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Demographic profile, Oral Health Impact Profile and Dental Anxiety Scale in patients with chronic periodontitis: a case–control study

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Objectives: To examine whether dental anxiety (DA) and oral health-related quality of life (OHRQoL) differ between persons with and those without chronic periodontitis. **Methods:** One-hundred patients with chronic periodontitis and 50 age- and- sex-matched controls were included. Data were collected on the following: demographics; smoking habits; Numerical Rating Scale (NRS) for dental pain assessment; Corah's Dental Anxiety Scale (DAS); Oral Health Impact Profile 14 (OHIP-14); Decayed, Missing and Filled Teeth (DMFT) index; Plaque Index (PI); probing depth (PD); bleeding on probing (BOP); and radiographic bone loss. **Results:** Patients with chronic periodontitis exhibited a significantly higher percentage of high anxiety and phobia compared with subjects in the control group. Furthermore, patients with chronic periodontitis were statistically significantly more likely to consider themselves as suffering from dental anxiety (68.7% *vs.* 14.3%, $P < 0.001$) as well as more likely to have fear of receiving dental injections, hearing the dental drill noise and feeling a foreign object in the mouth. Patients with chronic periodontitis exhibited worse OHIP-14 global scores as well as worse scores in the following individual domains: functional limitation ($P = 0.005$); physical disability ($P = 0.003$); psychological disability ($P = 0.010$); social disability ($P = 0.011$); and handicap ($P = 0.012$). **Conclusions:** Compared with controls, patients with chronic periodontitis had higher levels of dental anxiety and worse OHRQoL. It is important to consider dental anxiety and OHRQoL assessment as an integral component of the evaluation of patients with chronic periodontitis. Communication between dental and behavioral health professionals is needed to implement a multidisciplinary team approach involving behavioural and psychological interventions.

Key words: *Periodontal disease, chronic periodontitis, dental anxiety, dental fear, quality of life, oral health-related quality of life*

INTRODUCTION

Periodontal disease, the most common chronic inflammatory condition, is an infectious disease characterised by inflammation in the supporting tissues of the teeth and by progressive attachment loss and bone loss[1,2]. It is associated with pocket formation, gingival recession and alveolar bone loss[1,2]. Numerous clinical and radiological features are used to establish the diagnosis of periodontitis, such as inflammation, bleeding on probing (BOP), radiographic bone loss and increased probing depth (PD) or clinical attachment loss[2]. It is estimated that 5–20% of most adult populations have severe generalised periodontitis[3].

Chronic periodontitis, the most prevalent form of periodontal disease, is plaque induced[4], and factors contributing to the progression of this disease include cigarette smoking, diabetes mellitus and emotional stress[5,6]. Disease activity and tissue destruction are modulated through the production of pro-inflammatory mediators such as prostaglandins, interleukins and matrix metalloproteinases[7].

Dental anxiety and oral health-related quality of life (OHRQoL) are patient-reported measures.

Periodontal disease can impact the quality of life of adults[8,9] and may also be associated with dental anxiety[10]. Dental anxiety is an unreasonable apprehension regarding dental objects, procedures or the context of treatment, and is generally accompanied by significant physiological and emotional stimulation[11,12]. Population-based studies demonstrate that 5–20% of adults have dental anxiety that ranges from a mild anxiety to prominent anxiety and dental phobia[13–15]. The most severe form, dental phobia, is considered a Blood-Injection-Injury (BII) phobia in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), although recent data indicate that these entities may be separate in terms of aetiology and phobic stimuli[16–18]. Dental anxiety is a significant public health concern, not just because of its prevalence but also because of its negative psychosocial implications[19–21]. As a result of dental fear, patients avoid dental therapy, which may worsen dental health and might lead to emotions of shame and guilt, social isolation, poor well-being and a worse quality of life[19,22].

Indeed, in the last decades, the psychosocial impact of dental diseases on everyday life have gained attention, using subjective oral health indexes to evaluate and compare the influence of dental, as well as oral, conditions among different populations. In particular, the OHRQoL conceptual model[23] has become popular because it encompasses structural, psychosocial and behavioural implications of oral and dental diseases utilising the frame of the World Health Organization (WHO) International Classification of Impairments, Disabilities and Handicaps[24]. Slade and Spencer introduced the Oral Health Impact Profile (OHIP), the tool most extensively used to measure OHRQoL[25]. The OHIP has validated translations in multiple languages[26,27], including a validated Hebrew version[28].

