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ORIGINAL ARTICLE

Unstimulated whole saliva flow rate in relation to sicca symptoms in Hungary

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OBJECTIVE: To assess the prevalence of xerostomia and the related oral and extraoral dryness symptoms in Hungary, to evaluate the association of those symptoms with the unstimulated whole saliva (UWS) flow rate, and to find correlation between the level of UWS flow rate and the oral health status of the questioned patients.
SUBJECTS AND METHODS: A total of 600 patients between the age of 18 and 92 years, 265 male, 335 female, were selected in accordance with the current regional age and residence distribution scheme of the Hungarian Statistical Office. A questionnaire was designed to determine the subjective presence or absence of the sicca symptoms. UWS flow rate and the dental and periodontal status were determined.
RESULTS: The percentages of subjective symptoms in the questioned subjects were oral dryness, 34%; reduced salivation, 11%; mucous saliva, 15%; dysphagia, 13%; glossopyrosis, 7%; dysphonia, 31%; dysgeusia, 9%; nasal dryness, 32%; ocular dryness, 21%; itching, 40% and xeroderma, 60%. Vaginal dryness was 14%, vaginal itching was 16% in the interviewed women. The grade of xerostomia, dysphagia, tiredness, and additionally the gingival bleeding index showed a negative correlation with the UWS flow rate. After all decayed, missing and filled teeth (DMF-T) mean values, gingival bleeding index and plaque index were significantly higher in hyposalivators, compared with those who had normal flow rates
CONCLUSION: This cross sectional study, representative of the Hungarian population, clearly shows that one-third of the adult population suffers from xerostomia. The clinical severity of the xerostomia demonstrated a strong relationship with the lower levels of UWS flow rate. Reduced levels of UWS flow rate in this study were also shown to be associated with dysphagia, fatigue, and increased DMF-T numbers. The data show that oral dryness, its associated desiccation symptoms and its clinical manifestations are significant health problems in Hungary.
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Keywords: xerostomia; saliva; dysphagia; geriatric conditions; eye; dryness

Introduction

Xerostomia (dry mouth) is a subjective feeling of oral dryness, which might be accompanied by a severe reduction in the secretion of whole saliva (Sreebny, 1996). As flow rate varies widely among individuals, the cut-off point at which subjects will complain of dry mouth will vary, too. The normal flow rate of unstimulated whole saliva (UWS) is approximately 0.3 ml min^{-1}, and that of stimulated whole saliva is about 1–2 ml min^{-1} (Sreebny, 1996). Generally, subjects, whose UWS flow rate is $\leq$ 0.1 ml min^{-1} or whose stimulated flow rate is $\leq$ 0.5 ml min^{-1} are considered abnormal (hyposalivation or objective dry mouth). However, several investigators have reported (Ship *et al*, 1991) that xerostomia, *per se*, is not always accompanied by a reduced saliva flow rate. Moreover, the absence of oral dryness does not necessarily mean that there is adequate salivary secretion (Ship *et al*, 1991).

Dry mouth can be caused by many reasons including use of many drugs (Scully, 2003) and systemic conditions and/or diseases (diabetes insipidus, diabetes mellitus, therapeutic irradiation of the head and neck region, graft-versus-host disease and autoimmune diseases) (Sreebny, 1996). Sjögren's syndrome (SS) is a chronic, systemic, autoimmune disorder, characterized by generalized exocrine hypofunction, serologic abnormalities and different organ system changes. In the primary form of SS, dry mouth and dry eyes are the most prominent symptoms. In the secondary form of SS, these sicca symptoms are generally accompanied by a systemic

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autoimmune disease, mainly rheumatoid arthritis (Nederfors *et al*, 2002; Vitali *et al*, 2002). Other autoimmune diseases, such as systemic lupus erythematosus (Manoussakis *et al*, 2004), myositis (Marton *et al*, 2005), and progressive systemic sclerosis (Nagy *et al*, 1994) may also cause xerostomia.

