

## Occurrence of Oral Hypofunction among Community-Dwelling Older Adults

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### Abstract

To investigate the occurrence and factors associated with oral hypofunction among community-dwelling older adults.

The function of the organ system deteriorates, and the risk of chronic disease increases with age. A reduced oral function is associated with nutritional status, sarcopenia, frailty, as well as respiratory infection which is common in older adults.

Oral function of 436 older adults, aged 60 and over, was evaluated based on oral dryness, oral hygiene, tongue pressure, occlusal force, masticatory performance, tongue-lip motor function, and swallowing function. The diagnostic criteria for oral hypofunction were determined based on 3 or more of the seven measurements. The demographic data, socioeconomic status, body mass index, medications, past dental care, betel quid, and tobacco use were reviewed. Data were analysed using Binary Logistic Regression Analysis at 0.05 as a level of significance.

The occurrence of oral hypofunction was 34.6%. Oral hypofunction was significantly related to gender, age, body mass index, marital status, and betel quid use.

As age increases, the risk of oral hypofunction increases by 1.9 times. More oral functions deteriorate as people approach 70 years old, and deterioration increases with age thereafter. Promoting dental care services is necessary, especially before entering old age.

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### Introduction

Health dynamics in older adults are complex and changing both anatomically and physiologically. The function of the organ system deteriorates, and the risk of chronic disease increases with age. Consequently, older adults have a chance to develop geriatric syndrome as well as face changes in the environment that influence health, such as economic and social factors and health-related policies. This leads to a loss of body function.<sup>1, 2</sup> Reduced ability to perform routine tasks and being dependent is a factor affecting oral health.<sup>3</sup> Likewise, deteriorating oral health also affects physical health. According to previous studies, it has been found that reduced oral function is associated with nutritional status,<sup>4, 5</sup> sarcopenia,<sup>6</sup> frailty,<sup>7</sup> as well as respiratory infection which is

common in older adults.<sup>8, 9</sup> The frailty that causes older adults to become dependent is associated with low muscle mass and malnutrition. Oral function, especially the ability to eat, consists of characteristics of nutritious food that has been chewed until it is suitable for digestion, and the reduction of respiratory infection caused by poor oral hygiene, which is all essential for maintaining good health in older adults. Thus, it is important to assess the oral status and function in older adults.

The Japanese Society of Gerodontology proposed a framework for oral function consisting of 4 phases: healthy stage, oral frailty, oral hypofunction, and oral dysfunction. Oral hypofunction is determined by the status and function of the oral cavity that has deteriorated in many aspects, including oral dryness, poor oral hygiene, decreased tongue pressure, reduced occlusal force, decreased masticatory function, decreased tongue-lips motor function, and the deterioration of swallowing. Each of these symptoms has diagnostic criteria and alternative diagnostic criteria which are compiled from relevant studies. Oral hypofunction is diagnosed

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when 3 of such 7 symptoms are found.<sup>10</sup> In the previous study, there have been different dimensions of oral function among older adults. The suitable oral function might be considered from the occlusion efficiency, the number of teeth, the number and location of functional teeth, aesthetics, appearance, and personal preference.<sup>11</sup> These functions will affect food intake and quality of life. Although many studies in the past have different oral function evaluation criteria used. But most of the time, it was found that oral function was related to the physical conditions of older adults. There is no definitive study of how oral function includes the components and the gold standard of diagnostics criteria. Therefore, we focus on the oral function framework that shows a broader dimension of oral function and use assessment methods from relevant studies to find the occurrence and the associated factors of oral hypofunction among community-dwelling older adults.

## Materials and methods

### Participants

This was a cross-sectional study. All participants were Thai and living in Ubon Ratchathani province, Thailand, which has an estimated older adult population of 10%. The participant consisted of older adults who came from a multi-stage random sampling method, where 5 out of 8 subdistricts were randomly assigned, followed by villages in each subdistrict. Convenient participants who voluntarily participated in the study and lived in randomized areas were included. Cognitive function was evaluated with the Thai version of the Rowland Universal Dementia Assessment Scale (RUDAS) and activities of daily living (ADL) were assessed according to the Barthel index. Participants with RUDAS score less than 19 or ADL scores less than 11, histories of head and neck cancer, and previously had radiotherapy around the head and neck were excluded.

