

Xerostomia in 75–85-year-olds: A longitudinal population study

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Funding information

Region Örebro County; Region
Östergötland County

Abstract

Background: Xerostomia can pose significant problems for many elderly people.

Objectives: To investigate longitudinal changes in prevalence, persistence, progres-
sion, remission and incidence of xerostomia from age 75 to 85 years.

Methods: All 75-year-olds (born 1932) from two Swedish counties, Sweden were
mailed a questionnaire in 2007 ($N = 5195$), and again in 2017 when they were aged 85
($N = 3323$). The total response rates at ages 75 and 85 years were 71.9% and 60.8%,
respectively. A 'panel', those who participated in both surveys, comprised 1701 indi-
viduals (response rate 51.2%).

Results: At age 85, there was almost a doubling of self-reported 'yes often' xerosto-
mia compared with age 75 (from 6.2% to 11.3%) and was almost twice as common in
women than men ($p < .001$). When combining 'yes often'/'yes sometimes', xerostomia
increased from 33.4% to 49.0%, and was more so among women ($p < .001$). Xerostomia
was commoner at night than daytime, with 23.4% reporting 'yes often' night-time xe-
rostomia at 85 compared with 18.5% at 75, and was also higher in women ($p < .001$).
Progression rates for daytime and night-time xerostomia were 34.2% and 38.1%, for
persistence 67.4% and 68.6%, and for remission 24.4% and 16.5%. Average yearly
incidence was higher in women than men for both daytime (3.6% vs. 3.2%) and night-
time (3.9% vs. 3.7%). Regression analyses predicted protective factors for developing
xerostomia reported at age 75 as good general and oral health, absence of medica-
tions/intraoral symptom/s, good chewing function and social interaction.

Conclusions: Xerostomia increases markedly from age 75 to 85 years.

KEYWORDS

ageing, dry mouth, longitudinal, questionnaire, xerostomia

1 | INTRODUCTION

The world's population is both growing and ageing rapidly. In 1990
and 2019, those aged 65 years and above represented 6% and 9%,
respectively, of the world's population. In 2050, the proportion of

65-year-olds and older is expected to be about 16% of the total
population, corresponding to about 1.5 billion individuals. Within
this large group of older individuals, the oldest, namely those aged
80 years and above, increased about threefold between 1990 and
2019. It is predicted that their proportion of the world's population

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will be tripled again between 2019 and 2050, and is estimated at that time to comprise as much as 426 million of individuals aged 80 years or above.¹

Life expectancy varies among countries, and over time, has been seen to be affected by, for example, differences in social and medical welfare systems, among others. In 1840, Sweden had the world's longest life expectancy, which at that time was around 40 years. Today, life expectancy in Sweden has more than doubled (84.3 years for women and 80.3 years for men) and it is expected that by 2070 life expectancy at birth will increase to 89.8 years for women and 87.7 years for men.^{2,3} At a global level today, life expectancy at birth is 72.3 years, which is 74.4 years for women and 69.9 years for men, and with a majority of the world's oldest population being women.^{1,2,4,5} Also, remaining life expectancy at age 65 is on average 17.0 years, ranging from 12.6 to 21.2 years, depending on geographical location.¹

A growing population of older people presents a new challenge for their well-being in many countries. In 2020, the 'Decade of Healthy Ageing' was declared by the UN addressing the need for increased knowledge about the elderly and the importance of a multi-disciplinary approach in the action required to meet their needs and demands.⁶ In this regard, both social and medical care needs among the elderly are some of the factors planned to be considered.⁷ The health status of older individuals and their personal well-being and/or impaired health/incapacity in the future is not easy to predict. It, therefore, receives ongoing discussion, as do the economic consequences of a growing, older population and especially so alongside a smaller predicted proportion of younger individuals in the population.⁸

The concern about the older individual's future well-being includes oral health. It is known that saliva plays a key role in oral health and that hyposalivation and xerostomia (self-reported dry mouth) are connected. While studying longitudinal changes on xerostomia from age of 50 to 75 years it was found that xerostomia was common among the elderly and could be predicted by factors reported earlier in life. Also, an increasingly higher prevalence of xerostomia was found with age, and this was especially so among older women and at night-time.⁹ Self-reported dry mouth has been found to be associated with several important factors such as impaired general health, the use of medications, ability with speech, chewing/food selection, as well as the lifespan of dental restorations. Dry mouth has also been found to be associated with reduced oral health-related quality of life (OHRQoL) as well as smoking, depression and stress.¹⁰⁻¹⁶

