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Self-reported dry mouth in 50- to 80-year-old Swedes: Longitudinal and cross-sectional population studies

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Abstract

Xerostomia is a common condition among elderly. The objectives were to examine prevalence, persistence, progression, yearly incidence of xerostomia, associated background factors and its influence on oral impacts on daily performances (OIDP) in 50- to 80-year-old people. In 1992, a questionnaire was sent to all 50-year-old (n = 8888) and in 2007 to all 75-year-old persons (n = 5195) living in two Swedish counties. In 2012, the same questionnaire was sent to both age cohorts, now 70- and 80-year-old. Response rate was for the 50-, 70- 75- and 80-year-old groups 71.4%, 72.2%, 71.9% and 66.4%, respectively. In the 50- to 70-year-old sample, 40.3% of the participants answered all five examinations and in the 75-80 group 49.5% (intact samples). In all age groups, xerostomia was significantly more prevalent in women than in men. At age 80, "often mouth dryness at night" was reported by 24.3% and 16.2% of women and men, respectively. Prevalence increased with age and was more frequent at night-time. Persistence of xerostomia was reported by 61.4%-77.5%, progression by 11.5%-33.0% and remission by 5.7%-11.3%. Average yearly incidence was 0.99%-3.28%. Xerostomia was more prevalent in those who reported a negative impact on OIDP. Highest odd ratios for xerostomia were burning mouth (OR 12.0), not feeling healthy (OR 5.1) and medicine usage (OR 3.9). Xerostomia is common in older age, persistence is high and progression common. The comorbidity between xerostomia, oral health problems and impaired general health needs to be taken into consideration when providing dental care to elderly patients.

KEYWORDS
ageing, epidemiology, longitudinal studies, quality of life, xerostomia

1 | INTRODUCTION

Population studies have shown that self-reported dry mouth, xerostomia, increases just about linearly with age.[1] Both sexes report xerostomia at night more often than during the day and females report more often both daytime and night-time xerostomia than males.[2,3] Both day- and night-time xerostomia is associated with oral health-related quality of life (OHRQL) measured with Oral Impact of Daily Performance (OIDP).[4,18] Hyposalivation, a reduction in salivary flow and xerostomia are not always correlated,[5,6] and quality of life has been found to decrease significantly as a function of the severity of xerostomia but not always of hyposalivation.[7,8]

Hyposalivation as well as xerostomia, may also affect other oral functions such as chewing, swallowing and denture wearing[1,9-15] and may also increase the risk for both dental caries and erosion.[16,17] In 50- to 75-year-old subjects other oral symptoms like burning mouth, difficulties in opening the mouth and gum bleeding as well as intake of medications and the habit of smoking have been shown to be related to xerostomia, especially during the night.[18]

In an ageing population, it is likely that the intake of medications and prevalence of medical complications will increase. As a consequence of the foregoing, the risk of dry mouth will increase.[1,13] At the same time, the expectations for a high quality of life among older individuals are more closely associated with their medical health than in younger individuals.[19]

In previous population studies, we have reported an increasing prevalence of self-reported mouth dryness with ageing from 50 to 75 years of age.[2,3,18] The aims now are to extend the study both longitudinally and cross-sectionally up to 80 years of age and to further analyse factors associated with xerostomia in elderly people. In addition, analyses of persistence, progression, remission and average yearly incidence of xerostomia during the follow-up period will be presented.

2 | MATERIALS AND METHODS

2.1 | The first longitudinal sample: 50- to 70- year-old participants

In 1992, a total of 8888 persons, including all 50-year-old individuals (born in 1942) living in the counties of Örebro and Östergötland, Sweden, received a questionnaire on various health factors including dry mouth. The response rate in both counties was 71.4%, resulting in 6346 respondents.[20] The survey was repeated every 5 years: 1992, 1997, 2002, 2007 and 2012, and the same questionnaires were used in all surveys. In the survey 2012, the target population had become 70 years old (n = 7889) and 5697 individuals answered the questionnaire (response rate 72.2%). Those participants who responded to all five surveys (1992, 1997, 2002, 2007 and 2012) comprised 3585 subjects (40.3% of the original sample) and constituted the first longitudinal intact sample.

2.2 | The second longitudinal sample: 75- to 80-year-old participants

In 2007, the same questionnaire was sent also to all individuals born in 1932 (comprising all 75-year-old subjects, n = 5195) living in the same two counties as the first longitudinal sample. With a response rate of 71.9%, 3735 individuals participated. In 2012, the questionnaire was again sent to all the subjects born in 1932, now 80 years old (n = 4404) and 2922 responded (response rate 66.4%). Those subjects born in 1932, who took part in both surveys (n = 2573) represented the second longitudinal intact sample (49.5% of the original sample).

