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Perceived xerostomia, stress and periodontal status impact on elderly oral health-related quality of life: findings from a cross-sectional survey

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Abstract

Background: To investigate if self-perceived xerostomia and stress are significant variables on the Oral-Health Related Quality of Life (OHRQoL) of elderly patients, considering the periodontal status, oral hygiene habits and sociodemographic characteristics simultaneously.

Methods: The study cohort included 592 participants (320 females/272 Males), aged 65 years or older, representing the elder inhabitants of the Study of Periodontal Health in Almada-Seixal (SoPHIAS). Patients answered a socio-demographic and oral hygiene habits questionnaire. The Oral Health Impact Profile-14 (OHIP-14), Summated Xerostomia Inventory-5 (SXI-5) and Perceived Stress Scale-10 (PSS-10) were used. Full-mouth circumferential periodontal inspection was carried out. Multivariable regression analyses were used considering the level of periodontitis, clinical characteristics, the number of teeth, SXI, PSS-10, age, gender and oral hygiene habits.

Results: Self-perceived xerostomia and stress showed a positive significant correlation with OHRQoL and each of its domains. Multiple linear regression analysis demonstrated the significant impact of SXI-5 ($B = 1.20, p < 0.001$) and PSS-10 ($B = 0.35, p < 0.001$) on the OHRQoL. SXI-5 (Odds Ratio (OR) = 1.28, $p < 0.001$) and PSS-10 (OR = 1.03, $p = 0.022$) were associated with a more frequently affected OHRQoL. The number of missing teeth, being male, mean probing depth and mean clinical attachment loss were also significant towards a frequently affected OHRQoL. Conversely, age was negatively associated with a lower OHRQoL.

Conclusion: Self-perceived xerostomia and stress are significant variables towards OHRQoL in elderly patients. Future studies should consider these self-perceived xerostomia and stress when investigating the impact of periodontitis and missing teeth on quality of life of older adults.

Keywords: Xerostomia, Stress, Elders, Oral health-related quality of life, Periodontitis, Tooth loss, Aging

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Background

Patient-reported outcomes (PROs) are emerging key measures to aid oral health care decision-making policies [1]. In a disease or treatment situation, patients' perspective is often the most significant result over clinical outcomes [2]. Besides, in a world with a population ageing so fast, doing so healthy and with good quality of life has become an exciting matter to study [3].

Periodontal diseases are highly prevalent among older people and remain a substantial epidemiological challenge [4–6]. Periodontal diseases negatively impact on oral health-related quality of life (OHRQoL), especially with the worsening and extent of disease, and with special relevance in the elderly populations [7–11]. Notwithstanding, the lost quality of life can be recovered after nonsurgical periodontal therapy [12].

The impact of periodontitis on the OHRQoL, in elder populations, is poorly studied. Nevertheless, though periodontitis leads to poorer quality of life, its clinical consequences as missing teeth and denture use have apparently a higher impact [13, 14]. Nevertheless, it is important to investigate whether other confounders could influence the quality of life perception. Stress has been linked to both periodontitis and OHRQoL [15, 16], and xerostomia has been associated to poorer quality of life [17, 18]. Self-reported objective and subjective dry mouth complaints impact OHRQoL in senior men and women, because the majority has medical conditions and medications that might cause xerostomia [19, 20]. Besides, perceived stress has also been linked to worse OHRQoL in older people [21]. However, the impact of self-perceived xerostomia and stress together with periodontitis on the OHRQoL of elderly individuals has never been explored, and may be potential influential variables.

Therefore, we aimed to evaluate whether self-perceived xerostomia and stress could influence OHRQoL in a representative elderly population, considering also the extent of periodontitis, the number of missing teeth, clinical variables and oral hygiene habits.

Methods

Ethics and study design

The Study of Periodontal Health in Almada-Seixal (SoPHIAS) is a population-based representative study, with a target population living in the municipalities of Almada and Seixal (Portugal) [22]. This study was approved by the Research Ethics Committee of the Regional Health Administration of Lisbon and Tagus Valley, IP (Portugal) (8696/CES/2018) and in accordance with the Declaration of Helsinki, as revised in 2013. Participants were informed about their periodontal status after examination. Patients diagnosed with periodontal disease were referred to the Egas Moniz Dental Clinic (EMDC) for treatment without additional costs [22]. The study

followed the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines [23].