In an earlier study, two distinct groups of 75-year-old Swedes were investigated, one group in 2007 (born in 1932) and the other group in 2017 (born in 1942). The differences in oral health status between the two cohorts born 10 years apart were surprising. The 1942 cohort (examined in 2017) compared with the 1932 cohort (examined in 2007) reported a substantially lower prevalence in edentulousness from 7.8% to 2.3% as well as having more teeth present and better chewing efficiency.¹⁷ The much higher proportion of old

and older individuals expected in the future, with a high degree of retention of natural teeth poses an impending challenge relating to their need and demand for oral health, and one whose magnitude is clearly not yet known.

It would seem necessary to get a better understanding of the need and demand among the oldest in the population in relation to oral health in the future. There is a paucity in the literature as regards xerostomia and its consequences in the oldest old. The aim of this study was, therefore, to longitudinally study individuals from the age of 75 to 85 years and to report on both prevalence and incidence of xerostomia, as well as its persistence, progression and remission. In addition, an attempt was made to detect possible protective factors related to absence of xerostomia during a follow-up period.

2 | MATERIALS AND METHODS

2.1 | Sample

In the first survey, in 2007, all 75-year-olds (born in 1932), residing in the counties of Örebro and Östergötland, Sweden, were sent a questionnaire by mail ($N_{75}=5195$, 54.7% women and 45.3% men). The survey was repeated in 2017 when the participants were 85 years of age ($N_{85}=3323$, 58.9% women and 41.1% men). A written reminder was posted to those who had not responded within 2 weeks. As a last attempt, the questionnaire was sent again to those who had not responded to the reminder. The total response rates at ages 75 and 85 years of age were 71.9% (women 53.2%, men 46.8%) and 60.8% (women 56.1%, men 43.9%), respectively. At age 85, the gender distribution among nonresponders ($N=1302$) was 63.3% women and 36.7% men.

A 'panel' was constructed of those who participated at both timepoints (2007 and 2017) and consisted of 1701 individuals out of which 931 were women (54.7%) and 770 men (45.3%). The 'panel' response rate was consequently 51.2% of the total population available in 2017 ($N=3323$).

2.2 | Questionnaire

The questionnaire included general questions about age, gender and socio-economic factors. In addition, there were questions about oral/general health including weight and height, visits to the medical doctor, and the use of tobacco and intake of medications.

Questions about self-reported dry mouth during the day and/or night-time had four response alternatives: yes, often; yes, sometimes; no, seldom; and no. Information regarding presence of toothache, intraoral wounds and blisters were also obtained. In addition, questions about satisfaction with teeth/dental appearance and oral function, viz. chewing function, total number of teeth and restorations, for example, types of fillings, crowns and dentures, were also included.

2.3 | Statistical methods

All statistical analyses were performed using IBM Statistical Package for Social Sciences (SPSS, Release 26). The following definitions were used to describe the key variables investigated which were in accordance with a previous study.⁹ The definitions used to describe the key variables investigated (prevalence, persistence, progression, remission and incidence) were in accordance with a previous study⁹:

Gender differences within the variables were analysed by Pearson's chi-square test.

Unadjusted logistic regression was computed using daytime and night-time xerostomia as dependent variables in two different ways:

A. Persistence of 'no seldom/no never' dry mouth within age span of 75 to 85 years versus progression from 'no seldom/no never' to 'yes sometimes/yes often' over the age span of 75 to 85 years.

B. 'Yes, often' dry mouth at 85 years versus 'no, never' dry mouth at 85 years.

Independent variables were collected from the dichotomized responses to the questionnaire at age 75 years in 2007 (Table 1). In the adjusted logistic regression model (Forward Conditional Method), independent variables with $p \leq .05$ were entered.

3 | RESULTS

At age 85, there was almost a doubling of those who reported frequent ('yes, often') daytime xerostomia compared with age 75 years (from 6.2% to 11.3%). The same pattern was seen for both genders. Women reported about twice the prevalence of frequent daytime xerostomia compared with men both at age 75 (7.9% vs. 4.1%) and at age 85 (13.9% vs. 8.1%). If the answers 'yes, often' and 'yes, sometimes' xerostomia were combined, xerostomia increased from 33.4% at age 75 to 49.0% at age 85. At both 75 and 85 years, the prevalence of reported daytime xerostomia was significantly higher in women compared with men ($p < .001$) (Table 2).