Several studies have shown that the UWS flow rate decreases with age (Ben-Aryeh *et al*, 1986; Pozharitskaia *et al*, 1992; Percival *et al*, 1994, Yeh *et al*, 1998). The prevalence of dry mouth, on the other hand, increases with age (Ben-Aryeh *et al*, 1986; Pozharitskaia *et al*, 1992; Percival *et al*, 1994; Yeh *et al*, 1998). An investigation conducted on outpatients has shown that about one of four patients complains of xerostomia or associated symptoms (Sreebny and Valdini, 1988; Nederfors *et al*, 1997) and about 40% of the elderly complain of dry mouth (Narhi *et al*, 1992a,b).

Xerostomia is rarely a solitary symptom. When present for an extended period of time, it induces a wide variety of other oral symptoms, such as burning mouth, cheilitis, glossodynia, difficulty with eating dry foods, candidiasis, dysphonia and dysgeusia (Sreebny, 1996). Dysphagia is also a significant symptom of xerostomia and/or hyposalivation (Volter *et al*, Logemann *et al*, Russell *et al*). Clinically, the buccal mucosa in patients with dry mouth may appear pale and feel dry; the tongue may demonstrate signs of lobulation and fissuring; and these patients often demonstrate signs of extensive dental decay (Papas *et al*, 1993). Several authors reported that xerostomia and/or hyposalivation are accompanied by an increased risk for caries and gingival alterations (Baudet-Pommel *et al* 1994, Almstahl and Wikstrom, 1999; Hodgson *et al*, 2001; Moore *et al*, 2001). Not only lack of the salivary protective factors can be a possible reason of this (Sreebny, 1996), but also immunological causes may have a role in the increased risk for tooth loss in people with dry mouth, especially in immunological diseases (Marton *et al*, 2006).

Numerous non-oral clinical signs can be associated with xerostomia. These can be the possible signs of the generalized exocrinopathy. A prominent eye symptom can be keratoconjunctivitis sicca (the subjective feeling) and/or decreased lacrimation (objective result). More authors reported associations between dry eye and dry mouth (Price and Venables, 2002; Koseki *et al*, 2004). Hay *et al* (1998) found, in a population-based cross sectional study ($n = 341$), that 19% of the subjects suffered from dry mouth and 10% from dry eyes, whereas 29% of the subjects had hyposalivation as well. Nasal dryness, which may be accompanied by nasal crusts, epistaxes and a decrease in olfactory acuity, is often associated with the complaint of dry mouth (Sreebny, 1996). Xeroderma is the result of the diminished sweat gland activity (Sreebny, 1996). Moreover, the reduced saliva secretion leads to the lack of gastrointestinal mucous coating, aggravating gastrointestinal inflammatory diseases (Patinen *et al*, 2004), pharyngitis, laryngitis and recurrent bronchitis (Sreebny *et al*, 1992a,b). Vaginal dryness may lead to recurrent fungal infections and to consequent dyspareunia (Bertram, 1967; Sreebny *et al*, 1992a,b). Fatigue may also be an associated symptom of xerostomia (Sreebny, 1996).

The objective of the present study was to assess the prevalence of both subjective and objective dryness symptoms in a Hungarian population, and to evaluate the association of oral symptoms with the UWS flow rate. As many investigations revealed that decreased saliva flow rate can cause dental and periodontal alterations, a further aim of the authors was to find correlation between the level of UWS flow rate and the dental and periodontal status of the studied population.

Materials and methods

The clinical examinations and symptom questionnaires of 600 subjects (265 male and 335 female) were evaluated. The distribution of subjects by sex and age followed the current regional distribution pattern given by the Hungarian Statistical Office. The mean age of the participants was 48 ± 16 years. All of them were inhabitants from the urban and rural areas of different regions in Hungary, including the capital (Budapest).

Questionnaire

A questionnaire constructed especially for this study was used to determine the subjective presence or absence of oral and ocular dryness and their related symptoms (Table 1). It was established with a scale of no symptom, mild, moderate or severe to asses the severity of the certain symptoms. The questionnaire was given to the patients right before the clinical examinations.

