Original Article

Oral Health-related Quality of Life in Thai Older People with Metabolic Syndrome

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Abstract

This study evaluated oral health-related quality of life (OH-QoL) and factors related in Thai older people with and without metabolic syndrome (MS). Participants were Thai older people and their data were collected. MS was diagnosed; oral status and oral dryness were determined. OH-QoL was evaluated by the oral health impact profile index (OHIP-14). Forty-four (62.0 %) participants with MS and 27 (38.0 %) healthy older people were recruited. The age range of the participants was 60-86 years. Patients with MS had fewer sleeping hours than patients without MS but had higher tooth diseases. (p=0.009 and p=0.022, respectively) Oral dryness was significantly higher in patients with MS than in patients without MS. (p=0.007) A negative impact on the quality of life evaluated by OHIP-14 scoring 3-4 tended to be found more frequently in participants with MS. (p=0.041) An average score of each item in older persons with MS was more prominent than that of the non-MS group. However, the total score for the assessment of OH-QoL severity was a marginally significant difference. (p=0.055) The odds ratio for the response at OHIP-14 scoring 4 as predicted by waist circumference (WC), oral dryness and sleeping hours was 1.15 (95%CI:1.04,1.27), 0.61 (95%CI:0.38,0.99) and 0.32 (95%CI:0.14,0.71), respectively. Nevertheless, if the outcome for the response at OHIP-14 scoring 3-4 was determined, oral dryness factor disappeared. Therefore, older people with MS have an increasing undesirably negative impact on OH-QoL, influenced by WC, oral dryness, and sleeping hours.

Keywords: aged, metabolic syndrome, oral health, quality of life

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Introduction

Metabolic syndrome (MS) is a group of disorders that increase the risk of cardiovascular disease (CVD), diabetes mellitus (DM) and other health problems. The components of MS include central obesity, hyperglycemia, raised blood pressure (BP), and dyslipidemia (DLP), i.e. elevated levels of triglyceride (TG) but low levels of high-density lipoprotein cholesterol (HDL-C).[1]

There are particular studies of linking oral health with MS.[2,3] Chomkhakhai *et al.* reported oral health status in Thai patients with MS.[2] Approximately half of the patients with MS presented with dental caries, periodontitis, dry mouth, oral mucosal changes; and approximately one fourth had a high Candida level. In addition, 62.6 % of MS patients were more than 60 years old and discussed that the prevalence of MS and CVD were higher in Thai older people.[2] Thanakun *et al.* found that MS was strongly associated with severe periodontitis and MS with 4-5 components were higher associated with severe periodontitis than MS with three components.[3]

Apart from studies concerning the relationship between MS or pre-existing risks of MS and oral health, several studies focus on health-related quality of life (HR-QoL) and oral-health related quality of life (OH-QoL). The associations of MS or MS components, comprising of DM, obesity, HT and DLP, with low QoL have been reported.[4-7] However, the studies regarding the association between MS component and OH-QoL are not widely mentioned. The study of MS entity and OH-QoL was not established. Allen *et al.* showed a moderate impact of DM on OH-QoL, specifically dietary dissatisfaction.[8] Makhija *et al.* found a statistically significant association of BMI with OH-QoL.[9] Mehta reported edentulism, either partial or complete, can affect not only oral health but the general health of a person.[10] Motallebnejad *et al.* showed older people had an undesirable impact on OH-QoL.[11] Besides, some studies demonstrate the relationship of oral mucosal dryness that may occur in older people or other conditions with MS or pre-existing risks.[2,12] Previous studies also exhibit that dry mouth provokes a negative impact on OH-QoL.[13,14]

As aforementioned, half of the Thai patients with MS were older people and had oral problems.[2] Moreover, patients with a history of MS component usually had impaired OH-QoL.[8,9] However, the study of OH-QoL in older people with MS has not been presented. Therefore, this study aims to evaluate OH-QoL in older Thai people with MS and compare OH-QoL between older Thai people with MS and without MS. The factors related to OH-QoL in older Thai people with MS are determined.

Materials and Methods

Patient selection / Ethics approval

The participants screened in this study were 180 older Thai patients who came to the Geriatric Dentistry and Maxillofacial Prosthetic Clinic of Maha Chakri Sirindhorn Dental Hospital, Faculty of Dentistry, Mahidol University from October 2019 to February 2020. The inclusion criteria were older Thai people who were over 60 years old. All participants had to provide a laboratory profile and have no history of dental treatment within the prior six months. The results must comprise the levels of HDL-C, TG and fasting plasma glucose (FPG). The exclusion criteria were patients with a history of radiotherapy in the head and neck regions, had chemotherapeutic treatment during the previous three months, or the presence of diseases of the salivary gland.

The study was approved by the Ethics Committee of the Faculty of Dentistry, Mahidol University, and conformed with the Declaration of Helsinki (MU-DT/PY-IRB 2019/048.3107).

Assessment of patients' data

Age, sex, occupation, marital status, education level, living status, general and dental health care financial status were obtained from interviews.