Reported night-time xerostomia was considerably higher than that during daytime, and 'yes, often' dry mouth was reported by 18.5% at age 75 and 23.4% at age 85. Gender differences were not as pronounced as during daytime, but women reported about 60% higher prevalence of frequent night-time xerostomia compared with men. The combination of 'yes, often' and 'yes, sometimes' showed a prevalence of 58.6% and 65.3% at ages 75 and 85, respectively. Also at night-time, the prevalence of reported dry mouth was significantly higher in women compared with men ($p < .001$) (Table 3).

Persistence, that is, percentage of participants consistently reporting 'yes often'/'yes sometimes' dry mouth at ages 75 and 85 years, was 67.4% during daytime and 68.6% at night-time, and was significantly higher in women (Table 4).

Progression, that is, percentage of participants reporting a change from 'no, never'/'no seldom' to 'yes, often'/'yes sometimes' dry mouth from age 75 to 85 was 34.2% during daytime and 38.1% at night, and no statistically gender differences were found (Table 5).

TABLE 1 Complete list of all examined dichotomized variables in the unadjusted/adjusted regression analysis.

Variable	Dichotomization
Gender	Gender: 1 = woman; 2 = man
Education	Education: 1 = university; 2 = other (elementary school, high school, upper secondary school, other)
Birthplace	Birthplace: 1 = Sweden; 2 = other country
Residency	Residency: 1 = large city; 2 = small city/countryside
Social contacts	Social contacts: 1 = 0–10 people/week; 2 = >10 people/week
Marital status	Marital status: 1 = married/cohabiting; 2 = unmarried, divorced and widowed
Health	Health good: 1 = yes, absolutely; 2 = yes, for the most part, no, not especially, no, absolutely not
Health versus peers	Health compared with same-aged peers: 1 = much better, better; 2 = equal, worse, much worse
Medication	Medication usage last 14 days: 1 = yes; 2 = no
Doctor contact	Doctor visit last 3 months: 1 = yes; 2 = no
Smoking	Smoking: 1 = Daily/stopped/occasional/smoking; 2 = never smoked
BMI	Body mass index
Alcohol	Alcohol intake: 1 = One to more times/week; 2 = One to more times/month/ Never
Chewing	Chewing all kind of food: 1 = very good; 2 = fairly good, less good and bad
Appearance	Appearance: 1 = very satisfied; 2 = to large extent satisfied, not especially, absolutely not
Teeth number	Number of teeth: 1 = all teeth left; missing single tooth, 2 = missing rather many, edentulous
Burning mouth	Burning mouth: 1 = no problems; 2 = some, rather much, great problems
Wounds, blisters	Wounds/blister intraorally: 1 = no problems; 2 = some, rather much, great problems
Taste changes	Taste changes: 1 = no problems; 2 = some, rather much, great problems
TMJ pain	TMJ pain: 1 = no problems; 2 = some, rather much, great problems
TMJ sounds	TMJ sounds: 1 = no problems; 2 = some, rather much, great problems
Jaw opening	Jaw opening: 1 = no problems; 2 = some, rather much, great problems
Bruxism	Bruxism: 1 = no problems; 2 = some, rather much, great problems
Bleeding	Gingival bleeding: 1 = no problems; 2 = some, rather much, great problems

(Continues)

TABLE 1 (Continued)

Variable	Dichotomization
Bad breath	Bad breath: 1 = no problems; 2 = some, rather much, great problems
Dental material	Dental material side effects: 1 = no problems; 2 = some, rather much, great problems
Sensitive teeth	Sensitive teeth: 1 = no problems; 2 = some, rather much, great problems
Tooth extraction	Tooth extraction last 12 months: 1 = yes; 2 = no
OIDP	Oral impact on daily performance (OIDP) = 1 or more: 1 = yes; 2 = no
White/plastic fillings	White or plastic restorations—presence: 1 = yes; 2 = no
Gold	Gold restorations—presence: 1 = yes; 2 = no
Amalgam	Amalgam restorations—presence: 1 = yes; 2 = no
Porcelain	Porcelain restorations—presence: 1 = yes; 2 = no
Implant	Implant restorations—presence: 1 = yes; 2 = no
Temporary fillings	Temporary restorations—presence: 1 = yes; 2 = no
Partial denture	Partial denture—presence: 1 = yes; 2 = no
Complete denture both jaws	Complete denture, both jaws—presence: 1 = yes; 2 = no
Complete denture/one jaw	Complete denture, one jaw—presence: 1 = yes; 2 = no