Clinical examinations

Exocrine function tests

The flow rate of UWS was determined in every person according to the method described by Sreebny *et al* (1992a,b) after the filling of the questionnaire described above. UWS was collected into preweighed vessels for 5 min with the patient seated in an upright position. Patients were asked to refrain from eating and drinking 2 h prior to the test session, to avoid swallowing and to make as few movements as possible during the procedure (Sreebny *et al*, 1992a,b). Measuring vessels were weighed before and after each collection using an electronic scale (Sartorius BA 110 S. Sartorius, Germany). UWS flow rate was expressed in ml min^{-1} (which is nearly equivalent to g min^{-1}). A salivary secretion rate of 0.1 ml min^{-1} or less was considered as an objective sign of salivary hypofunction (hyposalivation).

Lacrimal flow rate was determined by the Schirmer's test. Lacrimation was considered abnormally low when the observed values were 5 mm or less.

Oral examinations

The number of the decayed, missing and filled teeth was determined individually with the use of a standard dental mirror and probe, and was expressed as DMF-T mean values (WHO, 1997).

The periodontal probing depth (PPD) was determined with a calibrated William's periodontal probe (Astir

Table 1 Results of the questionnaire. Columns show the number of persons answering different questions ($n = 600$)

Subjective symptom	*No*	*Mild*	*Moderate*	*Severe*	*Total 'YES'*
1. **Does your mouth usually feel dry?**	**395**	**82**	**78**	**45**	**205 (34%)**
2. **Do you have difficulty with swallowing?**	**521**	**44**	**26**	**9**	**79 (13%)**
3. Does your tongue often burn or tingle?	557	23	13	7	43 (7%)
4. Is your speech significantly affected when you speak for relatively long periods of time?	412	106	61	21	188 (31%)
5. Do you have difficulty with taste?	547	34	17	2	53 (9%)
6. Do you feel that you have enough saliva in your mouth?	67 (11%)	533			
7. Does your saliva often feel thick?	508	89	2	1	92 (15%)
8. **Do you suffer from dental caries?**	**187**	**88**	**194**	**131**	**413 (68%)**
9. Do you suffer from nasal dryness?	404	98	59	39	196 (32%)
10. Do your eyes often feel dry?	481	40	45	34	119 (21%)
11. Do your eyes frequently itch, burn, tingle or feel that there is something in them?	360	122	75	43	240 (40%)
12. Are you sensitive to light?	319	113	91	77	281 (47%)
13. Does your skin usually feel dry?	240	133	124	103	360 (60%)
14. Do you suffer from vaginal dryness?	289	15	22	12	311 (14%)
15. Do you experience vaginal itching or burning, or suffer from recurrent vaginal fungal infections?	284	30	21	4	316 (16%)
16. **Do you frequently feel tired?**	**224**	**108**	**182**	**86**	**376 (63%)**

Answers given to the questions signed with bold letters showed significant correlations with UWS flow rates analysed by the ANOVA test ($P < 0.05$).

Intermedica, Kensington, London) and was defined as the distance between the free gingival margin and the base of the pocket and measured in millimeter. The PPD was measured at six sites of every tooth (Nyman and Lindhe, 1983). The number of sites with a PPD $\geq$ 5 mm per person was recorded. In addition, the plaque-index (Löe and Silness, 1963) (PI) was determined.

Evidence of bleeding on probing was tested by the Ainamo-Bay gingival bleeding index (GBI). Four surfaces were examined on each tooth and the data were recorded as a percentage of the examined surfaces (Ainamo and Bay, 1975).

Statistical analysis

All data were expressed in the form of mean $\pm$ standard deviation values. The SPSS 11.0 for Windows (SPSS inc., Chicago, MI, USA) software program: Student's *t*-test (for the DMF-T, PPD, PI and GBI indexes), the ANOVA test (for analyzing differences between genders and age groups in UWS, sialometry, and its correlations with the questions of the questionnaire), and the Pearson-correlation test (for analyzing the correlation of hyposalivation and normosalivation with the DMF-T, PPD, PI and GBI indexes) were employed in the evaluation of the data. Results were considered statistically significant if the *P*-level was <0.05.

