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ORIGINAL ARTICLE

Oral health-related quality of life in patients under supportive periodontal therapy

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ABSTRACT

Objective: To assess the oral health-related quality of life (OH-QoL) in patients under supportive periodontal therapy (SPT) and the influence of the individual periodontal risk as well as different degrees of adherence during SPT on OH-QoL.

Materials and methods: 309 patients with at least 5 years of SPT were re-examined. Periodontal risk profile (according to Lang and Tonetti) was assessed and the adherence to SPT-appointments within the last 30(±6) months was reviewed for each patient (fully adherent: adherence to all appointments ±6 weeks, partially adherent: SPT-interval not extended more than half of the recommended interval, insufficiently adherent: SPT-interval extended more than half of the recommended interval, non-adherent: recommended SPT-interval interruption ≥12 months). OH-QoL was measured using the German short-version of the Oral Health Impact Profile (OHIP-G14). Differences between groups (Mann–Whitney *U* test, Kruskal–Wallis test), association between total OHIP-scores and the predictors age, mean periodontal probing depth and oral hygiene parameters were tested (Spearman's correlation). A multivariable linear regression model was fitted using all categorical predictors with a univariable p value <.1.

Results: Statistical analysis revealed no significant differences in OHIP-G14 scores for gender, periodontal diagnosis and prosthetic status. Patients with deep periodontal pockets (≥6 mm) showed significantly higher OHIP-G14 scores compared to patients without deep pockets ($p = .049$). Adherence and periodontal surgery were statistically significant predictors for the OHIP-G14 score.

Conclusions: OH-QoL of patients under long-term SPT seems to be influenced by periodontal status. Good compliance with SPT-intervals based on the individual periodontal risk profile seems to contribute to a better OH-QoL compared to irregular attendance of SPT.

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Introduction

Moderate to severe periodontitis, with a prevalence of 51.6% among the German younger adult population and 64.6% among the younger seniors [1], is a major health problem. Because of demographic changes within the German population leading to an increasing percentage of seniors, the number of patients requiring periodontal treatment is expected to increase within the next years [1]. This consequently increases the need for treatment capacity of periodontal diseases in dental offices and clinics and particularly increases the number of supportive periodontal therapy (SPT) sessions per year. Although chronic and aggressive periodontitis in its initial stages is usually not associated with clinical symptoms noticed by the affected individuals, it can cause signs and symptoms with impact on the patient's quality of life in advanced stages [2]. The symptoms of periodontitis include tooth mobility, tooth drifting, gingival bleeding, halitosis, chewing difficulties, unaesthetic appearance, pain and ultimately, tooth loss. All these symptoms can be significant oral health problems from an individual's point of view [2]. The improvement of these symptoms and thereby the improvement on the patient's individual level of oral well-being is one desirable outcome of periodontal therapy. This subjectively perceived oral well-being and the impact of it on daily life has been termed 'oral-health related quality of life' (OH-QoL) and was more precisely defined by Locker and Allen as 'the impact of oral disorders on aspects of everyday life that are important to patients and persons, with those impacts being of sufficient magnitude, whether in terms of severity, frequency or duration, to affect an individual's perception of their life overall' [3]. Various methods and tools have been developed to assess the impact of oral diseases including periodontitis on the OH-QoL [3]. One of the most common used tools is the Oral Health Impact Profile (OHIP) [3]. The OHIP is a questionnaire asking how frequently the patients experienced negative impacts on daily life because of problems regarding their oral health within a defined preceding time. The OHIP has been developed and evaluated in its original form by Slade & Spencer in 1994 [4] and contains seven conceptual subscales that were derived from the oral health model described by Locker [5]: functional limitation,

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handicap, psychological disability, psychological discomfort, physical disability, physical pain and social disability. In addition to the original version of the OHIP, different short-versions of the OHIP have been published [6–8] and were translated in numerous different languages.

Regarding the impact of periodontal diseases on OH-QoL, the actual literature shows conflicting outcomes. While some studies have shown that periodontal diseases have an impact on OH-QoL [2,9–16] and that periodontal therapy is able to improve it [17–20], there are also studies that did not find any correlation between periodontal status and OH-QoL [21–23]. Furthermore, studies have tended to focus on the short-term effect of periodontal therapy. It is proven, that the long-term success of periodontal therapy is not only referred to the active periodontal treatment but is also essentially depended on life-long SPT [24]. Modern SPT-concepts are based on the patient's individual periodontal risk profile and the intervals between SPT-appointments are chosen according to the individual risk profile [24].

Considering the potential influence of different periodontal risk profiles and adherence to SPT, this study aimed to evaluate the oral health-related quality of life (OH-QoL) in patients under long-term SPT using the German short-version of the Oral Health Impact Profile (OHIP-G14).

