



The Burden of Xerostomia in Independent Community-dwelling Older Adults: Results from the Saliwell Project

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Purpose: The Saliwell Project was a European Research Consortium initiative aimed at developing an intraoral device to treat dry mouth by electroneurostimulation. The purpose of the present study was to evaluate the burden of xerostomia in independent community-dwelling older adults using quantitative and qualitative analyses, as a preliminary phase of the project.

Materials and Methods: A cross-sectional postal questionnaire survey was carried out involving 1,000 adults aged 60 years and above, randomly selected from the Birmingham University Thousand Elders database. The questionnaire format was designed at two focus groups' meetings involving people with chronic xerostomia. Age, gender, chronic medical conditions and number of prescribed medications consumed daily, as well as dental, oral and general health status, Geriatric Oral Health Assessment Index (GOHAI), Xerostomia Inventory (XI), chewing capability and dry mouth questions were evaluated.

Results: Seven hundred and seventy completed questionnaires were available for analyses. There were 274 males and 496 females (age range 60 to 85). The overall prevalence of xerostomia (subjective complaints of dry mouth) was 15.5%. A logistic regression analysis showed that the following factors significantly ($P < 0.05$) contributed to xerostomia: gender; number of prescribed medications; complaints of anxiety, digestive, bladder and osteoporosis problems; oral health satisfaction level and perceived general health status.

Conclusions: The overall prevalence of xerostomia as well as its risk factors was in agreement with the previously published studies. Since chronic xerostomia is a distressing disorder with significant impact on oral health satisfaction and general health status, a comprehensive treatment of xerostomia should carefully consider patients' perspectives and behaviours.

Key words: Xerostomia, older adults, GOHAI, XI

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INTRODUCTION

Xerostomia has frequently been associated with salivary gland hypofunction and concomitant loss in the quality of life for sufferers (Fox et al, 1987; Sreebny

and Valdini, 1988; Locker, 1993; Hochberg et al, 1998; Ship, 2002a). The salivary glands hypofunction can be due to a number of serious medical conditions (Porter et al, 2004); Sjögren's syndrome (Kassan and Moutso-poulos, 2004); radiation induced-damage to salivary

glands (Jensen et al, 2003; Vissink et al, 2003) and psychiatric distress (Bergdahl and Bergdahl, 2000). However, it is well known that xerostomia is not always caused by salivary gland hypofunction: even if the symptom of oral dryness has been frequently reported in older adults, data on stimulated salivary flow rate in healthy elderly have revealed no significant age-related decrease (Vissink et al, 1996; Ghezzi and Ship, 2003).

The prevalence values for xerostomia vary widely (14–46%) due partly to methodological differences in study populations and diagnostic criteria used (Field et al, 2001). Whilst dry mouth *per se* is not a serious condition, its implications for the quality of life for older adults are well recognized; such as, difficulty in eating, chewing and swallowing (Fox et al, 1987; Locker, 1993), avoidance of certain foods (Loesche et al, 1995), discomfort in wearing dentures (Wolff et al, 2003), presence of oral burning symptoms (Pedersen et al, 2004) and the necessity of treating and retreating oral infections and dental caries. Complaints at night times are particularly common, as salivary output normally reaches its lowest circadian level during sleep. It often results in disturbed sleep due to a need to sip water to alleviate dry mouth symptoms and a feeling of tiredness on waking up in the mornings (Dawes, 1975).

Treatments for dry mouth are generally based upon replacing lost oral fluids with salivary supplements and stimulating remaining functional gland tissue with candies, chewing gums or sialogogue drugs (Ship, 2002a; Frost et al, 2002; Nieuw Amerongen and Veerman, 2003; Porter et al, 2004). However, some of these therapies are often burdened by a temporary unsatisfactory action or by systemic side effects (Sreebny et al, 1992).

A European Research Consortium was formed in 2002 to address possible medication-free treatments of xerostomia. The Saliwell Project was conceived by the Consortium to design and develop an intraoral electronic device to treat xerostomia by electrostimulation of nerves (mainly lingual nerve) relevant to salivary flow regulation. Since chronic xerostomia is a distressing disorder which requires a lifelong therapy and the treatments currently offered to alleviate this symptom are not always satisfactory, novel treatment modalities should be planned after careful assessment of the disorder's burden on patients' quality of life and their acceptability and preferences about potential therapies.