Assessment of general health

Participants with MS were diagnosed from remarkable laboratory profile or a medical history of three or more of the following criteria; 1) elevated TG: ≥150 mg/dL or on drug treatment for elevated TG, 2) reduced HDL-C: <40 mg/dL in men or <50 mg/dL in women or on drug treatment for

reduced HDL-C, 3) elevated BP: ≥130 mm Hg systolic BP or ≥85 mm Hg diastolic BP or on antihypertensive drug treatment in a patient with a history of HT, 4) elevated FPG: ≥100 mg/dL or on drug treatment for elevated glucose, 5) increased WC: ≥ 90 cm in men or ≥80 cm in women. [1]

The data of patients' travel type (independent or dependent), exercise behaviors (30-40 minutes per exercise time; <3 times weekly and ≥3 times weekly), sleeping time (hours), alcohol consumption (yes, former or never), smoking, medical problems and drug use were recorded. Height and weight were measured and calculated to BMI. BMI is calculated by dividing weight (kilogram) with height (meter) squared. For participants who are unable to stand upright, height was asked from the participant or the data of the ID card.

Assessment of oral health

The data, including the number of tooth diseases, number of tooth loss and remaining teeth, the Periodontal Screening and Recording Index (PSR) score, and oral mucosal dryness, were examined by one investigator (NK).

Tooth diseases consisted of dental caries, broken teeth, tooth wear, pulpal and periapical tissue diseases. The number of tooth loss and remaining teeth were also counted. Remaining teeth included sound teeth and retained root. The third molar was omitted from the study.

Periodontal status was evaluated by the PSR index. The method is based on the following three periodontal disease indicators: gingival bleeding on probing, calculus accumulation and probing depth. The mouth is divided to six sextants (tooth 18-14,13-23,24-28,34-38,33-43 and 44-48). Each tooth is examined and marked from code 0 to code 4, but only the highest score of the sextant is recorded. PSR code definitions are; code 0 showed absence of any clinical signs, code 1 showed bleeding on probing, code 2 showed supra and/or subgingival calculus and/or defective margins, code 3 showed periodontal pocket 4-5.5 millimeter (mm.) in depth (coloured band on probe partially visible), and code 4 showed periodontal pocket 6 mm. in depth or more (colored band no longer visible).[15] Sextants with fewer than two teeth are scored with an 'X' and are not considered in the overall evaluation.[15] PSR scores of 3 in two or more sextants or a PSR score of 4 in any sextant was diagnosed periodontitis.[15]

Oral mucosal dryness was determined from the Xerostomia Inventory (XI-11) questionnaire and the Clinical Oral Dryness Scoring (CODS).[16,17] Participants were interviewed face to face following the questions by the principal investigator (NK). The answer to each question of XI-11 (Thai-version) showed the frequency of symptoms in the preceding four weeks. The score of Likert-scale response to XI-11 is in the range of 11-55, a higher total score represented more xerostomia than a lower score.[16]

Hyposalivation was examined and interpreted using the CODS by one investigator (NK). Each feature which is clinically presented from ten items has 1 score. The total score is counted and valued from 1 to 10. A high total score indicates increased severity of oral dryness.[17]

Assessment of oral health-related quality of life

OH-QoL was determined by Oral Health Impact Profile (OHIP)-14 index developed by Slade.[18] The OHIP-14 related QoL index-Thai version was validated by Chatalongkorn in 2017 and used in this study.[19] Participants were interviewed face to face with the questions by the principal investigator (NK). The answer to each question showed the frequency of perception in the preceding four weeks. The OHIP-14 related QoL index consists of seven domains. Each domain consisted of two questions. Responses of 14 items were graded on a Likert-type scale ranging from 0 to 4; score 4 = "very often", 3 = "fairly often", 2 = "occasionally", 1 = "hardly ever" and 0 = "never".[18] For OHIP-14 related QoL index analysis, two aspects were analyzed, which were prevalence and severity. Prevalence is the percentage of participants whose response scored 3-4 (fairly often/very often) in at least one item.[20] Severity is the total score of Likert-scale response to OHIP-14 related QoL index, with the maximum score of 56.[20] A higher total score represented a more negative impact on QoL than a lower score.

Statistical analyses were performed using the SPSS software (IBM SPSS statistics version 26.0; SPSS Inc.) Descriptive statistics were used for evaluation OH-QoL in

older Thai people. Pearson's chi-square test, Fisher's Exact Test, Spearman's correlation and Mann-Whitney U test were analyzed where appropriate. Multivariate analysis was applied to determine the factors related to OH-QoL. Scoring 3-4 or 4 which represent negative impact to QoL were used as dependent variables. Significant factors from clinical relevance or bivariate-statistical analysis were put into the model as independent variables.

Results

Characteristics of the study population

Forty-four participants (62.0 %) were diagnosed with MS if they had three or more of the five components from a remarkable laboratory profile or history of drug use. Of these, twenty-four participants (33.8 %) had abnormal laboratory profiles of being diagnosed with MS and using drugs. Eleven (15.5 %) older people had an average laboratory profile and were being treated for MS. Nine (12.7 %) participants had abnormal laboratory profiles probably diagnosed with MS and no history of using drugs. There were 27 (38.0 %) non-MS participants whose laboratory profiles have not met the criteria for MS diagnosis and no history of any medicine.