Informed consent was obtained from each participant before data collection. This study was approved by the Faculty of Dentistry Human Experimentation Committee, Chiang Mai University (55/2019), and the Ethics Committee of the Ubon Ratchathani Provincial Health Office (SSJ.UB2562-037).

### Measurements

The oral functions examination included

assessment for oral dryness, oral hygiene, tongue pressure, occlusal force, masticatory performance, tongue-lip motor function, and swallowing function. Each item was evaluated and rated one point when a diagnosis was made by cut-off values. The total scores were calculated. A diagnosis of oral hypofunction was made when total scores are 3 or more.

### Oral dryness

A measure of oral mucosal wetness was measured using an oral moisture checker (Mucus, Life Co., Ltd) according to a standard procedure. The degree of moisture was measured on the lingual mucosa of the dorsal of the tongue. The measurement of tongue moisture was repeated three times continuously to assure its accuracy. A diagnosis of oral dryness was made when the measured values are less than 27.0.<sup>10, 12</sup>

### Oral hygiene

Oral hygiene was evaluated using the degree of Tongue Coating Index (TCI). We took a picture of each participant's tongue using a digital camera with a 60-mm. macro lens with ring flash. The camera was set up at ISO 100, f/22 with a shutter speed of 200, and the JPEG files were stored. TCI scores were assessed by visual inspection of the picture. A diagnosis of poor oral hygiene was made when TCI was 50% or more.<sup>10, 13</sup>

### Tongue pressure

According to a study by Yoshida et al.,<sup>14</sup> found that the evaluation of swallowing problems such as coughing at mealtime defined by a dentist or speech therapist is related to the clinical value of tongue pressure. In this study, tongue pressure was indirectly evaluated using a questionnaire. Participants were interviewed about the presence of choking or coughing at mealtime. A diagnosis of decreased tongue pressure is made when there is a presence of severe choking or coughing at mealtime.

### Occlusal force

Dentures were removed during the time participants' occlusal force were diagnosed. The number of existing natural teeth was counted, excluding the residual tooth roots, third-degree mobility teeth, and teeth with less than half of the coronal structure remaining. Teeth restored with crowns were included as existing teeth. A diagnosis of reduced occlusal force was made when the number of existing natural teeth is less than 20.<sup>10</sup>

### Masticatory performance

The Eichner Index determined masticatory performance based on occlusal contact of existing natural teeth and classified performance into 3 groups (A, B, and C). A diagnosis of decreased masticatory performance was made in group C, in which occlusal contact was not found.<sup>10, 15</sup>

### Tongue-lip motor function

Participants were instructed to pronounce each syllable /pa/, /ta/, /ka/ repeatedly as fast as possible for 5 seconds and then measured by hand tally counter. The number of times each syllable was pronounced per second was calculated. A diagnosis of decreased tongue-lip motor function was made when any syllable was less than 6 times per second.<sup>10</sup>

### Swallowing function

Swallowing performance was evaluated by a modified Water Swallowing Test Method (MWST). A 3 ml of water was poured on the participants' floor in the mouth with a syringe. Participants were instructed to swallow the water and then swallow saliva two times thereafter. A diagnosis of deterioration of swallowing function was made when participants were unable to swallow or had dyspnea, choking, coughing, or making horse sounds after swallowing the water.<sup>16</sup>

### Other data collections

The demographic characteristics of age, gender, body mass index, medications, betel quid use, tobacco use, past dental care, educational levels, marital status, and social relation were reviewed.

### Statistical Analyses

Data were analyzed using SPSS. The baseline characteristics were analyzed using descriptive statistics. We did a binary logistic regression analysis to determine associations between variables using p-value < 0.05 as the significant level. Results were presented as odds ratios and 95% confidence intervals.

## Results

Of 436 community - dwelling, independently living older adult participants, there were 172 men and 264 women participated the study. The mean age of samples was 69.4 ± 6.8 years. The participants' characteristics are shown in Table 1.