Sample size and measurement reproducibility

A fully detailed report on elderly sampling strategy and measurement reproducibility are mentioned in [22]. A total of 1064 participants, aged 18 to 95 years, gave their consent and were examined [22]. For the purpose of this study, a subset of 592 participants, 320 women and 272 men, with 65 years old or over were studied.

Periodontal examination and clinical variables

Each clinical examination was performed using proper lightening with the individuals seated on an adjustable stretcher in the FHU's medical office. Periodontal examination was made as described in Botelho et al. [22]. Periodontitis case definitions were defined according to the new AAP/EFP consensus [24].

Questionnaires

Information on sociodemographic characteristics and behaviours was collected by a self-reported questionnaire. The questionnaire covered questions on the following items: 1) gender, age, marital status, educational level, occupation; 2) monthly family gross income; 3) smoking habits; 4) oral hygiene-related behaviours (tooth brushing frequency, interproximal cleaning); 5) attitudes and awareness towards oral health.

Participants completed the Portuguese versions of the Oral Health Impact Profile-14 (OHIP-14-PT) [25] to assess OHRQoL, Summated Xerostomia Inventory-5 (SXI-5-PT) [26] to quantify xerostomia and Perceived Stress Scale-10 (PSS-10-PT) to estimate recognised stress [27].

The OHIP-14 consists of 14 questions representing seven domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap) of OHRQoL. Each question is scored by 0 (never), 1 (hardly ever), 2 (occasionally), 3 (fairly often) and 4 (very often). Thus, a higher score indicates poorer OHRQoL. Each pair of questions represents one of seven domains of the OHIP-14. The sum of the scores of the 14 questions ranges from 0 to 56 and the sum of each domain ranges from 0 to 8 (Slade et al. 1997). Further, individuals were categorised as frequently affected individual with respect to OHRQoL (answering with 3 or 4 to at least one of the questions in the OHIP-14) or with less affected individuals (responding with 0, 1 or 2 on all the items) [13].

The SXI-5 is a 5-questions tool where each question is scored by 0 = never, 1 = occasionally 2 = frequently. The scores from the five questions are summed, with the result representing the degree of xerostomia the subject feels [26].

The PSS-10 is 10-items instrument indicated to assess self-perceived stress. Each of the items on the PSS-10 is rated on a 5-point Likert scale, and each question is scored 0 = never, 1 = almost ever, 2 = sometimes, 3 = fairly often and 4 = very often. The PSS-10 consists of two domains: six positively (items 1, 2, 3, 6, 9 and 10) and four negatively (items 4, 5, 7 and 8, that require reversion) worded items. Total scores range from 0 to 40, with higher scores indicating higher levels of perceived stress [28].

Assessment of confounders

Furthermore, the participants have also been categorised into three groups according to the extent of periodontitis: no disease, localized periodontitis and generalized periodontitis [24]. Concerning oral hygiene, patients were categorized for their interproximal hygiene (no = 0, occasionally = 1, and yes = 2) and for frequency of toothbrushing per day (less than one time per day = 0, one time per day = 1, and two or more times per day = 2). Also, patients were questioned to the use of dentures and registered as a dichotomous variable (no = 0, or yes = 1).