Seventy-one participants were between 60-86 years of age. There were no statistical differences for age and sex of the two studied groups. General health laboratory profile used for the diagnosis of MS was significantly different between the non-MS and the MS groups. The average severity score of OHIP-14 related QoL index, which impacted the quality of life, had a marginally significant increase in participants with MS (p=0.055). (Table 1)

Table 1 *Characteristics of the participants [median (first,third quartile) or n (%)] according to non-MS or MS*

	Participants (N=71)		*p*-value
	Non-MS (n=27)	MS (n=44)	
Age	64.0 (62.0,68.0)	65.5 (62.0,69.0)	0.148
Sex			
Male	11 (40.74%)	26 (59.09%)	0.150
Female	16 (59.26%)	18 (40.91%)	
BMI (kg/m2)	23.1 (21.2,24.8)	25.6 (23.9,29.1)	< 0.001*
WC (cm)			
Male	86.2 (78.5,90.9)	90.7 (85.5,98.5)	0.023*
Female	79.6 (74.2,83.6)	86.2 (82.8,89.4)	0.003*
FPG (mg/dL)	95 (91,109)	106 (98,118)	0.001*
HDL (mg/dL)			
Male	57 (53,68)	50 (44,56)	0.005*
Female	68 (53,79)	49 (46,55)	0.001*
TG (mg/dL)	77 (59,110)	124 (92,173)	< 0.001*
SBP (mmHg)	125 (111,129)	130 (123,141)	0.004*
DBP (mmHg)	74 (68,82)	81 (73,88)	0.051
Medication for DM			
No	26 (96.30%)	34 (77.27%)	0.043*
Yes	1 (3.70%)	10 (22.73%)	
Medication for DLP			
No	23 (85.19%)	15 (34.09%)	< 0.001*
Yes	4 (14.81%)	29 (65.91%)	
Medication for HT			
No	23 (85.19%)	19 (43.18%)	< 0.001*
Yes	4 (14.81%)	25 (56.82%)	
OHIP-14 severity score	1 (0,3)	3 (0,11)	0.055

** Significant level at p<0.05*

There were no dissimilarities in education, finance, or personal habits of the two studied groups. However, sleeping hours were a predominantly significant variable in which patients without MS had more sleeping hours than patients with MS (p=0.009). (Table 2)

Table 2 *Personal, family and social history of older participants with and without MS [median (first,third quartile) or n (%)]*

	Participants (N=71)		*p*-value
	Non-MS (n=27)	MS (n=44)	
Education			
Less than bachelor's degree	5 (18.52%)	13 (29.55%)	0.403
Bachelor's degree or higher	22 (81.48%)	31 (70.45%)	
Living			
Alone	3 (11.11%)	6 (13.64%)	1.000
Family	24 (88.89%)	38 (86.36%)	
Health financial			
Independent	6 (22.22%)	9 (20.45%)	0.927
Dependent	10 (37.04%)	15 (34.09%)	
Welfare	11 (40.74%)	20 (45.45%)	
Dental financial			
Independent	15 (55.56%)	16 (36.36%)	0.285
Dependent	3 (11.11%)	7 (15.91%)	
Welfare	9 (33.33%)	21 (47.73%)	
Travel			
Independent	26 (96.30%)	42 (95.45%)	1.000
Dependent	1 (3.70%)	2 (4.55%)	
Exercise			
Less than 3 days/week	17 (62.96%)	30 (68.18%)	0.797
3 days or more/week	10 (37.04%)	14 (31.82%)	
Alcohol consumption			
Current	13 (48.15%)	17 (38.64%)	0.054
Former	2 (7.41%)	14 (31.82%)	
Never	12 (44.44%)	13 (29.55%)	
Smoking			
Current and former	4 (14.81%)	17 (38.64%)	0.070
Never	23 (85.19%)	27 (61.36%)	
Sleeping hours	7.0 (6.0,7.5)	6.0 (5.0,7.0)	0.009*

** Significant level at p<0.05*

Characteristics of oral condition

The number of tooth diseases shows a significant difference between people with and without MS (p=0.022). Participants with MS had more tooth diseases than individuals without MS. Also, there was a marginally significant increase (p=0.054) in the number of missing teeth in the MS group. Nevertheless, periodontal status or denture wearing were not different between these two groups. (Table 3)

Table 3 *Characteristics of the oral condition of participants according to non-MS and MS [median (first,third quartile) or n (%)]*

	Participants (N=71)		*p*-value
	Non-MS (n=27)	MS (n=44)	
Number of tooth disease	7 (3,13)	12 (7,17)	0.022*
Missing tooth	2 (1,5)	5 (1,8)	0.054
Periodontal status			0.127
Gingivitis	21 (77.78%)	26 (59.09%)	
Periodontitis	6 (22.22%)	18 (40.91%)	
Denture wear			
Upper	3 (11.11%)	5 (11.36%)	1.000
Lower	1 (3.70%)	1 (2.72%)	1.000
Upper and Lower	2 (7.41%)	7 (15.91%)	0.467
Total XI-11 score	17 (15,21)	17 (15,22)	0.953
Total CODS	0 (0,1)	1 (0,4)	0.007*

** Significant level at p<0.05*

Oral mucosal dryness

Xerostomia, represented by the total sum of XI-11 score in each patient, was not statistically distinctive between the researched groups (p=0.953). However, oral mucosal dryness determined by CODS was significantly higher in patients with MS than in patients without MS (p=0.007) as shown in Table 3.

