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Association of hyposalivation with oral function, nutrition and oral health in community-dwelling elderly Thai

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Objectives: This study was to analyze the association of hyposalivation with oral function, nutritional status and oral health in community-dwelling elderly Thai. ***Method:*** The subjects were 612 elderly people (mean age = 68.8, SD 5.9 years). Oral function (tasting, speaking, swallowing and chewing) and Mini Nutritional Assessment (MNA) were evaluated. Oral examination investigated teeth and periodontal status. Both unstimulated and stimulated whole saliva were collected for 5 minutes. ***Results:*** Among all subjects, 14.4 % were classified within the hyposalivation. Hyposalivation was associated with gender, systemic disease, medication, and smoking. Subjects within the hyposalivation group had a higher number of decayed teeth and a higher prevalence of periodontitis than the normal salivation group ($p<0.05$). The hyposalivation group also had a lower number of teeth present and a lower mean MNA score than the normal salivation group ($p<0.05$). Logistic regression analysis showed that hyposalivation in both dentate and edentulous subjects was significantly associated with tasting, speaking, swallowing and chewing. ***Conclusion:*** This study suggested that hyposalivation is a risk factor not only for dental caries and periodontal disease but also for taste disturbances, speaking problems, swallowing problems, poor chewing ability and malnutrition. Monitoring salivary flow is an important measure in the care of older people.

Key words: Hyposalivation, Oral Health, Oral Function, Nutrition, Elderly.

Introduction

Saliva is regarded as one of the important factors in regulating oral health, with respect to both the volume produced and the constituents it contains (Mandel & Wotman, 1976). Functional disturbances of the salivary glands can cause a reduction in salivary flow and oral dryness, which are common features in elderly people. The major causes of salivary hypofunction are medications, medical treatments and systemic disease (Thorselius *et al*., 1988).

Oral dryness may change the oral environment and precipitate oral disease. Many studies report that low salivary flow rate is a risk factor for such disorders as dental caries, periodontal disease, and candidiasis (Loesche *et al*., 1995a). However, only a few studies have emphasized the importance of salivary flow rate in maintaining oral function (Narhi, 1994). Patients with salivary gland hypofunction may complain of subjective oral dryness or suffer from eating problems (Loesche *et al*, 1995b). Additionally, subjects with low salivary flow rate may have taste problems (Ikebe *et al*., 2002). Oral health-related functions such as eating, communicating and interacting with others have effects on self-esteem and self-confidence, and these are correlated with quality of life.

Hyposalivation of the elderly is a worldwide problem which affects their quality of life. However, there is no research on oral dryness or salivary flow rate of elderly populations in Thailand. We hypothesis that salivary flow rate would be associated with oral health, discomfort oral function and malnutrition. Thus, the purposes of this study were: (1) to examine the prevalence of low salivary flow rate among community dwelling elderly; and (2) to determine associations of saliva flow rate with oral function, nutritional status and oral health.

Material and Methods

Subjects

The sample for this study was drawn from elderly people aged 60 years or older who lived in Phitsanuloke, Thailand. This study used a computer-generated random sampling framework to select 760 subjects from all of the 19 sub-districts in Phitsanuloke. A total of 612 people selected (158 males, 454 females, mean age 68.8 years; SD=5.9) agreed to join the study and signed the informed consent. Subjects, who were diagnosed as having mental diseases by a medical practitioner, were excluded from the study.

Questionnaire survey

Sociodemogaphics and health behaviour

Sociodemographic and health behavioural information including age, self-reported current medical history, intake of medications, smoking behaviours and drinking behaviours were collected by trained interviewers.

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Oral function

Oral function was evaluated by the response to the following questions: "Do you have, or have you had, speaking problems?" "Do you have, or have you had, swallowing problems?" and "Do you have, or have you had taste problems?" The interviewer asked participants to respond to each question by "yes" or "no".

