The relationship between DMFT index and cognitive impairment: A descriptive cross-sectional study

Yasaman Mohammadi Kamalabadi¹, Somaye Salari Sedigh², Moein Abbaslou³

¹General Dentist, ²Department of Periodontology, School of Dentistry, Rafsanjan University of Medical Sciences, Rafsanjan, Iran, ³General Dentist, Rafsanjan, Iran

Abstract

Background and Aims: Cognitive disorders are characterized by major impairments in functions such as memory, judgment, language and attention. One of the tests used to assess these disorders is called the Montreal Cognitive Assessment Test, which is one of the most recent tests known in this field. DMFT index is the most important dental index for evaluation of decayed, missing and filled teeth. Since alteration or damage to the sensory function of teeth can cause changes in chewing function and different levels of cognitive disorders. The objective of this study was to determine the relationship of DMFT index with cognitive disorders in people aged 25-55 in Rafsanjan in 2019. **Materials and Methods:** This cross-sectional study was performed on 350 patients chosen by simple random sampling within age range of 25-55 years, referred to Rafsanjan Dental School in 2019. Patients' demographic information was recorded and each was given a consent form and also Montreal Cognitive Assessment Test. Dental examination regarding decayed, missing and filled teeth was then carried out by a dentist and The DMFT index was recorded. Data were then analyzed by SPSS version 21; *P* value less than 0.05 was considered as significant level. **Results:** Data showed that the MOCA index had a negative significant relationship with DMFT (P = 0.001) and age (P = 0.001) and had a significant positive relationship with education (P = 0.001), but it had no significant relationship with gender (P = 0.853), time of last dental appointment (P = 0.231) and place of residence (P = 0.428). The effect of age (P = 0.67) and gender (P = 0.525) on the relationship of DMFT and MOCA was not significant. But the effect of education (P = 0.001), place of residence (P = 0.0003) and time of last dental appointment (P = 0.002) on it was significant. **Conclusion:** The results of this study showed that the relationship between DMFT index and cognitive disorders was significant and the higher the score of this index, the more severe cognitive disorders.

Keywords: Cognitive impairment, DMFT, tooth loss

Introduction

Cognitive impairment is a set of neurologic diseases and disorders that can directly or indirectly (permanently or transiently) disrupt the cognitive function and executive function of the nervous system, causing disturbance in patients' awareness of themselves and the world around them and result is specific behavioral abnormalities that could severely affect the patient's personal and social life.[1] With aging, decreasing changes occur in cognitive tasks which help one to process and transmit information to make decision quickly.[2] The term Mild Cognitive Impairment (MCI) has been used since the early 1990s, but about a decade ago acquired a more specific meaning of "transition" or intermediate state between normal cognition and dementia.[3] The prevalence of MCI ranges from 3% to 42% in various international studies and its incidence per 1000 individuals per year ranges from 22.5 to 60.1 depending on age.[4,5]

In previous studies, several risk factors have been identified for MCI, including educational level, nutrition, older age, hearing

How to cite this article: Kamalabadi YM, Sedigh SS, Abbaslou M. The relationship between DMFT index and cognitive impairment: A descriptive cross-sectional study. J Family Med Prim Care 2020;9:4317-22.

impairment, B12 deficiency and active depression in the past 2 years.[6-8] Furthermore, the relationship between oral health status, especially tooth loss, and cognitive impairment has attracted much attention, with tooth loss reported as a factor associated with cognitive impairment or its exacerbation.[9-15] Although according to a systematic review, it is unclear how oral health is associated with cognitive status,[16] hippocampus which is associated with memory, learning and emotions has been shown to be connected with masticatory system via neural circuits. It is suggested that neuronal and humoral pathways are responsible for interactions amongst these two areas.[17-19]

Although the effects of cognitive impairments on general health have been identified, it is probable that this disorder fails to be diagnosed specially in nursing home residents. American Academy of Neurology declares that the aim of early assessment of cognitive impairment is not usually achieved in everyday clinical practice. Since MCI is likely to progress to dementia early detection of MCI is crucial, so using a simple and rapid cognitive assessment tool is a valuable method in treatment and research.[20-22] Montreal Cognitive Assessment Test is one of the newest known tests in this field and takes about 10 minutes to complete and has 30 points for assessing cognitive impairment. This test can detect mild Alzheimer's cases with 100% sensitivity and 87% specificity. The Montreal test is considered to be the most useful test for assessing mild cognitive impairments.[23]