Statistical methods

The total scores of OHIP-14, PSS-10 and SXI-5 were calculated and their correspondent descriptive measures (mean and standard deviation (SD)) were computed. For analysis purposes, these scores were considered as continuous variables. The data analyses were conducted for all participants and for sample subsets, according to gender and periodontitis extent. Mann-Whitney and Kruskal-Wallis tests were used to compare OHRQoL scores as a function of gender and periodontitis extent. For categorical variables, the analyses were performed using Chi-square test. Spearman's rank correlation coefficient (ρ) was used to analyse the correlation of OHIP-14 scores with PSS-10 and SXI-5 total scores, number of missing teeth and periodontal clinical variables. The effect size of correlations was analysed according to Cohen's standard. Further, a multiple forward stepwise linear regression analysis was carried out in order to evaluate the impact of those variables on the OHIP-14 total score. Next, a multivariable forward stepwise logistic regression was applied using the dichotomised dependent OHIP-14 variable "frequently affected" vs "less affected" OHRQoL as in [13]. Odds ratio (OR) and correspondent 95% confidence level intervals (95% CI) were calculated. Data were analysed using IBM SPSS Statistics, v. 25, (NY, USA). A level of significance of 5% was considered in all inferential analyses.

Results

Sample description

In general, the average total OHIP-14 score indicates that these participants perceived their OHRQoL as

modest, although men perceived better OHRQoL than women (Table 1). Regarding periodontitis extent, 70.9% had periodontitis with 24.0 and 47.0% being localized and generalized forms, respectively. Men had more prevalence of localized and generalized periodontitis than women. Women had significantly more missing teeth, although self-reporting better oral hygiene habits than men, on interproximal cleaning and toothbrushing. Almost half of the population were denture wearers, with the majority using partial and removable acrylic types. Besides, this population self-reported moderate signs of dry-mouth and stress with significant differences between gender, with men experiencing more stress and women more signs of xerostomia.

Furthermore, in the overall sample, patients with generalized periodontitis stated average similar OHRQoL than patients with no periodontitis and localized (Table 2). Only the handicap domain demonstrated notable differences in men, between no disease patients and both localized and generalized periodontitis inmates. Periodontitis severity showed to influence OHRQoL levels, with more severe cases presenting worse OHRQoL parameters (Table 3). Also, in this analysis, only the functional limitation domain had differences among women between no disease and the different types of periodontitis.

OHIP-14 and covariates impact

Spearman's rank-order correlation coefficient was used to investigate the possible correlation between total and each domain of OHIP-14 with SXI-5 total, PSS-10 total, number of missing teeth, mean probing depth (PD), mean clinical attachment loss (CAL), mean gingival recession (Rec) and mean bleeding on probing (BoP) (Table 4). SXI-5 total and the number of missing teeth had small positive significant correlations with OHIP-14 and each domain scores.

To investigate which variables impacted the OHIP-14 total score, a multiple linear regression analysis was conducted (Table 5). Afterwards, age, the SXI-5 total, the PSS-10 total, missing teeth and mean PD significantly contributed to the OHIP-14 score. Notably, the factors that most contributed for the OHIP-14 score were mean PD ($B = 1.56$, 95% CI: 0.62–2.51) and SXI-5 ($B = 1.20$, 95% CI: 0.77–1.63). Conversely, age was a negative contributor ($B = -0.24$, 95% CI: $-0.36, -0.97$).

A multivariate logistic regression, with Oral Health Impact Profile (OHIP-14) dichotomised into less affected vs frequently affected, was also carried out (Table 6). Overall, age, SXI-5 total, PSS-10 total, gender and mean CAL were significant for the model. While age has a negative effect (OR = 0.96, 95% CI: 0.93–0.99), being male (OR = 1.44, 95% CI: 1.00–2.06), SXI-5 total (OR = 1.28, 95% CI: 1.14–1.43) and mean CAL (OR = 1.25, 95%

Table 1 Oral Health Impact Profile (OHIP-14), Summated Xerostomia Inventory-5 (SXI-5) and Perceived Stress Scale-10 (PSS-10) scores, age, number of missing teeth, periodontitis extent, oral hygiene variables and denture wearers, according to gender and for the overall participants (N = 592)