Remission, that is, percentage of participants reporting a change from 'yes, often'/'yes, sometimes' dry mouth to 'no, never'/'no, seldom' from 75 to 85 was 24.4% during daytime and 16.5% at night-time, with no statistically significant gender differences (Table 6).

Average incidence, that is, annual percentage of participants reporting dry mouth progression from 'no, never'/'seldom' dry mouth to 'yes, often'/'yes sometimes' from ages 75 to 85 years was higher in women than in men both during daytime (3.6% vs. 3.2%) and night-time (3.9% vs. 3.7%).

3.1 | Regression analysis

By using (i) progression from 'seldom'/'never' to 'sometimes'/'often' and (ii) persistence of 'seldom'/'never' dry mouth over the span of 75–85 years as dependent variable and tested against all registered variables reported at age 75 (Table 1), several variables were found to be statistically significant in the unadjusted model during both day- and night-time. In the adjusted model during daytime 'better/much better health vs. peers', and absence of 'taste changes', 'TMJ pain', 'sensitive teeth' and 'temporary fillings' were statistically significant variables that could predict persistence of 'seldom'/'never' dry mouth during the observation period. In terms of night-time dry mouth, remaining free of xerostomia could be predicted by 'better/

much better health vs. peers', no 'medication' and 'tooth extraction' (Table 7).

Regression analysis with (i) 'often' dry mouth and (ii) 'never' dry mouth at age 85 as dependent variable also showed a large number of significantly correlated variables reported at age 75 in the unadjusted analyses. In the adjusted model, a higher number of weekly 'social contacts' (>10), 'better/much better health vs. peers', 'good chewing', no reported 'medication', 'burning mouth', 'self-reported bruxism' and 'gingival bleeding' were significant factors reported at age 75 that predicted 'never dry mouth' during daytime at age 85. Predictive variables for remaining free of night-time xerostomia at age 85 in the adjusted model were as follows: 'better/much better health vs. peers', 'good chewing', no reported 'medication', 'wounds and blisters', 'self-reported bruxism' and 'sensitive teeth' reported at age 75 (Table 8).

4 | DISCUSSION

The main finding from this study was that xerostomia increased substantially in the population observed from the age of 75 to 85 years. Xerostomia was more common at night and in women, and protective factors for not developing dry mouth during the 10-year observation period or not reporting dry mouth at age 85 were related to both good general and oral health, chewing function as well as social interaction, as reported at age 75.

This study followed the same individuals, born in 1932, longitudinally from the age of 75 to the age of 85 years. During the period of this study, retirement age in Sweden was 65 years, indicating that the study population were well into their retirement. The total number of living individuals in the two counties were all invited to participate in this study, and the number decreased from 5195 at the age 75 to 3323 at the age 85. It was not possible for us to further investigate the reason for this, but it can be speculated that death is the most likely explanation and to a lesser extent moving outside the investigated counties. Despite the age of the participants the response rates at both baseline aged 75 (71.8%), and at the last investigation aged 85 (60.8%), as well as those in the 'panel' (51.2%) may be considered as relatively high and acceptable for our purpose.

In the whole of Sweden in 2017, there were 39850 individuals aged 85 and the gender distribution was 59.3% women and 40.7% men.¹⁸ The gender distribution in the two counties of our population (58.9% women and 41.1% men) thus corresponded well with that of the whole of Sweden, although the 'panel' in this study did have an underrepresentation of women (54.7%) and an overrepresentation of men (45.3%). Among the nonresponders at age 85 ($n = 1302$), the gender distribution was even more skewed than that of the total sample ($N = 3323$), being 63.3% women and 36.7% men. The restrictions set by the approval from the ethical committee precluded us from doing an in-depth analysis of nonrespondents but some speculations could nevertheless be offered as to the skewed gender distribution especially at age 85, as follows:

TABLE 2 Prevalence^a: Reported *daytime* mouth dryness in the longitudinal 'panel' (n = 1701) at ages 75 (2007) and 85 (2017) by gender (women n = 931; men n = 770).