Variable	Categories	Overall n=436 n(%) or Mean ± SD
Age(Y)	Overall	69.4±6.8
	60-69	237 (54.4)
	70 or more	199(45.6)
Gender	Male	172 (39.4)
	Female	264 (60.6)
BMI	Overall	23.7±4.1
	less than 23.0	191(43.8)
	23.0 or more	245(56.2)
Disease	No	195 (44.7)
	Yes	241(55.3)
Medication	No	243(55.7)
	Yes	193(44.3)
Polypharmacy	1-4 medications daily	347(79.6)
	5 or more medications daily	89(20.4)
Smoking	No	366 (83.9)
	Yes	70 (16.1)
Betel quid chewing	No	353 (81.0)
	Yes	83 (19.0)
Received dental services in the past 1 year	No	360 (82.6)
	Yes	76(17.4)
Marital status	Single (single, widowed, divorced)	133(30.5)
	Couple	303(69.5)
Educational level	No educational or Elementary school (grade1-4)	420(96.3)
	Higher education	16(3.7)
Number of family members who live together	1 - 3	228(52.3)
	>3	208(47.7)

**Table 1.** Characteristics of participants.

We found that 151 participants (34.6% ) had oral hypofunction. Mean and SD of each evaluation criterion are shown in table 2.

Evaluation criterion	Overall n=436	Normal n=285	Oral hypofunction n=151
	Mean ± SD or n (%)		
Oral moisture	27.6 ± 1.8	28.0 ± 1.7	27.0 ± 1.9
Tongue Coating Index (%)	54.0 ± 22.0	48.4 ± 21.6	64.5 ± 18.7
Number of teeth	17.9 ± 9.4	22.3 ± 6.9	9.4 ± 7.4
The number of each syllable which is pronounced per second (times/second)			
/pa/	6.3 ± 0.5	6.4 ± 0.5	6.2 ± 0.6
/ta/	6.3 ± 0.6	6.4 ± 0.6	6.2 ± 0.7
/ka/	6.3 ± 0.6	6.4 ± 0.6	6.1 ± 0.7
Presence of choking or coughs at mealtime			
Never	361 (82.8)	241 (86.6)	120 (79.5)
Mild	68 (15.6)	43 (15.1)	25 (16.6)
Severe	7 (1.6)	1 (0.4)	6 (4.0)
Eichner Index			
Group A	120 (27.5)	116 (40.7)	4(2.6)
Group B	216 (49.5)	157 ((55.1)	59 (39.1)
Group C	100 (22.9)	12 (4.2)	88 (58.3)
	Overall n (%)	Normal n (%)	Oral n (%)
Oral hypofunction	151 (34.6)	0 (0)	151 (100)
Dry mouth	126 (28.9)	52 (18.2)	74 (49.0)
Poor oral hygiene	241 (55.3)	117 (41.1)	124 (82.1)
Decreased tongue pressure	7 (1.6)	1 (0.4)	6 (4.0)
Reduced occlusal force	221 (50.7)	82.0 (28.8)	139 (92.1)
Decreased masticatory performance	100 (22.9)	12 (4.2)	88 (58.3)
Decreased tongue-lip motor function	151 (34.6)	64 (22.5)	87 (57.6)
Deterioration of swallowing function	25 (5.7)	7 (2.5)	18 (11.9)

**Table 2.** Evaluation criterion and Oral functions.

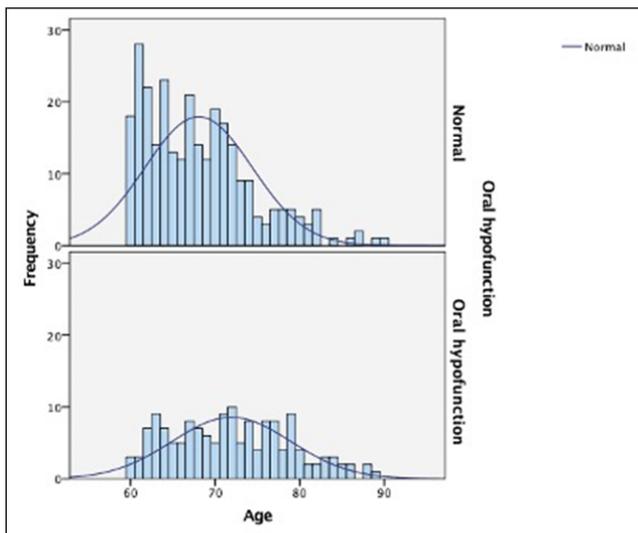
In the adjusted logistic regression model, the variables were adjusted by age, gender, body mass index, marital status, smoking, and betel

quid chewing behavior. Males, age of 70 and over, BMI of 23 and over, chewing betel quid, and being single were more likely to have oral hypofunction than their counterparts. Statistics and their significant level are shown in table 3.