Results

Subjective xerostomia

Thirty-four percent of the questioned subjects felt subjective oral dryness, and 7.5% described it to be severe. Eleven percent felt reduced salivation and 15% reported to have viscous saliva, 13% suffered from dysphagia, and 7% from glossopyrosis, 31% reported to have dysphonia and 9% had dysgeusia. Nasal dryness was mentioned by 32% of the questioned subjects, while 21% of the examined population suffered from the feeling of dryness of the eyes (xerophthalmia). Itching eyes were mentioned by 40%, dry skin by 60% of the questioned. Prevalence of vaginal dryness was mentioned by 14%, while vaginal itching in 16% of the interviewed women (Table 1).

Table 2 Unstimulated whole saliva (UWS) flow rate and ratio of xerostomia (subjective symptom) in patients with dry eyes (subjective symptom) ($n = 119$), and ratio of dry eyes in patients with xerostomia ($n = 205$) of 600 questioned patients

UWS and xerostomia in dry eye patients, dry eye symptom in xerostomic patients	
UWS $\pm$ s.d. (ml min^{-1}) in men with dry eyes ($n = 25$)	0.67 $\pm$ 0.36
UWS $\pm$ s.d. (ml min^{-1}) in women with dry eyes ($n = 94$)	0.4 $\pm$ 0.26
Ratio of xerostomia in men with dry eyes (%) ($n = 25$)	56
Ratio of xerostomia in women with dry eyes (%) ($n = 94$)	68
Ratio of dry eyes in men with xerostomia (%) ($n = 67$)	36
Ratio of dry eyes in women with xerostomia (%) ($n = 138$)	42

Clinical examinations

Unstimulated whole saliva flow rates, the influence of age and gender on the UWS flow rates in the different age groups and genders are summarized in Table 2, and in Figure 1. UWS flow rate was significantly higher in men than in women in every age group ($P < 0.001$); both groups showed a negative correlation with age ($P < 0.001$) by the ANOVA test. Twenty-three of 600 patients (3.8%) showed hyposalivation (UWS $\leq$ 0.1 ml min^{-1}). Most of them were women (91%) and 45% of them were from the age group of

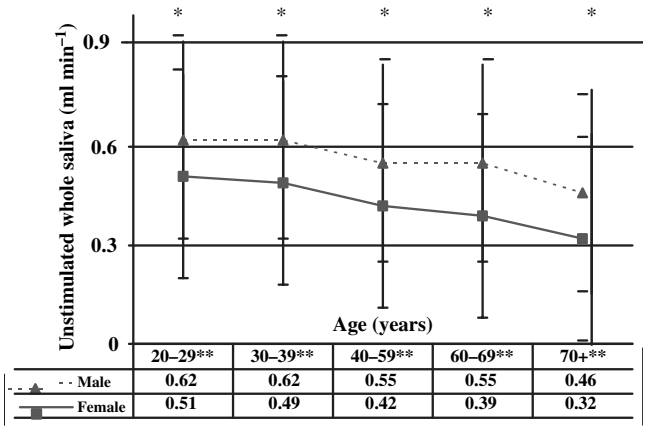

Figure 1 Unstimulated whole saliva (UWS) flow rate (mean ± standard deviation) in different age groups in men and women: UWS continuously decreases with age, and UWS is significantly higher in men in every age groups compared with women

40–59 years. Patients complaining of dry eyes did not show any difference in UWS flow rates in any age groups compared to those who did not complain of dryness of their eyes (Table 2).

Correlation of UWS with the subjective symptoms

According to the statistical analysis (ANOVA test), the grade of xerostomia (the subjective feeling of dry mouth) showed a strong correlation with the reduced levels of the UWS flow rate ($P < 0.0001$).

Dysphagia, and the reported frequent feeling of tiredness (fatigue) also correlated negatively with UWS ($P < 0.05$) (Figure 2). Other subjective symptoms investigated in the questionnaire were not associated with the UWS (Table 1).

Dry eye patients

Along with the data of the questionnaire, 119 persons complained, when asked, about the subjective feeling of dryness of the eyes (Table 2). The greatest group of those persons (45 of 119) was the group of women at the age group of 40–59 years. At the same time 65% of the dry eye patients had the feeling of subjective xerostomia, and 49% of the xerostomic patients suffered from ocular dryness (Table 2). Neither the subjective feeling of dry eyes nor other subjective eye symptoms were in correlation with UWS (Table 2).