	Women (n = 320)	Men (n = 272)	P-value	Overall (N = 592)
OHIP-14 Total, mean (SD)	9.57 (11.70)	5.83 (8.54)	< 0.001*	7.85 (10.53)
OHIP-14 domains, mean (SD)				
Functional limitation	1.23 (2.01)	0.85 (1.58)	0.032*	1.05 (1.83)
Physical pain	2.54 (2.70)	1.93 (2.40)	0.008*	2.26 (2.58)
Psychological discomfort	1.67 (2.58)	0.86 (1.94)	< 0.001*	1.30 (2.34)
Physical disability	1.58 (2.47)	0.97 (1.91)	0.003*	1.30 (2.25)
Psychological disability	1.28 (2.20)	0.58 (1.54)	< 0.001*	0.96 (1.95)
Social disability	0.41 (1.27)	0.17 (0.74)	0.029*	0.30 (1.07)
Handicap	0.87 (1.87)	0.47 (1.34)	0.008*	0.68 (1.66)
SXI-5, mean (SD)	7.1 (2.1)	6.3 (1.5)	0.001*	6.7 (1.9)
PSS-10, mean (SD)	14.2 (8.2)	16.1 (7.6)	0.002*	15.1 (8.0)
Age, mean (SD)	71.9 (6.2)	73.4 (6.6)	0.007*	72.6 (6.4)
Mean PD (mm), mean (SD)	1.88 (0.70)	2.00 (0.88)	0.372*	1.94 (0.79)
Mean CAL (mm), mean (SD)	2.86 (1.28)	3.22 (1.76)	0.259*	3.02 (1.53)
Mean Rec (mm), mean (SD)	0.98 (0.94)	1.24 (1.26)	0.047*	1.10 (1.10)
Mean BoP (%), mean (SD)	15.1 (20.7)	14.9 (21.5)	0.026*	15.0 (21.1)
Missing teeth, mean (SD)	10.9 (6.7)	11.9 (6.8)	< 0.001*	12,72 (6.77)
Periodontitis, n (%)				
Severity				
Healthy	104 (32.5)	68 (25.0)	0.032[#]	172 (29.1)
Stage I (Mild)	48 (15.0)	36 (13.2)		84 (14.2)
Stage II (Moderate)	79 (24.7)	77 (28.3)		156 (26.4)
Stage III (Severe/Advanced)	89 (27.8)	91 (33.5)		180 (30.4)
Extent				
No	104 (32.5)	68 (25.0)	0.135 [#]	172 (29.1)
Localized	73 (22.8)	69 (25.4)		142 (24.0)
Generalized	143 (44.7)	135 (49.6)		278 (47.0)
Interproximal cleaning, n (%)				
No	227 (70.9)	233 (85.7)	< 0.001[#]	460 (77.7)
Occasionally	35 (10.9)	18 (6.6)		53 (9.0)
Yes	58 (18.1)	21 (7.7)		79 (13.3)
Toothbrushing frequency per day, n (%)				
0	8 (2.5)	18 (6.6)	< 0.001[#]	26 (4.4)
1	79 (24.7)	114 (41.9)		193 (32.6)
2+	233 (72.8)	140 (51.5)		373 (63.0)
Denture wearer, n (%)				
No	137 (42.8)	170 (62.5)	< 0.001[#]	307 (51.9)
Yes	183 (57.2)	102 (37.5)		285 (48.1)
Denture extent, n (%) (n = 285)				
Partial	128 (69.9)	77 (75.5)	–	205 (71.9)
Full	12 (6.6)	5 (4.9)		17 (6.0)
Both	43 (23.5)	20 (19.6)		63 (22.1)

Table 1 Oral Health Impact Profile (OHIP-14), Summated Xerostomia Inventory-5 (SXI-5) and Perceived Stress Scale-10 (PSS-10) scores, age, number of missing teeth, periodontitis extent, oral hygiene variables and denture wearers, according to gender and for the overall participants (N = 592) (Continued)

	Women (n = 320)	Men (n = 272)	P-value	Overall (N = 592)
Type of denture, n (%) (n = 285)				
Removable Acrylic	124 (67.8)	73 (71.6)	–	197 (69.1)
Removable Metallic	58 (31.7)	24 (23.5)		82 (28.8)
Removable Acrylic and Metallic	1 (0.5)	0 (0)		1 (0.4)
Fixed	1 (0.5)	5 (4.9)		6 (2.1)

*Mann-Whitney test. #Chi-square test. Significant differences identified in bold (p < 0.05)

Mean BoP Mean bleeding of probing, Mean CAL Mean clinical attachment loss, Mean PD Mean probing depth; Mean Rec – Mean gingival recession; OHIP-14 - Oral Health Impact Profile-14; PSS-10 - Perceived Stress Scale-10; SD – standard deviation; SXI-5 - Summated Xerostomia Inventory-5

CI: 1.10–1.41) increase the risk towards a poorer quality of life.

