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RESEARCH

Dental anxiety and oral health-related quality of life before and after non-surgical periodontal treatment

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Abstract

Objectives To (1) investigate dental anxiety (DA) and oral health-related quality of life (OHRQOL) before and after non-surgical periodontal treatment (NSPT) and (2) determine correlations between these patient-reported measures.

Materials and methods Demographics, smoking habits, dental pain, Modified Corah's Dental Anxiety Scale (MDAS), and Oral Health Impact Profile (OHIP-14) were assessed in eighty-two participants.

Results Mean age was 48.3 years ± 11.5. At baseline, 8.5% reported being active smokers. Of non-smokers, 11% reported being an ex-smoker. After NSPT, 11.0% reported smoking. Patients' maximal pain in the last month decreased after therapy. Before treatment, participants reported higher DA. Extreme DA was observed in 8.5% of participants before therapy. Afterwards, 2.4% of participants reported extreme DA. Fear of having a foreign object in the mouth decreased after NSPT. All OHIP-14 scores, except functional limitation, improved post-treatment. Higher DA was associated with worse OHRQoL before treatment. After treatment, total MDAS score was associated with OHIP-14 global score, physical pain, psychological disability, and social disability. Worse MDAS sub-scores were associated with a higher OHIP-14 global score. Individuals with "normal/slight anxiety" had a significant improvement in OHRQoL, whereas people in the "moderate and extreme anxiety" group did not report a significant improvement. Patients diagnosed with generalized periodontitis (GP) stage III grade B and GP stage IV grade B reported less anxiety after NSPT.

Conclusions Associations of MDAS subcategories with OHIP-14 domain scores were found before and after therapy. DA decreases and OHRQoL enhances after NSPT in patients with "normal/slight" anxiety to dental treatment. Dental practitioners should plan strategies to cope with anxiety to dental treatment and prevent decreases in OHRQoL.

Clinical relevance Within the limitations of this study, DA and OHRQoL were positively correlated in patients with periodontitis, before and after NSPT, using the MDAS and OHIP-14 questionnaires. The results of our study suggest that treatment is effective in terms of alleviating DA and improving oral health, along with quality of life, in patients that report "normal/slight" anxiety to dental treatment. Nonetheless, results must be interpreted with caution since patients are generally anxious before any type of dental treatment. DA may not just be confined to NSPT per se. According to our results, evaluation of both outcomes should be an integral part of routine periodontal clinical evaluation and periodontal reevaluation of initial therapy. It is important that clinicians learn to identify patients that suffer from anxiety and take time to explain the treatment procedures to the patient, to strive for patient's emotional well-being before, during, and after dental care services. The use of specific questionnaires for both DA and OHRQoL may be more appropriate to demonstrate the psychological and quality of life differences due to periodontal disease and NSPT.

Keywords Periodontitis · Anxiety to dental treatment · Oral health-related quality of life · Non-surgical periodontal treatment

Introduction

Periodontitis is a chronic inflammatory disease that originates from a dysbiotic oral biofilm and has been associated with deregulation of the host immune response [1]. Periodontitis is characterized by progressive destruction of

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tooth-supporting tissues, manifested through clinical attachment loss, radiographically assessed alveolar bone loss, presence of periodontal pockets, and gingival bleeding [2, 3]. During its pathogenesis, signs and symptoms may not be noticeable to the patient. However, endpoints of the disease, such as tooth loss, may cause dental disability and masticatory dysfunction that may provoke a poor nutritional status. Other manifestations of periodontitis, namely halitosis, gingival recession, and tooth mobility, can exert an impact on the quality of life of the individual sufferer. Therefore, periodontal disease should also be evaluated subjectively through measures that quantify its influence on oral health-related quality of life (OHRQoL) [4].

OHRQoL describes a person's perception of how oral diseases and conditions affects overall well-being [5, 6]. OHRQoL aids clinicians and public health actors in identifying patient's concerns, expectations, and satisfaction of provided therapy [7]. The short version of the Oral Health Impact Profile (OHIP-14) is a patient-reported instrument that measures OHRQoL in adults. It has been validated in several geographic populations, translated in several languages, and is accepted as a gold standard.

Consistent evidence using OHIP-14 have found that periodontal disease negatively impacts quality of life [8]. For instance, Borges et al. revealed a decline in masticatory performance and OHRQoL in patients with bone loss of more than 50% of root length, because of periodontitis [9]. Additionally, one of the earliest studies exploring the connection between periodontitis and OHRQoL showed a correlation between OHRQoL scores and number of > 5-mm pockets, suggesting an association between the severity of disease and overall quality of life [10]. Similarly, a systematic review found higher impairment, and worse OHRQoL, as the extent and severity of periodontal disease increased [11]. As well, tooth loss has been documented to influence patient's quality of life [12–14].

Dental anxiety (DA), an unreasonable apprehension regarding dental procedures, is also a patient-reported measure. Recent studies have indicated an association between DA and OHRQoL [15]. For example, people who suffer from high DA tend to report lower OHRQoL [16]. Several studies have stated that high levels of DA have been correlated with periodontal treatment [17–20]. Periodontitis is a multifactorial disease, and anxiety to dental treatment may contribute to the onset and relapse of periodontal disease, since feeling anxious about dental situations may be a reason why patients avoid dental appointments and even postpone treatments, including periodontal treatment. It has been documented that patients with DA avoid periodontal preventive measures and exhibit poor oral hygiene compliance, which culminates in deteriorating periodontal health [15]. In a study by Santoncito et al., patients with periodontitis were positively associated with higher levels of DA and worse OHRQoL, compared to periodontally healthy counterparts [21]. In a more recent study by Goh et al., the authors reported that the severity of periodontitis was not related to anxiety-only and patients with anxiety experienced worse OHRQOL, regardless of their periodontal status [22].

The relationship between DA and OHRQoL in patients with periodontal disease has been studied [21, 23, 24]. However, there is lack of assessment of the effect of non-surgical periodontal treatment (NSPT) on both, DA and OHRQoL, in patients with periodontitis. Furthermore, studies evaluating the periodontal state of Costa Ricans are scarce with no studies regarding DA and OHRQoL. Therefore, the aims of this study were (1) to examine whether DA and OHRQoL differed before and after NSPT and (2) to describe correlations between these two self-reported measures, pre- and post-NSPT.

Methods

Study population

The study was conducted between February and November 2022. Eighty-two patients with periodontal disease who attended the Clinic of Periodontics of the Faculty of Dentistry of the University of Costa Rica (FODUCR) were included. Only newly admitted patients with periodontitis were chosen, who had never had NSPT, defined as root scaling and planing or root surface debridement, to determine if participants perceived a change in DA and OHRQoL after NSPT.