	75 years			85 years		
	Women	Men	Total	Women	Men	Total
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Yes often	7.9 (71)	4.1 (31)	6.2 (102)	13.9 (119)	8.1 (58)	11.3 (177)
Yes sometimes	31.1 (278)	22.7 (170)	27.2 (448)	39.7 (339)	35.2 (253)	37.7 (592)
No seldom	28.2 (252)	33.5 (251)	30.6 (503)	27.6 (236)	34.5 (248)	30.8 (484)
No never	32.8 (294)	39.7 (298)	36.0 (592)	18.7 (160)	22.1 (159)	20.3 (319)
n total	895	750	1645	854	718	1572
p			<0.001			<.001

Note: N.B. Some missing data at the different examination points explains why (n) differs from the total (1701). p denotes gender differences (Pearson's chi-square test).

^aPrevalence: Percentage of 'panel' participants reporting 'yes often/yes sometimes' regarding *daytime* dry mouth at ages 75 and 85 years.

TABLE 3 Prevalence^a: Reported *night-time* mouth dryness in the longitudinal 'panel' (n = 1591) at ages 75 (2007) and 85 (2017) by gender (women n = 931; men n = 770).

	75 years			85 years		
	Women	Men	Total	Women	Men	Total
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Yes often	22.2 (201)	14.0 (106)	18.5 (307)	28.3 (224)	17.5 (116)	23.4 (340)
Yes sometimes	41.1 (372)	38.8 (293)	40.1 (665)	40.3 (319)	43.8 (291)	41.9 (610)
No seldom	16.7 (151)	22.6 (171)	19.4 (322)	18.0 (142)	22.4 (149)	20.0 (291)
No never	20.0 (181)	24.5 (185)	22.0 (366)	13.4 (106)	16.3 (108)	14.7 (214)
n total	905	755	1660	791	664	1455
p			<.001			<.001

Note: N.B. Some missing data at the different examination points explains why (n) differs from the total (1701). p denotes gender differences (Pearson's chi-square test).

^aPrevalence: Percentage of 'panel' participants reporting 'yes often/yes sometimes' regarding *night-time* dry mouth at ages 75 and 85 years.

TABLE 4 Persistence^a: Percentage of participants consistently reporting: 'yes often'/'yes sometimes' dry mouth at ages 75 and 85: daytime n_{total 75} = 550 and n_{total 85} = 371, respectively; night-time n_{total 75} = 972 and n_{total 85} = 667, respectively.

	Daytime	Night-time
Age span	75–85	75–85
	%	%
Women	69.1	69.4
Men	64.7	67.4
Total	67.4	68.6
p	<.001	<.001

Note: p denotes gender differences (Pearson's chi-square test).

^aPersistence: Percentage of 'panel' participants reporting 'yes often/yes sometimes' regarding continued presence of daytime and night-time dry mouth within age spans: 75–85 years.

In Sweden special housing is allocated for those elderly who have a need for help in everyday life due to, for example, physical, mental or intellectual disabilities. In 2020, 18.2% of Swedish women

and 11.7% of men above 80 years of age, lived in this type of special housing. These are substantially higher numbers than those within the ages 65 to 79 years, and showing a larger gender difference.¹⁹ It is known that women develop more disability with ageing than men and one large multicountry study reported that in the age group 80+, as many as 68.9% of women had disability compared with only 45.5% of men,²⁰ which could be one explanation for the overrepresentation of women living in the Swedish special housing, and thus to the underrepresentation of women in this study.

In this study, the nonresponse rate in 2007 was less than 30% and increased to about 40% in 2017. The reason for the increase of nonresponders could to an extent be explained by the likelihood that a proportion of the inhabitants had some disability possibly making a response more difficult, and especially so for women as previously discussed. Based on the foregoing, there is a need for caution when extrapolating results from this study to the general population of 85-year-olds living in Sweden. The response rate in this study is, however, high compared with other recent cross-sectional epidemiological studies on xerostomia.^{21–23}

TABLE 5 Progression^a: Percentage of participants reporting a change from 'no, never'/'no seldom' to 'yes, often'/'yes sometimes' dry mouth over age span 75–85: daytime $n_{\text{total } 75} = 1095$ and $n_{\text{total } 85} = 374$, respectively; night-time $n_{\text{total } 75} = 688$ and $n_{\text{total } 85} = 262$, respectively.