2.3 | Questionnaire

The questionnaire has been described and discussed previously.[21] The questions were divided into socio-economic conditions (eg, age, gender, occupation), general health and oral conditions (eg, satisfaction with teeth, oral problems, chewing ability, number of teeth and presence of prostheses). This study has focused on answers to two questions regarding perceived mouth dryness. The wordings of these questions were as follows: (a) "Does your mouth usually feel dry at night" and (b) "Does your mouth usually feel dry in the daytime" with four response alternatives: (a) yes, often; (b) yes, sometimes; (c) no, seldom and (d) no, never.

In an early study in this series of investigations using the same methods and questionnaire, clinical examination was performed on 941 randomly selected subjects of the total sample to validate and quantify the responses regarding reported number of remaining teeth and jaw opening capacity. There was good congruence between self-reports and clinical registrations.[21]

This study focuses on the 50- to 70-year-old subjects responding in the first longitudinal sample and the 75- to 80-year-old subjects responding in the second longitudinal sample.

2.4 | Statistical methods and ethical considerations

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, Release 22). Cramer's V was used for testing differences between day- and night-time xerostomia at each occasion. Longitudinal variations in reported dry mouth were determined as follows:

2.4.1 | Prevalence

The percentage of participants reporting "yes, often/sometimes" dry mouth at age 50-70 and 75-80, respectively.

2.4.2 | Persistence

The percentage of participants reporting remaining as: "yes, often/sometimes" dry mouth at age 50-70 and 75-80, respectively.

2.4.3 | Progression

The percentage of participants reporting change from "no, never/seldom" to "yes, often/sometimes" at age 50-70 and 75-80, respectively.

2.4.4 | Remission

The percentage of participants reporting change from: "yes, often/sometimes" dry mouth to "no, never/seldom" from age 50-70 and 75-80, respectively.

2.4.5 | Average yearly incidence

Yearly percentage of participants reporting dry mouth progression from: "no, never/seldom" dry mouth to "yes, often/sometimes" from age 50-70 and 75-80, respectively.

Logistic regression model (Forward Conditional Method) was computed using daytime and night-time xerostomia as dependent variables. The selection of the independent variables was done according to previous papers,[2,3,18] that is a Spearman correlation analysis was first performed between the dependent variable (dichotomized as 1 = "never dry mouth"; 2 = "often dry mouth") and all recorded variables (n = 72). Numerous significant correlations were exhibited and used in the logistic regression analyses (Table 1).

The Ethics Committee in Uppsala, Sweden, approved the 2012 study (Dnr 2011/336).

3 | RESULTS

3.1 | Longitudinal results

In the first longitudinal sample (50- to 70-year-old participants), the night-time xerostomia increased with age. The proportion of women

TABLE 1 Dichotomization of independent variables used in the stepwise logistic regression models

Variable	Description	1	2	3	4
Gender	1. Man 2. Woman	X	X	X	X
Place of birth	1. Sweden 2. Outside Sweden				X
Education	1. University 2. High-/elementary-/lower-school	X	X		
Healthy	1. Yes/on the whole 2. No/absolutely not	X	X	X	X
Use of medicine last 2 wk	1. No 2. Yes	X	X	X	X
Smoking	1. Not daily, stopped, never 2. Daily		X	X	
Chewing ability	1. Very good 2. Rather good/not so good/bad	X	X	X	X
Toothache	1. During the last year 2. >1 y ago/never/don't remember	X	X		X
Number of teeth	1. All or almost all remaining 2. Many missing and no teeth	X	X	X	X
Removable complete/partial denture	1. No 2. Yes		X		X
Burning mouth	1. No problems 2. Some/rather many/great problems	X	X	X	X
Taste changes	1. No problems 2. Some/rather many/great problems	X	X	X	X
Sensitive teeth	1. No problems 2. Some/rather many/great problems	X	X	X	X
TMJ pain	1. No problems 2. Some/rather many/great problems	X	X	X	X
Difficulty wide opening	1. No problems 2. Some/rather many/great problems	X	X	X	X
Bruxism	1. No problems 2. Some/rather many/great problems	X	X	X	X
Gum bleeding	1. No problems 2. Some/rather many/great problems	X	X	X	X
Bad breath	1. No problems 2. Some/rather many/great problems	X	X	X	X
Oral blisters	1. No problems 2. Some/rather many/great problems	X	X	X	X

Note: 1-4 present variables significantly correlated to reported dry mouth (Spearman correlation analysis) and were included in the different analyses. 1 = regression night 70-y-old; 2 = regression day 70-y-old; 3 = regression night 80-y-old; 4 = regression day 80-y-old; X = included in the regression analysis.

reporting "often dry mouth" increased from 5.1% at age 50 to 18.2% at age 70. The corresponding figures for men were substantially lower: 3.8% and 12.7%, respectively (Table 2). The daytime xerostomia showed a more modest increase during the observation period. Among the 70-year-old participants, 6.9% of the women and 2.9% of the men reported that they often had dry mouth during the day (Table 3).