Chewing-ability was evaluated by asking whether the subject was able to chew the following 12 food items that were arranged from easy to hard chewable Thai food: rice porridge, well-cooked rice, noodles, steamed glutinous rice, green corns, papaya in papaya salad, fried meat ball, grilled pork, fried chicken, pah taung goh (a type of Chinese flour with sweet meat), grilled dry cuttlefish and an ice cube. The score was the number of food items subjects reported that they could chew. Subjects with scores between 0-7 were classified as having chewing problems (Jittima *et al*., 2008).

Nutritional status

The Mini Nutritional Assessment (MNA) comprised of 18 items, and was originally developed for the assessment of nutritional status of older patients in clinics, nursing homes and hospitals, or those who were otherwise frail. The score is calculated using an assigned weighted number for each item and the total score ranges from 0 to 30. Persons with scores 23.5 and over are classified as having a "normal" nutritional status, those with scores from 17 to 23 are classified as having a "questionable" nutritional status, and those with scores 16 or less are classified as having "malnutrition" (Guigoz *et al*, 1996).

Oral examination

Standard clinical oral examinations were performed by one dentist who examined the number of teeth present and decayed teeth (DT) using standardized clinical criteria based on the WHO format. A periodontal examination included the determination of a gingival index , pocket depth and clinical attachment loss using a Williams Periodontal Probe (Hu-Friedy™). Based on the definition of the Center for Disease Control American Academy of Periodontics, periodontitis (periodontal disease) is defined as present in a subject who has at least one periodontal site with 3 mm or more of attachment loss and 4 mm or more pocket depth.

Salivary flow rate

All subjects abstained from smoking, eating and drinking for 2 hours prior to the measurement of salivary flow rate. Subjects with complete or removable partial dentures kept their denture in place during the saliva collection (Bergdahl, 2000). Unstimulated whole saliva was collected for 5 minutes by a spitting method. Stimulated whole saliva was collected by a mastication method, in which subjects were asked to chew a small paraffin block for 5 minutes. Subjects were classified into 2 groups according to salivary flow rates. Subjects whose unstimulated salivary flow rate was less than 0.1ml/min and stimulated flow rate was less than 0.5ml/min were classified as hyposalivation.

Statistical analyses

The statistical analyses were performed with the SPSS 17 software and $p<0.05$ accepted as the level for statistical significance. The Chi-square tests, Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) were used to compare the difference in frequency distribution and mean scores. Multiple logistic regression analysis was used for predicting and computing odds ratios (OR) of significant variables.

Ethics

The study protocol was approved by the Naresuan University, Thailand and Tokyo Medical and Dental University Ethical Committee, Japan.

Results

Sociodemogaphics and health behaviour

The number of subjects aged 60-69 years was 354 (58%) and those aged 70 years and older was 258 (42%). Ninety-eight subjects (16%) were smokers, no subject reported being a past smoker, and very few subjects (1.5%) regularly drank alcohol. Systemic diseases were reported by 74.8% of subjects: hypertension 37.3%, diabetes mellitus 18.3%, heart disease 6.5% and other disease 12.7%; and 76.1% of subjects routinely used medicines.

Oral function

Among all subjects, 28.8% complained about swallowing problems, 30.6% had speaking problems, 29.1 % complained about taste problems and 44.2% had chewing problems.

Nutritional status

The mean MNA score of all subjects was 21.5 (3.0). Twenty-five percent of subjects were defined as having normal nutrition, 67.1% were at risk of malnutrition and 7.7% were classed within the malnutrition group.

Oral health status

Thirty percent of subjects (n=184) were edentulous. Of dentate subjects, 82% (n=352) were diagnosed with periodontal disease while their mean numbers of teeth present and decayed teeth were 10.8 (9.9) and 1.4 (2.5), respectively. In the older age group (70+ years old), the mean numbers of teeth present were significantly lower compared with the younger age group ($p<0.05$).