In both analyses, the SXI-5 and PSS-10 significantly influenced the OHRQoL perception (Tables 4 and 5).

Discussion

In this study, we hypothesized that self-perceived xerostomia and stress can change OHRQoL perception, analysing simultaneously the periodontal status, number of missing teeth, clinical characteristics and other variables. To test this hypothesis, through a significant dataset from a representative elderly population, we developed multivariable regression analyses accounting for these variables. Our results confirmed that self-perceived xerostomia and stress are associated with OHRQoL. The

number of missing teeth, gender, and mean PD and CAL had a meaningful association to predict OHRQoL.

These findings have wide implications. (1) Self-perceived xerostomia revealed to be influential on OHRQoL in a population of elders, with a similar magnitude to the extent of periodontitis. (2) Self-perceived stress has a mild influence on OHRQoL. (3) The number of missing teeth and age are important variables to the OHRQoL variation. (4) The periodontal status does not influence the OHRQoL, rather some clinical features do. (5) As a result, self-perceived xerostomia and stress are important variables towards the OHRQoL in elderly patients.

As previously debated [22], the results of this epidemiological study indicate a disturbing prevalence of periodontitis among this elderly population and affecting

Table 2 Oral Health Impact Profile (OHIP-14) scores, total and for each domain, presented as mean and standard deviation (SD), according to gender and periodontitis extent

	Women (n = 320)				Men (n = 272)				Overall (N = 592)			
	ND	L	G	P-value #	ND	L	G	P-value #	ND	L	G	P-value #
OHIP-14, mean (SD)	9.02 (11.90)	9.29 (10.45)	10.11 (12.23)	0.430	4.28 (6.46)	5.64 (8.78)	6.71 (9.24)	0.165	7.15 (10.35)	7.51 (9.81)	8.42 (10.98)	0.178
OHIP-14 domain, mean (SD)												
Functional limitation	1.19 (2.23)	1.25 (1.70)	1.25 (2.00)	0.435	0.71 (1.39)	0.77 (1.37)	0.96 (1.76)	0.732	1.00 (1.95)	1.01 (1.56)	1.11 (1.89)	0.466
Physical pain	2.44 (2.68)	2.56 (2.45)	2.61 (2.85)	0.897	1.81 (2.32)	1.77 (2.44)	2.07 (2.43)	0.501	2.19 (2.56)	2.18 (2.47)	2.35 (2.66)	0.866
Psychological discomfort	1.56 (2.60)	1.75 (2.45)	1.66 (2.61)	0.405	0.53 (1.69)	0.84 (1.91)	1.04 (2.07)	0.079	1.15 (2.33)	1.31 (2.24)	1.36 (2.38)	0.178
Physical disability	1.57 (2.47)	1.36 (2.18)	1.68 (2.62)	0.936	0.81 (1.70)	0.87 (3.88)	1.11 (1.97)	0.395	1.27 (2.23)	1.12 (2.09)	1.40 (2.34)	0.601
Psychological disability	1.13 (2.09)	1.36 (2.19)	1.35 (2.28)	0.443	0.25 (1.01)	0.58 (1.45)	0.74 (1.77)	0.199	0.78 (1.80)	0.98 (1.90)	1.05 (2.06)	0.223
Social disability	0.49 (1.29)	0.23 (1.01)	0.44 (1.39)	0.348	0.04 (0.27)	0.2 (0.85)	0.21 (0.83)	0.267	0.31 (1.04)	0.22 (0.93)	0.33 (1.15)	0.708
Handicap	0.64 (1.59)	0.78 (1.45)	1.07 (2.22)	0.387	0.13 (0.54)^a	0.61 (2.15)^b	0.57 (1.52)^b	0.043*	0.44 (1.31)	0.7 (1.45)	0.83 (1.93)	0.060