The main objectives of the present study were to identify the prevalence of symptoms of xerostomia in independent, community-dwelling older adults, to ascertain quality of life indicators and to investigate older adults' expectations of possible technical solutions to manage xerostomia. Furthermore in recent years the

United Kingdom (UK) Department of Health and research funding bodies have emphasised the importance of user involvement in clinical research (Trivedi and Wykes, 2002). Accordingly a qualitative analysis in the form of focus groups was used initially to collect users-generated data about potential, more appropriate and acceptable solution to alleviate xerostomia. Further investigation of the intervention with a specific saliva stimulating tool would be the next target of the Saliwell Project.

MATERIALS AND METHODS

The study comprised two parts – a qualitative study by means of two small focus groups and a quantitative study involving 1,000 older adults for a postal questionnaire survey.

Focus Groups

Two focus group meetings, one for males and one for females, were planned to identify older adults' perception of mouth dryness. Participants were selected from the Thousand Elders nationwide database that has been established by the Centre for Applied Gerontology (Centre), the University of Birmingham, UK (Nayak, 1995). The members of this consumer panel were volunteers aged 60 years and older who lived independently in the community. They belonged to various socio-economic backgrounds. There were seven males and seven females (age range 67 to 81). All of them had shown symptoms of xerostomia, with disturbed sleep patterns, and on average, they took more than two prescribed medications per day. Participants were encouraged to talk about their mouth dryness and its consequences on their quality of life, as well as potential and preferred solutions to alleviate dryness. The focus groups also helped to develop the questionnaire that later was used for a postal survey.

Questionnaire Survey

Participants for the questionnaire survey were selected by a computer at random from the Thousand Elders database that was used as a sampling frame with a registration of 4,000 older people. Assuming a 14% prevalence value for xerostomia in community-dwelling older adults (Narhi, 1994; Field et al, 2001), a sample size of 714 was required to have at least 100 people with complaints of xerostomia. The Centre regularly obtained a 75% response rate for a questionnaire survey involving the Thousand Elders panel. Consequently, it was decided to select 1,000 people from the Thou-

sand Elders database using a stratified random sampling procedure (age range 60 to 85).

Questionnaire Design

The questionnaire format published by researchers in this field was adopted for comparison of results. Specifically the questionnaire was designed to extract information on the following: socio-demographic details, chronic medical conditions as diagnosed by a doctor and number of prescribed medications taken daily, self-perceived general health, dentition and dental health status, satisfaction with the health of teeth and mouth, chewing capacity (Leake, 1990), Geriatric Oral Health Assessment Index (GOHAI) (Atchison and Dolan, 1990; Locker, 1993), xerostomia inventory (XI) and a 'gold standard' dry mouth question (Thomson et al, 1999).

The chewing capacity score was obtained by asking participants whether they had any problems in chewing one of the following six items: a piece of fresh carrot, boiled vegetables, fresh lettuce salad, firm cooked meat, a piece from a whole fresh apple and a sandwich. The ability to chew was given a score of '1' and inability to chew was given a score of '0'. The sum total from the six items gave the chewing capacity score. Participants not scoring six points were considered to have problems in chewing, in general.

The GOHAI was a self-reported measure designed to assess oral health problems and concomitant reduction in oral functioning in older adults. It comprised 12 items on oral symptoms, physical and psychosocial functioning and pain or discomfort. Participants described the problems for each of the 12 items using responses scored on a scale ranging from 0 to 5; '0' being 'never' and '5' being 'all the time'. The GOHAI score was obtained by summing the response codes for the 12 items, higher scores indicating more serious problems (Locker, 1993).

The Xerostomia Inventory, developed by Thomson et al (1999), was used to measure the severity of dry mouth symptoms. The inventory comprised 11 items and participants were asked to indicate which one of the five response options best described their symptoms over the preceding four weeks. The response options ranged from 1 to 5; '1' being 'never' and '5' being 'very often'. The responses were summated to give a single Xerostomia Inventory score; again higher scores indicating the severity of dry mouth symptoms.

The prevalence of xerostomia was obtained by a standard dry mouth question used as the 'gold standard'. This question was 'How often has your mouth felt dry in the last four weeks?'. Response options were – 'never', 'occasionally', 'frequently' and 'always'.

The prevalence of xerostomia was ascertained by combining the last two responses 'frequently' and 'always'.

The questionnaire was piloted using 20 members from the Thousand Elders panel, before distributing to 1,000 randomly selected adults between ages 60 and 85 years.