An appropriate sample size of sixty-nine patients was calculated. This sample size allowed estimates with a confidence level of 95%, a maximum permissible error of 7% in the proportion of people with improved quality of life after treatment, which was estimated at 85%. The Finite Population Correction Factor was used. This sample was adjusted with a 10% non-response. We recruited eighty-two patients in case some of the participants were lost to follow-up.

Inclusion criteria were as follows: 18 years of age or older, both sexes, diagnosed with periodontal disease with at least twenty teeth, and newly admitted to the Clinic of Periodontics of the FODUCR. Exclusion criteria were mental and psychiatric disabilities; use of illicit drugs, malignant diseases, taking sedatives, anxiolytics, or analgesics; pregnancy or lactation; an acute dental or periodontal condition; and patients who had in the past dental deep cleaning or NSPT, defined as root scaling and planing or root surface debridement for gum disease.

Data collection

This study was conducted in two phases. Phase one occurred at the initial visit of the participant, before NSPT. Participants were asked to complete a questionnaire that consisted of the following: (1) demographic details that included as follows: age, gender, and educational level (elementary school, high school, university studies, or other); (2) smoking habits; (3) dental pain; (4) Modified Corah's Dental Anxiety Scale (MDAS); and (5) OHIP-14. In addition to the questionnaire, the following data was collected from the patient's electronic health record: periodontal diagnosis, Plaque Index (PI) according to the Modified O'Leary Index [25, 26], and Gingival Bleeding Index (GBI) [27].

Phase 2 occurred after completion of NSPT. Participants were asked to complete a questionnaire about (1) smoking habits, (2) dental pain (3) MDAS, and (4) OHIP-14. GBI was also recorded from the patient's electronic health record.

Past and current smoking habits were recorded as yes/no. Current smokers were asked the number of cigarettes consumed per day.

Assessment of DA was based on the MDAS Spanish version [28], which comprises 5 questions, each assessing DA levels in different dental situations. A "not anxious" response is scored 1, and an "extremely anxious" response is scored 5. To assess the patient's level of DA, response scores of all 5 questions are added. The total score of this scale ranges from 5 to 25. A score < 11 is considered normal/slight, whereas those lying between 11 and 18 represent moderate anxiety. Scores > 19 represent extreme anxiety [29, 30].

MDAS questions are as follows: (1) If you went to your Dentist for TREATMENT TOMORROW, how would you feel? (2) If you were sitting in the WAITING ROOM (waiting for treatment), how would you feel? (3) If you were about to have a TOOTH DRILLED, how would you feel? (4) If you were about to have your TEETH SCALED AND POLISHED, how would you feel? (5) If you were about to have a LOCAL ANAESTHETIC INJECTION in your gum, above an upper back tooth, how would you feel?

To capture additional information regarding other specific stimuli that may trigger anxiety in the dental setting, patients indicated a yes or no response, whether the following phobic stimuli evoked anxious feelings: (1) dental injection; (2) the sound of the dental drill, the sound of rotatory instruments, or the sound of the ultrasonic scaler noise; and (3) having a foreign object in the mouth. As dental phobia is considered a blood-injection-injury (B-I-I) phobia, we assessed whether dental B-I-I-related situations (fear of dental injections) provoke the same anxiety as non-B-I-I-related situations (fear of the sound of the dental drill, fear of the sound of rotatory instruments, or fear of the sound of ultrasonic scaler noise and fear of having a foreign object in the mouth) [23, 24].

To assess OHRQoL, the validated Spanish version of the OHIP-14 was used. This questionnaire measures seven domains: functional limitation, physical pain, psychological distress, physical disability, psychological disability, social disability, and disability. Each question consists of 5 response options for which a score is assigned (0 = never, 1 = almost never, 2 = occasionally, 3 = frequently, 4 = always). Each dimension is made up of two questions and a value ranging from 0 to 8 is obtained per dimension. The value of the OHIP-14 is obtained by adding the values of the 7 dimensions. Scores are calculated between 0 and 56 [31]. For each of the questions that were asked in the OHIP-14, the participants were asked the frequency of the impact in the last 6 months.

Statistical analysis

Statistical analysis was performed using R studio software (4.0.3).

To assess normality, a quantile plot was used, to compare the theoretical quantiles that the data should have if they were perfectly distributed with normality and the quantiles of the measured values. Also, the Shapiro–Wilk test was used, where the null hypothesis was that the frequency distribution of the data was normally distributed.

In this study, no variable met the assumption of normality.

Internal consistency of the MDAS and the OHIP-14 was determined by Cronbach's Alpha coefficient. The change in DA and OHRQoL after NSPT by subtracting MDAS scores and OHIP-14 scores at follow-up from baseline. To analyze the hypothesis that there were differences before and after treatment for quantitative variables, the Wilcoxon rank test was used. For binary variables, a sign test was used. Significance level was set at 5% (0.05). The chi-square test was used to determine differences between MDAS categories before and after NSPT. Cohen's *D* test was used to measure effect size in OHRQoL. The effect size was calculated by dividing the mean change score by the standard deviation of the baseline score [32].

Associations between MDAS total score and sub-scores with OHIP-14 total and domain scores before and after NSPT were determined using the Spearman correlation and the Wilcoxon signed-rank test. Additionally, analysis of variance (ANOVA) was used to analyze differences among means. Also, a Spearman's partial correlation analysis between DA and OHRQoL was performed adjusting for age, gender, educational level, smoking habits, and ex-smoker status. $p < 0.05$ was considered statistically significant.

Finally, anxiety was characterized in two groups, which were as follows: participants with "normal /slight anxiety" and participants with "moderate and extreme anxiety," before and after treatment NSPT; to detect mean differences in OHRQoL (OHIP-14) between anxiety groups, using the

Wilcoxon-signed rank test. The Minimally Important Difference (MID) in OHIP-14 score between DA groups ("normal/slight anxiety" vs "moderate and extreme anxiety") before and after NSPT was calculated using the distribution-based approach, for comparison between groups. The size of the effect (SE) and standardized response mean (SRM) were calculated. An ES and SRM of ≤ 0.2 indicate a small but clinically significant magnitude of change, 0.3–0.7 a moderate change, and ≥ 0.8 a large change [32, 33].

Results

The current study included eighty-two adults, 61.0% female and 39.0% male. Mean age of the participants was 48.3 years $\pm$ 11.5 years (range 18–69 years). A total of 24.4% attained primary education, 39% secondary education, 29.3% higher education, and 7.3% completed a non-degree program. Regarding smoking habits, 8.5% reported being an active smoker before periodontal treatment. On average, they smoked 9 ± 7.9 cigarettes per day. Of the non-smoker population, 11% reported being an ex-smoker. At the second interview, 11.0% reported being active smokers, consuming an average of 7.3 ± 7.2 cigarettes per day. Of the non-smoker population, 8.5% reported being an ex-smoker (Table 1).