To date, only a few studies have investigated dental fear among patients with periodontal diseases[10,29–33]. Surprisingly, although periodontal diseases have been studied extensively since the 1960s, dental anxiety, as well as quality of life, and the association between these factors in patients with chronic periodontal disease, are poorly documented. Evaluation of the association of periodontal status with dental anxiety and OHRQoL requires differentiation between distinct periodontal diagnoses (e.g. between chronic periodontitis and aggressive periodontitis) as each specific periodontal diagnosis possesses unique characteristics. In order to reduce confounders, it is also essential to include an age- and sex-matched periodontally healthy control group for patients with chronic periodontitis. Moreover, in order to ensure a proper diagnosis, comprehensive clinical and radiographic examinations should be performed when assessing these patients. Assessment of plaque levels, PD and BOP, as well as radiological bone loss, will exclude cases in which pseudo-pockets, which exist in gingivitis, are considered as periodontitis. Nevertheless, most studies that assessed the association of anxiety and OHRQoL with periodontal status did not include a periodontal disease-free control group, did not differentiate between chronic and aggressive periodontitis[10,32] and did not use bone loss as an indication of periodontitis (but rather used PD only)[32].

Regarding dental anxiety assessment, some studies did not use validated questionnaires designated to assess dental anxiety[29] but rather used a one-item Numerical Rating Scale (NRS) of 0–10[30]. Moreover, some studies did not include a periodontal disease-free control group and did not differentiate between chronic and aggressive periodontitis[10,29,30] or included cases of self-reported periodontal disease without clinical examination[10].

Moreover, to the best of our knowledge, a study addressing both dental anxiety and OHRQoL, and the associations between these conditions, among patients with chronic periodontitis, has not been published in the English language.

The objectives of this research were to examine whether dental anxiety and OHRQoL differed between persons with chronic periodontitis and those without that disease. To that end, we measured dental anxiety levels and OHRQoL in patients with chronic periodontitis, compared the results obtained with those from a control group and analysed the association between demographic and clinical parameters and disease severity.

METHODS

Study groups

The study was conducted between 1 May 2013 and 31 May 2015. One-hundred consecutive patients with chronic periodontitis who attended the Department of Periodontology, Oral and Maxillofacial Medical Center (Tel-Hashomer, Israel) were included. Dentists refer patients to this department from a few dozen dental clinics throughout the country, for specialist evaluation and management of periodontal diseases. All patients were examined at their first visit to the Department of Periodontology before periodontal treatment.

The control group was composed of 50 age- and sex frequency-matched consecutive individuals with no known history of periodontal disease who were attending elective dental screening at the Department of Conservative Dentistry, Oral and Maxillofacial Center.

Sample size was calculated using the WINPEPI software[34] which concluded that at least 141 patients, in

two groups, with a 2:1 ratio of subjects between the test group and the control group, are required to achieve 80% statistical power to identify a 4.48-point difference in the 14-item OHIP (OHIP-14) global score, with α set at 0.05 and an estimated standard deviation (SD) of 9.93 for the group with the highest SD and 8.25 for the group with the lowest SD, based on our experience of assessing OHIP-14 scores[35].

Ethical approval

The study was carried out in accordance with the 1964 Helsinki declaration and its later amendments. The consent procedure and use of human data were approved by the Medical Corps, Israel Defense Forces Institutional Review Board. All patients read and signed a written informed consent.

Inclusion and exclusion criteria

Inclusion criteria for all groups were: age 18–65 years (both genders); and at least 20 remaining teeth.

The exclusion criteria were: mental and psychiatric disorders; drug or alcohol abuse; malignancy; taking sedative, anxiolytic or analgesic drugs up to 1 week before the survey; pregnancy or lactation; an acute dental or periodontal condition, such as acute pain, abscesses, pulpitis or other acute infections; and completion of a periodontal treatment course during the 6 months before attending the periodontal clinic.

Chronic periodontitis was diagnosed according to the American Academy of Periodontology guidelines[1,2].

