, the prevalence of cognitive impairment among older people ranged from 11 to 24% [11]. Several factors have been identified as possible predictors for increased cognitive impairment. These include physical inactivity, lack of participation in mental activity, malnutrition and reduced physical function [12]. However, to date, little attention has been given to the study on association between number of teeth and cognitive functioning especially in the local setting. For a developing country like Malaysia where prevalence of tooth loss is high among older people and where dental health services might not be easily accessible in some rural areas, such study on the possible association between these variables need to be further investigated. Therefore, this study aimed to assess the association between number of remaining teeth and cognitive function in a group of elderly in the community.

2. Material and Methods

2.1 Study population
This is a cross-sectional study conducted in four selected elderly activity centres in Kuala Lumpur, Malaysia. Individuals aged 60 years and above, Malaysians and able to communicate clearly in Malay language were included in this study. Based on a formula [13] used to calculate the adequate sample size in cross-sectional studies, $n = z^2 \times P(1-P) / d^2$, whereby n is the sample size, z is the level of confidence at 95%, P is the estimated prevalence (11% prevalence of cognitive impairment among older Malaysians) [11], and d is precision of 5%, the estimated sample size was 150. With estimation of 10% non-response subjects, a sample size of 165 was required for this study.

Respondents were recruited using convenience sampling. Through the officer-in-charge for each centres, all the elderly members were invited to participate in a dental screening programme at their respected activity hall. Prior to the interview and dental examination, respondents were informed on the aim and conduct of study. Those who agreed to participate and matched the inclusion criteria were included. Approval to conduct this study was obtained from the Research Ethics Committee, Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2019-636) and all respondents provided written consent. Data collected include socio-demographic characteristics, dental status, perceived masticatory and cognitive ability.

2.2 Socio-demographic and chewing ability
Data on socio-demographic characteristics and perceived masticatory and cognitive ability were attained from face-to-face questionnaire interview. Demographic variables include gender, age category, ethnic group, educational level and self-reported medical condition. The 12-item Malay version of Geriatric Oral Health Assessment Index (GOHAI) was used to measure the chewing ability of the respondents in the past 3 months [14]. The GOHAI index consisted of three dimensions: physical function, psycho-social function, and pain and discomfort. The perceived masticatory ability was determined through the physical function domain.

2.3 Cognitive function
Cognitive status was measured using the Malay version of Mini-Mental State Examination (MMSE) [15]. The MMSE is widely used to measure cognitive function and has been validated into various languages [16]. The total scores of MMSE range from 0 to 30. Respondent was classified as having low cognitive status if

the scores were less than 25 points.

2.4 Dental examination

Dental examination was carried out to assess the oral health condition of respondents, namely the total number of remaining teeth, presence of denture and dental caries experience. The clinical examination was based on the National Oral Health Survey of Adults 2010 [2] and World Health Organization (WHO) criteria for Oral Health Surveys 2013 [17]. One examiner was involved in the clinical assessment and demonstrated high intra-examiner reliability (Kappa value of 0.97).

2.5 Statistical analysis

Statistical analysis was carried out using IBM SPSS version 24.0. Mean and standard deviation were determined for continuous variables, and frequency and percentage for categorical variables. Associations between categorical variables were assessed with Chi-square test of independence. Spearman correlation coefficient was used to investigate the correlation between number of teeth and cognitive function score. The significance level was set at $p < 0.05$.

3. Results

3.1 Socio-demographic characteristics

A total of 152 older persons aged 60 years and above participated in the study. As shown in Table 1, 71.7% respondents were female and 28.3% male. The mean age was 67.5 years (SD 9.2) and about 40% were more than 70 years old. Majority of the respondents were Malay (58.6%). In relation to formal educational level, 15.1% had never attended school, 41.4% and 35.6% were with primary and secondary level of education, respectively, and only a small proportion (7.9%) had tertiary education. About 82.9% reported that they suffered from at least one medical condition.

Table 1: Demographic characteristics of study population.

Items	n (%)	Mean (SD)
Sex		
Male	43 (28.3)	
Female	109 (71.7)	
Age Group		67.5 (9.2)
Below 70 years old	92 (60.5)	
70 years old & above	60 (39.5)	
Race		
Malay	89 (58.6)	
Chinese	52 (34.2)	
Indian	11 (7.2)	
Level of education		
No formal education	23 (15.1)	
Primary & secondary education	117 (77.0)	
Tertiary education	12 (7.9)	
Systemic disease		
Yes	126 (82.9)	
No	26 (17.1)	

3.2 Dental condition and cognitive function

The mean number of teeth present in the oral cavity was 12 (SD 9.6) with majority of the respondents had less than 20 functional teeth (72.4%). About 23.7% or 36 respondents were edentate or having total tooth

loss. As for the cognitive function, the mean MMSE score of respondents was 23.8 (SD 5.7). About 23% and 7.9% of respondents demonstrated mild and moderate cognitive impairment, respectively. Only 3.9% elderly had severe cognitive impairment. Table 2 presents the demographic, dental and cognitive function characteristics of the older adults.