There was a higher prevalence of xerostomia in participants with MS compared to patients without MS (Fig. 1); however, with varying frequency from never to very often. Nevertheless, the second highest categorical summation that represented more severe xerostomia was still of the participants with MS. (Fig. 1)

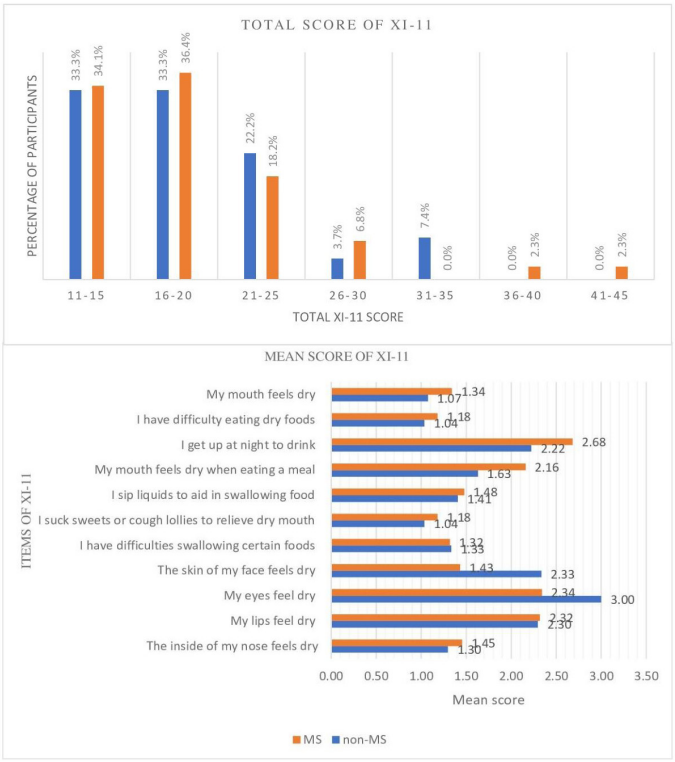

Figure 1 *Percentage of participants according to the total sum of the XI-11 score and the mean score of XI-11 according to items*

Regarding CODS, though the highest percentage of participants with score 0 or no signs of dry mouth were participants with non-MS, the percentage of participants with MS who revealed the signs of oral dryness varied from 1 to 6 items. The results were higher than those of the non-MS group. (Fig. 2) For the mean score of CODS, there was the same trend as the percentage of CODS. Participants with MS had a higher mean score of oral dryness than participants without MS in all items except the last item (Debris on palate) that did not reveal in both groups. (Fig. 2) These results demonstrate that participants with MS had more significant signs of dry mouth than participants without MS.

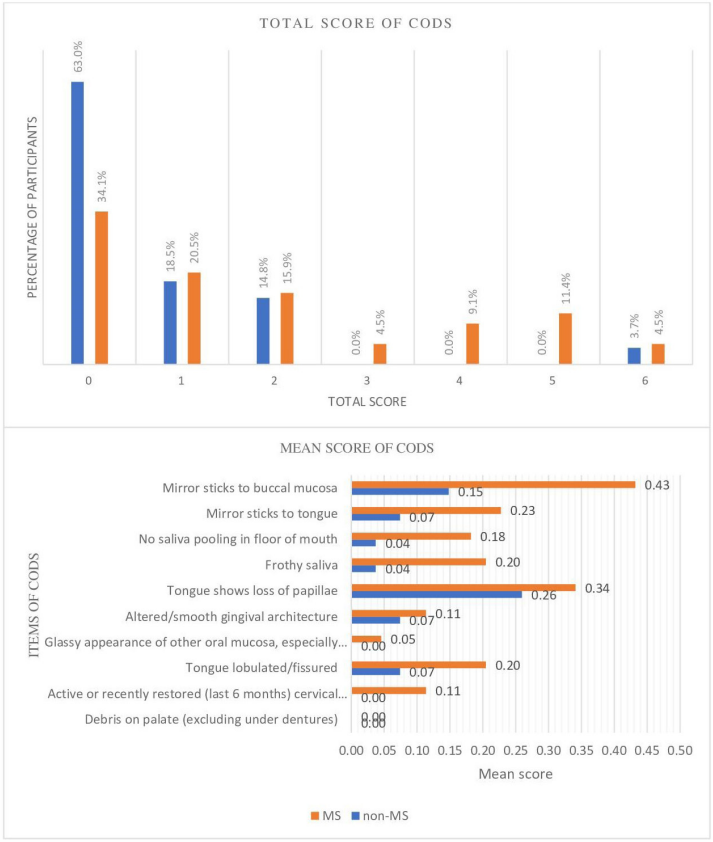

Figure 2 *Percentage of participants according to total score of CODS and mean score of CODS according to items*

Oral health-related quality of life

The prevalence of OHIP-14 related QoL index scoring 3-4 in the MS group was 19 (43.81 %), which was higher than that of the non-MS group [5 (18.52 %)] (p=0.041). (Table 4) Consequently, a negative impact on the quality of life evaluated by OHIP-14 related QoL index tends to be found more frequently in participants with MS, compared with the ones without MS.