Data collection

The research included a questionnaire and a clinical examination. The questionnaire was composed of the following parts: (i) demographics (*Table 1*); (ii) smoking habits; (iii) current and maximal NRS to evaluate dental pain[36]; (iv) Corah's Dental Anxiety Scale (DAS)[11,12,37]; and (v) the OHIP-14[25,26]. At the first periodontal appointment, before dental treatment and before prescription of medications, a face-to-face interview was performed for completion of the questionnaires. The questionnaires as well as the clinical examination were performed on the same day.

Smoking habits

Current smoking habits were recorded as: current smoking habits (yes/no); and history of smoking (calculated in smoking pack-years, as described elsewhere[38]).

Periodontal disease evaluation

Clinical examinations were performed using artificial light, mouth mirrors and a standard periodontal probe. Vertical bilateral bitewings for the molar and premolar areas combined with parallel peri-apical radiographs of the maxillary and mandibular incisors were included.

Before starting the research, a training and calibration session was conducted for the examiners to assure mutual agreement and proper interpretation of the measurements of the indices used in the study. The clinical examination was conducted on both the chronic periodontitis group and the control group.

DMFT

Dental caries experience was evaluated using the decayed, missing and filled teeth (DMFT) index, according to the WHO criteria (i.e. of 28 teeth, excluding wisdom teeth; http://www2.paho.org/hq/dmdocuments/2009/OH_st_Esurv.pdf). However, while in the DMFT index, the missing (M) component is limited to teeth missing as a result of dental caries, in adults, especially periodontally compromised adults, it can be a challenge to determine why a specific tooth is missing. Therefore, records included teeth missing for any reason, not those missing only as a result of dental caries.

Plaque index

Oral hygiene was measured using the Plaque Index (PI)[39]. The PI was calculated as the percentage of teeth (out of 28, excluding wisdom teeth) with visible plaque on any surface of the tooth.

For the other periodontal parameters, clinical examination was performed on the six Ramfjord index teeth (teeth numbers 16, 21, 24, 36, 41 and 44) as well as for two of the remaining the molar teeth (teeth 26 and 46). Ramfjord index teeth have been shown to be representative of the various types of teeth [40]. For each tooth the variables were recorded on six points around the tooth. The variables PD, BOP and radiographic bone loss were recorded[41,42].

Pain evaluation

The mean level of dental pain was assessed by the patients using an NRS of 0–10[36]. 'Current NRS' denotes current pain while 'maximal NRS' denotes the maximal pain recorded during the last month[43,44].

Corah's DAS

Dental anxiety was evaluated using the validated Hebrew version[45–48] of Corah's DAS[11,12]. In the DAS

Table 1 Demographic characteristics, smoking habits, pain scores, periodontal status and caries experience of patients with chronic periodontitis compared with controls

Parameter	Variable	Chronic periodontitis group	Control group	*P*
Sex	Male	81 (81.8)	43 (87.8)	**0.356**
	Female	18 (18.2)	6 (12.2)	
Birth country	Africa	4 (4)	0 (0)	**0.593**
	Asia	1 (1)	1 (2)	
	Western	16 (16.2)	8 (16.3)	
	Israel	77 (77.8)	40 (81.6)	
	Others	1 (1)	0 (0)	
Smoking habits	Yes	27 (27.3)	9 (18.4)	**0.235**
	No	72 (72.7)	40 (81.6)	
Age (years)		38.8 ± 7.8	37.7 ± 4.3	**0.344**
Years of schooling		13.9 ± 1.9	16.2 ± 3.1	**<0.001**
Smoking pack years		18.6 ± 12.5	16.7 ± 6.5	**0.650**
Current NRS		1.5 ± 1.7	0.5 ± 1.0	**<0.001**
Maximal NRS		5.1 ± 2.7	4.5 ± 2.9	**0.225**
Radiographic bone loss		4.5 ± 1.5	2.1 ± 0.3	**<0.001**
Probing depth		4.5 ± 1.1	2.9 ± 0.6	**<0.001**
PI		61.7 ± 31.1	33.3 ± 21.6	**<0.001**
Bleeding score		66.8 ± 30.9	15.3 ± 10.3	**<0.001**
Decayed teeth		1.59 ± 1.8	0.90 ± 1.4	**0.033**
Missing teeth		1.9 ± 2.9	0.60 ± 0.90	**0.003**
Filled teeth		9.7 ± 5.7	11.6 ± 4.5	**0.049**
DMFT score		13.2 ± 6.6	13.1 ± 4.9	**0.931**

Values are given as *n* (%) or mean ± standard deviation.
P-values were calculated using the chi-square test (sex, birth country and smoking habits) or the Independent *t*-test (the remaining variables). *P* values in bold denote statistical significance ($P < 0.05$).
DMFT, decayed, missing and filled teeth; NRS, numerical rating scale; PI, plaque index.

questionnaire, participants score their level of anxiety regarding four dental scenarios using a 5-point scale (total score range: 4–20). The DAS is a reliable and valid instrument, and the most extensively studied dental fear scale among adults[11,37,49].