The participants with oral hypofunction had an average age of  $71.9 \pm 7.0$  years. Most of the participants (27.3%) showed 2 out of 7 symptoms of deterioration and tended to show more symptoms of deterioration with age. (Table 4)

The number of deterioration symptom	n (%)	Age Median	Age Mean $\pm$ SD
Normal	0	69 (15.8)	66.7 $\pm$ 4.8
	1	97 (22.2)	67.0
	2	119 (27.3)	68.0
	Sub-total	285 (65.4)	67.0
Oral hypofunction	3	88 (20.2)	71.5
	4	48 (11.0)	71.0
	5	10 (2.3)	74.0
	6	5 (1.1)	76.0
	7	0 (0.0)	
Sub-total	151 (34.6)	72.0	71.9 $\pm$ 7.0

**Table 4.** Age of each deterioration symptom.



**Figure 1.** Age distribution of normal group and oral hypofunction group.

Of all participants, there were 84.2% with show one to six symptoms of deterioration and can be classified into 43 groups. (Table 5) Reduced occlusal force is the most frequent symptom detected and found in 29 groups. The symptoms that were second most frequently found were poor oral hygiene and decreased tongue-lip motor function respectively.

Participants with two symptoms have average age approaching 70. On the other hand, those with three symptoms, which is

the criteria of being diagnosed as oral hypofunction, had an average age of a bit over 70. When the age histogram of those with normal oral function and hypofunction groups was plotted together it can be extrapolated those participants in this study enter oral hypofunction status when they were 70 of age. (figure1)

### Discussion

The oral function of 436 older adults was evaluated based on oral dryness, oral hygiene, tongue pressure, occlusal force, masticatory performance, tongue-lip motor function, and swallowing function. The diagnostic criteria for oral hypofunction were determined based on 3 or more of the seven measurements. Within these methods, we found that the occurrence rate of oral hypofunction in order adults was 34.6%. Oral hypofunction was significantly related to gender, age, body mass index, marital status, and betel quid use.

This study used an indirect method to evaluate participants' tongue pressure. This is possible to make the study results differ from other studies that measure tongue pressure by different methods. By using a tongue pressure measuring device to assess tongue pressure, the tongue pressure began to drop at the age of 50-60 years.<sup>17</sup> Recent studies show that more than 50% of the rural community-dwelling older adults had decreased tongue pressure.<sup>18</sup>

In this study, tongue pressure was indirectly evaluated using questions about choking experiences while eating and found that 1.6% of the participants had low tongue pressure. A previous study found that heavy choking while eating was significantly associated with reduced tongue pressure, was found in participants older than 83 years.<sup>14</sup> Therefore, using the report of choking while eating as an assessment criterion in this study where the mean age of participants was 69.4 years might cause this study to find a small number of participants with decreased tongue pressure. The prevalence of dysphagia was found in 5-72% of the older adults living in the community. The prevalence of dysphagia increased with the degree of dependency. Also, the prevalence of dysphagia among independent older adults increased with age.<sup>19</sup>

These findings were consistent with the studied prevalence of dysphagia among the older adults using the EAT- 10 assessment, finding that 25.1% of the independent older adults and 53.8% of the dependent adults had dysphagia.<sup>20</sup> In this study, only 5.7% of participants were a deterioration of swallowing function. Most of the subjects in this study were active living. If future studies were performed on older aged or dependent older adult, a greater prevalence of dysphagia or deterioration in swallowing function could be found more frequently. In addition, the Water Swallow Test with 3 ml. of water used in this study was less sensitivity and specificity<sup>16</sup> than the assessment method using EAT-10.<sup>21</sup> In the future, the sensitivity and specificity of the EAT-10 self-assessment in the Thai version should thus be studied to increase the accuracy of declining swallowing functions in older adults living in community dwellings.