Table 1 shows that patients' maximal pain in the last month decreased from a score of 3.2 ± 3.2 to 2.0 ± 3.2 ($p = 0.019$) after NSPT.

PI at baseline was 63.61 ± 16.95 and 28.87 ± 12.79, after treatment. The mean GBI before NSPT was 31.08 ± 23.13. We could only extract from the patient's dental record the initial GBI, since many of the participants did not have a second periodontal screening registered when the second questionnaire was applied.

Most of the participants were diagnosed with generalized periodontitis (GP) stage III grade C, 37.8%, followed by GP stage III, grade B, 17.1%. Distribution of the periodontal diagnosis of the studied population by gender is shown in Table 2.

Cronbach's alpha coefficient for MDAS was 0.88 before and 0.89 after NSPT, indicating good internal consistency. Table 2 shows mean MDAS total and sub-scores, MDAS categories, and self-assessment of phobic stimuli as indicated by participants before and after treatment. Before treatment, participants reported higher MDAS total as well as sub-scores ($p < 0.001$). MDAS categories differed before and after treatment ($p = 0.011$). Extreme DA was observed in 8.5% of the studied population before therapy. After treatment, only 2.4% of the studied population reported experiencing extreme anxiety. Moderate anxiety was reported

Table 1 Demographic characteristics, smoking habits, and pain scores of the studied population

Parameter	Variable	Before	After	*p* value**
		No. (%)	No. (%)	
Gender	Male	32 (39.0)	-	
	Female	50 (61.0)	-	
Education level	Primary	20 (24.4)	-	
	Secondary	32 (39.0)	-	
	Higher education	24 (29.3)	-	
	None-degree program	6 (7.3)	-	
Smoking habits	Yes	7 (8.5)	9 (11.0)	0.500
	No	75 (91.5)	73 (89.0)	
Ex-smoker	Yes	9 (11.0)	7 (8.5)	0.625
	No	73 (89.0)	75 (91.5)	
Parameter	Variable	Mean	SD	*p* value***
*Number of cigarettes per day	Before	9.0	7.9	0.789
	After	7.3	7.2	
Age		48.3	11.5	
Current pain	Before	1.4	2.6	0.971
	After	1.4	2.8	
Maximal pain in the last month	Before	3.2	3.2	**0.019**
	After	2.0	3.2	

*The variable "number of cigarettes per day" only considered current smokers

**Sign test

***Wilcoxon test

p value in bold denotes statistical significance ($p < 0.05$)

SD, standard deviation

Table 2 Periodontal diagnosis of the studied population by gender

Diagnosis	General	Gender	
		Male	Female
	No. (%)	No. (%)	No. (%)
Gingivitis-dental biofilm-induced	2 (2.4)	1 (1.2)	1 (1.2)
*Stage I grade A	1 (1.2)	0 (0.0)	1 (1.2)
*Stage II grade A	1 (1.2)	1 (1.2)	0 (0.0)
*Stage II grade B	6 (7.3)	4 (4.9)	2 (2.4)
*Stage II grade C	1 (1.2)	0 (0.0)	1 (1.2)
*Stage III grade B	5 (6.1)	1 (1.2)	4 (4.9)
*Stage III gradeC	3 (3.7)	2 (2.4)	1 (1.2)
*Stage IV grade C	1 (1.2)	1 (1.2)	1 (0.0)
**Stage II grade A	3 (3.7)	0 (0.0)	3 (3.7)
**Stage II grade B	7 (8.5)	2 (2.4)	5 (6.1)
**Stage III grade A	1 (1.2)	1 (1.2)	0 (0.0)
**Stage III grade B	14 (17.1)	6 (7.3)	8 (9.8)
**Stage III grade C	31 (37.8)	12 (14.6)	19 (23.2)
**Stage IV grade B	2 (2.4)	0 (0.0)	2 (2.4)
**Stage IV grade C	4 (4.9)	1 (1.2)	3 (3.7)

*Localized periodontitis (clinical attachment loss/bone loss affects less than 30% of the teeth)

**Generalized periodontitis (clinical attachment loss/bone loss affects more than 30% of the teeth)

by 32.9% of the sample before periodontal care, and this percentage decreased after therapy to 19.5%. After completion of NSPT, more patients were classified as experiencing normal/slight anxiety. Before treatment, patients were more likely to fear having a foreign object in the mouth. This changed after treatment ($p = 0.02$). No change was found regarding fear to the sound of the dental drill noise, fear to the sound of the ultrasonic scaler, or fear to the sound of the rotatory instruments (Table 3). To clarify, the dental drill was not used on any patient for NSPT. The question employed in the survey consists of three items related to dental instruments which noise may trigger anxiety in the dental setting. Additionally, no change was found regarding fear to dental injections (Table 3).

Cronbach's alpha coefficient for OHIP-14 was 0.88 before NSPT and 0.86 after treatment, indicating a good level of internal consistency. OHIP-14 global score and domain scores are presented in Table 4. OHIP-14 global score was lower post-treatment ($p < 0.001$; $d = 0.88$). All OHIP-14 domain scores, except functional limitation, were improved post-treatment: physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap (all ps < 0.001; $d = 0.44$, 1.19, 0.40, 0.89, 0.49, and 0.69 respectively).

Table 3 Mean MDAS total and sub-scores, dental anxiety categories, and self-assessment of phobic stimuli, as reported by participants before and after NSPT

Phobic stimuli	Variable	Before		After		*p* value*
		No. (%)		No. (%)		
Dental injections	Yes	41 (50.0)		34 (41.5)		0.167
	No	41 (50.0)		48 (58.5)		
Sound of the dental drill/rotatory instruments, or ultrasonic scaler noise	Yes	32 (39.0)		23 (28.0)		0.078
	No	50 (61.0)		59 (72.0)		
Foreign object in the mouth	Yes	23 (28.0)		11 (13.4)		**0.002**
	No	59 (72.0)		71 (86.6)		
MDAS categories	Normal/slight	48 (58.5)		64 (78.0)		**0.011****
	Moderate anxiety	27 (32.9)		16 (19.5)		
	Extreme anxiety	7 (8.5)		2 (2.4)		
Parameter		Before		After		*p* value***
		Mean	SD	Mean	SD	
Visit tomorrow		2.0	1.2	1.5	0.9	**< 0.001**
Waiting room		1.9	1.0	1.4	0.7	**< 0.001**
Use of drill		2.3	1.3	1.6	1.0	**< 0.001**
Scale and polish		2.2	1.2	1.6	0.9	**< 0.001**
Injection		2.5	1.3	1.8	1.0	**< 0.001**
Total MDAS score		11.0	4.9	7.9	3.8	**< 0.001**