The second longitudinal sample followed from 75 to 80 years of age showed higher frequency of xerostomia during the night than the 70-year olds in the first longitudinal sample. At age 80, 24.3% of the women and 16.2% of the men reported often dry mouth, which in both groups and sexes corresponded to an increase from the age of 75 (Table 2). The corresponding figures for daytime xerostomia at age 80 were 11.8% in women and 5.5% in men; both results were considerably higher than those in the 75-year-old group (Table 3).

The first longitudinal sample presented a steady increase of night- and daytime xerostomia between 50 and 70 years of age. The second longitudinal sample reported further increased night- and daytime dry mouth between 75 and 80 years of age. If "yes often" and "yes sometimes" were pooled together there was more than a doubling of xerostomia from age 50 to age 80 for both men and women. Women reported significantly higher prevalence at all time points ($P < .001$, Tables 2 and 3).

Among the 3585 participants in the first longitudinal sample, 61.4%-76.9% reported no change of dry mouth ("yes often" or "yes sometimes") during the observation period and the persistence was higher for daytime than for night-time dry mouth (Table 4). Xerostomia developed in 15.2%-33.0%, and progression of xerostomia was more common during night-time than daytime. Remission rate was between 5.7% and 9.4% and occurred more often for daytime xerostomia. The average yearly incidence for xerostomia during the 20-year observation period was 0.76%-1.65% and higher for night-time than for daytime (Table 4).

For the 2573 participants in second longitudinal sample, persistence was steady varying between 72.5% and 77.5% with no major difference for night and day (Table 5). Progression was 11.5%-16.7% and similar for night and day whereas remission was 8.4%-11.3%. The average yearly incidence for daytime xerostomia was 2.92%-3.28%, higher for daytime than for night-time and fairly equally distributed among gender (Table 5).

In both men and women, the prevalence of xerostomia was significantly higher among those who were found to have an impact according to OIDP than among those without any impact. This was especially obvious for daytime xerostomia, which was 2.4-3.3 times more common in those with impact from OIDP than in those with no impact. Night-time xerostomia was about 1.5-1.9

TABLE 2 Percentage distribution (%) of answers at age 50-70 y (first longitudinal sample) and 75 and 80 y (second longitudinal sample) responding to the question "Does your mouth usually feel dry at night" with four response alternatives

	First longitudinal sample[a]										Second longitudinal sample[b]			
	Men (n = 1707)					Women (n = 1878)					Men (n = 1184)		Women (n = 1389)	
	50 y	55 y	60 y	65 y	70 y	50 y	55 y	60 y	65 y	70 y	75 y	80 y	75 y	80 y
Yes, often	3.8	5.1	8.1	11.0	12.7	5.1	7.2	12.6	16.1	18.2	14.5	16.2	22.3	24.3
Yes, sometimes	21.0	25.5	28.9	33.3	34.3	22.8	29.5	32.0	34.6	37.2	36.7	38.2	41.7	41.1
No, seldom	37.0	36.9	33.2	30.1	28.8	29.5	29.2	25.4	23.4	22.2	25.6	26.2	17.4	17.3
No, never	38.2	32.5	29.8	25.6	24.1	42.6	34.1	29.9	25.8	22.3	23.1	19.3	18.6	17.3

[a]Answered the questionnaire all five times.
[b]Answered the questionnaire both times.

TABLE 3 Percentage distribution (%) of answers at age 50-70 y (first longitudinal sample) and 75 and 80 y (second longitudinal sample) responding to the question "Does your mouth usually feel dry in the daytime" with four response alternatives

	First longitudinal sample[a]										Second longitudinal sample[b]			
	Men (n = 1707)					Women (n = 1878)					Men (n = 1184)		Women (n = 1389)	
	50 y	55 y	60 y	65 y	70 y	50 y	55 y	60 y	65 y	70 y	75 y	80 y	75 y	80 y
Yes, often	1.0	1.0	2.6	3.1	2.9	3.7	4.1	5.7	6.8	6.9	4.4	5.5	9.9	11.8
Yes, sometimes	14.5	14.5	17.6	17.4	20.2	20.0	22.6	24.2	24.3	27.0	22.7	29.4	31.8	35.7
No, seldom	43.4	45.1	40.1	41.9	41.1	35.0	36.1	33.0	33.4	32.6	36.7	37.7	28.1	27.4
No, never	41.2	39.4	39.8	37.3	35.8	41.3	37.2	37.2	35.4	33.5	36.0	27.4	30.1	25.1

[a]Answered the questionnaire all five times.
[b]Answered the questionnaire both times.