Data Analyses

Questionnaire responses were analysed using SPSS, version 11.5 (SPSS Inc., Chicago, IL). Chi-square analyses and t-tests were carried out to identify significant differences between males and females, and also differences between groups with and without xerostomia. From Chi-square analysis, all variables showing significant associations with oral dryness were entered into a logistic regression analysis to determine which had independent effects on the prevalence of xerostomia. Categorical variables were reduced to binary variables coded 1 or 0, indicating the presence or absence of xerostomia respectively. Age and number of prescribed medications taken daily were entered as continuous variables. The GOHAI and XI scores were not entered into the regression analysis.

RESULTS

Questionnaire Survey

Out of 1,000 questionnaires posted the Centre received 770 completed questionnaires for inclusion in the study, giving a response rate of 77%. The demographic data are shown in Table 1. Just about half of the total sample (size=770) were married and lived together with their partner. About two-fifths of the sample lived alone. About 19.1% of the total sample were edentulous (19.0% of females and 19.3% of males, Chi-square significance $P>0.05$) and 45.7% of the sample had more than 20 natural teeth. More than half of the sample (56.5%) wore one or more partial plates or dentures. About one-third of the total sample had problems in chewing (36.4% of females and 26.9% of males, $P<0.05$). The prevalence of xerostomia, as determined by the responses to the 'gold standard' question was 15.5% with higher percentage in females (18.1% of females and 10.6% of males, $P<0.05$).

Table 1 shows significant differences ($P<0.05$) between males and females for age, number of prescribed medications taken, GOHAI and XI scores as per t-test statistics calculations. The table also shows significant differences ($P<0.05$) between xerostomic (i.e. participants with oral dryness) and nonxerostomic (those without oral dryness) groups.

Table 1 Comparisons between male and female groups, between xerostomic and nonxerostomic groups

Groups		Age (years)	NM	GOHAI score	XI score
Males	n	274	266	263	268
Mean (\pm SD)		74.14 (\pm 6.3)	2.71 (\pm 2.1)	7.93 (\pm 6.4)	18.06 (\pm 6.8)
Females	n	496	483	483	491
Mean (\pm SD)		72.6 (\pm 6.2)	2.37 (\pm 2.1)	9.36 (\pm 7.7)	20.77 (\pm 8.3)
t-test statistics (df)		3.284 (768)	2.147 (747)	-2.707 (628)*	-4.873 (647)*
P-value		0.001	0.032	0.007	0.000
Xerostomic	n	119	115	117	115
Mean (\pm SD)		74.28 (\pm 6.4)	3.65 (\pm 2.5)	15.58 (\pm 9.5)	31.66 (\pm 7.7)
Nonxerostomic	n	651	634	629	644
Mean (\pm SD)		72.94 (\pm 6.2)	2.28 (\pm 1.9)	9.24 (\pm 7.2)	17.70 (\pm 5.8)
t-test statistics (df)		2.137 (768)	5.624 (140)*	6.971 (140)*	18.529 (137)*
P-value		0.033	0.000	0.000	0.000

n=sample size, SD=standard deviation, NM=Number of prescribed medications, GOHAI=Geriatric Oral Health Assessment Index, XI=Xerostomia Inventory. P-value from t-test statistics, df=degrees of freedom, * Levene's test, equality of variances not assumed.

Chi-square analyses were carried out to identify associations between xerostomic and nonxerostomic groups and variables such as gender, dental health, chewing capacity, general health and chronic medical conditions. Table 2 shows most of the significant variables; however self-reported hypertension, diabetes (controlled) and hearing ability were not significant between the two groups.

All variables (see Table 2) were entered into a forward, stepwise, logistic regression analysis to identify variables that were most important in the prediction of the prevalence of xerostomia. The GOHAI and XI scores were not used in the analysis. The predictor accuracy of the regression model was 75.8%, with sensitivity and specificity values of 70.3% and 76.8% respectively. The odds ratio was 7.84 with 95% confidence limits of 4.9 and 12.55. The significant variables for xerostomia in the community-dwelling older adults were: number of prescribed medications taken daily; presence of digestive, bladder, anxiety and osteoporosis problems; oral health satisfaction; perception of general health and the gender of an older adult.