*Sign test

**Chi-square test

***Wilcoxon test

p values in bold denote statistical significance ($p < 0.05$)

MDAS, Modified Dental Anxiety Scale

SD, standard deviation

Table 4 Mean oral health impact profile (OHIP-14) global and domain scores before and after NSPT

OHIP-14		Mean	SD	Effect size*	*p* value**
OHIP-14 Global score	Before	16.06	10.57	0.88	**< 0.001**
	After	7.72	8.10		
Functional limitation (OHIP-1 + 2)	Before	0.98	1.55	0.11	**0.351**
	After	0.82	1.34		
Physical pain (OHIP-3 + 4)	Before	2.80	2.31	0.44	**0.001**
	After	1.80	2.21		
Psychological discomfort (OHIP-5 + 6)	Before	4.57	2.45	1.19	**< 0.001**
	After	1.87	2.19		
Physical disability (OHIP-7 + 8)	Before	1.87	2.11	0.40	**0.001**
	After	1.07	1.88		
Psychological disability (OHIP-9 + 10)	Before	3.11	2.31	0.89	**< 0.001**
	After	1.32	1.65		
Social disability (OHIP-11 + 12)	Before	0.88	1.52	0.49	**< 0.001**
	After	0.27	0.88		
Handicap (OHIP-13 + 14)	Before	1.85	2.40	0.69	**< 0.001**
	After	0.57	1.08		

*An effect size of < 0.2 indicates a small but clinically significant magnitude of change, 0.3–0.7 a moderate change, and > 0.7 a large change

**Wilcoxon test

p values in bold denote statistical significance ($p < 0.05$)

OHIP, Oral Health Impact Profile

SD, standard deviation

Tables 5 and 6 show positive correlations between MDAS total and sub-scores with OHIP-14 global and domain scores, before therapy ($r = -0.01$–0.50) and afterwards ($r = 0.02$–0.41). A worse MDAS total score and sub-scores were associated with higher OHIP-14 global score and domain scores, before NSPT (all $ps \leq 0.030$). After treatment, total MDAS score was associated with OHIP-14 global score, physical pain, psychological disability,

Table 5 Correlations and associations of MDAS total and sub-scores with OHIP-14 global and domain scores before NSPT

	Functional limitation (OHIP-1 + 2)	Physical pain (OHIP-3 + 4)	Psychologicdiscomfort (OHIP-5 + 6)	Physical disability (OHIP-7 + 8)	Psychologicdisability (OHIP-9 + 10)	Social disability (OHIP-11 + 12)	Handicap (OHIP-13 + 14)	OHIP-14 Global score
Total MDAS score*	0.09	0.31	0.46	0.37	0.39	0.28	0.40	0.50
	0.011	*0.003*	*< 0.001*	*< 0.001*	*< 0.001*	*0.007*	*< 0.001*	*< 0.001*
*Visit tomorrow***	− 0.01	0.23	0.39	0.21	0.31	0.16	0.39	0.39
		0.018	*< 0.001*	*0.016*	*0.002*		*< 0.001*	*< 0.001*
*Waiting room***	0.02	0.31	0.38	0.36	0.33	0.21	0.32	0.44
		0.002	*0.001*	*< 0.001*	*0.001*	*0.030*	*< 0.001*	*< 0.001*
*Use of drill***	0.14	0.29	0.36	0.36	0.30	0.25	0.30	0.42
	0.019	*0.013*	*0.002*	*< 0.001*	*0.013*	*0.027*	*0.006*	*< 0.001*
*Scale and polish***	0.21	0.30	0.48	0.31	0.36	0.26	0.36	0.47
	0.004	*0.014*	*< 0.001*	*0.002*	*0.002*	*0.031*	*0.001*	*< 0.001*
*Injection***	0.17	0.17	0.25	0.25	0.27	0.25	0.26	0.33
			0.026	*0.017*	*0.008*	*0.007*	*0.012*	*0.001*

*Spearman correlation

**ANOVA means' association

Numbers in italics means a significant *p* value ($p < 0.05$)

Table 6 Correlations and associations of MDAS total and sub-scores with OHIP-14 global and domain scores after NSPT

	Functional limitation (OHIP 1 + 2)	Physical pain (OHIP 3 + 4)	Psychologic discomfort (OHIP 5 + 6)	Physical disability (OHIP 7 + 8)	Psycholog-icdisability (OHIP 9 + 10)	Social disability (OHIP 11 + 12)	Handicap (OHIP-13 + 14)	OHIP-14 Global score
Total MDAS score*	0.16	0.34	0.27	0.20	0.36	0.34	0.14	0.40
		0.002			*0.004*	*0.004*		*0.004*
*Visit tomorrow***	0.14	0.35	0.27	0.34	0.38	0.37	0.19	0.41
		< 0.001		*< 0.001*	*< 0.001*	*< 0.001*		*< 0.001*
*Waiting room***	0.20	0.17	0.15	0.15	0.18	0.19	0.20	0.23
*Use of drill***	0.13	0.32	0.27	0.15	0.30	0.25	0.14	0.35
		0.002			*0.008*	*0.005*		*0.009*
*Scale and polish***	0.10	0.33	0.22	0.17	0.39	0.26	0.16	0.35
		0.002			*0.002*			*0.011*
*Injection***	0.10	0.20	0.20	0.05	0.17	0.34	0.02	0.35
						0.002		

*Spearman correlation

**ANOVA means' association

Numbers in italics means a significant p value ($p < 0.05$)

and social disability (all $ps \leq 0.0011$). Before NSPT worse scores in the four MDAS sub-scores were associated with a higher OHIP-14 global score ($p \leq 0.001$). Similarly, after therapy, except for MDAS second question, sitting in the waiting room ($p = 0.23$). Significant associations of MDAS subcategories with OHIP-14 domain scores before NSPT and after therapy are shown in Table 5 and Table 6. Non-significant values were not included in the tables.

Partial correlation analysis confirmed these results. After adjusting for age, the association between DA total score and OHIP total score was $r = 0.509$, before NSPT and $r = 0.396$ after NSPT ($p = < 0.001$). As DA total score increases, OHIP-14 total score also tends to increase, assuming age remains constant. Similarly, after adjusting for gender, the association between the DA total score and OHIP total score was $r = 0.483$, before NSPT and $r = 0.395$ after NSPT ($p = < 0.001$). After adjusting for educational level, DA total score and OHIP total score were $r = 0.499$, before NSPT and $r = 0.406$ after NSPT ($p = < 0.001$), a moderate positive correlation. And for smoking habits and ex-smoking status, before NSPT $r = 0.497$ and $r = 0.491$ and after NSPT $r = 0.387$ and $r = 0.391$, respectively. All indicating a moderate positive correlation between total DA score and OHRQoL total score.