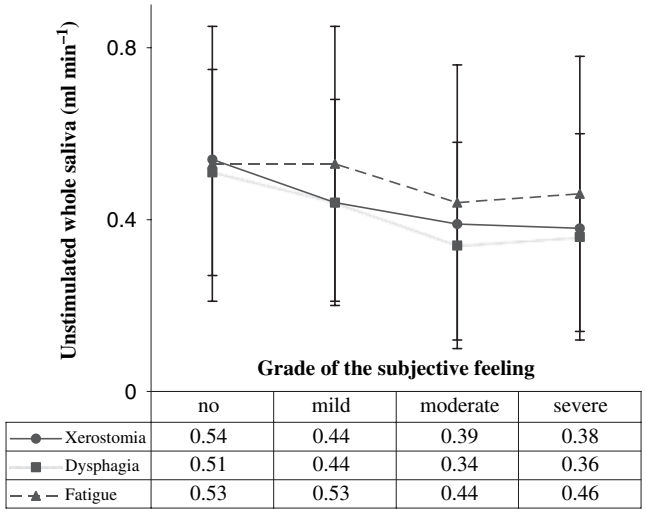

Figure 2 Association between different subjective symptoms and unstimulated whole saliva (UWS) flow rate (mean ± standard deviation): decreasing of the UWS flow rate was accompanied by a number of severe subjective symptoms

Table 3 Dental and periodontal condition in patients with hyposalivation (unstimulated whole saliva flow rate ≤ 0.1 ml min^{-1}) compared with normosalivators (unstimulated whole saliva flow rate < 0.1 ml min^{-1})

	Hyposalivators (UWS ≤ 0.1 ml min^{-1})	*Normosalivators (UWS > 0.1 ml min^{-1})*
DMF-T number	27 ± 6**	21 ± 8
PPD ≥ 5 mm (average no. sites per person)	0.93 ± 2	0.75 ± 1
Plaque index (Löe Silness)	0.78 ± 0.57*	0.61 ± 0.55
Gingival bleeding (Ainamo-Bay)	0.5 ± 0.38**	0.26 ± 0.31

*$P < 0.05$ by the Student's *t*-test; **$P < 0.001$ by the Student's *t*-test.

Associations between UWS and the intraoral condition

The DMF-T number was significantly higher in patients with hyposalivation (UWS ≤ 0.1 ml min^{-1}), compared with those who had normal UWS flow rates (21 ± 8, 27 ± 6 respectively; $P < 0.001$), analyzed by the Student's *t*-test (Table 3).

Neither the GBI, nor the number of the periodontal pockets deeper than 4 mm, nor the plaque index was in direct correlation with UWS, although both GBI and plaque index showed to be significantly higher in hyposalivators (UWS ≤ 0.1 ml min^{-1}), compared with those who had normal flow rates (plaque: 0.78 ± 0.57 and 0.61 ± 0.55 respectively; $P < 0.05$) (bleeding: 0.26 ± 0.31 and 0.5 ± 0.38 respectively; $P < 0.001$) by the Student's *t*-test (Table 3).

Discussion

This study was conducted to find correlations between the UWS flow rate, subjective xerostomia and various other symptoms associated with oral desiccation in the Hungarian population. A further aim was to investigate a possible link between caries, periodontal disease and either subjective or objective hyposalivation.

Slightly more than 1/3 of the examined persons suffered from subjective oral dryness (xerostomia). This is slightly higher than the result of Sreebny and Valdini (1988), where they reported in a population-based study that the prevalence of subjective dry mouth feeling was 29%. Hay *et al* (1998) had similar findings in their population-based study in England. In a study conducted on 3311 patients in Sweden by Nederfors *et al* (1997), the prevalence of xerostomia varied between 23% for men and 28% for women. The prevalence of xerostomia in Hungary is slightly higher than that in the