Focus Groups

The participants in the focus groups were asked to comment on one biggest problem they had experienced with dry mouth and a possible treatment they would like to see. The most common manifested complaints were about the functional consequences of xerostomia, such as mastication, swallowing, sleeping, taste and speaking disturbances. Some of the representative views were: *"Very occasionally difficult to masticate and/or swallow if the food is rather dry";*

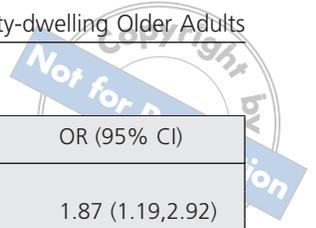
"Waking up during the night several times with mouth like a ridged cardboard"; "Makes me conscious that my breath might smell offensive"; "When talking, sometimes I suddenly dry up in the middle of a conversation"; "Discomfort, makes my speech sounds like I have a plum in my mouth."

Furthermore, when asked the focus groups expressed their wish for a functional, constant and non-pharmacological cure, by articulating expectations for solutions, such as: *"Non-chemical cure, rather than more tablets"; "Something that would prevent waking up with a very dry mouth"; "Something simple that can be used anywhere and at any time."*

DISCUSSION

The limitations of this study were clearly the lack of data on salivary production and names of the prescribed medications taken by the survey participants as well as the lack of information about presence of systemic and local diseases. The logistical problems (time and money) posed by the nationwide spread of the study sample prevented in getting accurate data on these variables. Nevertheless we found an overall prevalence value of 15.5% for xerostomia by the present community-based study of older adults, a number comparable to those previously reported by Locker (1993) and Thomson and Williams (2000) who gave figures of 17.7% and 14.5%, respectively.

The prevalence of xerostomia has been found to be difficult to ascertain due to methodological and population differences used in various studies (Hochberg et

**Table 2 Percentage participants with Xerostomia by predictor variables**

Variables	Sample size	%	Pearson chi-square	P-value	OR (95% CI)
Gender					
Males	274	10.6	7.72	0.005	1.87 (1.19,2.92)
Females	496	18.1			
Dental status					
Dentate	589	13.8	4.43	0.035	1.65 (1.03,2.65)
Edentulous	139	20.9			
Dental health					
Good/very good	593	12.0	26.77	0.000	2.93 (1.93,4.45)
Fair/poor	165	28.5			
Chewing problems					
None	511	11.4	21.19	0.000	2.49 (1.68,3.71)
One or more	252	24.2			
Satisfaction with oral health					
Satisfied	662	11.3	59.66	0.000	5.39 (3.4,8.53)
Dissatisfied	103	40.8			
Perception of general health					
Good/very good	570	9.1	66.59	0.000	5.10 (3.36,7.74)
Fair/poor	186	33.9			
Arthritis					
No	300	9.3	14.49	0.000	2.36 (1.5,3.71)
Yes	460	19.6			
High blood pressure					
No	418	15.3	0.01	0.93	1.02 (0.68,1.51)
Yes	341	15.5			
Heart problems (angina, heart attacks)					
No	618	12.9	16.8	0.000	2.46 (1.58,3.81)
Yes	142	26.8			
Anxiety problems					
No	533	10.3	37.77	0.000	3.37 (2.26,5.03)
Yes	229	27.9			
Digestive problems (ulcers)					
No	600	12.2	22.8	0.000	2.74 (1.37,5.47)
Yes	160	27.5			
Diabetes					
No	709	15.5	0.12	0.732	0.87 (0.38,1.97)
Yes	51	13.7			
Osteoporosis					
No	631	12.7	21.67	0.000	2.78 (1.79,4.34)
Yes	132	28.8			
Breathing problems					
No	602	12.3	23.48	0.000	2.78 (1.82,4.25)
Yes	157	28.0			
Bladder problems (kidney, incontinence)					
No	597	11.9	26.21	0.000	2.91 (1.91,4.44)
Yes	163	28.2			
Eye problems (glaucoma, cataracts)					
No	555	13.5	6.36	0.012	1.70 (1.12,2.57)
Yes	205	21.0			
Problems with hearing					
No	542	14.2	2.59	0.107	1.41 (0.93,2.13)
Yes	217	18.9			

P-value=Significance value, OR=Odds Ratio, CI=Confidence Interval.

al, 1998; Sreebny and Valdini, 1988; Ship et al, 2002b). Hochberg et al (1998) reported a 10.7% prevalence of xerostomia in non-institutionalized community dwelling residents (sample=2520, age range 65 to 84) of Salisbury in Maryland. Sreebny and Valdini (1988) reported a value of 40% for dry mouth in older adults (sample = 529, age range 55 to 83). The data were collected while these people visited a family health centre for care in Stony Brook area of New York. Sreebny and Valdini (1988) observed that the prevalence value of xerostomia was influenced by the way the questions were worded in a questionnaire. Consequently the questionnaire in the present study adopted the terminology used by Locker (1993) and Thomson et al (1999), in order to make comparisons between the findings from the different studies.