Table 4 *The prevalence of participants [n (%)] whose response to OHIP-14 related QoL index at score 3 and 4 at least 1 item ac cording to non-MS and MS*

OHIP-14	Participants (N=71)		*p*-value
	Non-MS (n=27)	MS (n=44)	
score 3-4	5 (18.52%)	19 (43.18%)	0.041*
score 0-2	22 (81.48%)	25 (56.82%)	

** Significant level at p<0.05*

For the severity of OHIP-14 related QoL index, when the sum score was divided to a different interval of severity, it is demonstrated that the percentage of participants with MS in every categorical score, except the lowest one (score-range 0-4) were superior to non-MS. (Fig. 3) According to 14 items, i.e. 7 domains of OHIP-14 related QoL index, an average score of each item in the older persons with MS was more prominent than that of the non-MS group. Thus, the participants with MS had a more unpleasant quality of life from oral health than participants without MS. For domain 2 (physical pain), the average score was the highest in both studied groups. If each item is considered, the highest mean score was item 4 in MS and non-MS persons. (Fig. 3)

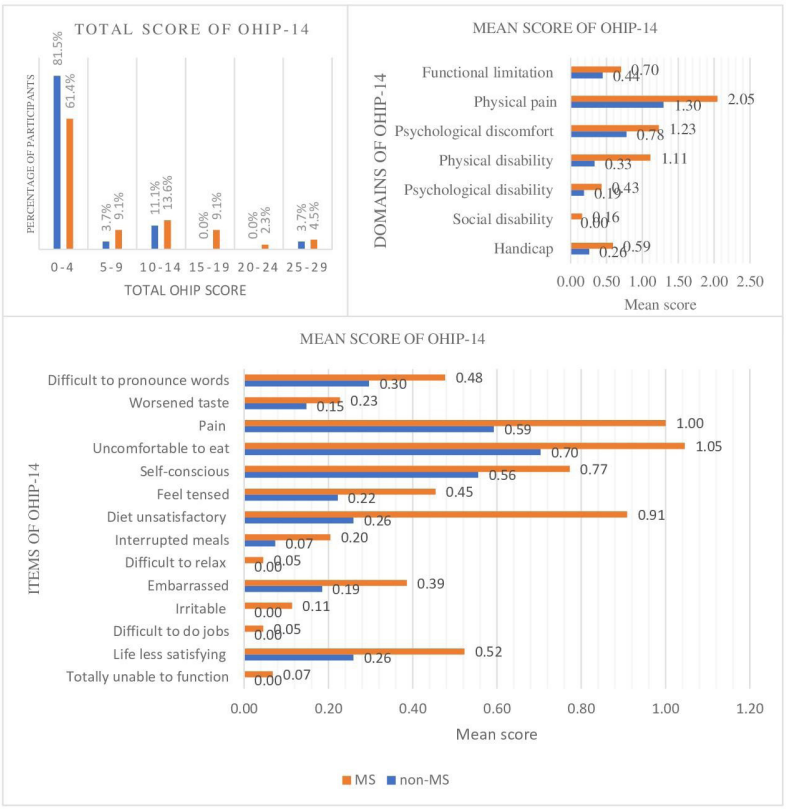

Figure 3 *Percentage of participants according to the OHIP-14 related QoL index total score, the average score of OHIP-14 related QoL index according to 14 items and 7 domains*

Association of OHIP-14 related QoL index with relevant factors

After controlling for MS factor, the correlations of the severity of the score of OHIP-14 related to the QoL index with total XI-11 (r=0.482, p<0.001), number of missing teeth (r=0.251, p=0.036) and sleeping hours (r=-0.283, p=0.017) are depicted. (Fig. 4) Therefore, if participants had a lot of xerostomia or a number of missing teeth, they would have a greater impact on OH-QoL. On the other hand, if participants had more sleeping hours, they would have less impact on OH-QoL. Besides, the positive association of the total XI-11 score and the total CODS amount were significantly presented. (Fig. 4)

Finally, the variables that were associated with the outcome for the response at OHIP-14 related QoL index scoring 3-4 (fairly often/very often) or scoring 4 (very often) for at least one item, were assessed by logistic regression analysis. (Table 5) The OR for the response at OHIP-14 related QoL index scoring 4 as predicted by WC, CODS and sleeping hours, after adjusting for all related factors was 1.15 (95% CI: 1.04, 1.27), 0.61 (95% CI: 0.38, 0.99) and 0.32 (95% CI: 0.14, 0.71), respectively. (Table 5)