Salivary flow rate

The result shows that 14.4 % (n=88) of subjects had hyposalivation. The total means of unstimulated and stimulated salivary flow rates were 0.23 ml/min and 1.05 ml/min, respectively. The mean unstimulated salivary flow rate for males and females were 0.32 (0.28) and 0.20 (0.22), respectively. The mean stimulated salivary flow rate were 1.36 (0.85) and 0.95 (0.55), respectively. Both the unstimulated and stimulated salivary flow rates were significantly higher in males than females ($p<0.05$), and hyposalivation was significantly more common in females than males ($p<0.05$). The results did not show any significant differences of salivary flow rate by age group.

Relationship between hyposalivation, demographics and health behaviour variables

A multiple logistic regression analysis (Table 1) showed that hyposalivation was significantly associated with gender (OR=7.98), systemic disease (OR=1.27), taking medicine routinely (OR=1.79) and smoking (OR= 5.34; $p<0.05$).

Relationship between hyposalivation, oral health and nutritional status

Table 2 shows the relationship between hyposalivation, oral health, and nutritional status in dentate people, adjusting for confounding factors (age, gender, systemic disease, taking medicine routinely, alcohol consumption and smoking). Subjects who were classified as having hyposalivation had a lower mean number of teeth present (12.9) than those who were classified as normal salivation (15.6, $p<0.05$). Subjects who were classified as hyposalivation had a higher mean number of decayed teeth (1.8) compared with those who had normal salivation (1.1, $p<0.05$). A higher prevalence of periodontal disease was observed in subjects who were classified as hyposalivation, (83.9%) compared with those who were classified as normal salivation (74.2%, $p<0.05$). Subjects who were classified as hyposalivation had a lower mean MNA score (20.7) compared with those who were classified as normal salivation (22.6, $p<0.05$).

Relationship of hyposalivation with oral function

A multiple logistic regression analysis of oral function problems was conducted both in dentate and edentulous subjects (Table 3 and 4). In dentate subjects, hyposalivation was significantly associated with swallowing problems (OR=2.05), speaking problems (OR=1.93), tasting problems (OR=1.61), and chewing problems (OR=1.61). The number of teeth present, was significantly associated with swallowing problems and chewing ability ($p<0.05$). Subjects who smoked and took medication had significant associations with tasting problems ($p<0.05$). Nutritional status was associated with all oral function problems.

Table 1. Logistic regression of hyposalivation on demographic and health behaviour variables

Independent factors			*95% confidence interval*		
	N(%)	*OR*	*Lower bound*	*Upper bound*	*p-value*
Gender					
Male	158 (25.8)				
Female	454 (74.2)	7.98	3.40	18.71	<0.001
Age					
60-69 (reference)	354 (57.8)				
70+	258 (42.2)	0.67	0.41	1.075	0.096
Systemic disease					
No (reference)	154 (25.2)				
Yes	458 (74.8)	1.27	1.14	2.39	0.046
Medication					
No (reference)	146 (23.9)				
Yes	466 (76.1)	1.79	1.04	4.30	0.022
Smoking					
Never (reference)	514 (84.0)				
Current smoker	98 (16.0)	5.34	2.66	10.68	<0.001
Alcohol consumption					
Never/moderate (reference)	599 (97.9)				
Regular	13 (2.1)	3.18	0.88	11.56	0.077

OR = Odds Ratio

Table 2. Relationship between hyposalivation, oral health, and nutritional status by ANCOVA[1]

	N	*%*	*Number of teeth present (SD)*	*Number of decayed teeth (SD)*	*% of periodontal disease*	*MNA (SD)*
Hyposalivation	56	13.1	12.9 (1.0)*	1.8 (0.1)*	83.9*	20.7 (0.4)*
Normal salivation	372	86.9	15.6 (0.4)	1.1 (0.1)	74.2	22.6 (0.2)

[1]Adjusted by gender, systemic disease, taking medicine and smoking.
* $p < 0.05$

Table 3. Logistic regression of oral function in dentate subjects.