TABLE 4 Prevalence, persistence, progression, remission and average yearly incidence for perceived dry mouth in the first longitudinal sample: 1942 cohort at ages 50 and 70 during, day time and night-time and for men and women

	Prevalence		Persistence	Progression	Remission	Average yearly incidence
	50 y	70 y	50-70 y	50-70 y	50-70 y	50-70 y
Day						
Men (n = 1707)	15.5	23.1	76.9	15.2	7.9	0.76
Women (n = 1878)	23.7	33.9	70.9	19.7	9.4	0.99
Night						
Men (n = 1707)	24.8	47.1	65.9	28.2	5.8	1.41
Women (n = 1878)	27.9	55.4	61.4	33.0	5.7	1.65

Note: Percentages of the intact gender divided cohort.
Prevalence = participants reporting "yes, often/sometimes" dry mouth at age 50 and 70.
Persistence = participants reporting remaining as: "yes, often/sometimes" dry mouth at age 50-70.
Progression = participants reporting change from "no, never/seldom" to "yes, often/sometimes" at age 50-70.
Remission = participants reporting change from: "yes, often/sometimes" dry mouth to "no, never/seldom" from age 50-70.
Average yearly incidence: yearly percentage of participants reporting change from: "no, never/seldom" dry mouth to "yes, often/sometimes" from age 50-70.

TABLE 5 Prevalence, persistence, progression, remission and average yearly incidence for perceived dry mouth in the first longitudinal sample: 1932 cohort at ages 75 and 80, day time and night-time and for men and women

	Prevalence		Persistence	Progression	Remission	Average yearly incidence
	75 y	80 y	75-80 y	75-80 y	75-80 y	75-80 y
Day						
Men (n = 1184)	27.2	34.9	74.9	16.7	8.4	3.34
Women (n = 1389)	41.8	47.5	72.5	16.4	11.1	3.28
Night						
Men (n = 1184)	51.3	54.4	74.2	14.6	11.3	2.92
Women (n = 1389)	64.0	65.4	77.5	11.5	11.1	2.30

Note: Percentages of the intact gender divided cohort.
Prevalence = participants reporting "yes, often/sometimes" dry mouth at age 75 and 80.
Persistence = participants reporting remaining as: "yes, often/sometimes" dry mouth at from 75 to 80.
Progression = participants reporting change from "no, never/seldom" to "yes, often/sometimes" at age 75-80.
Remission = participants reporting change from: "yes, often/sometimes" dry mouth to "no, never/seldom" from age 75-80.
Average yearly incidence: yearly percentage of participants reporting change from: "no, never/seldom" dry mouth to "yes, often/sometimes" from age 75-80.

times more common in those with impact from OIDP than in those without, and the pattern was the same in both men and women (Table 6).

Among the 70- and 80-year-old participants, a number of variables were significantly correlated to dry mouth according to the regression analyses. In both these samples and for both night- and daytime xerostomia, female gender, not feeling healthy, use of medicine last 2 weeks, burning mouth, impaired chewing and taste changes had a significant positive association with xerostomia (OR 1.4-7.3, Tables 7 and 8). For night-time xerostomia in the 70-year-old participants, the most important factors were as follows: not feeling healthy, burning mouth and taste changes (OR 2.8, 2.5 and 2.3, respectively, Table 7). For daytime xerostomia among the 70-year olds, the most important factors were as follows: not feeling healthy, use of medicine last 2 weeks and impaired chewing (OR 5.1, 3.9 and 2.9, respectively, Table 8). In the 80-year-old group, burning mouth symptoms were the most important factor for reporting xerostomia both at night and day (OR 7.3 and 12.0, respectively) followed by temporomandibular joint (TMJ) pain (OR 3.7 and 3.8, respectively) and use of medicine last 2 weeks (OR 3.2 and 2.8, respectively, Tables 7 and 8). Nagelkerke R^2 varied between .26 and .43 in the different analyses.

3.2 | Cross-sectional results

The cross-sectional samples between age 50 (1992) and 70 (2012) and at ages 75 (2007) and 80 (2012) showed almost identical prevalence of xerostomia as that reported in the longitudinal samples

TABLE 6 Comparison between individuals (total sample 2012) with or without impact of xerostomia according to oral impacts on daily performances (OIDP) regarding the response alternative often daytime or night-time xerostomia in 2012

		OIDP	Often dry mouth daytime				Often dry mouth night-time			
Age group	Gender	Impact	N	n	%	*P*	N	n	%	*P*
70-y	Women	No impact	2030	106	5.2	<.001	2013	330	16.4	<.001
		Impact	578	98	17.0		560	161	28.8	
	Men	No impact	2061	48	2.3	<.001	2013	220	10.9	<.001
		Impact	575	44	7.7		558	103	18.5	
80-y	Women	No impact	1035	84	8.1	<.001	1030	212	20.6	<.001
		Impact	300	58	19.3		297	93	21.3	
	Men	No impact	891	35	3.9	<.001	878	119	13.6	<.001
		Impact	270	34	12.6		266	69	25.9	

Note: P refers to the difference between individuals with or without impact.