	Daytime	Night-time
Age span	75–85	75–85
	%	%
Women	36.3	39.2
Men	32.1	37.1
Total	34.2	38.1
<i>p</i>	NS	NS

Note: *p* denotes gender differences (Pearson's chi-square test).

Abbreviation: NS=not significant.

^aProgression: Percentage of 'panel' participants reporting a change in daytime and night-time dry mouth from 'no, never/no, seldom' to 'yes often/yes sometimes' over the age span 75–85 years.

TABLE 6 Remission^a: Percentage of participants reporting a change from 'yes, often'/'sometimes' dry mouth to 'no, never'/'no seldom' over age span 75–85: daytime $n_{\text{total } 75} = 550$ and $n_{\text{total } 85} = 134$, respectively; night-time $n_{\text{total } 75} = 972$ and $n_{\text{total } 85} = 160$, respectively.

	Daytime	Night-time
Age span	75–85	75–85
	%	%
Women	22.6	16.1
Men	27.4	17.0
Total	24.4	16.5
<i>p</i>	NS	NS

Note: *p* denotes gender differences (Pearson's chi-square test).

Abbreviation: NS=not significant.

^aRemission: Percentage of 'panel' participants reporting a change in daytime and night-time dry mouth from 'yes often/yes sometimes' to 'no never/no seldom' within age span 75–85.

To be able to longitudinally follow the occurrence and characteristics of xerostomia in older age groups is important for the understanding of the condition but there are very few other such reports on longitudinal changes of dry mouth in the elderly. The present longitudinal study started when the study group was aged 75 in 2007. This age was at that time considered to be rather old, and that we should be able to follow these individuals (having a supposedly high attrition rate due to mortality as well), and with a respectable response rate at the age of 85 years was not straightforward and was not taken for granted.

Although not directly comparable with our study, a longitudinal report in adults above 50 years of age showed an increase of xerostomia from 15.5% to 29.5% over 3 years.²⁴ In another paper from Australia, people aged 60 or above found an increase of dry mouth, graded as 'frequently' or 'always', from 21.4% to 24.8% over a 6-year

observation period, with the incidence being strongly associated with medication intake.²⁵

In regard to a previous study with a similar design as the present one, reporting on longitudinal change of xerostomia between age 50 and 75 years in individuals born in 1942, certain comparisons can be made.⁹ Taking the two sets of findings together, prevalence of daytime xerostomia (reported as 'yes often'/'sometimes') increased 2.5 times from the age of 50 (19.4%) to 85 (49.0%), with a similar pattern seen for night-time xerostomia (25.8% vs. 65.3%).⁹ Similarly, persistence was high in both the aforementioned study⁹ as well as in the present study, ranging from about 50% up to 85%. Remission, that is, when the individual reported having dry mouth at baseline but not at follow-up, occurred less frequently during daytime in our present older-aged study group of 75–85-year-olds compared with the relatively younger group of 50–75-year-olds in the previous study.⁹ The average yearly incidence was more than five times greater in the 75–85-year-olds compared with the 50–75-year-old group for daytime xerostomia and about three times greater at night-time.⁹ Gender differences showed the same patterns in both studies. Overall, it can be concluded that xerostomia increases steadily in prevalence as people grow older, at least up to the age of 85, that incidence accelerates, and that women are more affected.

The increasing incidence in the 75–85-year-olds compared with younger-aged groups is most likely due to an increase in impaired general health and accompanying medication possibly affecting salivary state, among others.^{25,26} In line with this, an Australian study found xerostomia to be reported by more than 25% of those aged 65 years and over, which was related to social and behavioural factors like low socio-economic standard, lack of dental insurance and 'unfavorable dental visiting pattern'.²⁷ In New Zealand, xerostomia was studied in dentate adults, and it was found that xerostomia was common especially among the oldest and in women and that OHRQoL was impacted by xerostomia.²⁸

Xerostomia may also be related to dietary intake. One systematic review showed a correlation between salivary hypofunction and food consumption.²⁹ It has also been reported that older patients with dry mouth have a lower intake of water and certain nutritional components than patients without dry mouth,¹¹ and that malnutrition is significantly associated with xerostomia³⁰ as well as with hard and soft tissue problems.³¹ Similar findings between xerostomia and intraoral symptoms/conditions were also found in our study. As regards malnutrition, which is documented as having a detrimental effect on the health of the elderly,³² the correlation between impaired chewing and xerostomia could be an indirect link to nutritional status being affected by not being able to select/masticate food properly. On the contrary, we did not find any association between low body mass index (BMI) and xerostomia in this study.