The chi-square analyses showed that a number of variables were associated with reporting of xerostomia (see Table 2). However, the logistic regression analysis showed that the following variables significantly contributed to the prediction of xerostomia - gender of the participant; number of prescribed medications taken; complaints of digestive, osteoporosis, bladder and anxiety problems; oral health satisfaction and perceived general health. In comparison, female gender and number of medications were found to be significant in older adults in a study carried out by Field et al (2001) who reported a 17.6% prevalence value for dry mouth in people aged 60 years and older who attended five general dental practices in Merseyside in the North of England. According to the regression analysis carried out by Locker (1993) there were three significant variables: income, taking prescribed medications and a major life event in the prior six months period. Locker's study comprised people aged 50 years and older who lived in private households in four communities in Ontario, Canada. The diversity of variables implicated in the prevalence of xerostomia only highlights the need to use a standard instrument in determining the prevalence of xerostomia; since it is a subjective complaint, the interpretation of it may vary from subject to subject, with different social backgrounds.

The original Xerostomia Inventory developed by Thomson et al (1999) was shown to have a temporal stability in a prospective cohort study involving two groups of people (Thomson and Williams, 2000). The first group comprised patients (sample=57, age range 29 to 87) who were about to undergo radiotherapy for head and neck cancer, and the second group comprised volunteer, healthy older adults (sample = 55, age range 52 to 90) recruited from the community in Otago, New Zealand. The XI scores were obtained for

the two groups at baseline, two, four and six months time intervals. The former group showed a marked increase in the XI score during the first two months, whilst very little changes were recorded from the second group. The prevalence of xerostomia at baseline for the first group was 21.1% and for the second group 14.5%. The mean XI scores were 23.81 (± 8.99) and 20.04 (± 7.27) respectively for the first and the second groups. The present study showed a prevalence value for xerostomia of 15.5% (age range 60 to 85) and a mean XI score of 19.81 (± 7.87). Good correlation can be seen between the present study group and the group of healthy older adults reported by Thomson and Williams (2000). It is therefore proposed to use the XI to measure any treatment-induced changes in the severity of dry mouth symptoms.

Our study also included a qualitative analysis, in the form of focus groups as a greater involvement of patients in the research process is desirable in assessing the effects of treatments and in randomised controlled trials (Hanley et al, 2001; Trivedi and Wykes, 2002).

The participants in the focus groups felt that the mouth dryness affected their quality of life with comments related to physical and psychosocial functioning such as difficulty in swallowing dry foods, chewing difficulties, discomfort in communicating with others and self consciousness while in a social environment. When asked, these xerostomic persons expressed their interest for novel more user-friendly treatment modalities of xerostomia than the ones that are available on the market today. Since qualitative research is currently considered as a rigorous inductive approach to data collection and data interpretation used to describe patients' perspectives and behaviours (George and Apter, 2004), findings from our focus groups could be used to meet the needs and requirements of patients with dry mouth and to better planning of future research on treatment modalities.

CONCLUSIONS

The cross-sectional survey of the community-dwelling older adults aged 60 years and above indicated that about 15.5% of them showed symptoms of xerostomia. The oral dryness was more pronounced in females and in those adults who took more prescribed medications daily; in particular to alleviate symptoms of bone, digestive, bladder and anxiety problems. The oral health satisfaction and the general health status were also linked to xerostomia. Consequently a comprehensive treatment of xerostomia should consider all

these factors in order to be effective in relieving symptoms for a long time and avoiding systemic side effects.