Anxiety levels were: (i) mild anxiety (DAS score: 4–8); (ii) moderate anxiety (DAS score: 9–12); (iii) high anxiety (DAS score: 13–14); and (iv) phobia (DAS score: 15–20)[50].

Phobic stimuli

As the DAS score fails to capture additional information regarding other specific phobic stimuli, we assessed the fear-provoking nature of other phobic stimuli[16].

Patients indicated (yes/no response) whether the following phobic stimuli evoked an anxiety response: dental injection; the sound of the dental drill; and having a foreign object in the mouth[16,51]. As dental phobia is considered a B-I-I phobia, we assessed whether dental B-I-I-related situations (dental injections) provoke the same anxiety as non-B-I-I-related situations (fear of the sound of the dental drill and fear of having a foreign object in the mouth). For this reason, we did not use the modified DAS (MDAS) questionnaire[52] because we were concerned that by using the MDAS, the item about dental injections would become incorporated within the total score, and we would be unable to compare this item with other non-B-I-I-related fears.

OHIP-14

OHRQoL[25,26] was assessed using the validated Hebrew version of the OHIP-14[28]. Detailed explanation regarding calculation of the OHIP-14 score can be found elsewhere[28,44].

Statistical analysis

Analysis of data was conducted using the SPSS software version 22.0 (SPSS, Chicago, IL, USA), and the two-tailed statistical significance (α) level was defined as $P < 0.05$.

Continuous variables are displayed as mean and SD, while categorical variables are displayed as frequencies and percentages.

Differences between groups were analysed using Pearson's chi-square test for categorical variables and analysis of variance (ANOVA) for numerical variables. DAS and OHIP scores were analysed against the independent variables using the chi-square test, ANOVA and the *t*-test. Multivariate logistic regression analysis included significant parameters ($P < 0.05$) on the univariate analysis.

RESULTS

In both the control and the chronic periodontitis groups there were no losses as all patients met the inclusion criteria and agreed to participate. However, we included, in the final statistical analysis, 148

participants: 99 with chronic periodontitis and 49 control individuals. One patient in the chronic periodontitis group and one patient in the control group were not included in the final analysis because of missing data.

Table 1 presents the demographic characteristics, smoking habits, pain scores, periodontal status and caries experience of patients with chronic periodontitis compared with controls. The study groups did not differ regarding age, sex, birth country, smoking habits and maximal NRS scores (*Table 1*). Fewer schooling years and higher current NRS scores were positively associated with the chronic periodontitis group compared with the control group (*Table 1*). As expected, the chronic periodontitis group exhibited statistically significant higher mean bleeding score, PI, radiographic bone loss and PD scores compared with controls (*Table 1*). Patients with chronic periodontitis had statistically significantly more decayed and more missing teeth but fewer filled teeth compared with controls, and therefore the global DMFT score did not reach statistical significance (*Table 1*).

Table 2 presents self-assessed dental anxiety, phobic stimuli, DAS categories and the mean DAS total score for the chronic periodontitis and control groups. There was no statistically significant difference in the mean DAS total score between the chronic periodontitis and control groups (*Table 2*). Nevertheless, there were statistically significant differences in the distribution of DAS categories between the chronic periodontitis group and the control group. Compared with controls, the chronic periodontitis group exhibited a significantly higher percentage of patients with high anxiety and phobia (*Table 2*).

Furthermore, compared with controls, patients with chronic periodontitis were statistically significantly more likely to consider themselves as suffering from dental anxiety (68.7% *vs.* 14.3%, $P < 0.001$) as well as more likely to fear receiving dental injections, hearing the dental drill noise and feeling a foreign object in the mouth (*Table 2*). The highest rated fear among both chronic periodontitis and control groups was fear of dental injection.