It has been suggested that medical research among the elderly has largely been focused on increasing the quantity rather than the quality of life. The value of those years being added at the end of our lives is being increasingly questioned.⁸ The WHO, in their policy document 'UN Decade of Healthy Ageing' for 2021–2030, identified

TABLE 7 Unadjusted and adjusted (Forward Conditional Method) logistic regression model for daytime and night-time xerostomia. Dependent variable: 1=Progression from *seldom/never* to *sometimes/often* from 75 to 85 years ($n=374$ and $n=262$ for daytime and night-time, respectively); 2=Persistence of *seldom/never* dry mouth between 75 and 85 years ($n=644$ and $n=337$ for daytime and night-time, respectively). Selection of independent variables for the adjusted model were made based on those found significantly correlated ($p < .05$) to either day- or night-time xerostomia in unadjusted analysis using all variables according to [Table 1](#) reported at age 75.

	Daytime					Night-time				
	Unadjusted		Adjusted			Unadjusted		Adjusted		
	p	OR	p	OR	CI	p	OR	p	OR	CI
Healthy (ref. yes, absolutely)	.007	0.62				.009	0.58			
Health versus peers (ref. much better/better)	<.001	0.60	<.001	0.58	0.42–0.78	.006	0.62	.04	0.68	0.47–0.98
Medication (ref. yes)	.03	1.36				.001	1.86	.002	1.83	1.24–2.70
Chewing (ref. very good)	.01	0.71				NS				
Appearance (ref. very satisfied)	.01	0.65				NS				
Teeth number (ref. all teeth left)	.006	0.69				NS				
Burning mouth (ref. no)	.001	0.29				NS				
Wounds/blisters (ref. no)	.004	0.56				NS				
Taste (ref. no)	.007	0.38	.04	0.40	0.17–0.95	NS				
TMJ pain (ref. no)	<.001	0.35	.02	0.45	0.23–0.90	.02	0.35			
TMJ sounds (ref. no)	.02	0.61				NS				
Bruxism	.002	0.54				NS				
Bleeding gingival (ref. no)	.003	0.62				NS				
Dental material (ref. no)	<.001	0.37				NS				
Sensitive teeth (ref. no)	<.001	0.52	.003	0.57	0.40–0.83	.005	0.53			
Tooth extraction (ref. yes)	NS					.01	1.76	.04	1.67	1.02–2.74
OIDP	.01	1.50				NS				
Temporary fillings ref. yes)	<.001	5.4	.005	4.62	1.60–13.39	NS				
Denture both jaws (no)	NS					.01	0.15			

Abbreviations: NS, not significant; OIDP, oral impact on daily performance.

four areas for action in order to improve life for the elderly, one area being 'integrated care'.⁶ In our study, 'protective factors' in relation to xerostomia were found to be good general health and absence of medications, as well as good oral health and absence of intraoral symptom/s, good chewing function and social interaction.

Regarding medications, the questionnaire only recorded usage in the past 14 days with a 'yes' or 'no' response. It would of course have been desirable to have recorded the number and nature of medications as well the number of chronic diseases in each of the subjects as both of these may contribute substantially to the presence of xerostomia.

In addition, poor mastication, a reduced number of teeth and dysphagia are also suggested to contribute to the lower OHRQoL in xerostomia patients.¹⁶ To address such aspects, not only does the field of dentistry need to be included, but there is also the broader need to integrate the medical healthcare and social welfare systems.