MDAS total and sub-scores before and after treatment by periodontal diagnosis are presented in Table 7. Patients diagnosed with GP stage III grade B and GP stage IV grade B reported less anxiety after NSPT ($p \leq 0.001$).

Table 8 shows mean OHIP-14 global score and mean domain scores for the following domains: functional limitation, physical pain, psychological discomfort, and physical disability. Table 9 is a continuation of the previous table and shows mean domain scores for the following domains: psychological disability, social disability, and handicap. Patients diagnosed with localized periodontitis stage II grade B, GP stage III grade B, and GP stage IV grade B reported better OHRQoL in all global and domain scores compared to baseline ($p = 0.036$, $p = 0.001$, $p < 0.001$, respectively).

Anxiety was characterized in two groups which were "normal/slight anxiety" and "moderate and extreme anxiety" before and after treatment. Differences in OHRQoL (OHIP-14) between anxiety groups, before and after NSPT, are shown in Table 10. Mean differences were significant in the "normal/slight anxiety group" only. The MID, according to the distribution-based approach, for the ES was 0.80 for the "normal/slight anxiety" group and 0.76 for the "moderate and extreme anxiety" group. The SRM was 0.68 for the "normal/slight anxiety" and 0.49 for the "moderate and extreme anxiety" group.

Discussion

To the best of our knowledge, this is the first study that measures and correlates both OHRQoL and DA in individuals with periodontitis, before and after NSPT. The patients recruited for the study had never had their periodontal

Table 7 Mean MDAS total and sub-scores before and NSPT by diagnosis

Diagnosis	Total MDAS score		*Visit tomorrow*		*Waiting room*		*Use of drill*		*Scale and polish*		*Injection*		*p* value*
	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	
Gingivitis-dental biofilm-induced	8.0 (4.2)	5.5 (0.7)	1.5 (0.7)	1.0 (0.0)	1.5 (0.7)	1.0 (0.0)	1.5 (0.7)	1.0 (0.0)	1.5 (0.7)	1.0 (0.0)	2.0 (1.4)	1.5 (0.7)	1.000
+ Stage I grade A	8.0 (NA)	5.0 (NA)	1.0 (NA)	1.0 (N)	1.0 (NA)	1.0 (NA)	2.0 (NA)	1.0 (NA)	2.0 (NA)	1.0 (NA)	2.0 (NA)	1.0 (NA)	NA
+ Stage II grade A	14.0 (N)	10.0 (N)	3.0 (NA)	2.0 (N)	3.0 (NA)	2.0 (NA)	3.0 (NA)	2.0 (NA)	3.0 (NA)	2.0 (NA)	2.0 (NA)	2.0 (NA)	NA
+ Stage II grade B	12.0 (5.)	10.3 (6.)	1.8 (0.8)	1.2 (1.0)	2.2 (1.2)	1.0 (1.3)	2.7 (1.4)	2.2 (1.5)	2.5 (1.4)	2.0 (1.3)	2.8 (1.2)	2.3 (1.2)	0.581
+ Stage II grade C	19.0 (N)	14.0 (N)	5.0 (NA)	3.0 (N)	2.0 (NA)	1.0 (NA)	5.0 (NA)	4.0 (NA)	5.0 (NA)	4.0 (NA)	2.0 (NA)	2.0 (NA)	NA
+ Stage III grade B	9.2 (4.3)	6.4 (2.1)	2.0 (1.2)	1.2 (0.4)	2.0 (1.2)	1.2 (0.4)	1.6 (0.5)	1.2 (0.4)	1.8 (0.8)	1.2 (0.4)	1.8 (0.8)	1.6 (0.5)	0.371
+ Stage III grade C	12.0 (4.)	8.0 (3.6)	2.3 (1.5)	1.3 (0.6)	2.0 (1.7)	1.3 (0.6)	2.3 (1.5)	1.3 (0.6)	1.7 (0.6)	1.3 (0.6)	3.7 (1.2)	2.7 (1.5)	0.174
+ Stage IV grade C	9.0 (NA)	9.0 (NA)	2.0 (NA)	2.0 (N)	2.0 (NA)	2.0 (NA)	2.0 (NA)	2.0 (NA)	2.0 (NA)	2.0 (NA)	1.0 (NA)	1.0 (NA)	NA
+ + Stage II grade A	10.7 (3.)	6.7 (1.2)	1.7 (0.6)	1.3 (0.6)	2.0 (0.0)	1.3 (0.6)	2.0 (1.0)	1.0 (0.0)	2.0 (1.0)	1.0 (0.0)	3.0 (1.7)	2.0 (0.0)	0.250
+ + Stage II grade B	10.1 (3.)	8.6 (3.5)	1.7 (1.0)	1.7 (0.8)	1.9 (0.9)	1.6 (0.5)	2.0 (1.0)	1.7 (0.8)	2.0 (1.0)	1.7 (0.8)	2.6 (1.0)	1.9 (0.9)	0.586
+ + Stage III grade A	5.0 (NA)	5.0 (NA)	1.0 (NA)	1.0 (N)	1.0 (NA)	1.0 (NA)	1.0 (NA)	1.0 (NA)	1.0 (NA)	1.0 (NA)	1.0 (NA)	1.0 (NA)	NA
+ + Stage III grade B	10.9 (5.)	6.6 (2.0)	2.0 (1.2)	1.2 (0.4)	1.7 (0.9)	1.3 (0.5)	2.4 (1.2)	1.2 (0.4)	2.3 (1.1)	1.3 (0.6)	2.5 (1.3)	1.6 (0.8)	**0.002**
+ + Stage III grade C	11.7 (5.)	8.1 (3.8)	2.2 (1.4)	1.6 (1.0)	2.1 (1.2)	3.0 (0.5)	2.4 (1.4)	1.7 (1.1)	2.3 (1.3)	1.6 (1.0)	2.7 (1.4)	1.9 (1.2)	**0.002**
+ + Stage IV grade B	11.5 (6.)	14.0 (17)	1.5 (0.7)	3.0 (2.8)	1.5 (0.7)	1.0 (2.8)	2.5 (2.1)	3.0 (2.8)	3.0 (1.4)	3.0 (2.8)	3.0 (1.4)	2.0 (1.4)	1.000
+ + Stage IV grade C	8.8 (3.5)	6.8 (2.9)	1.5 (1.0)	1.5 (1.0)	1.2 (0.5)	1.0 (0.0)	2.2 (1.3)	1.5 (1.0)	2.5 (1.0)	1.5 (1.0)	1.2 (0.5)	1.2 (0.5)	0.098

*Wilcoxon test

p values in bold denote statistical significance ($p < 0.05$)