The associations and correlations of DAS categories, as well as DAS total scores with the demographics, periodontal parameters and DMFT scores among the entire study population ($n = 148$) were analysed and the results are presented in *Table 3*. Female sex, greater radiographic bone loss, higher PI scores and periodontal indexes and a larger number of decayed teeth were positively associated with higher DAS scores (*Table 3*). The correlations between male or female sex and DMFT with DAS scores were not statistically significant. Female sex was the only parameter which retained a statistically significant association with the DAS total scores in the multivariate linear regression analysis [$P = 0.04$, $B = 2.116$, standard error (SE) = 0.731, $\beta = 0.230$, $t = 2.89$].

The OHIP-14 global and domain scores of the study groups are presented in *Table 4*. Compared with controls, the chronic periodontitis group exhibited higher OHIP-14 global scores as well as higher scores in the domains functional limitation ($P = 0.005$), physical disability ($P = 0.003$), psychological disability ($P = 0.010$), social disability ($P = 0.011$) and handicap ($P = 0.012$) (*Table 4*).

Table 2 Mean Dental Anxiety Scale (DAS) total scores, DAS categories, self-assessment of dental anxiety and phobic stimuli, as indicated by patients with chronic periodontitis and controls

Item	Variable	Chronic periodontitis group	Control group	*P**
Self-assessed dental anxiety	Yes	68 (68.7)	7 (14.3)	**<0.001**
	No	31 (31.3)	42 (85.7)	
Phobic stimuli				
Dental injections	Yes	61 (61.6)	6 (13.6)	**<0.001**
	No	38 (38.4)	38 (86.4)	
Dental drill noise	Yes	32 (32.3)	3 (7.0)	**0.001**
	No	67 (67.7)	40 (93.0)	
Foreign object in the mouth	Yes	31 (31.3)	5 (11.6)	**0.013**
	No	68 (68.7)	38 (88.4)	
DAS categories	Mild anxiety	49 (49.5)	27 (55.1)	**0.036**
	Moderate anxiety	28 (28.3)	20 (40.8)	
	High anxiety	15 (15.2)	1 (2.0)	
	Phobia	7 (7.1)	1 (2.0)	
Total DAS score		8.9 ± 3.6	8.1 ± 2.4	**0.122**

Values are given as *n* (%) or mean ± standard deviation.
P-values were calculated using the chi-square test, except for total DAS score which was calculated using the Independent *t*-test.
P values in bold denote statistical significance ($P < 0.05$).

Table 3 Associations and correlations of demographic and clinical parameters with Dental Anxiety Scale (DAS) total scores and DAS categories among patients with chronic periodontitis and controls combined*

Variable	Variable	Total DAS score	DAS categories
Demographic parameter	Sex	0.018†	0.047‡
Periodontal parameters	Bleeding score	NS†	NS‡
	Probing depth	NS†	0.030‡
	Radiographic bone loss	0.020†	0.002‡
	PI	0.018†	NS‡
Caries experience	D	0.031§	NS†

*P values are presented in the Table.
†Analysis of variance (ANOVA).
‡Chi square.
§Pearson correlation.
D, decayed teeth; NS, non-significant; PI, plaque index.

Among the chronic periodontitis group, the highest scores were recorded on the physical pain domain, while the lowest scores were recorded on the functional limitation domain (*Table 4*).

Table 5 presents the associations between demographic and clinical parameters and OHIP-14 global and domain scores among the study population. Worse current and maximal NRS scores, higher probing depth and radiographic bone loss scores, more decayed and missing teeth and patients from the 'others' category of birth country, had a positive association with higher OHIP-14 global scores (*Table 5*). Multivariate linear regression analysis of parameters that exhibited a positive significant association with the mean OHIP-14 global score demonstrated a significant association of the current NRS scores [$P = 0.006$, $B = 1.160$, SE = 0.417, $\beta = 0.232$, 95% confidence interval (95% CI): 0.336–1.984] and radiographic bone loss ($P = 0.045$, $B = 1.029$, SE = 0.508, $\beta = 0.225$, 95% CI: 0.024–2.033).

A worse DAS total score as well as DAS categories were positively associated with higher OHIP-14 global scores (*Table 6*). A worse DAS total score as well as DAS categories were positively associated with higher OHIP-14 scores in the following domains: functional limitation; physical pain; psychological discomfort; physical disability and psychological disability (*Table 6*).