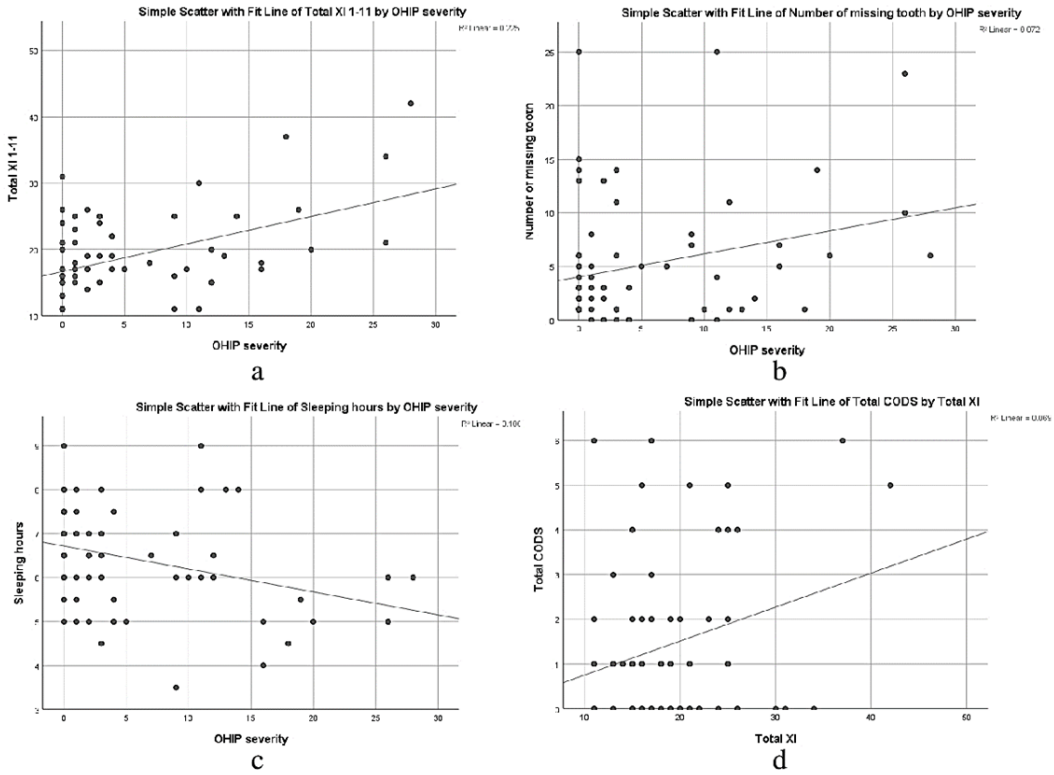

Figure 4 *Correlation of the severity of OHIP-14 related QoL index with the total XI-11 score, the number of missing teeth and sleeping hours (Fig. 4 a,b,c); total XI with total CODS amount (Fig. 4d)*

Nevertheless, if the outcome for the response at OHIP-14 related QoL index scoring 3-4 (fairly often/very often) was determined, only WC and sleeping hours were the associated factors related to the unfavorable quality of life. For every centimeter increase of WC, the chance of unfavorable quality of life will increase 1.12 times (OR 1.12 (95% CI: 1.02, 1.22). Whereas every one hour increase of sleep, the chance of an unfavorable quality of life will decrease by 58% [OR 0.42 (95% CI: 0.21, 0.81)]. (Table 5)

Table 5 *Logistic regression analysis for OHIP-14 related QoL index and associated factors [odds ratio (95% confidence interval)] (n=71)*

	OHIP-14: scoring 4			OHIP-14: scoring 3-4		
	B	OR (95% CI)	*p*-value	B	OR (95% CI)	*p*-value
Age (years)	0.09	1.10 (0.95,1.27)	0.209	0.08	1.09 (0.96,1.24)	0.206
Sex (female)	0.21	1.23 (0.19,7.94)	0.825	0.37	1.45 (0.29,7.34)	0.652
WC (cm)	0.14	1.15 (1.04,1.27)	0.007*	0.11	1.12 (1.02,1.22)	0.015*
FPG (mg/dL)	-0.00	0.99 (0.96,1.04)	0.927	0.01	1.01 (0.98,1.04)	0.531
HDL (mg/dL)	-0.02	0.99 (0.93,1.04)	0.577	-0.01	0.99 (0.95,1.05)	0.848
TG (mg/dL)	0.00	1.00 (0.99,1.01)	0.729	0.00	1.00 (0.99,1.01)	0.972
SBP (mmHg)	-0.01	0.99 (0.93,1.05)	0.634	-0.01	0.99 (0.94,1.05)	0.789
DBP (mmHg)	0.03	1.03 (0.94,1.03)	0.557	0.01	1.01 (0.93,1.10)	0.796
CODS	-0.50	0.61 (0.38,0.99)	0.044*	-0.19	0.83 (0.57,1.21)	0.331
Tooth disease	-0.03	0.97 (0.86,1.09)	0.579	-0.07	0.93 (0.83,1.04)	0.215
Sleeping hours	-1.14	0.32 (0.14,0.71)	0.005*	-0.88	0.42 (0.21,0.81)	0.009*

** Significant level at p<0.05*

Discussion

To the best of our knowledge, this is the first study to report that older Thai people with MS have an undesirable QoL affected by oral health. Seventy-one older Thai people aged over 60 years old were studied. The ratio of patients with MS was 62 %, which is comparable to the prevalence (69.1 %) of older people with MS in the study of Saad *et al.* that used the same criteria.[21] The matching median age of participants was revealed, 65.5 years in the MS group and 64.0 years in the non-MS group, with no difference between sexes. BMI, WC, FPG, TG and BP in the MS group were higher than the non-MS group that can confirm the exact recruitment of participants for the study. This is consistent with another study that older people with MS had a significant difference in these components.[22]