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REFERENCES

- Atchison KA, Dolan TA. Development of the Geriatric Oral Health Assessment Index. *J Dent Educ* 1990;54:680-687.
- Bergdahl M, Bergdahl J. Low unstimulated salivary flow and subjective oral dryness: association with medication, anxiety, depression and stress. *J Dent Res* 2000;79:1652-1658.
- Dawes C. Circadian rhythms in the flow rate and composition of unstimulated and stimulated human submandibular saliva. *J Physiol* 1975;244:535-548.
- Field EA, Fear S, Higham SM, Ireland RS, Rostron J, Willetts RM. Age and medication are significant risk factors for xerostomia in an English population, attending general dental practice. *Gerodontology* 2001;18:21-24.
- Fox PC, Busch KA, Baum BJ. Subjective reports of xerostomia and objective measures of salivary gland performance. *JADA* 1987; 115:581-584.
- Frost PM, Shirlaw PJ, Walter JD, Challacombe SJ. Patient preferences of an intra-oral lubricating device over other dry mouth lubrication methods. *Br Dent J* 2002;193:403-408.
- Ghezzi EM, Ship JA. Aging and secretory reserve capacity of major salivary glands. *J Dent Res* 2003;82:844-848.
- George M, Apter AJ. Gaining insight into patients' beliefs using qualitative research Methodologies. *Curr Opin Allergy Clin Immunol* 2004;4:185-189.
- Hanley B, Truesdale A, King A, Elbourne D, Chalmers I. Involving consumers in designing, conducting, and interpreting randomised controlled trials: questionnaire survey. *BMJ* 2001;322:519-523.
- Hochberg MC, Tielsch J, Munoz B, Bandeen-Roche K, West SK, Schein OD. Prevalence of symptoms of dry mouth and their relationship to saliva production in community dwelling elderly: The SEE project. *J Rheumatol* 1998;25:486-491.
- Jensen SB, Pedersen AM, Reibel J, Nauntofte B. Xerostomia and hypofunction of the salivary glands in cancer therapy. *Support Care Cancer* 2003;11:207-225.
- Kassan SS, Moutsopoulos HM. Clinical manifestations and early diagnosis of Sjögren syndrome. *Arch Intern Med* 2004;164: 1275-1284.
- Leake JL. An index of chewing capacity. *J Public Health Dent* 1990;50:262-267.
- Locker D. Subjective reports of oral dryness in an older adult population. *Community Dent Oral Epidemiol* 1993;21:165-168.
- Loesche WJ, Bromberg J, Terpenning MS, Bretz WA, Dominguez BL, Grossman NS. Xerostomia, xerogenic medications and food avoidances in selected geriatric groups. *J Am Geriatr Soc* 1995; 43:401-407.
- Narhi TO. Prevalence of subjective feelings of dry mouth in the elderly. *J Dent Res* 1994;73:20-25.
- Nayak USL. Elders-led design. *Ergonomics in Design* 1995;1:8-13.
- Nieuw Amerongen AV, Veerman ECI. Current therapies for xerostomia and salivary gland hypofunction associated with cancer therapies. *Support Care Cancer* 2003;11:226-231.
- Pedersen AML, Smidt D, Nauntofte B, Christiani CJ, Jerlang BB. Burning mouth syndrome: Etiopathogenic mechanisms, symptomatology, diagnosis and therapeutic approaches. *Oral Biosci Med* 2004;1:3-19.
- Porter SR, Scully C, Hegarty AM. An update of the etiology and management of xerostomia. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;97:28-46.
- Ship JA. Salivary glands and saliva. Diagnosing, managing, and preventing salivary gland disorders. *Oral Dis* 2002(a);8:77-89.
- Ship JA, Pillemer SR, Baum BJ. Xerostomia and the geriatric patient. *J Am Geriatr Soc* 2002(b);50:535-543.
- Sreebny LM, Banoczy J, Baum BJ. Saliva: Its role in health and disease. *Int Dent J* 1992;42:291-304.
- Sreebny LM, Valdin A. Xerostomia. Part I: Relationship to other oral symptoms and salivary gland hypofunction. *Oral Sur Oral Med Oral Pathol* 1988;66:451-458.
- Thomson WM, Chalmers JM, Spencer AJ, Williams SM. The Xerostomia Inventory: a multi-item approach to measuring dry mouth. *Community Dent Health* 1999;16:12-17.
- Thomson WM, Williams SM. Further testing of the xerostomia inventory. *Oral Surg, Oral Med Oral Pathol Oral Radiol Endod* 2000;89:46-50.
- Trivedi P, Wykes T. From passive subjects to equal partners: qualitative review of user involvement in research. *Br J Psychiatry* 2002;181:468-472.
- Vissink A, Spijkervet FK, Van Nieuw Amerongen A. Aging and saliva: a review of the literature. *Spec Care Dentist* 1996;16:95-103.
- Vissink A, Jansma J, Spijkervet FK, Burlage FR, Coppes RP. Oral sequelae of head and neck radiotherapy. *Crit Rev Oral Biol Med* 2003;14:199-212.
- Wolff A, Gadre A, Begleiter D, Moskona D, Cardash H. Correlation between patient satisfaction with complete dentures and denture quality, oral condition and the flow rate of submandibular/sublingual salivary glands. *Int J Prosthodont* 2003;16: 45-48.

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