DISCUSSION

To the best of our knowledge, this is the first study published in English that measures and compares both OHR-QoL and dental anxiety in two groups of individuals (patients with chronic periodontitis and with control subjects) in terms of severity, self-assessment and response to dental phobic stimuli. The present study adjusted for multiple relevant confounders, such as demographic parameters, smoking habits and caries experience.

The patients in the chronic periodontitis group were matched for age and sex with their corresponding controls. Moreover, there was no statistically significant difference between patients with chronic periodontitis and controls regarding birth country and smoking habits. However, fewer schooling years were positively associated with patients with chronic periodontitis compared with controls. As patients were matched for age, lower education levels among patients with periodontitis could not be attributed to age differences. Our findings are in agreement with Meusel *et al.*[9], who studied the influence of the chronic periodontitis severity on quality of life and found that severe chronic periodontitis was associated with a low education level. This association can be explained by the fact that lower education could result in lower socio-economic status and less access to information as well as to oral health services[9,53].

Table 4 Mean 14-item Oral Health Impact Profile (OHIP-14) global and domain scores among patients with chronic periodontitis compared with control subjects

Variable	Study group	*n*	Mean	SD	95% CI for mean		Minimum	Maximum	*P*
					Lower bound	Upper bound			
Functional limitation (OHIP-1 + 2)	Control	49	0.110	0.32	0.020	0.200	0.000	1.50	**0.005**
	Chronic periodontitis	99	0.360	0.57	0.24	0.470	0.000	3.00	
	Total	148	0.280	0.51	0.190	0.360	0.000	3.00	
Physical pain (OHIP-3 + 4)	Control	49	0.910	0.63	0.730	1.09	0.000	2.50	**0.120**
	Chronic periodontitis	99	1.13	0.860	0.960	1.30	0.000	3.50	
	Total	148	1.06	0.800	0.930	1.19	0.000	3.50	
Psychological discomfort (OHIP-5 + 6)	Control	49	0.82	0.780	0.600	1.05	0.000	3.00	**0.304**
	Chronic periodontitis	99	0.97	0.880	0.800	1.15	0.000	3.50	
	Total	148	0.9291	0.850	0.790	1.06	0.00	3.50	
Physical disability (OHIP-7 + 8)	Control	49	0.280	0.48	0.140	0.42	0.00	2.00	**0.003**
	Chronic periodontitis	99	0.660	0.800	0.500	0.820	0.00	4.00	
	Total	148	0.530	0.730	0.410	0.650	0.00	4.00	
Psychological disability (OHIP-9 + 10)	Control	49	0.460	0.640	0.280	0.650	0.000	2.00	**0.010**
	Chronic periodontitis	99	0.860	0.94	0.670	1.05	0.000	4.00	
	Total	148	0.730	0.870	0.590	0.870	0.000	4.00	
Social disability (OHIP-11 + 12)	Control	49	0.310	0.470	0.170	0.450	0.000	1.50	**0.011**
	Chronic periodontitis	99	0.65	0.84	0.480	0.82	0.000	4.00	
	Total	148	0.540	0.750	0.41	0.660	0.000	4.00	
Handicap (OHIP-13 + 14)	Control	49	0.340	0.600	0.170	0.52	0.000	2.50	**0.012**
	Chronic periodontitis	99	0.690	0.850	0.520	0.860	0.000	3.50	
	Total	148	0.570	0.790	0.440	0.70	0.000	3.50	
OHIP-14 global score	Control	48	6.66	5.78	4.98	8.34	0.000	21.00	**0.004**
	Chronic periodontitis	98	10.651	8.47	8.95	12.35	0.00	38.00	
	Total	146	9.34	7.89	8.05	10.63	0.000	38.00	

*Independent *t*-test. *P* values in bold denote statistical significance ($P < 0.05$). 95% CI, 95% confidence interval; OHIP, Oral Health Impact Profile; SD, standard deviation.