Since no similar studies have been conducted in the Iranian statistical community so far and as far as we are concerned, most of previous studies have examined the relationship between tooth loss, and not DMFT index, with cognitive impairment, the aim of this study was to determine the relationship between DMFT index and cognitive disorders in 25-55 year old people in Rafsanjan in 2019, seeking future plans for diagnosing dental problems in early stages and conducting primary cares before affecting cognition.

Methods

This cross-sectional study was performed on 350 patients aged 25-55 years referred to Rafsanjan dental school January to April 2019. Ethical approval (IR.RUMS.REC.1398.068) was obtained from Rafsanjan University of Medical Science on 24th December 2018 and the information about the procedure and the test was given to patients and written consents were obtained from them. Then, their demographic data including gender, educational level and place of residence were recorded, they were also asked about the last time they had visited a dentist.

Sample selection

Among patients referring to Rafsanjan Dental School, 350 patients were chosen by simple random sampling. Inclusion criteria included: age between 25 and 55 years, and living in Rafsanjan urban or rural area; exclusion criteria included: being smoker, being medically compromised and unwillingness to participate.

Dental examination

Dental examination was performed by a dentist on a dental unit using mirror and explorer No. 17. DMFT index was used to determine decayed, missed and filled teeth. World Health Organization (WHO) definition was used to detect caries. Accordingly, a tooth was diagnosed as a decayed one if there were lesions in its points and grooves or in the smooth surfaces, if it was temporarily filled, if it was filled by permanent restorative materials and was decayed, if the tip of dental explorer was entered to a hole in proximal surfaces. Otherwise, the tooth was considered healthy.[24] Teeth that did not exist were identified as extracted ones. The age at which the edentulous patients had lost all their teeth and also the date of last dental visit was recorded. The scores were collected and the patient was informed of the result of the test.

Montreal Cognitive Assessment Test

The Montreal Cognitive Assessment Test (MoCA) measures eight cognitive domains through different skills. The highest score on this test is 30. For those with 12 or fewer years of education, one additional score is added. People with a score of 26 and above are considered normal, score of 21 to 25 and 11 to 20 are considered MCI (Mild Cognitive Impairment) and severe cognitive impairment respectively.[23]

Statistical analysis

After collecting the checklists, data were entered into SPSS 21 software (IBM, Armonk, NY, USA). Results were reported for quantitative data as mean and standard deviation and for qualitative data as numbers (%). In case of confirmation of their normal distribution and homogeneity of variances, independent t-test was used. Otherwise, they were analyzed by U Mann-Whitney. Chi-square test or Fisher's exact test were used for data analysis. The relationship of dependent and independent variables was determined by logistic regression test. Significance level was set at 0.05.

Results

Kolmogorov-Smirnov test was used to determine the normality of the data distribution. Results showed that clients' scores in both MoCA and DMFT indices were not normal (p = 0.001). Nonparametric tests such as Mann-Whitney, Kruskal-Wallis and Chi-square tests were therefore used for data analysis.

Of the 350 subjects, 49.1% were men and 50.9% were women (172 men and 178 women), most of whom had a high school diploma level (50.6%) and a city resident (68%). Time of last dental appointment was also divided into three groups, with the highest percentage being in the group over 2 years (48.6%) of which 54.7% were male and 45.3% female [Table 1].

Results of Table 2 indicate that the mean age of the patients was 38.14 ± 7.57 years with no significant difference between men and women (P = 0.58), Montreal Cognitive Assessment

Table 1: Frequency distribution of clients by gender, education, place of residence and time of last dental appointment (*n*=350)

Variable	Gender		Education				Place of residence		Time of last dental appointment		
Quantity	Female	Male	Less than diploma	diploma	Associate Degree	Bachelor	Urban	Rural	<1 year	1-2 years	>2 years
Number	172	178	55	177	53	65	238	112	50	130	170
Percent	49.1	50.9	15.7	50.6	15.1	18.6	68	32	14.3	37.1	48.6