In this study, we found that the rate of oral hypofunction in older adults was lower than in the other study, which found over 42.6% of the older adults living in community-dwelling had oral hypofunction. This might be due to the age difference between the participants. Most of the participants in mentioned studies were between 70 and 79 years old and 25% were older than 80 years old. Meanwhile, most individuals for this study's participants (54.4% ) were between 60 and 69 years. However, similar results consistently found that the occurrence of oral hypofunction was related to age. Hence, it was likely that the different ages of the participants explain the different proportions of individuals having oral hypofunction.<sup>18</sup>

Recent studies have shown that occlusal force is related to the number of remaining teeth.<sup>22</sup> The loss of posterior occlusion in older adults was associated with reduced dietary, protein intake, and muscle mass.<sup>23</sup> Although many studies did not find a clear association between the number of remaining teeth and the occurrence of malnutrition,<sup>24, 25</sup> several studies found that occlusal force and masticatory performance affected nutritional status in older adults through reduced fruit and vegetable food choices and altered nutritional intake.<sup>26, 27</sup>

In addition, decreased number of remaining teeth is associated with age and health conditions in older adults including mental status, nutritional status, frailty, and muscle mass. The Japanese Society of Gerodontology proposed

the main method for measuring maximum occlusal force by using pressure-sensitive film and also suggested counting the number of remaining teeth as an alternative method. Later studies found that these two evaluation criteria affect the rate of oral hypofunction.<sup>18</sup> Although both criteria had some degree of validity but may not be equivalent. In this study, we assessed occlusion force using an alternative method by counting the number of remaining teeth. We found that reduced occlusal force is the most common symptom among participants with oral hypofunction. Moreover, when considering the pattern of symptoms, reduced occlusion force is the most common symptom found among the seven symptoms evaluated in this study. This suggests that oral health promotion to maintain functional teeth before entering old age, as well as rehabilitation with prostheses, might decrease the occurrence of oral hypofunction in older adults. We also found that betel quid chewing and marital status related to oral hypofunction. Generally, betel consumption in Thailand often contains areca nut, tobacco, red lime, and a betel leaf.<sup>28</sup>

The betel, along with these components, is genotoxic and carcinogenic affecting oral mucosal cells. Betel chewing causes inflammation of oral tissues, periodontal disease,<sup>29</sup> mucus formation, and decreased salivation.<sup>30</sup> Although chewing betel nuts alone will induce salivation while chewing because the alkaloid and arecoline in betel nuts stimulate the parasympathetic nervous system.<sup>31</sup> As a result, chewing betel nuts with other ingredients may result in a decrease in salivation. Betel quid chew may relate to oral hypofunction by reducing the number of remaining teeth. It was found in previous studies that marital status was related to the quality of life, with relationship characteristics also depending on sex and age.<sup>32</sup>

Unmarried older people are more likely to develop frailty than those who are married.<sup>33</sup> People in single status ( single, widowed, divorced) were associated with having a greater risk of death than those in marital relationships.<sup>34</sup>

This study found that those who married were less likely to develop oral hypofunction than those with a single marital status. There was a possibility that marital status was associated with oral health through health care behaviors and social advocacy according to racial and cultural contexts, which required further long-term

studies. As with previous studies of oral function, we found that the occurrence of oral hypofunction increased with age. Participants who had up to two deteriorate oral symptoms, which classified as normal oral function, had average age less than those with three or more symptoms, which classified as oral hypofunction group. The average and median age of participants increased by several symptoms of their oral function. In figure 1, it can be seen that more participants had oral hypofunction when approaching 70 years old.

Maintaining health longevity and delaying the time for a dependent state may require both a change of behavior and lifestyle of the older adults themselves, as well as health policy. Good oral health also influences the physical, mental, and quality of life of older adults. From this study, the occurrence of oral hypofunction could be found in as many as one-third of participants who were independent older adults. In addition, it suggests that oral health promotion, prevention, and treatment policy to restore oral functions are necessary, especially before entering their older years, and also shows that there is a need for older people in the community to undergo a diagnosis for oral hypofunction by dental personnel who will promote appropriate rehabilitation for each individual to prevent the oral dysfunction.

As a result, further studies should be conducted about the accuracy, sensitivity, and specificity of diagnostic methods that can be appropriately used with community-dwelling older adults. Apart from diagnostic activities, oral health promotion in older adults is still very necessary, which should include a model and

study of the effectiveness of community health programs.

### **Conclusions**

The occurrence of oral hypofunction could be found in as many as one-third of participants who were independent older adults. The conditions severity increases with age. This study suggests that oral health promotion, prevention, and treatment policy to restore oral functions are necessary, especially before patients entering their older years. Older people in the community are suggested to undergo a diagnosis for oral hypofunction in order to be prepares for promoting appropriate rehabilitation for each individual.