+Localized periodontitis (clinical attachment loss/bone loss affects less than 30% of the teeth)

+ +Generalized periodontitis (clinical attachment loss/bone loss affects more than 30% of the teeth)

Table 8 Mean OHIP-14 global and domain scores before and after NSPT by diagnosis

Diagnosis	OHIP-14 Global score		Functional limitation (OHIP-1 + 2)		Physical pain (OHIP-3 + 4)		Psychological discomfort (OHIP-5 + 6)		Physical disability (OHIP-7 + 8)	
	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)
Gingivitis-dental biofilm-induced	9.5 (3.5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	1.5 (2.1)	0.0 (0.0)	4.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
+ Stage I grade A	5.0 (NA)	0.0 (NA)	1.0 (NA)	0.0 (NA)	1.0 (NA)	0.0 (NA)	2.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)
+ Stage II grade A	19.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	4.0 (NA)	0.0 (NA)	6.0 (NA)	0.0 (NA)	3.0 (NA)	0.0 (NA)
+ Stage II grade B	12.5 (7.7)	6.5 (4.5)	1.2 (1.2)	0.8 (1.0)	2.7 (1.5)	1.8 (1.8)	3.3 (1.8)	1.8 (1.3)	1.3 (1.8)	0.8 (1.3)
+ Stage II grade C	12.0 (NA)	10.0 (NA)	0.0 (NA)	0.0 (NA)	4.0 (NA)	2.0 (NA)	6.0 (NA)	5.0 (NA)	0.0 (NA)	0.0 (NA)
+ Stage III grade B	11.4 (9.6)	5.4 (7.8)	0.6 (1.3)	0.4 (0.9)	0.6 (1.3)	1.4 (1.9)	4.0 (2.9)	1.4 (1.9)	1.2 (1.8)	0.8 (1.8)
+ Stage III grade C	13.3 (8.1)	3.7 (2.5)	0.0 (0.0)	0.3 (0.6)	4.3 (3.8)	1.7 (2.9)	3.3 (2.1)	1.0 (0.0)	1.7 (2.1)	0.0 (0.0)
+ Stage IV grade C	4.0 (NA)	4.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	2.0 (NA)	4.0 (NA)	0.0 (NA)	0.0 (NA)
+ + Stage II grade A	19.7 (10.)	10.0 (8.9)	1.7 (1.5)	1.0 (1.0)	3.0 (1.0)	1.3 (1.2)	5.0 (2.6)	2.7 (2.3)	1.3 (1.2)	1.3 (1.2)
+ + Stage II grade B	18.9 (12.)	12.7 (14.)	1.6 (2.3)	1.1 (2.0)	3.1 (2.5)	1.6 (2.1)	4.6 (2.5)	3.4 (3.5)	3.0 (2.7)	1.7 (2.8)
+ + Stage III grade A	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)
+ + Stage III grade B	15.2 (7.9)	5.3 (6.3)	0.9 (1.2)	0.4 (0.9)	3.3 (2.5)	1.5 (2.1)	4.7 (2.5)	1.6 (2.3)	2.4 (2.2)	0.5 (1.1)
+ + Stage III grade C	17.9 (12.)	9.3 (8.0)	1.0 (1.7)	1.2 (1.6)	2.7 (2.2)	2.2 (2.4)	4.9 (2.7)	1.9 (2.2)	2.0 (2.3)	1.2 (1.9)
+ + Stage IV grade B	14.5 (12.)	3.0 (4.2)	0.5 (0.7)	0.0 (0.0)	1.0 (1.4)	2.0 (2.8)	5.0 (1.4)	0.0 (0.0)	1.0 (1.4)	0.0 (0.0)
+ + Stage IV grade C	24.2 (7.7)	14.0 (8.6)	2.0 (2.3)	1.5 (1.9)	5.5 (1.9)	3.5 (3.4)	6.5 (1.0)	2.0 (1.6)	2.2 (1.7)	4.5 (2.5)

+ Localized periodontitis (clinical attachment loss/bone loss affects less than 30% of the teeth)

+ + Generalized periodontitis (clinical attachment loss/bone loss affects more than 30% of the teeth)

Table 9 Mean OHIP-14 domain scores before and after NSPT by diagnosis

Diagnosis	Psychological disability (OHIP-9 + 10)		Social disability (OHIP-11 + 12)		Handicap (OHIP-13 + 14)		*p* value*
	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	Before Mean (SD)	After Mean (SD)	
Gingivitis-dental biofilm-induced	4.0 (1.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.500
+ Stage I grade A	1.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	NA
+ Stage II grade A	4.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	2.0 (NA)	0.0 (NA)	NA
+ Stage II grade B	1.8 (1.8)	0.7 (1.0)	1.0 (0.9)	0.2 (0.4)	1.2 (1.3)	0.3 (0.8)	**0.036**
+ Stage II grade C	0.0 (NA)	3.0 (NA)	0.0 (NA)	0.0 (NA)	2.0 (NA)	0.0 (NA)	NA
+ Stage III grade B	2.2 (3.5)	0.4 (0.5)	0.6 (0.9)	0.2 (0.4)	2.2 (3.5)	0.8 (1.1)	0.269
+ Stage III grade C	2.3 (1.5)	0.0 (0.0)	0.3 (0.6)	0.0 (0.0)	1.3 (0.6)	0.7 (1.2)	0.500
+ Stage IV grade C	2.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	NA
+ + Stage II grade A	4.3 (3.2)	2.7 (2.5)	0.7 (1.2)	0.0 (0.0)	3.7 (2.5)	1.0 (1.0)	0.250
+ + Stage II grade B	3.7 (3.0)	2.1 (2.3)	1.3 (1.9)	1.1 (1.6)	1.6 (2.9)	1.6 (2.1)	0.375
+ + Stage III grade A	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	NA
+ + Stage III grade B	2.8 (1.4)	0.9 (1.5)	0.1 (0.5)	0.0 (0.0)	1.0 (1.7)	0.4 (0.7)	**0.001**
+ + Stage III grade C	3.5 (2.5)	1.8 (1.6)	1.4 (2.0)	0.4 (1.1)	2.4 (2.7)	0.5 (1.0)	**< 0.001**
+ + Stage IV grade B	4.0 (2.8)	1.0 (1.4)	0.0 (0.0)	0.0 (0.0)	3.0 (4.2)	0.0 (0.0)	1.000
+ + Stage IV grade C	3.8 (1.5)	1.5 (1.9)	1.8 (1.0)	0.0 (0.0)	2.5 (2.5)	1.0 (1.2)	0.269

*Wilcoxon test

p values in bold denote statistical significance ($p < 0.05$)

+ Localized periodontitis (clinical attachment loss/bone loss affects less than 30% of the teeth)