(Figure 1). At all time points, the women reported significantly higher prevalence ($P < .001$) of dry mouth than the men.

4 | DISCUSSION

The definition of "elders" or "older people" seems to depend on a large number of factors and differs among different populations. In addition, "elders" does not imply the same today as it has done historically and should not be viewed on only chronologically but also from a biological and gender perspective.[22] For example, with respect to dry mouth, studies referring to older people have used starting points from 60 to 83 years.[9,10,12,15,23] People today reach a higher age than previously, and the proportion of older people in most populations is increasing rapidly. The World Health Organization estimates that in 2050, the total number of individuals over the age of 60 years will be twice as many as today.[22]

It is clear from the results of the cross-sectional and longitudinal samples in this study that both day- and night-time xerostomia after the age of 50 is common among both men and women and increasing with age at least up to the age of 80 years. By searching the literature, we have only found two papers reporting on longitudinal

TABLE 7 Logistic regression model (Forward Conditional Method) for night-time xerostomia presenting independent variables significantly associated with the dependent variable at age 70 and 80 y

	70 y—night $n_1 = 1239$; $n_2 = 839$			80 y—night $n_1 = 490$; $n_2 = 528$		
	OR	95% CI	*P*	OR	95% CI	*P*
Female gender	1.8	1.4-2.3	<.001	1.4	1.0-2.0	.042
Lower education	1.6	1.2-2.1	.001	–	–	–
Not feeling healthy	2.8	2.0-3.8	<.001	1.8	1.3-2.6	.001
Use of medicine last 2 wk	2.0	1.5-2.7	<.001	3.2	1.9-5.4	<.001
Daily smooking	–	–	–	0.3	0.1-0.8	.011
Impaired chewing	1.6	1.2-2.1	.001	1.9	1.4-2.7	<.001
Number of teeth	1.3	1.0-1.8	.050	–	–	–
Burning mouth	2.5	1.4-4.8	.004	7.3	2.9-18.3	<.001
Taste changes	2.3	1.3-4.0	.004	2.0	1.0-3.8	.045
Sensitive teeth	1.4	1.0-1.9	.035	1.9	1.1-3.1	.021
TMJ pain	–	–	–	3.7	1.6-8.2	.002
Bruxism	1.7	1.2-2.4	.001	1.9	1.1-3.3	.034
Bad breath	1.6	1.1-2.2	.006			
Nagelkerke R^2	.26			.30		

Note: Dependent variable dichotomized as 1 = never dry mouth night-time, 2 = often dry mouth night-time.
Abbreviations: CI, confidence interval for OR; n, number of individuals in group 1/group 2; n_1, never dry mouth night-time; n_2, often dry mouth night-time; OR, odds ratio.

TABLE 8 Logistic regression model (Forward Conditional Method) for daytime xerostomia presenting independent variables significantly associated with the dependent variable at age 70 and 80 y

	70 y—day n_1 = 1851; n_2 = 311			80 y—day n_1 = 716; n_2 = 237		
	OR	95% CI	*P*	OR	95% CI	*P*
Female gender	2.4	1.6-3.7	<.001	1.7	1.1-2.8	.02
Not feeling healthy	5.1	3.4-7.7	<.001	2.7	1.7-4.4	<.001
Use of medicine last 2 wk	3.9	2.0-7.8	<.001	2.8	1.1-7.1	.036
Daily smoking	2.1	1.1-3.8	.02	–	–	–
Impaired chewing	2.9	1.9-4.5	<.001	2.6	1.6-4.1	<.001
Many missing teeth	1.7	1.1-2.6	.024			
Burning mouth	2.4	1.1-5.4	.033	12.0	4.2-34.5	<.001
Taste changes	2.6	1.3-5.1	.005	2.3	1.0-5.1	.045
Sensitive teeth	1.8	1.1-2.8	.014	–	–	–
TMJ pain	–	–	–	3.8	1.7-8.6	.001
Bruxism	1.7	1.0-2.7	.041	–	–	–
Blisters	2.3	1.3-4.2	.006	2.0	1.0-3.9	.042
Nagelkerke R^2	.43			.40		

Note: Dependent variable dichotomized as 1 = never dry mouth daytime, 2 = often dry mouth daytime.