G Generalized, L Localized, ND No Disease

Kruskal-Wallis test. Significant differences identified in bold (*p < 0.05)

OHIP-14 - Oral Health Impact Profile-14; SD – standard deviation

Table 3 Oral Health Impact Profile (OHIP-14) scores, total and for each domain, presented as mean and standard deviation (SD), according to gender and periodontitis severity

Stage	Women (n = 320)					Men (n = 272)					Overall (N = 592)				
	0	1	2	3	P-value #	0	1	2	3	P-value #	0	1	2	3	P-value #
OHIP-14. mean (SD)	9.0 (11.9)	6.3 (8.9)	8.6 (10.4)	12.8 (13.2)	0.101	4.3 (6.5)	6.3 (9.0)	5.6 (7.4)	7.0 (10.3)	0.502	7.2 (10.3)	6.3 (8.9)	7.1 (9.2)	9.9 (12.2)	0.225
OHIP-14 domain. Mean (SD)															
Functional limitation	1.2 (2.2)	0.8 (1.6)	1.4 (1.9)	1.3 (2.1)	0.027	0.7 (1.4)	1.3 (2.1)	0.6 (1.2)	1.0 (1.7)	0.216	1.0 (2.0)	1.0 (1.9)	1.0 (1.6)	1.2 (1.9)	0.466
Physical pain	2.4 (2.7)	1.9 (2.5)	2.2 (2.5)	3.4 (2.9)	0.410	1.8 (2.3)	1.7 (2.3)	2.0 (2.5)	2.0 (2.5)	0.704	2.2 (2.6)	1.8 (2.4)	2.1 (2.5)	2.7 (2.7)	0.397
Psychological discomfort	1.6 (2.6)	1.1 (2.2)	1.5 (2.3)	2.3 (2.9)	0.293	0.5 (1.7)	1.0 (2.3)	1.0 (1.8)	1.0 (2.1)	0.126	1.2 (2.3)	1.0 (2.2)	1.2 (2.1)	1.6 (2.6)	0.190
Physical disability	1.6 (2.5)	1.0 (1.9)	1.4 (2.7)	1.1 (2.1)	0.404	0.8 (1.7)	1.0 (1.8)	0.9 (1.8)	1.1 (2.2)	0.835	1.3 (2.2)	1.0 (1.9)	1.2 (2.2)	1.6 (2.5)	0.715
Psychological disability	1.1 (2.1)	1.0 (2.0)	1.1 (2.0)	1.8 (2.5)	0.765	0.3 (1.0)	0.7 (1.4)	0.5 (1.3)	0.9 (2.0)	0.266	0.8 (1.8)	0.9 (1.8)	0.8 (1.7)	1.3 (2.3)	0.725
Social disability	0.5 (1.3)	0.0 (0.2)	0.4 (1.2)	0.6 (1.6)	0.112	0.0 (0.3)	0.2 (0.8)	0.2 (0.5)	0.3 (1.0)	0.300	0.3 (1.0)	0.1 (0.6)	0.3 (1.0)	0.4 (1.3)	0.261
Handicap	0.6 (1.6)	0.5 (1.4)	0.7 (1.8)	1.4 (2.3)	0.946	0.1 (0.5)	0.5 (1.1)	0.4 (1.1)	0.8 (1.9)	0.101	0.4 (1.3)	0.3 (1.3)	0.5 (1.5)	1.1 (2.1)	0.493

0 – Healthy; 1 – Stage I, Mild Periodontitis; 2 – Stage II, Moderate Periodontitis; 3 – Stage III, Severe/Advanced Periodontitis; OHIP-14 - Oral Health Impact Profile-14; SD – standard deviation
Kruskal-Wallis test. Significant differences identified in bold (*p < 0.05)

more men. Further, this population reported faulty oral hygiene habits in agreement with a previous national report [29]. These characteristics may explain the high number of missing teeth and, as a consequence, more than half of the population were denture wearers. Besides, this population reported high levels of xerostomia and stress with significant differences between gender.