Table 5 Associations of demographic and clinical parameters with the 14-item Oral Health Impact Profile (OHIP-14) global and domain scores among patients with chronic periodontitis and control subjects

Variable	Functional limitation (OHIP-1 + 2)	Physical pain (OHIP-3 + 4)	Psychological discomfort (OHIP-5 + 6)	Physical disability (OHIP-7 + 8)	Psychological disability (OHIP-9 + 10)	Social disability (OHIP-11 + 12)	Handicap (OHIP-13 + 14)	OHIP-14 global score
Current NRS	0.005	0.017	NS	0.030	0.021	<0.001	<0.001	<0.001
Maximal NRS	<0.001	0.001	NS	0.004	NS	0.005	0.013	<0.001
Bleeding score	NS	NS	NS	0.013	NS	NS	NS	0.050
Probing depth	NS	NS	NS	0.010	NS	0.006	0.001	0.003
Radiographic bone loss	<0.001	0.009	NS	<0.001	0.034	0.023	<0.001	<0.001
PI	NS	NS	NS	NS	NS	NS	NS	NS
D	0.024	<0.001	0.008	0.006	0.011	NS	NS	0.001
M	0.002	NS	NS	<0.001	NS	NS	0.003	0.006
F	NS	NS	NS	NS	NS	NS	NS	NS
DMFT	0.007	0.045	0.046	NS	0.018	NS	NS	0.010
Country of birth	NS	NS	NS	<0.001	0.006	NS	NS	0.008

P-values for all variables were calculated using Pearson correlation, except for 'Country of birth', which was calculated using analysis of variance (ANOVA).
D, decayed teeth; DMFT, decayed, missing and filled teeth; F, filled teeth; M, missing teeth; NRS, Numerical Rating Scale; PI, plaque index.

Table 6 Associations of Dental Anxiety Scale (DAS) total and DAS categories with the 14-item Oral Health Impact Profile (OHIP-14) global and domain scores among patients with chronic periodontitis and control subjects

Variable	Functional limitation (OHIP-1 + 2)	Physical pain (OHIP-3 + 4)	Psychological discomfort (OHIP-5 + 6)	Physical disability (OHIP-7 + 8)	Psychological disability (OHIP-9 + 10)	Social disability (OHIP-11 + 12)	Handicap (OHIP-13 + 14)	OHIP-14 global score
DAS total Score*	0.008	<0.001	<0.001	0.001	<0.001	NS	NS	<0.001
DAS categories†	0.010	0.001	<0.001	0.008	<0.001	NS	NS	<0.001

*Pearson correlation.
†Analysis of variance (ANOVA).NS, non-significant.

In the current study, the chronic periodontitis group exhibited a significantly higher percentage of patients with high anxiety and phobia compared with their corresponding control group, were more likely to consider themselves as suffering from dental anxiety (68.7% *vs.* 14.3%, $P < 0.001$) and they were also more likely to fear receiving dental injections, hearing the dental drill noise and having a foreign object in their mouth. The highest rated fear for both study groups was fear of dental injection. Our findings agree with those of others who reported that 71% of patients experience dental fear associated with periodontal therapy, and 12.1% exhibit extreme anticipatory anxiety during treatment[29,54]. Liu *et al.*[10] reported that the DAS score in patients with periodontitis (without discriminating between chronic and aggressive periodontitis), was 10.70 ± 3.09, which was significantly higher than in periodontitis-free patients. Their mean DAS score was higher than the DAS score obtained in the chronic periodontitis group in the current study (8.9 ± 3.6). However, in the current study, high anxiety and phobia DAS categories were more prevalent among patients with chronic periodontitis; moreover, compared with controls, patients with chronic periodontitis were more likely to consider themselves as suffering from dental anxiety and to fear the phobic stimuli presented above. Therefore, for careful evaluation of dental fear we relied not only on the DAS total score but also on a more comprehensive evaluation.

It should be noted that although stress, depression and anxiety have not yet been established as risk factors of periodontitis, they are thought to be potential contributors affecting the occurrence, development and prognosis of periodontitis[10,55,56]. Moreover, an anxious sensation may be regarded as a relevant pathogenic contributor to periodontitis[57].

In contrast with our findings, others have reported that anxiety disorders were not associated with dental caries or periodontitis among Finnish adults[32], and periodontal disease and gingivitis were not found to be associated with dental anxiety[58].

Our finding that women exhibited higher dental anxiety than men is consistent with the literature[10] and could be attributed to a higher existence of anxiety and phobia in women, or even heritability[55].

The current findings are also consistent with previous reports that higher DMFT and PI scores were found in patients with dental anxiety[14]. Other previous studies revealed that dentally anxious subjects were more likely to be edentulous and among the dentate were more likely to have an increased number of decayed surfaces, larger numbers of decayed and missing teeth but fewer filled teeth[58]. Moreover, among a birth cohort study of young Aboriginal Australian adults, anxiety was associated with having one or more decayed teeth, among other factors[59]. Higher dental anxiety was associated with worse oral-hygiene practices[60].