Abbreviations: CI, confidence interval for OR; n, number of individuals in group 1/group 2; n_1, never dry mouth daytime; n_2, often dry mouth daytime; OR, odds ratio.

changes of xerostomia in older people. Locker reported in 1995 on a sample of 907 community dwelling adults of 50 years and over an increase from 15.5% at baseline to 29.5% 3 years later.[24] In a paper from 2006, Murray Thomson et al showed figures on changes of xerostomia in older South Australians (age 60+) over a 6-year period. The latter study reported a prevalence of xerostomia (graded as "frequently" or always) of 24.8% at the 6-year follow-up, which generally was higher than in our follow-up at age 70 and 80.[25] However, in our study "yes, often" night-time xerostomia was reported at the same level in 80-year-old women at night (24.3%).

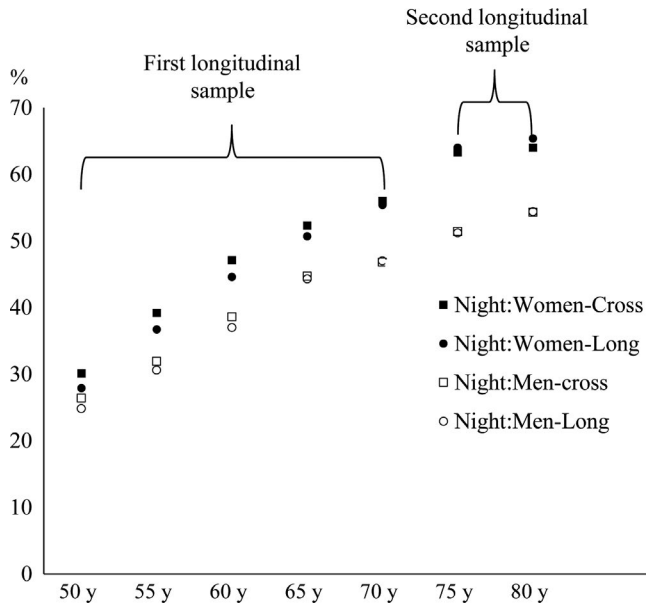

FIGURE 1 Distribution of night-time xerostomia ("yes, often" and "yes, sometimes") in the five cross-sectional samples aged 50 (n = 6346) to 70 y (n = 5697) and two cross-sectional samples aged 75 (n = 3735) and 80 y (n = 2922) in men and women compared with the first (n = 3585) and second (n = 2573) longitudinal sample

Generally, the persistence of dry mouth (reported as "yes, often" or "sometimes") was high in both samples and the majority reported no change. In the first longitudinal sample between 50 and 70, about 30% of both men and women reported a deterioration as regards night-time xerostomia but lesser for daytime. In the second longitudinal sample, about 15% had a worsening of dry mouth problems between age 75 and 80 for both day and night with an average yearly incidence of about 3%. It seems consequently that xerostomia progresses throughout life and continue to do so even in older ages. Remission was fairly low but did occur and was highest between 75 and 80 and at night-time. The reason for these variations in reported dry mouth is hard to speculate on but can be due to changes in general and oral health status including type and amount of prescribed medications.

It has been suggested that the higher prevalence of dry mouth in women compared with men from age 50 and onwards might be related to hormonal changes during menopause as for example higher levels of testosterone in women with xerostomia.[26] In one study, it was found that hormonal replacement medication reduced the feeling of dry mouth in postmenopausal women[27] while another study reported contrasting results.[28] Nevertheless, female hormonal alterations cannot be the sole explanation for the higher experience of

xerostomia both at day- and night-time in women than in men since it seems to persist, and even increase, decades after menopause. It is noteworthy that a similar magnitude of the prevalence of reported dry mouth found in women of age 50 was found in men first at the age of 80. It is evident that the salivary physiology or at least symptoms of xerostomia are developing differently in men and women.

In agreement with our study from 2012, daytime xerostomia was more closely associated with OIDP than night-time xerostomia.[18] This finding might be caused by the fact that OIDP focus on daytime and not night-time impact. A modification of the index would therefore be necessary to detect further associations between night-time xerostomia and impact on OHRQL.

It was not unexpected that "burning mouth", in the logistic regression, was found to be a strong independent variable for both day- and night-time xerostomia as xerostomia is commonly found among patients with intraoral burning symptoms.[29] This finding is also in agreement with our previous results in the age groups 50- to 75-year olds.[18] Besides this, "Impaired chewing", "TMJ pain" "bruxism" and "tooth sensitivity" were all associated with xerostomia. These symptoms are not uncommon in patients with temporomandibular disorders, and it has been suggested that salivary function needs to be assessed in orofacial pain patients in order to facilitate treatment.[30]