Table 2: Descriptive Indicators, Age, MoCA and DMFT of Clients (n=350)

| Variable Index	Age	MoCA	DMFT
Mean±standard deviation	38.14±7.57	25.52±2.04	18.27±7.23
Minimum	25	17	1
Maximum	55	30	28

D: Decayed, M: Missing, F: Filled, T: Teeth. MoCA: Montreal Cognitive Assessment Test

Test (MoCA) score mean 25.25 ± 2.04 (female 25.50 ± 2.31 and male 25.54 ± 1.74) and mean of DMFT index 18.27 ± 7.23 (female 18.38 ± 7.17 and male 18.16 ± 7.31), there was no significant difference between males and females (P = 0.95).

Mann-Whitney test showed that there was no significant difference between male and female clients in terms of MoCA (P = 0.29) and DMFT (P = 0.94). Also, there was no significant difference between the two groups of those who lived in rural areas and those who lived in urban areas in terms of MoCA (P = 0.23) and DMFT (P = 0.91).

According to Table 3, the results of Kruskal-Wallis test showed that there was a significant difference between clients with different educational levels in terms of MoCA (P = 0.001) and DMFT (P = 0.001). Also, there was a significant difference between the three groups related to the variable "time of last dental appointment" (P = 0.01), but for DMFT index, there was no significant difference between these groups (P = 0.14).

Clients were divided into five groups according to the number of missing teeth: first group (0-4), second group (5-12 missed teeth), third group (13-19 missed teeth), fourth group (20- 27 missed teeth) and the fifth group (28 missed teeth). Frequency distribution of three groups of MoCA index (normal, mild cognitive impairment and severe cognitive impairment) were calculated in these 5 groups. The results showed that the highest percentage of people with normal MoCA index belonged to the first group (84.3%), the second group (81.8%) and the third group (73.4%) and the highest percentage of people with mild cognitive disorders belonged to the fifth group (55%) and the fourth group (45.5%) and the highest percentage of people with severe cognitive disorders belonged to the fifth group (10%). Of the 350 volunteers, 67.4% had normal MoCA score, 28.6% had mild cognitive impairment, and 4% had severe cognitive impairment. The results of Chi-square test showed a significant relationship between MoCA index and the five groups (P = 0.001) [Figure 1].
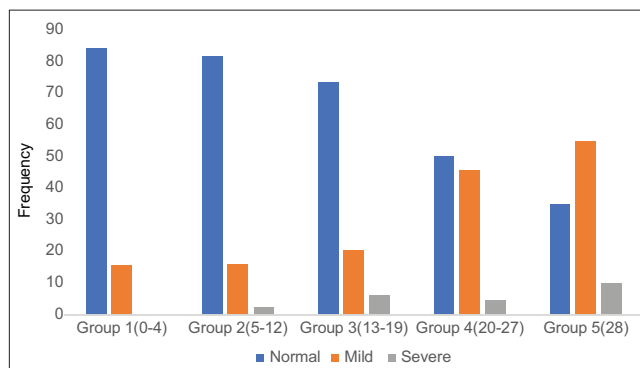
Figure 1: Frequency distribution of MoCA subscales of missing groups . MoCA: Montreal Cognitive Assessment Test

Participants were divided into four groups according to DMFT index: first group (0-8), second group (9-16), third group (17-23) and fourth group (24-28). Frequency distribution of three groups of MoCA index (normal, mild cognitive disorders and severe cognitive impairment) was calculated in these four groups. Results showed that the highest percentage of people with normal MoCA index belonged to the first group 86%, second group 82% and third group 78.2%. The highest percentage of people with mild cognitive disorders belonged to the fourth group (48.1%) and the highest percentage of people with severe cognitive disorders belonged to the fourth group (7.5%). The results of Chi-square test showed a significant relationship between the MoCA index and the 4 groups (P = 0.001) [Figure 2].

Comparing anterior DMFT and MoCA (P = 0.001) and posterior DMFT and MoCA (P = 0.001), both cases showed a significant inverse relationship, which was higher in anterior teeth. Also, comparing MoCA with anterior missing (P = 0.16) and posterior missing (P = 0.001), both showed inverse association, which was not significant in anterior teeth, but it was significant in the posterior teeth.