Personal data of the older participants in both groups were not different except for sleeping hours, the average duration of sleeping time at night. Sleeping hours was the rigorous factor that was statistically significant in all analysis. Our result is consistent with the study of Magee *et al.,* which looked at the relationships between QoL and sleep duration in elderly Australians.[23] They found that short sleep (≤6 hours) were significantly associated with lower QoL. Although the present study recorded only sleeping duration that was the one part of Sleep Quality Index, Sato *et al.* also demonstrated that people with low QoL determined by OHIP-14 related QoL questionnaire exhibit poor sleep quality.[24]

Regarding the sleeping on MS component, some studies have reported similar relationships. The study of Grandner *et al.* showed that short sleep is associated with HT, hyperlipidemia, DM, and obesity.[25] Among older people, short sleep duration and poor sleep quality can increase life dissatisfaction.[26] The higher chance of irregular sleeping hours may occur in unhealthy and older people than healthy or less unhealthy people of a younger age. Because the median sleeping hours in the participants with negative impact and no impact on OH-QoL were 6 and 7, respectively in the current study, the assumption based on previous and the present studies is that the favorable average sleeping duration of older people should exceed seven hours.[21-2423-26] This period can probably improve their QoL and OH-QoL. However, this study did not record the use of medication for sleep such as hypnotic or antidepressant drugs which are sometimes used by older people. Future data on medication for sleep might better indicate an association between sleeping and HR-QoL or OH-QoL.

The number of tooth diseases in the MS group was higher than those in the non-MS group. Medication for MS induced hyposalivation might decrease the self cleansing mechanism and enhance dental caries susceptibility.[23,24] This finding is similar with other studies.[27,28] While the study of Ojima *et al.* showed that the number of dental caries was significantly related to an increase of MS, Timonen *et al.* showed a weak association between dental caries and MS that was similar with this study.[27,28] The different criteria for tooth disease and the number of researched participants might explain the dissimilar results. Generally, participants with tooth disease may have a higher chance of pain that impacts their QoL. It is parallel to the present study that both groups had the highest frequency of response in item 4 (uncomfortable to eat) and item 3 (pain) of OHIP-14 related QoL index that showed tooth disease might be related factors on OH-QoL. Chomkhakhai found half of the Thai patients with MS had periodontitis.[2] However, the results of this study demonstrated that periodontal status was not different between both groups, which is allied with the previous study that found a weak association between periodontitis and MS.[29] The number of participants and the criteria of the periodontal examination might cause the dissociation between periodontitis and MS in this study. Further investigation has to be performed to clarify these discrepancies.

The number of missing teeth between people with and without MS in this study was almost different. After controlling for MS, the positive correlation was found

between the OHIP-14 related QoL score and several missing teeth. This study showed that an increase in missing teeth led to a low OH-QoL. This result was similar to a previous Thai study which disclosed that older Thai people with less than 20 natural teeth or less than four posterior occluding pairs had less OH-QoL than those with at least 20 natural teeth or at least four posterior occluding pairs.[30] Nevertheless, the conflicting results were reported.[31] The number of missing teeth or remaining teeth had no impact on OH-QoL.[31] However, the number of occluding pairs and the location of the remaining teeth have a high impact on OH-QoL. Further study with this controversial topic and necessity to prosthesis wearing in a larger number of older people would be clarified to evaluate the correlation with OH-QoL.

Assessment of dry mouth was performed by the XI-11 questionnaire to determine xerostomia and by CODS to indirectly evaluate hyposalivation. MS and non-MS participants with xerostomia determined by the XI-11 questionnaire were not different. The average score of the XI-11 was indistinguishable in both groups. Jager *et al.* demonstrated that CODS was associated with a decrease of both unstimulated and stimulated salivary flow as well as XI and Bother Index (BI).[32] The current results show a comparable pattern, which is the difference of CODS score between both studied groups and the correlation of CODS with xerostomia. Most participants without MS had a total score of CODS at 0, and this was the highest percentage. There was no participant with a total scoring 3-5 in the non-MS group, whereas the MS group exhibited a total score of 1-6. These actual results showed that hyposalivation might be more predominant in participants with MS than in people who don't have MS. In the same tendency, the total number of dry mouth signs was greater in the MS than the non-MS group. Usually, older people have a complex systemic disease and always use polypharmacy. Drug-induced hyposalivation might occur in this group.[33] One of these was antihypertensive drugs such as calcium channel blockers or ACE inhibitors.[33] In this study, participants with HT continuously used antihypertensive drugs, such as amlodipine, manidipine, losartan that can cause hyposalivation for people with MS. However, anxiolytics and antidepressants which have an anticholinergic effect and sometimes used by older people were not explored in this study. The self-adaptation of participants with MS might explain the different results between XI-11 and CODS in the MS and the non-MS group. Individuals might gradually adjust themselves to their dry mouth feeling because of the gradual prolonged duration and vague character. Jager *et al.* suggested that XI, BI and CODS are all able to differentiate between hyposalivation and normal salivation because the participants in their study became aware of dry mouth symptoms when salivary flow drops below 0.1 mL/min.[32] Accordingly, they recommended using CODS or a combination of CODS with XI or BI as a routine clinical assessment to detect hyposalivation.[32] Moreover, participants with MS should beware of oral problems such as dental caries, oral candidiasis or irritation from the denture, as a result of hyposalivation even though there are no symptoms. Worsening dry mouth resulting in poorer OH-QoL were also demonstrated from previous studies.[23,24]