Thus, in order to maintain good OHRQoL for the elderly, in which having few or no problems with xerostomia is a part, a multidisciplinary approach to patients' general and oral health as well as social environment is of importance and in line with that mentioned by the WHO.⁶

5 | CONCLUSION

The prevalence of xerostomia increased markedly between the ages of 75 and 85 years and was more common at night and in women. Factors that included good general health and absence of medication, good oral health and absence of intraoral symptoms, and good chewing function and social interaction, as reported at age 75, were found to be 'protective' against a deterioration of xerostomia. Measures should, therefore, be carried out addressing these factors

TABLE 8 Unadjusted and adjusted (Forward Conditional Method) logistic regression model for daytime and night-time xerostomia. Dependent variable: 1= *Often dry mouth* at 85 ($n=177$ and $n=340$ for daytime and night-time, respectively); 2= *Never dry mouth* at 85 ($n=319$ and $n=214$ for daytime and night-time, respectively). Selection of independent variables for the adjusted model were made based on those found significantly correlated ($p < .05$) to either day- or night-time xerostomia in unadjusted analysis using all variables according to [Table 1](#) reported at age 75.

	Daytime					Night-time				
	Unadjusted		Adjusted			Unadjusted		Adjusted		
	p	OR	p	OR	CI	p	OR	p	OR	CI
Gender (ref. man)	<.001	0.49				<.001	0.51			
Education	NS					.04	1.44			
Social contacts (>10 people/week)	.003	1.85	.02	2.19	1.16–4.11	NS				
Healthy (ref. yes, absolutely)	<.001	0.28				<.001	0.29			
Health versus peers (ref. much better/better)	<.001	0.24	<.001	0.23	0.12–0.44	<.001	0.28	.001	0.33	0.21–0.53
Medication (ref. yes)	<.001	3.45	.03	2.11	1.07–4.18	<.001	2.29	.012	1.96	1.16–3.33
Doctor contact (ref. yes, last 3 months)	.002	1.82				<.001	1.87			
BMI	.003	0.92				NS				
Chewing (ref. very good)	<.001	0.27	<.001	0.33	1.19–0.57	<.001	0.32	.002	0.44	0.26–0.73
Appearance (ref. very satisfied)	<.001	0.33				<.001	0.36			
Teeth number (ref. all teeth left)	<.001	0.42				<.001	0.57			
Burning mouth (ref. no)	<.001	0.13	.004	0.19	0.06–0.59	<.001	0.17			
Wounds/blisters (ref. no)	<.001	0.22				<.001	0.25	.02	0.42	0.19–0.89
Taste	<.001	0.11				.004	0.27			
TMJ pain (ref. no)	<.001	0.12				<.001	0.14			
TMJ sounds (ref. no)	<.001	0.24				<.001	0.34			
Jaw opening (ref. no)	<.001	0.27				.006	0.41			
Bruxism (ref. no)	<.001	0.23	.004	0.29	0.13–0.67	<.001	0.22	.01	0.34	0.14–0.80
Bleeding gingival (ref. no)	<.001	0.29	<.001	0.32	0.17–0.62	<.001	0.43			
Bad breath (ref. no)	<.001	0.35				<.001	0.43			
Dental material (ref. no)	.01	0.32				.001	0.09			
Sensitive teeth (ref. no)	<.001	0.36				<.001	0.30	.007	0.41	0.22–0.78
Tooth extraction (ref. yes)	.02	1.85				.008	2.09			
OIDP	<.001	3.04				<.001	3.14			
Amalgam	NS					.03	1.52			
Implant	NS					.046	1.81			
Temporary fillings	.02	6.53				NS				

Abbreviations: NS, not significant; OIDP, oral impact on daily performance.

in order to maintain good oral health-related quality of life and reduce the negative effects of xerostomia during ageing.

AUTHOR CONTRIBUTIONS

Sannevik J and Mastrovito B were involved in investigation, project administration and data curation. Johansson A, Omar R, Carlsson GE, Sannevik J, Mastrovito B and Johansson AK were involved in formal

analysis. Johansson A, Omar R, Carlsson GE, Sannevik J, Mastrovito B and Johansson AK were involved in writing original draft and final manuscript review/editing.

ACKNOWLEDGEMENTS

This study was funded by grants from Örebro and Östergötland counties, Sweden.

CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interests in relation to this paper.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The study was approved by Ethics Committee in Uppsala, Sweden, (Dnr 2016/424) and an informed consent was obtained from all participants.

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How to cite this article: Johansson A-K, Omar R, Mastrovito B, Sannevik J, Carlsson GE, Johansson A. Xerostomia in 75–85-year-olds: A longitudinal population study. *J Oral Rehabil*. 2023;00:1-10. doi:[10.1111/joor.13512](https://doi.org/10.1111/joor.13512)