"Not feeling healthy" was found to be associated with both daytime and night-time xerostomia both in the 70- and 80-year-old samples. The relationship between impaired health and xerostomia is in agreement with our and others' earlier findings.[3,31,32] "Medicine usage", which may represent a more objective sign of diagnosed disease than the variable "not feeling healthy", was associated with both day and night-time xerostomia in both age groups. In this regard, there is a well-documented effect on reduced salivary secretion by frequent intake of medications,[13,33] but in addition, the secretion may be further impaired by the circadian rhythmicity by which the salivary secretion is dramatically lower during the night than the day.[34] It would have been valuable if we have had more detailed data on the type of medicine the participants used and which specific diseases they suffered from. Such information included in the analyses could have given a more comprehensive picture of the relationships between medicine usage, general health status and the increasing frequency of xerostomia in these populations. However, the data available were self-reported information regarding use of medicine or not and on health status. Both of these variables were included in the analyses and turned out to be highly significant for predicting the presence of xerostomia.

"Bad breath" was related to daytime xerostomia in the 70-year-old group, and this association has been reported previously.[35] Smoking is another commonly reported association with xerostomia[36] and daily smoking showed associations with xerostomia also in our study, however in a somewhat surprising way: the 70-year-old group but not the older group exhibited an association between daily smoking and daytime xerostomia. In contrast, smoking and night-time xerostomia were significantly associated in the 80-year-old group but not in the younger group. Taste changes were also related to night and daytime xerostomia in booth age groups, corroborating results of an earlier study.[37]

In this study, the self-reported presence of dry mouth among both men and women was high among the elders, especially so among women and it was shown that xerostomia has a negative impact on oral health-related quality of life. There was also a strong comorbidity between xerostomia and several oral health parameters such as chewing problems, burning mouth, TMJ pain, bruxism and tooth sensitivity. Besides these associations with oral health factors, it is also important to note the association between xerostomia and impaired general health.

5 | CONCLUSIONS

Based on the results of the present study, it can be concluded that there is a high prevalence of xerostomia among the elders, especially in women, which needs to be taken into consideration in the assessment of their oral health and when providing dental care to this age group.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Nederfors T, Isaksson R, Mörnstad H, Dahlöf C. Prevalence of perceived symptoms of dry mouth in an adult Swedish population–relation to age, sex and pharmacotherapy. *Community Dent Oral Epidemiol*. 1997;25:211-216.
2. Johansson AK, Johansson A, Unell L, Carlsson GE. Prevalence of self-reported xerostomia in 50- and 60-year old subjects. *Int J Clin Dent*. 2008;1:93-99.
3. Johansson AK, Johansson A, Unell L, Ekbäck G, Ordell S, Carlsson GE. A 15-yr longitudinal study of xerostomia in a Swedish population of 50-yr-old subjects. *Eur J Oral Sci*. 2009;117:13-19.
4. Astrøm AN, Haugejorden O, Skaret E, Trovik TA, Klock KS. Oral impacts on daily performance in Norwegian adults: validity, reliability and prevalence estimates. *Eur J Oral Sci*. 2015;113:289-296.
5. Van der Putten GJ, Brand HS, Schols JM, de Baat C. The diagnostic suitability of a xerostomia questionnaire and the association between xerostomia, hyposalivation and medication use in a group of nursing home residents. *Clin Oral Investig*. 2011;15:185-192.
6. Ying Joanna ND, Thomson WM. Dry mouth - an overview. *Singapore Dent J*. 2015;36:12-17.
7. Hahnel S, Schwarz S, Zeman F, Schäfer L, Behr M. Prevalence of xerostomia and hyposalivation and their association with quality of