In terms of potential variables on the OHRQoL perception, SXI-5 exhibited a meaningful effect, while the perception of stress was meaningful but with mild

impact. Comprehensively, the higher the perception of xerostomia and stress factors the higher odds of poorer OHRQoL. These results are in line with recent literature where perceived chronic stress impacted the perception of dry mouth and quality of life [18, 21, 30].

Two recent systematic reviews asserted that periodontal diseases might have an impact on OHRQoL [9, 31]. Though none of them had centred exclusively on elder populations, higher disease severity leads to a greater negative impact on OHRQoL. The results of this study

Table 4 Correlation of OHIP-14 total and domain scores with Summated Xerostomia Inventory-5 (SXI-5), Perceived Stress Scale-10 (PSS-10) scores, number of missing teeth, mean PD, mean CAL, mean Rec and Mean BoP

	OHIP-14							
	Total	Functional limitation	Physical pain	Psychological discomfort	Physical disability	Psychological disability	Social disability	Handicap
SXI-5 Total	0.281**	0.246**	0.213**	0.185**	0.207**	0.218**	0.143**	0.192**
PSS-10 Total	0.083*	0.008	0.019	0.093*	0.017	0.114***	0.053	0.115**
Number of missing teeth	0.184**	0.165**	0.105**	0.158**	0.182**	0.135**	0.091**	0.125**
Mean PD	0.126**	0.043	0.097*	0.118**	0.092*	0.095*	0.068	0.084*
Mean CAL	0.162**	0.089*	0.090*	0.140**	0.131**	0.117**	0.077	0.124**
Mean Rec	0.136**	0.085*	0.066	0.115**	0.106**	0.095*	0.054	0.115**
Mean BoP	0.110**	-0.015	0.105*	0.109**	0.071	0.071	0.060	0.090*

Overall trend across OHIP-14 scores, total and for each domain, assessed by Spearman's rank correlation coefficient (rho). Significant correlations identified in bold (*p < 0.05, **p < 0.01)

Mean BoP Mean bleeding of probing, Mean CAL Mean clinical attachment loss, Mean PD Mean probing depth, Mean Rec Mean gingival recession, OHIP-14 Oral Health Impact Profile-14, PSS-10 Perceived Stress Scale-10, SXI-5 Summated Xerostomia Inventory-5

Table 5 Multiple linear regression describing the influence of continuous variables on the total OHIP-14 score, with regression coefficients (B) and correspondent 95% confidence intervals (95% CI)

	OHIP-14 Total Score	
	B	p-value
Age	-0.24 (- 0.36, - 0.97)	< 0.001***
SXI-5 Total	1.20 (0.77–1.63)	< 0.001***
PSS-10 Total	0.35 (0.26–0.45)	< 0.001***
Missing teeth	0.24 (0.13–0.35)	< 0.001***
Mean PD	1.56 (0.62–2.51)	0.001**

p < 0.01 and *p < 0.001. R² = 0.51
OHIP-14 Oral Health Impact Profile-14, PSS-10 Perceived Stress Scale-10, SXI-5 Summated Xerostomia Inventory-5

agree with the latter since greater PD and CAL values led to worse OHRQoL, although neither the periodontal condition nor the extent of the disease had an influence on the quality of life perception. Besides, the number of missing teeth was a significant factor and complies with a recent systematic review in which retention of teeth is associated with better OHRQoL [32]. Apparently, patients esteem much more the number of missing teeth for their quality of life than having periodontitis or its extension and confirms what has already been reported [13, 14, 33]. The number of missing is a characteristic that patients often recognize, though with periodontitis this perception is scarce [22, 34]. Recently, we have validated a brief perception questionnaire for periodontal diseases [34], and it will be interesting to associate the perception levels towards periodontitis with the OHR-QoL impact.