As shown in Figure 3, regression analysis was used to examine the relationship of the subscales of the DMFT index with the MoCA index in the clients. The data showed that the MoCA index had a significant inverse relationship with Decay (P = 0.001) and Missing) (P = 0.001), but with Filling (P = 0.001) has a significant direct relationship.

To investigate the relationship between DMFT index, age, gender, education, place of residence and time of last dental appointment dentist with MoCA index in patients, regression analysis was used.

Group	Variable	Chi-square statistic	Significance level (sig)
Level of education	MoCA	60.169	0.001
	DMFT	23.423	0.001
time of last dental appointment	MoCA	8.346	0.01
	DMFT	3.892	0.14

D: Decayed, M: Missing, F: Filled, T: Teeth. MoCA: Montreal Cognitive Assessment Test

The data showed that MoCA index was negatively correlated with DMFT index (P = 0.001) and age (P = 0.001) and was positively correlated with education (P = 0.001). There was no significant relationship between gender (0.853), the time of last dental appointment (P = 0.231) and place of residence (P = 0.428) with MoCA index. The relationship between the total score of MoCA and DMFT is shown in Figure 4.

Analysis of variance was used for the evaluation of the effect of age, gender, education, place of residence and time of last dental appointment on the relationship of DMFT index with MoCA. The results showed that the interaction effect of DMFT and age and also gender on MoCA score was not significant (P = 0.67 and P = 0.525, respectively), but the interaction effect of DMFT and education, place of residence and time of last dental appointment on MoCA score was significant (P = 0.001, P = 0.0003 and P = 0.002 respectively).

The results showed a significant relationship between DMFT index and cognitive disorders. There was also a significant relationship between DMFT index and cognitive disorders by education level, time of last dental appointment and place of residence, but no significant relationship was found based on age and gender.

Discussion

Teeth have chewing function and mature memory whose loss or decay causes functional changes in brain. Several studied have been conducted to show the relationship between loss of tooth and different forms of cognitive impairment.[9-13,25] However, DMFT index has not been studied as a related factor to cognition yet.

The aim of this study was to determine the relationship between DMFT index and cognitive disorders in people aged 25-55 in Rafsanjan in 2019. Based on the results of this study, new methods are needed to be designed to conduct early dental treatment in patients with mild cognitive impairments to prevent the more deterioration and to improve the quality of patients' life due to the progressive nature of their disorders.

The results of this study showed a significant relationship between DMFT and cognitive impairment, and there was a significant relationship according to education level, time of last dental appointment and place of residence, but no significant
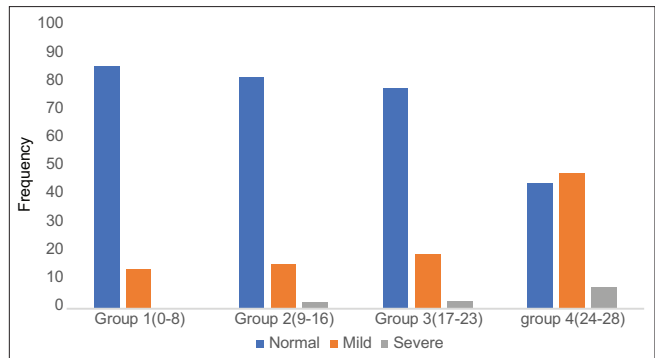

Figure 2: Frequency distribution of MoCA index sub-scales in DMFT groups. D: Decayed, M: Missing, F: Filled, T: Teeth MoCA: Montreal Cognitive Assessment Test
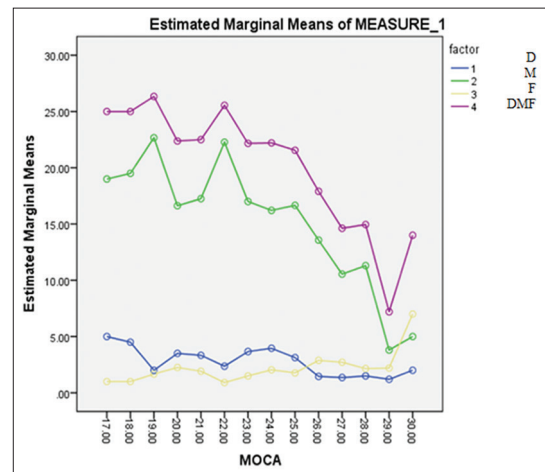