Table 2: Dental condition and cognitive function characteristics of study population.

Items	n (%)	Mean (SD)
Dental status		
Dentate	116 (76.3)	
Edentate	36 (23.7)	
Number of teeth		12.0 (9.6)
20 teeth and more	42 (27.6)	
Less than 20 teeth	110 (72.4)	
Chewing difficulty		
Yes	60 (39.5%)	
No	92 (60.5%)	
Cognitive status		23.8 (5.7)
Normal cognition	99 (65.1)	
Mild cognitive impairment	35 (23.0)	
Moderate cognitive impairment	12 (7.9)	
Severe cognitive impairment	6 (3.9)	

3.3 Association between cognitive function and number of teeth and chewing ability

Table 3 summarizes the association between cognitive function and number of teeth and chewing ability. Bivariate analysis using Chi-square test showed that those cognitively impaired had higher percentage of respondents (90.6%) with less than 20 teeth (p<0.01). Similarly, a higher percentage of respondents (52.8%) with chewing difficulty was observed among older individuals with cognitive impairment (p<0.05).

Table 3: Association of number and teeth and masticatory ability with cognitive function of study population.

	Cognitive impairment n (%)	Normal cognition n (%)	p value
Number of teeth			
20 teeth and more	5 (9.4)	37 (37.4)	< 0.01
Less than 20 teeth	48 (90.6)	62 (62.6)	
Chewing difficulty			
Yes	28 (52.8)	32 (32.3)	< 0.05
No	25 (47.2)	67 (67.7)	

* significant at p<0.05

Correlation between number of teeth and total MMSE score is shown in Table 4. Findings highlighted that number of remaining teeth in the oral cavity significantly correlated with cognitive ability score among the study population (r=0.30; p<0.01).

Table 4. Association between number of teeth and total MMSE score

	Number of teeth mean (SD)
MMSE score	23.8 (5.7)

r = 0.30, p<0.01*

*Spearman correlation coefficient; significant at p<0.01

4. Discussion

To the best of our knowledge, this is the first local study assessing the association between number of remaining teeth and cognitive decline in a group of community-dwelling elderly. Findings showed that reduced number of teeth were significantly associated with cognitive impairment among older adults. Consistent results were also observed in other studies that evaluated the association among elderly worldwide [5- 7]. [18] suggested that loss of functional posterior teeth caused degenerative and abnormal changes in the periodontal mechanoreceptos, resulting in reduced sensory input from the periodontal ligaments, thus affecting the brain function. In addition, it was also suggested that masticatory stimulation from occluding posterior teeth caused increase in cerebral blood flow, activation of cortical area and blood oxygen level. Therefore, reduced masticatory function due to loss of posterior teeth might cause cognitive decline [4]. A strong relationship between masticatory ability and the state of dentition has been established in many research [19], [20]. However, chewing ability is not determined entirely by number of teeth present. Instead, it is a complex process composed of physical, social, and psychological components [21]. Also, chewing process is an individually determined and adaptive process. As for in elderly population, chewing ability is associated with several non-dental functional impairments, such as decreased biting force and reduced saliva flow, as well as factors like general health and psychological and social well-being [22].

In contrast, a study by [23] concluded contradicting results whereby there was inadequate evidence to support the association between reduced number of teeth and cognitive decline. It must be noted that older individuals usually presented with other risk factors which may have affected their cognitive function. Hence, the decreased number of remaining teeth may not alone lead to cognitive decline but may be markers of comorbidities [24]. Furthermore, various studies have shown significant association between number of teeth and chewing ability with nutrient intake and nutritional status [25] thus supporting the views that masticatory performance is related to cognitive function by influencing nutritional status. Hence, further studies that investigate the association between masticatory ability and cognitive function and their link to nutrient intake and nutritional status are greatly needed.

This study also reported that majority (72.4%) of the respondents had less than 20 functional teeth. Partial and complete tooth loss can interfere with the functioning of the aged group, for example in chewing and swallowing, speech and also appearance. As the aged population grows in number, the major challenge is on the burden of illness of oral diseases and treatment needs for the older group. There are also high unmet needs in certain segment of elderly group like the homebound, medically compromised, institutionalized and those deprived socio-economically. Moreover, this group is faced with multiple barriers in accessing oral healthcare thus expanding the gap of inequality in oral health.

Although findings demonstrated significant association between variables, some limitations of the study were observed. First, its cross-sectional design could not establish causal relationship between number of teeth and cognitive function. Longitudinal study with larger sample size may be needed to further explore the relationships. In addition, the assessment of nutritional parameters can be useful as chewing ability is closely related to dietary pattern and nutritional status of older individuals. Information on frailty, clinical co-morbidities and medication were also lacking since these factors can serve as confounders to the study [26]. These factors can be evaluated in future studies. Nevertheless, studies of association between these variables are still limited in the local setting, thus findings from this study can serve as a baseline data for future research.

5. Conclusion
In conclusion, this study concluded that reduced number of teeth among the older adults was significantly associated with cognitive decline. Findings also suggested the importance of maintaining an optimum number of natural and functional dentition into old age for healthier cognitive function.

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