USA, the UK and Sweden. As it was expected, UWS was in direct association with the grade of a number of subjective dryness symptoms, like xerostomia, dysphagia and suffering from dental caries. Hay *et al* (1998) reported of a weak association between the subjective and the objective symptoms analyzed by the predictive value test, although the grades of the symptoms were not evaluated in their 314 subjects. Our results demonstrate a strong association between the grade of dry mouth feeling and the UWS flow rates. It should be noted, however, that only 4% of the persons had hyposalivation. Seventy-five percent of these subjects complained of xerostomia; 20% of them suffered from the feeling of dry eyes. About 25% of the interviewed subjects were reported to have dry eyes in the study of Hay *et al* (1998), which is slightly higher than that in our work. Xerostomia and dry eyes were simultaneously present in 13% of the subjects, which is in accordance with the data of Hay *et al* (1998).

In their functional study on patients with SS, Volter *et al* (2004) reported that a reduced saliva volume did not correlate with slowed or inefficient swallowing. Rather, the reduced saliva flow rate seemed to change the patients' perceptions of their swallowing ability. This observation is supported by Logemann *et al* (2003), who stated that xerostomia affects the sensory process of swallowing. This study did not find correlation between the physiologic aspects of bolus transport and the saliva flow rate. Russell and Reisine (1998) did find that dysphagia was not correlated with xerostomia in patients with primary SS, but an abnormal esophageal peristalsis could be responsible for the severe dysphagia. Our results indicated that a positive response to the question of possible dysphagia was in correlation with the reduced levels of the UWS flow rate, although we did not examine the esophageal function. Considering the results, we can agree with Volter *et al* (2004) and Logemann *et al* (2003), that the sensory process of swallowing may be the reason for dysphagia in case of the lower levels of UWS flow rates.

Results of Papas *et al* (1993) showed that both coronal and root caries were higher in old xerostomic (subjective dry mouth) patients with different medications, compared with medication free individuals. They also added that caries varied inversely with the UWS flow rates, and stimulated flow rates of parotid, submandibular/sublingual flow rates. Moore *et al* (2001) also found that UWS flow rates were associated with a higher prevalence of dental caries in subjects with type I diabetes mellitus. Hodgson *et al* (2001) reported a case of a child with major salivary gland agenesis, where they detailed the rampant caries as a consequence of the severe xerostomia. The results of Almstahl and Wikstrom (1999) indicated that a low salivary secretion rate mainly promotes a flora associated with the development of caries. We agree with Papas *et al* (1993), Moore *et al* (2001), Almstahl and Wikstrom (1999) and with Hodgson *et al* (2001), because we also found a negative correlation between UWS flow rate and the DMF-T number in the present study and also in Sjögren patients in a previous study (Marton *et al*, 2006). Additionally, patients with hyposalivation had significantly higher DMF-T numbers than those of normal flow rates. Sreebny and Valdini (1988) noticed that patients felt fatigue in association with different dryness symptoms. A negative correlation between the UWS flow rates and tiredness was evidenced in this study.

According to our study neither the GBI, nor the number of the periodontal pockets deeper than 4 mm, nor the plaque index was in direct correlation with UWS. This is in accordance with the results of Crow and Ship (1995) that could not find correlation between the WS flow rate and the periodontal status in healthy people. Janket *et al* (2003) could detect significant deleterious effects of xerostomic medications on oral mucosa. However, xerostomic medications did not appear to increase coronal caries, or periodontal index measured by the Community Periodontal Index of Treatment Needs (CPITN) among ambulatory, community dwelling participants (Janket *et al*, 2003). It should be noted, however, that in our study both gingival bleeding and plaque indices were significantly higher in hyposalivators (UWS ≤ 0.1 ml min^{-1}), so in case of hyposalivation there is an increased risk for plaque accumulation and gingivitis in these group of patients.

Conclusion

This population based study revealed that 34% of the questioned subjects felt subjective oral dryness, and 7.5% among them were severely troubled by oral dryness. Lower levels of UWS flow rate were in direct association with a number of subjective sensations, like xerostomia, dysphagia, fatigue, and also with increased DMF-T numbers. Subjects with hyposalivation might have a higher risk for caries and gingivitis, but not for periodontitis. The data show that oral dryness, its associated desiccation symptoms and its clinical manifestations are significant health problems in Hungary.

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