Figure 3: Correlation between DMFT subscales with MoCA . D: Decayed, M: Missing, F: Filled, T: Teeth MoCA: Montreal Cognitive Assessment Test
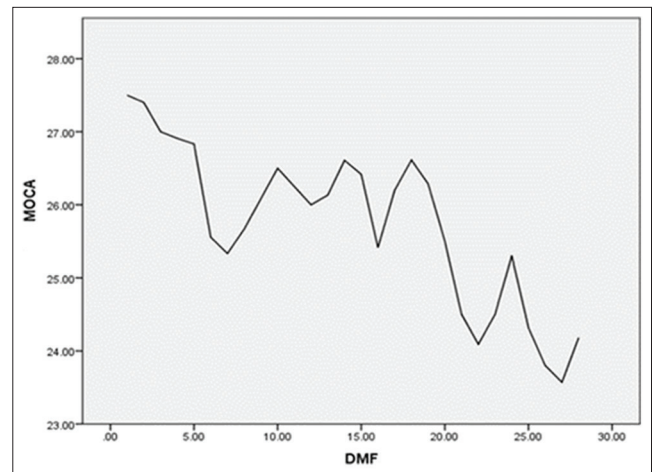

Figure 4: Relationship between DMFT and MoCA indices in clients . D: Decayed, M: Missing, F: Filled, T: Teeth MoCA: Montreal Cognitive Assessment Test

relationship was found by age and gender between DMFT index and cognitive impairment. With respect to the relationship between tooth loss and cognitive status, our study confirms the result of previous studies. Ranjan *et al.* who used Mini-Mental

Status Examination (MMSE) for assessing cognitive impairment concluded that there was a significant association between less number of teeth and lower MMSE score.[12] In their study, Han *et al.* who analyzed 411 people found out that loss of functional teeth and functional occlusal units were associated with lower odds of cognitive impairment.[26] Kato *et al.* reported a significant association between the number of natural teeth and cognitive function, especially the calculation ability.[14] The reasons why cognitive impairment and dental status are associated might be:

1) Previous periodontitis which can results in tooth loss. Some systemic inflammatory markers increase due to periodontal diseases which can affect brain as well.[27,28]

2) Poor nutrition as a result of oral and dental problems. Nutritional problems have been reported as an important factor in cognitive disorders.[29,30]

3) Masticatory dysfunction has been also shown to be a reason for cognitive decline due to morphological change and decreased activity in the hippocampus.[31,32]

The results of this study showed that the interaction between DMFT and gender on MoCA score was not significant. In a study of 557 individuals over 77 years old, Lexomboon *et al.* examined the relationship between chewing ability and missing teeth with cognitive impairments in the elderly population and realized that gender did not explain the relationship between chewing ability and cognitive impairment which was similar to our study.[33] However, the finding of ALFotawi *et al.* was not the same as ours, they found out that cognitive impairments were significantly higher in women with less teeth than in men, which may be due to their hormonal status.[34]

The results of the study showed that more literate people had more teeth and less cognitive impairment. Ismail F *et al.* examined cognitive performance and tooth loss in relation to education level. They concluded that people with lower educational and socioeconomic level had poorer cognitive function status (Lower MMSE score), which was similar to our study.[35] Nevertheless, Lexomboon *et al.* in a study of the relationship between chewing ability and missing teeth with cognitive impairments in elderly population came to the conclusion that education did not explain the relationship between chewing ability and cognitive impairment, which was not consistent with our results. It might be due to the older statistical population in their study.[33]

Our study also showed that there was a significant relationship between the MoCA index and the 4 DMFT groups. The highest percentage of people with normal MoCA index belonged to the first group (0-8), the second group (9-16) and the third group (17-23). The highest percentage of people with mild and severe cognitive disorders belonged to the fourth group (24-28). No similar or opposite study was found.