life in elderly patients in dependence on dental status and prosthetic rehabilitation: a pilot study. *J Dent*. 2014;42:664-670.
8. Flink H, Bergdahl M, Tegelberg Å, Rosenblad A, Lagerlöf F. Prevalence of hyposalivation in relation to general health, body mass index and remaining teeth in different age groups of adults. *Community Dent Oral Epidemiol*. 2008;36:523-531.
9. Locker D. Dental status, xerostomia and the oral health-related quality of life of an elderly institutionalized population. *Spec Care Dentist*. 2008;23:86-93.
10. Ikebe K, Hazeyama T, Morii K, Matsuda K, Maeda Y, Nokubi T. Impact of masticatory performance on oral health-related quality of life for elderly Japanese. *Int J Prosthodont*. 2007;20:478-485.
11. Benn AM, Broadbent JM, Thomson WM. Occurrence and impact of xerostomia among dentate adult New Zealanders: findings from a national survey. *Aust Dent J*. 2015;60:362-367.
12. Enoki K, Matsuda KI, Ikebe K, et al. Influence of xerostomia on oral health-related quality of life in the elderly: a 5-year longitudinal study. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2014;117:716-721.
13. Villa A, Wolff A, Narayana N, et al. World workshop on oral medicine VI: a systematic review of medication-induced salivary gland dysfunction. *Oral Dis*. 2016;22:365-382.
14. Lopez-Jornet P, Lucero Berdugo M, Fernandez-Pujante A, et al. Sleep quality in patients with xerostomia: a prospective and randomized case-control study. *Acta Odontol Scand*. 2016;74:224-228.
15. Lee YS, Kim HG, Moreno K. Xerostomia among older adults with low income: nuisance or warning? *J Nurs Scholarsh*. 2016;48:58-65.
16. Cassolato SF, Turnbull RS. Xerostomia: clinical aspects and treatment. *Gerodontology*. 2003;20:64-77.
17. González-Aragón Pineda ÁE, Borges-Yáñez SA, Lussi A, Irigoyen-Camacho ME, Angeles MF. Prevalence of erosive tooth wear and associated factors in a group of Mexican adolescents. *J Am Dent Assoc*. 2016;147:92-97.
18. Johansson AK, Johansson A, Unell L, Ekbäck G, Ordell S, Carlsson GE. Self-reported dry mouth in Swedish population samples aged 50, 65 and 75 years. *Gerodontology*. 2012;29:e107-e115.
19. McKee KJ, Kostela J, Dahlberg L. Five years from now: correlates of older people's expectation of future quality of life. *Res Aging*. 2015;37:18-40.
20. Unell L, Söderfeldt B, Halling A, Solén G, Paulander J, Birkhed D. Equality in satisfaction, perceived need, and utilization of dental care in a 50-year old Swedish population. *Community Dent Oral Epidemiol*. 1996;24:191-195.
21. Unell L. On oral disease, illness and impairment among 50-year-olds in two Swedish counties. *Swed Dent J*. 1999;135:1-45.
22. World Health Organization. *World Report on Ageing and Health*. Geneva, Switzerland: World Health Organization; 2015.
23. Viljakainen S, Nykänen I, Ahonen R, et al. Xerostomia among older home care clients. *Community Dent Oral Epidemiol*. 2016;44:232-238.
24. Locker D. Xerostomia in older adults: a longitudinal study. *Gerodontology*. 1995;12:18-25.
25. Murray Thomson W, Chalmers JM, John Spencer A, Slade GD, Carter KD. A longitudinal study of medication exposure and xerostomia among older people. *Gerodontology*. 2006;23:205-213.
26. Agha-Hosseini F, Moosavi MS, Mirzaii-Dizgah I. Salivary flow, testosterone, and femur bone mineral density in menopausal women with oral dryness feeling. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2013;115:612-616.
27. Eliasson L, Carlén A, Laine M, Birkhed D. Minor gland and whole saliva in postmenopausal women using a low potency oestrogen (oestriol). *Arch Oral Biol*. 2003;48:511-517.
28. Tarkkila L, Linna M, Tiitinen A, Lindqvist C, Meurman JH. Oral symptoms at menopause–the role of hormone replacement therapy. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2001;92:276-280.
29. Kolkka-Palomaa M, Jääskeläinen SK, Laine MA, Teerijoki-Oksa T, Sandell M, Forssell H. Pathophysiology of primary burning mouth syndrome with special focus on taste dysfunction: a review. *Oral Dis*. 2003;21:937-948.
30. da Silva LA, Teixeira MJ, de Siqueira JT, de Siqueira SR. Xerostomia and salivary flow in patients with orofacial pain compared with controls. *Arch Oral Biol*. 2011;56:1142-1147.
31. Ship JA, Pillemer SR, Baum BJ. Xerostomia and the geriatric patient. *J Am Geriatr Soc*. 2002;50:535-543.
32. Liu B, Dion MR, Jurasic MM, Gibson G, Jones JA. Xerostomia and salivary hypofunction in vulnerable elders: prevalence and etiology. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2012;114:52-60.
33. Johanson CN, Österberg T, Lernfelt B, Ekström J, Birkhed D. Salivary secretion and drug treatment in four 70-year-old Swedish cohorts during a period of 30 years. *Gerodontology*. 2015;32:202-210.
34. Thie NMR, Kato T, Bader G, Montplaisir JY, Lavigne GJ. The significance of saliva during sleep and the relevance of oromotor movements. *Sleep Med Rev*. 2002;6:213-227.
35. Cortelli JR, Barbosa MD, Westphal MA. Halitosis: a review of associated factors and therapeutic approach. *Braz Oral Res*. 2008;22(Suppl 1):44-54.
36. Dyasanoor S, Saddu SC. Association of xerostomia and assessment of salivary flow using modified schirmer test among smokers and healthy individuals: a preliminutesary study. *J Clin Diagn Res*. 2014;8:211-213.
37. Mese H, Matsuo R. Salivary secretion, taste and hyposalivation. *J Oral Rehabil*. 2007;34:711-723.

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