+ + Generalized periodontitis (clinical attachment loss/bone loss affects more than 30% of the teeth)

Table 10 Differences in OHRQoL (OHIP-14) between anxiety groups, before and after NSPT

	Normal/slight anxiety	Moderate and extreme anxiety
OHIP-14		
N before NSPT	48	34
Mean score before NSPT (SD)	11.7 (8.0)	22.2 (10.9)
N after NSPT	64	18
Mean score after NSPT (SD)	5.8 (6.7)	14.5 (9.2)
Change	5.9	7.7
p value* (within group)	**< 0.001**	0.089
MID		
Distribution-based approach		
ES**	0.80	0.76
SRM**	0.68	0.49

N, sample size

*Wilcoxon test

p values in bold denote statistical significance ($p < 0.05$)

MID, Minimally Important Difference

**An effect size (ES) and standardized response mean (SRM) of ≤ 0.2 indicate a small but clinically significant magnitude of change, 0.3–0.7 a moderate change, and ≥ 0.8 a large change

disease treated by scaling and root planing or root surface debridement. The present study also addressed confounding factors such as demographics, smoking habits, and ex-smoking status.

Regarding sociodemographic data, most of the participants were women. The scientific literature reports that women are more likely to visit their dentist and receive professional dental care compared to men [34, 35].

We assessed education level since lower educational attainment has been associated with increased risk of periodontitis [36, 37] and higher OHIP-14 scores [29, 38, 39]. Other studies have reported that people with higher education experience lower DA since these people have a better understanding of treatment [40–42]. In our study, only 29.3% of the participants completed higher education, indicating most of the studied population had a lower educational level. Our findings agree with Levin et al. [23, 24], who examined whether DA and OHRQoL differed between persons with and without chronic periodontal disease. The authors found lower education levels among patients with aggressive and chronic periodontitis, suggesting that lower education could result in less access to oral health information and services [23, 24].

It has been well documented smoking is an independent risk factor for the initiation, extent, and severity of periodontitis [42–44]. As well, smokers report poorer OHRQoL

[45–48]. Concerning anxiety to dental treatment, Pohjola et al. confirmed that tobacco smokers are more likely to have dental fear than those who use tobacco occasionally or not at all [49]. Nonetheless, only 8.5% of the participants in this study referred smoking at baseline and 11% reported smoking after concluding periodontal therapy. This could be because in Costa Rica, The General Law on Tobacco Control and its Harmful Effects on Health, No. 9028, regulates smoking in public areas. According to this law, individuals can only smoke in private areas, for this reason, smoking or vaping is not allowed in shared areas. Also, because of massive antismoking campaigns in Costa Rica, the prevalence and consumption of tobacco cigarettes have decreased over time [50].

Periodontitis is usually painless, but it some cases may cause a mild, episodic pain due to acute infectious entities. When orofacial pain of periodontal origin is present, it exerts a negative effect of patient's quality of life [51]. Participants in this study reported a significant decrease in maximal pain felt in the last month. Nonetheless, no differences were reported between baseline current pain and current pain after periodontal treatment. It is worth mentioning that when the second questionnaire was applied, some participants reported experiencing a slight discomfort around their teeth for several days after periodontal debridement. Other patients reported increased sensitivity to hot or cold drinks and sometimes to sweets. Periodontal disease is usually not painful. For current pain, most of the participants reported feeling no pain before NSPT ($n=56$) and after ($n=61$). As for pain in the last month, most of the participants mentioned no pain before ($n=32$) NSPT and after ($n=54$). Changes detected in the variable pain in the last month may have been related to sensitivity due to scaling and root planing, and not related to periodontitis.

In this study, participants exhibited higher scores in the MDAS total as well as most sub-scores at baseline. The mean MDAS total score of all participants in our study was 11 ± 4.9. This was like that reported by Bhattarai et al. (11.59 ± 3.808) who found out the prevalence of anxiety among patients visiting for periodontal treatment at a tertiary care dental hospital [52]. These authors reported that many of the interviewed patients were anxious (36.33%), their cutoff score was between 11 and 14 in the MDAS, and slightly anxious (36.69%), with a cutoff score between 6 and 10. Most of our participants were classified as having normal/slight anxiety at baseline, 58.5% of participants, and after therapy, 78.0% of participants. Also, the means of the MDAS scores in our study, before periodontal treatment, were like the ones reported by these authors [52].

Levin et al. [23] reported that patients with periodontitis were more likely to fear receiving dental injections, hearing the dental drill noise, and the feeling of having a foreign object in the mouth compared to healthy controls. Furthermore, compared to controls, patients with aggressive periodontitis were more likely to fear the dental drill noise and a foreign object in the mouth [24]. Participants in our study did not report a change in fear to dental injections and fear to dental drill noise, rotatory instruments, or ultrasonic scaler. However, there was a significant change from baseline, when asked about fearing having a foreign object in the mouth. Since the participants of this study had never had root scaling and planing or root surface debridement for gum disease, we assume these patients at baseline may have feared or were distressed about an uncertain situation such as a new method of dental treatment. After NSPT, this phobia decreased significantly.

Liu et al. corroborated in a recent study that dental fear reduced after scaling and root planing in periodontal patients with stages III and IV, but no significant differences in dental fear were found between pre- and post-treatment in patients with periodontitis stages I and II [53]. Likewise, in our study, we found differences in MDAS total scores and sub-scores before and after treatment in GP stage III grade B and GP stage IV grade C. Correspondingly, Santuchi et al. revealed that patients with moderate chronic periodontitis exhibited a decrease in levels of fear and anxiety after non-surgical periodontal therapy [54]. Based on these results, clinicians should pay more attention to anxiety to dental treatment in patients with periodontitis stages III and IV and introduce preventive and corrective measures to reduce anxiety experienced during periodontal treatment.

OHIP-14 is one of the most commonly used validated self-reported questionnaires measuring the impact of oral diseases on the individual's quality of life. We decided to use OHIP-14, since there are other publications using this instrument to evaluate OHRQoL in patients with periodontitis. Also, the questionnaire has been previously validated in Spanish in Costa Rica to evaluate the effect of dental treatment on quality of life [55–57]. In addition, Fuller et al. [58] stated that this instrument has been used in periodontal patients to assess the quality of life. These authors investigated the association between OHRQoL, using OHIP-14 and the presence of different severity and forms of periodontitis, using the 1999 classification of Periodontal Diseases. Moreover, a systematic review by Paśnik-Chwalik and Konopka [59] chose 10 studies (8 cross-sectional and 2 case-controls) from 1346 titles that were eligible to establish the impact of periodontitis on quality of life measured with OHIP-14. These studies indicated a significant influence of periodontal disease on the deterioration of OHIP-14 values, which was related to the degree of advancement of periodontitis and extent of periodontal breakdown.