The limitations of this study include the small sample size and that it is a cross-sectional study so in spite of understanding that DMFT and cognitive impairment are associated, it cannot be determined which one is the cause of the other one. Strengths of our study are that teeth were examined by a dentist and it was not based on self-report, and also we have investigated other dental status such as decays and fillings in addition to tooth loss because even pain caused by caries might cause nutritional problems and amalgam restorations have been shown to increase the likelihood of Alzheimer's disease.[36]

Based on the results of this study, cognitive function and dental status are associated and the deterioration of one can have negative impact on the other one. It seems that dentists play an important role in assessing dental status of patients, enriching their knowledge about dental health care and also providing primary preventive dental care to decline probable subsequent effects on cognition.

Conclusion

In conclusion, DMFT was associated with cognitive impairment, the higher the score of DMFT index is, the more severe cognitive impairment is. Cognitive conditions and DMFT were also evaluated in relation to age, place of residence, educational level and time of last dental appointment, the last two ones were found to be associated. Further longitudinal studies with larger sample sizes are needed to evaluate the causal relationship of dental and cognitive status.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Conflicts of interest

There is no conflicts of interest.

References

1. Alicata D, Jacobs N. Problem-Based Behavioral Science and Psychiatry. In: Guerrero A, Piasecki M, editors. New York; Springer; 2008.

2. Harada CN, Love MC, Triebel KL. Normal cognitive aging. Clin Geriatr Med 2013;29:737-52.

3. Kelley BJ, Petersen RC. Alzheimer's disease and mild cognitive impairment. Neurol Clin 2007;25:577-609.

4. Ward A, Arrighi HM, Michels S, Cedarbaum JM. Mild cognitive impairment: Disparity of incidence and prevalence estimates. Alzheimers Dement 2012;8:14-21.

5. Gillis C, Mirzaei F, Potashman M, Ikram MA, Maserejian N. The incidence of mild cognitive impairment: A systematic review and data synthesis. Alzheimers Dement (Amst) 2019;11:248-56.

6. Salama II, Salama SI, Elmosalami DM, Saleh RM, Rasmy H, Ibrahim MH, *et al.* Risk factors associated with mild cognitive impairment among apparently healthy people and the role of MicroRNAs. Open Access Maced J Med Sci 2019;3:3253-61.

7. Xu Z, Zhang D, Sit RW, Wong C, Tiu JY, Chan DC, *et al.* Incidence of and risk factors for mild cognitive impairment in Chinese older adults with multimorbidity in Hong Kong. Sci Rep 2020;10:4137.

8. Gallagher D, Kiss A, Lanctot KL, Herrmann N. Toward prevention of mild cognitive impairment in older adults with depression: An observational study of potentially modifiable risk factors. J Clin Psychiat 2018;80:18m12331. doi: 10.4088/JCP.18m12331.

9. Tsai YC, Wang HJ, Wang LY, Shaw CK, Lee YP, Lin MC, *et al.* Retrospective analysis of the association between tooth loss and dementia: A population-based matched case-control study. Community Dent Health 2020;37:59-64.

10. Tsakos G, Watt RG, Rouxel PL, de Oliveira C, Demakakos P. Tooth loss associated with physical and cognitive decline in older adults. J Am Geriatr Soc 2015;63:91-9.

11. Li J, Xu H, Pan W, Wu B. Association between tooth loss and cognitive decline: A 13-year longitudinal study of Chinese older adults. PLoS One 2017;12:e0171404. doi: 10.1371/journal.pone. 0171404.

12. Ranjan R, Rout M, Mishra M, Kore SA. Tooth loss and dementia: An oro-neural connection. A cross-sectional study. J Indian Soc Periodontol 2019;23:158-62.

13. Abdulhade Ganem A, Sandeepa NC, Hassan Alkhayri A, Mohammed Mousa Y. Impact of tooth loss and other risk factors on cognitive impairment in Saudi female population. Neurosci J 2019;2019:6086515. doi: 10.1155/2019/6086515.

14. Kato H, Takahashi Y, Iseki C, Igari R, Sato H, Sato H, *et al.* Tooth loss-associated cognitive impairment in the elderly: A community-based study in Japan. Intern Med 2019;58:1411-6.

15. Goto T, Leung WK. Tooth loss and Alzheimer's disease. Curr Oral Health Rep 2019;6:82-8.

16. Wu B, Fillenbaum GG, Plassman BL, Guo L. Association between oral health and cognitive status: A systematic review. J Am Geriatr Soc 2016;64:739-51.