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### **Declaration of Interest**

The authors report no conflict of interest.

Variables	Crude OR	Adjusted OR	95%CI of Adjusted OR	p-value
Age (Y)				
60-69	1	1		
70 or more	2.49	1.91	(1.23,2.97)	0.004
Gender				
Male	1	1		
Female	0.65	0.56	(0.33,0.95)	0.031
BMI				
<23.0	1	1		
23.0 or more	0.48	0.63	(0.41,0.96)	0.033
Smoking				
No	1	1		
Yes	1.87	1.74	(0.93,3.27)	0.083
Betel quid chewing				
No	1	1		
Yes	2.03	1.86	(1.05,3.30)	0.034
Marital status				
Single (single, widowed, divorced)	1	1		
Couple	0.5	0.51	(0.32,0.83)	0.006
Disease				
No	1			
Yes	1.07			
Medication				
No	1			
Yes	1.24			
Polypharmacy				
1-4 medications daily	1			
more than 5 medications daily	1.45			
Received dental services in the past 1 year				
No	1			
Yes	0.73			
Educational level				
No educational or Elementary school (grade1-4)	1			
Higher education	1.62			
Number of family members who live together				
1-3	1			
>3	0.82			

**Table 3.** Regression analysis model for the association with oral hypofunction.

Symptoms	n (%)	Age		
		Mean	SD	Median
No symptom	69 (15.8)	66.7	4.8	67
One symptom				
T	0 (0.0)	-		-
M	0 (0.0)	-		-
H	40 (9.2)	66.2	6.3	64
S	1 (0.2)	67.0		67
D	12 (2.8)	67.7	6.3	67
O	25 (5.7)	68.4	6.4	68
L	19 (4.4)	68.8	7.4	67
Two symptoms				
H L	21 (4.8)	66.5	4.8	66
D H	26 (6)	68.4	6.8	66
H O	26 (6)	69.0	6.0	69
D L	10 (2.3)	69.2	7.2	67
H S	4 (0.9)	70.0	5.3	69
L S	1 (0.2)	70.0		70
O L	13 (3)	70.6	4.8	71
O M	12 (2.8)	71.7	11.1	67.5
O S	1 (0.2)	72.0		72
D O	4 (0.9)	74.8	4.4	75
T O	1 (0.2)	86.0		86
Three symptoms				
D O S	1 (0.2)	61.0		61
H T L	2 (0.5)	62.0		62
O L S	2 (0.5)	66.0	4.2	66
H O L	12 (2.8)	69.5	4.4	68.5
D H L	9 (2.1)	70.8	6.0	70
H O M	24 (5.5)	71.1	7.3	71.5
D H O	19 (4.4)	71.5	8.6	71
D O M	6 (1.4)	75.2	8.0	75
O M L	10 (2.3)	75.9	5.6	75.5
H O S	1 (0.2)	76.0		76
O M S	1 (0.2)	76.0		76

Symptoms		n (%)	Age		
			Mean	SD	Median
H	L S	1 (0.2)	78.0		78
Four symptoms					
D	O M S	1 (0.2)	63.0		63
D H	O S	2 (0.5)	67.0		67
D	T O S	1 (0.2)	69.0		69
D H	O L	11 (2.5)	71.6	5.4	72
D H	O M	7 (1.6)	71.7	7.2	71
	H O M L	19 (4.4)	71.8	7.4	72
	H O L S	2 (0.5)	73.5	6.4	73.5
D	O M L	5 (1.1)	74.2	11.1	77
Five symptoms					
D H	O M L	7 (1.6)	73.4	7.2	72
	H T O M L	2 (0.5)	78.0	5.7	78
D H	O M S	1 (0.2)	79.0		79
Six symptoms					
	H T O M L S	1 (0.2)	71.0		71
D H	O M L S	4 (0.9)	77.0	4.5	78

**Table 5.** Patterns of deterioration symptoms.

\*D = Dry mouth, H = Poor oral hygiene, T = Decreased tongue pressure, O = Reduced occlusal force, M = Decreased masticatory performance, L = Decreased tongue-lip motor function, S = Deterioration of swallowing function.

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