Independent factors		*Swallowing problem*			*Speaking Problem*			*Tasting problem*			*Chewing problem*		
		95% confidence interval			*95% confidence interval*			*95% confidence interval*			*95% confidence interval*		
	N(%)	*OR*	*Lower-Upper*	*p-value*	*OR*	*Lower-Upper*	*p -value*	*OR*	*Lower-Upper*	*p-value*	*OR*	*Lower-Upper*	*p-value*
Saliva flow rate													
Normal (reference)	372 (86.9)												
Hyposalivation	56 (13.1)	2.05	1.12-3.75	0.020	1.93	1.23-2.90	0.038	1.61	1.17-3.00	0.030	1.61	1.34-3.11	0.031
Gender													
Males (reference)	119 (27.8)												
Females	309 (72.2)	0.78	0.45-1.33	0.362	1.72	0.21-3.27	0.998	0.62	0.35-1.11	0.106	1.08	0.65-1.77	0.770
Age													
60-69 (reference)	354 (57.8)												
70+	258 (42.2)	0.79	0.49-1.25	0.316	1.25	0.18-8.60	0.821	0.94	0.58-1.53	0.815	0.93	0.60-1.42	0.723
Systemic disease													
No (reference)	98 (22.9)												
Yes	330 (77.1)	0.98	0.48-2.01	0.956	0.11	0.05-2.73	0.179	0.65	0.29-1.45	0.296	1.01	0.55-2.18	0.793
Medication													
No (reference)	91 (21.3)												
Yes	337 (78.7)	1.31	0.62-2.77	0.481	12.16	0.33-442.6	0.173	1.71	1.31-2.65	0.023	1.48	0.72-3.04	0.290
Smoking													
Never (reference)	353 (82.5)												
Current smoker	75 (17.5)	0.69	0.37-1.26	0.230	0.62	0.02-1.23	0.998	1.53	1.28-2.01	0.036	2.03	1.12-3.66	0.019
Alcohol consumption													
Never/moderate (reference)	419 (97.9)												
Regular use	9 (2.1)	1.68	0.36-7.89	0.514	0.87	0.05-2.34	0.992	0.44	0.10-1.88	0.270	0.95	0.23-3.98	0.939
Number of teeth													
10 teeth + (reference)	307 (71.7)												
Less than10 teeth	121 (28.3)	1.80	1.37-2.95	0.030	0.44	0.04-4.64	0.491	1.08	0.65-1.77	0.771	2.23	1.79-3.93	0.035
Dental caries													
No (reference)	174 (40.7)												
Yes	254 (59.3)	0.99	0.65-1.54	0.995	1.46	0.23-9.09	0.687	1.06	0.65-1.77	0.818	1.14	0.76-1.71	0.537
Periodontal disease													
No (reference)	108 (25.2)												
Yes	320 (74.8)	1.55	0.96-2.49	0.070	0.99	0.10-10.10	0.997	1.58	0.96-2.59	0.089	1.47	0.92-2.36	0.108
Nutritional status													
Normal (reference)	30 (7.0)												
Questionable	280 (65.4)	2.41	1.81-3.00	0.041	2.31	0.71-74.66	0.064	1.19	0.46-3.12	0.072	1.61	1.33-3.11	0.028
Malnutrition	118 (27.6)	1.71	1.43-2.18	0.048	2.90	1.01-12.68	0.049	1.36	1.11-1.92	0.046	1.30	1.08-2.06	0.026

OR = Odds Ratio

Table 4. Logistic regression of oral function in edentulous subjects.