17. Iinuma M, Kondo H, Kurahashi M, Ohnishi M, Tamura Y, Chen H, *et al.* Relationship between the early toothless condition and hippocampal functional morphology. Anat Physiol 2014;4:8-13.

18. Tyng CM, Amin HU, Saad MN, Malik AS. The influences of emotion on learning and memory. Front Psychol 2017;8:1454.

19. Krishnamoorthy G, Narayana AI, Balkrishanan D. Mastication as a tool to prevent cognitive dysfunctions. Jpn Dent Sci Rev 2018;54:169-73.

20. Westerlind B, Östgren CJ, Midlöv P, Marcusson J. Diagnostic failure of cognitive impairment in nursing home residents may lead to impaired medical care. Dement Geriatr Cogn Disord 2019;47:209-18.

21. Rae-Grant A, Bennett A, Sanders AE, Phipps M, Cheng E, Bever C. Quality improvement in neurology: Multiple sclerosis quality measures: Executive summary. Neurology 2015;85:1904-8.

22. Fong TG, Jones RN, Rudolph JL, Yang FM, Tommet D, Habtemariam D, *et al.* Development and validation of a brief cognitive assessment tool: The sweet 16. Arch Intern Med 2011;171:432-7.

23. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, *et al.* The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695-9.

24. World Health Organization. Oral health surveys: Basic methods-5th ed.ition 2013. Available from: https://apps.who.int/iris/handle/10665/97035.

25. Chen H, Iinuma M, Onozuka M, Kubo KY. Chewing maintains hippocampus-dependent cognitive function. Int J Med Sci Public Health 2015;12:502-9.

26. Han JH, Lee HJ, Han JW, Suh SW, Lee JR, Byun S, *et al.* Loss of functional dentition is associated with cognitive impairment. J Alzheimers Dis 2020;73:1313-20.

27. Bretz WA, Weyant RJ, Corby PM, Ren D, Weissfeld L, Kritchevsky SB, *et al.* Systemic inflammatory markers, periodontal diseases, and periodontal infections in an elderly population. J Am Geriatr Soc 2005;53:1532-7.

28. Ide M, Harris M, Stevens A, Sussams R, Hopkins V, Culliford D, *et al.* Periodontitis and cognitive decline in Alzheimer's disease. PLoS One 2016;11:e0151081.

29. Wong JC, Scott T, Wilde P, Li YG, Tucker KL, Gao X. Food insecurity is associated with subsequent cognitive decline in the Boston Puerto Rican Health Study. J Nutr 2016;146:1740-5.

30. Sanders C, Behrens S, Schwartz S, Wengreen H, Corcoran CD, Lyketsos CG, *et al.* Nutritional status is associated with faster cognitive decline and worse functional impairment in the progression of dementia: The cache county dementia progression study 1. J Alzheimers Dis 2016;52:33-42.

31. Lin CS. Revisiting the link between cognitive decline and masticatory dysfunction. BMC Geriatr 2018;18:5.

32. Fukushima-Nakayama Y, Ono T, Hayashi M, Inoue M, Wake H, Ono T, *et al.* Reduced mastication impairs memory function. J Dent Res 2017;96:1058-66.

33. Lexomboon D, Trulsson M, Wårdh I, Parker MG. Chewing ability and tooth loss: Association with cognitive impairment in an elderly population study. J Am Geriatr Soc 2012;60:1951-6.

34. ALFotawi R, Alzahrani S, Alhefdhi R, Altamimi A, Alfadhel A, Alshareef A, *et al.* The relation between teeth loss and cognitive decline among Saudi population in the city of Riyadh: A pilot study. Saudi J Dent Res 2019. doi: 10.1016/j.sdentj. 2019.09.007.

35. Ismail F, Muneer MU, Ahmed AR, Hussain MW, Farhan M, Khan MU, *et al.* Factors affecting cognition in individuals with tooth loss. Ann Dent Spec 2019;7:7.

36. Sun YH, Nfor ON, Huang JY, Liaw YP. Association between dental amalgam fillings and Alzheimer's disease: A population-based cross-sectional study in Taiwan. Alzheimers Res Ther 2015;7:65.