Paśnik-Chwalik and Konopka state that two specialized Oral Health Impact Profile questionnaires have been designed concerning the most common symptoms of periodontitis, and how these impact the patient's well-being

[59]. Thus, a limitation of the present study is that the questions in OHIP-14 questionnaire are not related specifically to the condition of the periodontium, periodontal diseases, or NSTP. Taking in account this limitation, our results show substantial differences between pre- and post-test measures on OHRQoL. A systematic review by Shanbhag et al. suggests that all forms of non-surgical periodontal therapy can improve OHRQoL in adult patients, immediately and long-term [60]. Brauchle et al. [61] determined the impact of periodontitis and periodontal therapy on OHRQoL and found higher scores in patients with probing pocket depth of > 7 mm. In our study, periodontal treatment showed a positive effect on patient's OHIP-14 global score and domain scores, regardless of periodontal disease diagnosis.

Saito et al. [62] found a moderate effect size in perceived oral health of patients after receiving initial periodontal therapy [63], which further supports the notion that periodontal health is an important aspect in OHRQoL. The effect size in OHRQoL global score in the current study was large, $d = 0.88$, equally to the one reported in a later study by Saito et al. [64], $d = 0.8$. We also found a large effect in psychological discomfort described as a "feeling of uncertainty, tense feeling" and psychological disability described as "being upset." Other authors have also reported these domains to be the most affected at baseline in periodontitis patients [62, 64–66]. The scores for these domains improved after non-surgical periodontal therapy [61, 65, 67]. As Paśnik-Chwalik and Konopka [59] suggest, this indicates that the most important problems perceived by periodontal patients are embarrassment, stress, and difficulty relaxing. Periodontal disease may even affect interpersonal relations or enjoying everyday activities. In our study, functional limitation had a small effect after non-surgical periodontal therapy. This may be related to the fact that inclusion criteria specified that patients enrolled in this study had to have at least twenty teeth. The domain functional limitation is related to loss of teeth functionality, difficulty to chew, and severe tooth loss.

A positive correlation was found in this study, between MDAS total score and sub-scores with OHIP-14 global and domain scores, suggesting that apprehension to dental treatment, in this case periodontal treatment, was reciprocally related. However, our data should be interpreted with caution since we determined state anxiety and not trait anxiety. Goh et al. [22] evidenced that individuals with depression, anxiety, and stress had a worse periodontal support, tooth loss, and a poorer OHRQoL. Patients with trait anxiety might maintain adverse lifestyle factors such as smoking and deficient hygiene practices, which may impair OHRQoL [68]. For instance, police academy recruits that self-reported both, high stress levels and ability to cope with stress, presented more plaque accumulation [69].

It is uncertain if the participants of our study will have a significant long-term impact in their OHRQoL. In this line, recent studies have reported that patients that underwent supportive periodontal treatment maintained long-term low OHIP-14 scores [70–72]. These studies mentioned good compliance contributes to better OHRQoL. Nonetheless, state and trait anxiety can lead to behavioral changes that might affect treatment outcomes, or lead to treatment interruption in the worst of cases [73–76]. Regarding response to NSPT, Vettore et al. showed that patients with trait anxiety had higher probing pocket depths and lower reductions in clinical attachment level frequencies, thus a poorer response to periodontal therapy [77]. Both state anxiety and trait anxiety matter; therefore, efforts should be implemented by the dental practitioner to improve confidence in patients, and motivate for treatment readiness, especially in individuals that suffer from DA in combination with other psychological burden.

Regarding levels of anxiety, most of the participants of the study reported "normal/slight anxiety," regarded as "mild anxiety" before and after NSPT. Only a few participants reported "extreme anxiety" before (8.5%) and after (2.4%) therapy. Similar findings were found by Eren and Türkoglu with 4.3%, who suggested that only a small number of individuals self-report extreme anxiety, since people with high levels of DA, may tend to avoid or suspend dental treatment, unless they experience severe pain [78].

We further characterized in two groups anxiety levels, which were "normal/slight anxiety" and "moderate and extreme anxiety" to determine differences in OHRQoL (OHIP-14), before and after NSPT. Individuals with "normal/slight anxiety" had a significant improvement in OHRQoL. Even though OHRQoL scores decreased in the "moderate and extreme anxiety" group, the reduction was not significant, suggesting that NSPT had no effect in improving these individuals' quality of life in the latter group. This supports current research in other populations, with different oral diseases, that has found a strong association between increased DA and OHRQoL, with a greater DA score being associated with lower OHRQoL [79–83].

Based on the calculation of the MID, using the distribution-based approach, we could infer that the "normal/slight anxiety group" and the "moderate and extreme anxiety group" had a large ES change and a moderate SRM change. However, one of the limitations of our study was that we did not use an anchor-based approach, which would have provided more evidence that the changes we observed were meaningful [33]. This approach is essential to assess treatment effectiveness [84]. A future follow-up study should consider using patients' responses to global transition questions, for self-assessment of perceived change in oral health status as reference criterion. A MID of 2–3 OHIP units has been reported [85, 86]; however, we cannot compare our results with these studies, since sociodemographic differences and treatment procedures vary. MID is specific to the

population of study and type of treatments received by the patients.

Conclusion

In the present study, DA and OHRQoL were correlated; as DA total and sub-scores increased, OHRQOL worsened. DA and OHRQoL are both patient-reported measures of pivotal importance in dental care. DA may be a barrier in the access to periodontal treatment, while OHRQoL is of central significance when trying to understand the impact of periodontitis and the effectiveness of interventions upon patient's well-being.

It is well known NSPT has a positive effect on patients' periodontal state and also improves patient-reported measures, such as OHRQoL. The results of this study confirm the positive impacts between pre- and post-NSPT measures on DA and OHRQoL in patients with "normal/slight anxiety." Although our results provide robust improvement in scores of DA and OHRQoL, it should be considered post-treatment scores were taken after completion of NSPT. Hence, it would be interesting to conduct a follow-up study to investigate if a possible relapse of periodontitis on some of these patients, with recurrence of signs and symptoms of periodontitis, could affect DA and OHRQoL. Futures studies should include calculating the MID, to determine the extent the results are clinically relevant to the population of study.

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Author contribution K.R. contributed to the study conception and design. Material preparation and data collection, were performed by K.R., L.P–H., and D.B-C. Analysis of raw data and interpretation was done by K.R. and D.B-C. The first draft of the manuscript was written by K.R. Tables 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 were prepared by K.R and D.B-C. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability The data of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval The Scientific Ethics Committee of the University of Costa Rica approved all procedures performed in the study (CEC- 341-2021).

Consent to participate Written informed consent was obtained from each participant included in the study.

Competing interests The authors declare no competing interests.

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