Independent factors		*Swallowing problem*			*Speaking problem*			*Tasting problem*			*Chewing problem*		
		95% confidence interval			*95% confidence interval*			*95% confidence interval*			*95% confidence interval*		
	N(%)	*OR*	*Lower -Upper*	*p-value*	*OR*	*Lower-Upper*	*p-value*	*OR*	*Lower-Upper*	*p-value*	*OR*	*Lower-Upper*	*p-value*
Salivary flow rate													
Normal (reference)	152 (82.6)												
Hyposalivation	32 (17.4)	1.67	1.27-4.20	0.028	1.85	1.19-5.30	0.038	2.21	1.59-5.30	0.048	1.67	1.28-2.59	0.037
Gender													
Males (reference)	145 (78.8)												
Females	39 (21.2)	0.42	0.13-1.34	0.142	0.82	0.31-2.15	0.681	0.82	0.31-2.15	0.681	1.36	0.56-3.37	0.499
Age													
60-69 (reference)	111 (60.3)												
70+	73 (39.7)	1.14	0.53-2.47	0.731	0.46	0.23-0.93	0.103	0.46	0.23-0.93	0.060	0.79	0.41-1.53	0.488
Systemic disease													
No (reference)	56 (30.4)												
Yes	128 (69.6)	0.95	0.31-2.91	0.093	1.24	0.43-3.57	0.684	1.24	0.43-3.57	0.684	3.13	1.05-8.84	0.032
Medication													
No (reference)	55 (29.9)												
Yes	129 (70.1)	1.01	0.35-3.42	0.087	0.25	0.08-0.78	0.102	2.25	2.08-2.79	0.017	0.80	0.28-2.28	0.674
Smoking													
Never (reference)	161 (87.5)												
Current smoker	23 (12.5)	0.46	0.13-1.56	0.211	0.88	0.28-2.77	0.825	1.88	1.28-2.77	0.025	1.23	0.42-3.62	0.705
Alcohol consumption													
Never/moderate (ref)	180 (97.8)												
Regular	4 (2.2)	4.93	0.04-1.90	0.999	1.01	0.02-1.02	0.999	1.01	0.02-0.23	0.999	1.76	0.20-15.43	0.599
Denture													
Yes (reference)	132 (71.7)												
No	52 (28.3)	1.84	1.14-2.95	0.514	1.32	1.19-2.16	0.028	1.00	0.86-1.16	0.998	1.51	1.20-2.31	0.049
Nutritional status													
Normal (reference)	17 (9.2)												
Questionable	131 (71.2)	1.80	1.19-3.28	0.046	0.78	0.20-3.10	0.073	1.78	1.20-3.10	0.028	2.67	1.74-9.69	0.014
Malnutrition	36 (19.6)	1.29	1.15-2.94	0.030	0.51	0.21-1.24	0.137	1.51	1.21-2.24	0.037	1.96	1.83-4.58	0.012

OR = Odds Ratio

In edentulous subjects, hyposalivation was significantly associated with swallowing problems (OR=1.67), speaking problems (OR=1.85), tasting problems (OR=2.21) and chewing problems (OR=1.67). Wearing a denture was significantly associated with speaking problems and chewing ability ($p<0.05$). Intake of medication was significantly associated with tasting problems ($p<0.05$). Subjects who were classified as malnourished were more likely to have swallowing, tasting and chewing problems.

Discussion

The current study population represented 18.2% of 3,371 elderly people in Phitsanuloke (National Statistical Office of Thailand, 2007). The proportions of males and females (25.8% and 74.2%) were very similar to those of the whole Thai population (27.0% and 73.0%). The highest proportion of the elderly in Thailand is found in the 60-69 years old age group (60.9%), and this proportion is also similar to the distribution in this study population (57.9%). The subjects of this study therefore, were considered approximately representative of the elderly in Thailand.

Two types of salivary flow rates were measured. The unstimulated salivary flow is a measure of the amount of saliva that is constantly secreted into the oral cavity, whereas the stimulated salivary flow is a measure of the functional capacity of the salivary gland (Dodds *et al*., 2005). Most studies have shown that unstimulated salivary flow rate is a determinant of oral dryness (Sreebny & Valdini, 1988a). The stimulated salivary flow rate can be a more meaningful indicator of the extent of gland dysfunction (Valdez & Fox, 1993). Loesche *et al*., (1995b) reported that a stimulated salivary flow rate of less than 0.5 ml/min was associated with a significant increase in anaerobic bacteria in the oral cavity. The hyposalivation group of this study can therefore be viewed as representative of the elderly who had both secretory and salivary gland functional capacity problems.