The association between OHRQoL and gender has been addressed in many investigations. In our report, women perceived poorer OHRQoL than men similarly to what has been found before [18, 33, 35, 36], although

Table 6 Multivariate stepwise logistic regression, with Oral Health Impact Profile (OHIP-14) dichotomised into less affected vs frequently affected, with Odds ratio (OR) and correspondent 95% CI

	OHIP-14 Total Score	
	OR (95% CI)	p-value
Age	0.96 (0.93–0.99)	0.003**
SXI-5 Total	1.28 (1.14–1.43)	< 0.001***
PSS-10 Total	1.03 (1.00–1.05)	0.022*
Gender		
Female	1	–
Male	1.44 (1.00–2.06)	0.048*
Mean CAL	1.25 (1.10–1.41)	< 0.001***

*The model was statistically significant, $\chi^2(5) = 71.041$, $p < 0.001$, explained 15.1% (Nagelkerke R²) of the variance and correctly classified 63.3% of cases
Mean CAL Mean clinical attachment loss, OHIP-14 Oral Health Impact Profile-14, PSS-10 Perceived Stress Scale-10, SXI-5 Summated Xerostomia Inventory-5

there are contrary results showing that men report poorer OHRQoL [37], or no difference whatsoever in the perception between men and women [13]. Still, we demonstrate that men have a higher risk of a frequently affected quality of life than women, possibly because of the overall poorer periodontal condition reported.

Strengths and limitations

The results provided by our investigation have some notable strengths, as previously proposed [9]. We employed a full-mouth protocol with circumferential inspection, ensuring precise estimation of the prevalence and extent of periodontitis [38]. Also, we used the new AAP/EFP joint case definition with an up-to-date diagnosis with PD and CAL combination analysis. Besides, these results are representative and with adequate sample size calculation, stratified for each health centre. Further, we have included a periodontally healthy control group and possible factors.

However, there are limitations worth to mention in our study. Although we have included the number of missing teeth we could not account for occlusal pairs that have proven impact on OHRQoL [32]. The lack of information related to dentinal sensitivity as a result of gingival recession was also a limitation and shall be considered in the future. Further, the control group was derived from the same sample which can be seen as a possible shortcoming. Too, we employed the OHIP-14 which is more focused on the impact of pain on the patient’s psychological and behavioural traits, while the Geriatric Oral Health Assessment Index (GOHAI) tool is more suitable to examine functional limitations in relation to pain [39, 40] and ought to be considered in further investigations.

Conclusions

We demonstrate that self-perceived xerostomia and stress are significant variables for the total score of OHRQoL in elderly patients, that is, they worsen the quality of life. Also, the significance was maintained even when analyzed simultaneously with the periodontal status, the number of missing teeth, periodontal clinical measures and oral hygiene habits. Future studies should consider these parameters when investigating the impact of periodontitis in quality of life.

Abbreviations

BoP: Mean bleeding on probing; CAL: Clinical Attachment Loss; CI: Confidence Interval; EMDC: Egas Moniz Dental Clinic; OHIP-14: Oral Health Impact Profile-14; OHRQoL: Oral Health Related Quality of Life; OR: Odds Ratio; PD: Pocket Depth; PROs: Patient-reported outcomes; PSS-10: Perceived Stress Scale-10; Rec: Mean gingival recession; SD: Standard Deviation; SoPHiAS: Study of Periodontal Health in Almada-Seixal; STROBE: STrengthening the Reporting of OBServational studies in Epidemiology; SXI-5: Summated Xerostomia Inventory-5

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Authors' contributions

JB, VM, LP, MJO, MAC, LA, AA and JJM contributed to the study conception and design. Material preparation, data acquisition and analysis were performed by JB, VM and LP. The first draft of the manuscript was written by JB, VM and LP. All authors have approved the submitted version and have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Availability of data and materials

Due to legal arrangements with governmental institutions, we are not authorized to disclose data.

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of the Regional Health Administration of Lisbon and Tagus Valley, IP (Portugal) (8696/CES/2018). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its latter amendments or comparable ethical standards. Written informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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