The main finding found in the present study is the significant difference in the prevalence of undesirable impact on OH-QoL, which was more frequently found in older participants with MS. Although the severity of OHIP-14 related QoL between both groups was insignificantly different and most participants' responses were inconsiderable to QoL, with a score ranging between 0 and 3. OH-QoL in older people with MS has never been studied. There were some studies about HR-QoL in MS.[34,35] A major finding in the study by Tziallas *et al.* was that MS is significantly correlated with impaired HR-QoL.[34] In contrast, a study in Korea showed that MS was not significantly associated with HR-QoL after adjusting for socio-demographic factors, medical comorbidities and obesity.[35] The current study showed that WC, indicating obeity, was the factor associated with OH-QoL after adjusting for age, sex, general and oral health. Although HR-QoL was QoL of whole health, this explanation might be a possibility why participants with MS tend to have poor OH-QoL, one part of QoL.

Regarding each item and domain of OHIP-14 related QOL, the highest mean score in both groups were domain 2, physical pain, which was determined by pain and feeling uncomfortable while eating. Our results in the present study are consistent with previous studies that revealed

the most frequently experienced problems of older people in Norway were aching in the mouth and discomfort while eating food.[36] It was not surprising that physical pain leads to negative OH-QoL. Effective management of pain in patients or prevention of oral problems in all people may improve OH-QoL.

There were a few studies which focused on the relationship between OH-QoL and older persons with the components of MS.[37] However, a study about the relationship between OH-QoL and MS entities in older people has not been done. Irani et al. reported that type 2 DM does not impact on overall OH-QoL as measured by OHIP-49.37 They discussed that patients with DM are less concerned about the impact of their periodontal condition than with their other health issues that they must manage as part of DM.[37] In contrast to our study, there were significant differences in OH-QoL between the MS and the non-MS group. The reason might be influenced by multiple components of MS, or a different studied measurement or age of participants. WC is an indicator of central obesity, that increases the risk of developing DM.[38] Participants with high levels of WC, FPG and ageing, may have a greater chance of DM. Moreover, Azogui-Lévy *et al.* reported that poor oral health in DM patients had a negative impact on OH-QoL.[39] Accordingly, the increasing of WC and FPG in the present study, which might negatively influence OH-QoL can be assumed. Because participants whose response to OHIP-14 related QoL scoring 3-4 also had significantly higher levels of WC and FPG than participants whose response to OHIP-14 related QoL scoring 0-2.

After adjusting for related factors, multivariate analysis for OHIP-14 related QoL demonstrated that WC, CODS and sleeping hours were the associated factors related to the response to OHIP-14 related QoL scoring 4 (very often). However, only WC and sleeping hours were the associated factors related to the response OHIP-14 related QoL scoring 3-4 (fairly often or very often). From this finding, it seems that WC, indicating obese and predilection to DM, was an important factor for the increased negative impact on OH-QoL in older Thai people. It is in accordance with the previous study that patients with obesity and DM tended to have poor OH-QoL.[40] For sleeping hours, the current result was consistent with other studies which showed fewer sleeping hours had a negative impact on QoL or OH-QoL.[23,24] Nevertheless, CODS was the factor that was inconsistently associated with OHIP-14 related QoL. Participants might decrease saliva flow rate at some point which leads to a dry mouth feeling. Also, participants might have hyposalivation but had no dry mouth feeling due to self-adaptation. This explanation may be supported by a study of Jager *et al.*[32] Further study in a larger population should be performed to clarify these conflicting results.

The limitation of this study was the small number of participants caused by strictly definite inclusion criteria. Additionally, the study group was a select group who presented for a medical checkup and a further dental checkup. All participants had to present their laboratory profile, not beyond six months, which comprises the levels of TG, HDL-C and FPG, and had no history of dental treatment within the prior six months. Many participants that had no HDL-C results and have a history of recent dental treatment were excluded. So, the findings may not be able to be generalized. Furthermore, the COVID-19 pandemic of COVID-19 and restrictions on health service by the Thai government forced this research to temporarily discontinue. Therefore, these results should be interpreted with caution. However, the strength of the strict inclusion of participants supports the methodology for older people. The questionnaires were filled following the answer of participants by the principal investigator that can avoid the mistake from the irregular vision in older people. Accordingly, this is the first study to demonstrate the relationship between unfavorable OH-QoL and older patients with MS. Future studies should be performed with a larger sample size and adjunct data about occlusion and nutrition should be collected for a thorough assessment. A longitudinal study may demonstrate underlying reasons which impact OH-QoL of older people with MS.

Conclusion

This study reveals the significant difference of OH-QoL in older Thai people with MS and without MS. Participants with MS have a more undesirably negative impact on OH-QoL than participants without MS. OH-QoL is influenced by several factors; not only oral health but

also general health. There is an association between WC, hyposalivation determined by CODS and sleeping hours with OH-QoL. This study suggests that OH-QoL should be a part of the oral assessment in older people because geriatric care has to focus on QoL improvement. The OHIP-14 related QoL index is a considerable questionnaire used to cooperate with other geriatric assessment in older people.

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