The salivary flow rates were higher for men than women in this study. The gender difference in salivary flow rate was in line with previous studies (Bergdahl, 2000; Narhi *et al*., 1992; Thorselius *et al*., 1988b.). The reasons suggested for lower salivary flow rate in females was that they had smaller salivary glands than males and were subject to postmenopausal hormonal change (Thorselius *et al.*, 1988). This study found the association of hyposalivation with systemic disease and routine use of medicine. It has been reported that the daily intake of multiple drugs and multiple systemic disease result in less salivary secretion (Narhi *et al.*, 1992). However, in our study, we could not define the kind of medication, therefore, we could not determine which medicines had a xerostomic potential. An association between hyposalivation and smoking was also found in this study. Moore et al. reported that hyposalivation was associated with current smoking (Moore *et al*., 2001).

The study subjects who were classified as hyposalivation had a higher prevalence of decayed teeth and lower number of teeth present than those with normal salivation, consistent with findings from previous studies (Lagerlöf & Oliver, 1994b).The periodontal status of subjects showed a significant relationship with salivary flow rate. Previous studies reported that a low salivary flow rate had a deleterious effect on periodontal disease, as this permits opportunistic infections in the oral cavity (Hirotomi *et al*., 2006).

Oral function of elderly Thai was found to be a problem for at least 28 % of subjects. This study showed that subjects with hypersalivation were more likely to have oral function problems such as swallowing, speaking, tasting and chewing in both dentate and edentate groups. Association of oral dryness with difficulty in speech and swallowing has been reported in previous studies (Narhi, 1994). Taste disturbances found in patients with dry mouth may be due to a salivary flow deficiency, whereby substances are prevented from reaching the taste buds (Bergdahl, 2000, Ikebe *et al*., 2002). Chewing ability of the elderly who were in the hyposalivation group was significant lower than those in the normal salivation group.

Saliva is indispensable to preparing food for digestion and swallowing. Subjects with low salivary flow are likely to have difficulty in masticating and swallowing, particularly dry foods, and they may need liquids to help swallow their food (Loesche *et al.*, 1995b). These problems can lead to changes in food and fluid selection, which may compromise nutritional status.

The result confirms that malnutrition is a major public health concern in elderly Thai. Tooth loss reduces chewing ability and affects food choice, which consequently contributes to malnutrition. It is noteworthy also that there was a significant association between salivary flow rate and nutritional status. Association between reduced saliva flow and poor nutritional status was also found by Dormenval et al. in Swiss subjects (Dormenval *et al*., 1998).

Low salivary flow interferes with functions such as chewing, swallowing, tasting and speaking, thereby affecting the well-being of the individual. An oral function promotion program for the independent elderly in Japan (Hakuta *et al.*, 2009), found a decrease in dryness of tongue, an enhancement of the mobility of the tongue and lips and the increase in salivary flow rate as a result of the muscular-function intervention program. Assessing salivary flow is, therefore, important in the care of the elderly. In order to promote oral health of elderly Thai, interventions for increasing salivary flow appear warranted, and may assist in the necessary to prevention of malnutrition and in improving quality of life.

The limitation of present study was that we did not diagnose xerostomia. This was partly because we could not measure the detailed composition of saliva in the community-based research setting. Xerostomia may impact on the studied parameters, particularly oral function. In addition, not all subjects with xerostomia have hyposalivation (and vice versa) as pointed out in a former study (Navazesh *et al.*, 1992). Nonetheless, salivary flow rate measurement is thought to be the easy and objective index for mornitoring oral health care of the community elderly.

In conclusion, 14% of a community-dwelling elderly Thai population had hyposalivation problems. The factors impacting on hyposalivation were gender, systemic disease, medication and smoking. It is suggested that hyposalivation might be a risk factor not only for dental caries and periodontal disease but also for oral function such as tasting, speaking, swallowing and chewing

problems. In addition, hyposalivation was associated with malnutrition. The findings of this study emphasizes the necessity for inclusion of salivary flow rates measurement when designing preventive and treatment programs, and in evaluating oral health and oral function status of the population, especially the elderly.

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