As expected, patients with chronic periodontitis had significantly worse OHIP-14 global scores. In fact, periodontal disease consequences, such as redness, bleeding upon brushing, gingival recession, persistent halitosis, pain, tooth mobility and tooth loss, may compromise mastication, speech, swallowing and smile aesthetics, and consequently negatively affect self-esteem and quality of life[9,61]. Patients with chronic periodontitis exhibited worse individual domains in five of the seven domains studied (5/7), reflecting again the significant impact of chronic periodontitis on OHRQoL.

Worse periodontal scores in most periodontal parameters in patients with chronic periodontitis were positively associated with higher OHIP-14 global scores and some domain scores. This is in line with a previous report demonstrating that patients with severe periodontitis had significantly worse OHIP-14 scores, and worse functional limitation, physical pain, physical incapacity and psychological incapacity domain scores, compared with those with mild/moderate periodontitis[9].

The association of a larger number of missing teeth with OHRQoL could be because fewer teeth correlated with greater discomfort during chewing and, as a result, impaired OHRQoL, as also confirmed in other studies[9,61].

The association of OHRQoL with pain is reflected in the current research by the following findings: (i) in the chronic periodontitis group, the highest scores were recorded on the physical pain domain; and (ii) a positive association between higher current and maximal NRS scores was noted with higher OHIP-14 global scores. Our findings are as reported by other studies demonstrating that periodontitis severity was related to self-reported pain and discomfort during chewing[9].

Finally, a positive association was found between DAS categories and DAS total scores with OHIP-14 global and domain scores in patients with chronic periodontitis, reflecting that dental fear and OHRQoL were reciprocally related.

The relatively large study population (148 patients), including both patients with chronic periodontitis and control subjects, together with the uniform protocol using standardised validated internationally recognised DAS and OHIP-14 questionnaires, NRS scores, periodontal and caries-experience measurements, are among the strengths of this study.

A limitation of the current research is the fact that the study sample was a convenience cohort, composed of volunteers, which might result in selection bias and limit the generalisability of our results. Nevertheless, patients were referred from various clinics that treated different populations. Owing to the case–control study design we cannot assume causality between any of the study variables and, for this reason, we suggest only associations/correlations between the variables. Despite the fact that the current study considered the association and correlations of multiple parameters with the DAS score and OHIP-14, such as a specific periodontal diagnosis (i.e. chronic periodontitis), demographic factors, smoking, pain and DMFT scores, considering the depth and complexities of the issues, there may be other parameters that could influence both the DAS and the OHIP-14 scores that were not considered. Further longitudinal studies, as well as basic laboratory studies, are essential to comprehend how these phenomena develop and are maintained.

CONCLUSIONS

In conclusion, compared with controls, patients with chronic periodontitis showed a positive association with higher dental anxiety levels and worse OHRQoL.

Evaluation of dental anxiety and OHRQoL should be regarded as an integral part of the routine diagnostic work-up and clinical evaluation.

There is a strong need, from a public health perspective, to establish communication between dental-health and behavioural-health professionals in order to implement a multidisciplinary team approach involving behavioural and psychological interventions. Integration of patient-reported measures and periodontal treatment should lead health practitioners to plan health strategies that will cope with the dental anxiety associated with dental treatment and prevent decreases in OHRQoL.

Conflicts of interest

The authors deny any conflicts of interest.

AUTHOR CONTRIBUTION

A substantive intellectual contribution to the activities related to this paper was provided by the contributors: Liran Levin: contributed to the conception and design of the research, interpretation of data, revised

and approved the manuscript; Avraham Zini: analysis and interpretation of data and approved the manuscript; Jonathan Levine: collection of data for the chronic periodontitis group and approved the manuscript; Maor Weiss: collection of data for the chronic periodontitis group and approved the manuscript; Ron Lev: Revised and approved the manuscript; Daniella Chebath-Taub: collection of data for the control group and approved the manuscript; Avihay Hai: collection of data for the control group and approved the manuscript; Galit Almoznino: principal investigator, contributed to the conception and design of the research, acquisition of data, and analysis and interpretation of data; drafted the submitted the article and provided final approval of the version to be published.

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