Materials and methods

Assessment of oral health-related quality of life

All patients who completed active periodontal treatment (APT) at least 5 years ago and who were scheduled for SPT between July 2014 and January 2016 in the Section of Periodontology (Department of Conservative Dentistry, Clinic for Oral, Dental and Maxillofacial Diseases, University Hospital Heidelberg, Heidelberg, Germany) were asked to participate in the study. After completion of the SPT appointment, the included patients were asked about their OH-QoL. The OH-QoL was measured using the German short-version of the Oral Health Impact Profile (OHIP-G14) [6]. The OHIP-G14 questionnaire is an abbreviated version of the original OHIP with 49 questions [4] and is the direct translation of the original OHIP-14 version in English language [7]. The OHIP-G14 consists of 14 questions on the frequency of adverse impairments caused by oral conditions during the last month. The questions are grouped into seven distinct sub-domains with two questions for each domain: (1) functional limitation (trouble in pronouncing words, worsened sense of taste), (2) handicap (life in general less satisfying, totally unable to function), (3) psychological disability (difficult to relax, been a bit embarrassed), (4) psychological discomfort (felt tense, been self-conscious), (5) physical disability (had to interrupt meals, diet has been unsatisfactory), (6) physical pain (uncomfortable to eat any foods, painful aching) and (7) social disability (irritable with other people, difficult doing usual jobs). The answers are recorded on a Likert scale, with values ranging from 0 to 4 coded as follows: 0 'never', 1 'hardly ever', 2 ''occasionally', 3 'fairly often', or 4 'very often'. Responses of the OHIP G-14 are summed to give the total OHIP score and can range from 0 to 56 with a high score indicating a poorer OH-QoL. The values can also be summed within the seven sub-domains. The OHIP-G14 questionnaire was self-completed by the participants. Inclusion criteria were as follows:

- Presence of moderate to severe chronic periodontitis (chP) or aggressive periodontitis (agP) [25] before periodontal treatment. Patients who were diagnosed according to another classification system were re-classified based on their baseline periodontal charts.
- Active periodontal treatment (APT) at the Section of Periodontology of the Department of Conservative Dentistry, Clinic for Oral, Dental and Maxillofacial Diseases at the University Hospital Heidelberg.
- Ability to adequately understand written and spoken German language and to self-complete the OHIP-G14 questionnaire
- Presence of at least 12 teeth before APT
- Informed and written consent to participate in the study and permission for retrospective data analysis
- Recent dental and periodontal status (PPD at six sites per tooth)

Data of patients that did not completely respond to all 14 questions of the OHIP-G14 questionnaire were excluded from data analysis.

The data presented in this publication were assessed as part of a study that was approved by the Institutional Review Board for Human Studies of the medical Faculty of Heidelberg University (Application # S132/2014) and is registered at the German Clinical Trials Register (DRKS00011316). All patients were informed about possible risks and benefits of the study and gave their written informed consent.

APT and SPT

APT of all patients included three to four appointments with assessment of oral hygiene indices, oral hygiene instructions, motivation to optimize individual dental biofilm control and professional tooth cleaning. Afterwards, subgingival debridement was performed. Patients that had received APT before the year 2000 were treated subgingival by quadrant-wise scaling and root planing in combination with open flap debridement. From the year 2000 on, subgingival debridement was performed according to the concept of full-mouth disinfection (FMD) modified from Quirynen et al. [26]. If required, periodontal surgery was performed 3 to 6 months after FMD. After successful completion of APT, all patients were advised to regularly participate in the SPT program every 3 to 6 months. Since 1999, individual periodontal risk assessment according to Lang and Tonetti [27] was performed for each patient, including the patients already under SPT. Patients with a low individual periodontal risk profile were recommended to undergo SPT every 12 months. Patients with a moderate-risk profile were advised to adhere to 6-month intervals and patients with a high-risk profile to a 3-month interval. SPT appointments included assessment of oral hygiene indices, re-instruction and re-motivation to

optimize individual oral biofilm control, and professional tooth cleaning. Periodontal and dental statuses were assessed at least once a year. Periodontal pockets with PPD = 4 mm and bleeding on probing and pockets ≥5 mm were re-instrumented.

Periodontal and dental examination

All participants were re-examined by seven calibrated dentists specialized in periodontology within a regular SPT appointment between July 2014 and January 2016. At this appointment, the anamnesis and the dental status of each patient was updated. The oral hygiene parameters Plaque Control Record [28] and Gingival-Bleeding-Index [29] were assessed. The periodontal examination included the assessment of PPD at six sites per tooth (mesiobuccal, centrobuccal, distobuccal, distolingual, centrolingual and mesiolingual) with a millimetre-scaled periodontal probe (PCPUNC 15, Hu-Friedy, Chicago, IL) and recording of bleeding on probing (BOP) at each site after 30 seconds. In addition, furcation degree [30] and tooth mobility [31] were assessed. The OHIP-G14 questionnaire was handed out to each patient after completion of the SPT session and was independently self-completed without the presence of the examiner. The periodontal baseline diagnosis (chP or agP) was assigned to each patient retrospectively by evaluation of the patients' chart.

Periodontal risk assessment and adherence to SPT

For each patient, the individual periodontal risk was assessed at re-examination according to Lang and Tonetti (low-risk profile, moderate-risk profile, high-risk profile) [27]. The adherence to STP appointments within the last 30 (±6) months (in accordance to the recommended SPT intervals 30 (±6) months ago) was reviewed by evaluating the documented SPT sessions in the patients' chart. All patients were categorized into four distinct degrees of adherence: fully adherent (adherence to all appointments ±6 weeks), partially adherent (not extended the SPT-interval more than half of the recommended interval), insufficiently adherent (extended the SPT-interval more than half of the recommended interval), non-adherent (recommended SPT-interval interruption of more than one year).

Statistical analysis

All demographic (sex, age) and clinical data (number of teeth, prosthetic status, PPD, bleeding on probing, oral hygiene indices, periodontal surgery, smoking status, systemic diseases) as well as the individual periodontal risk and the different degrees of adherence were entered into a digital data file. Results of the OHIP questionnaire for each of the 14 items were entered by an operator blinded to the rest of the data file. Response scores of all OHIP-G14 questions were summed to give the total OHIP-G14 summary score for each patient. The patient was chosen as statistical unit of inference. Differences between groups were tested using the Mann–Whitney *U* test for two groups, or Kruskal–Wallis test in the case of more than two groups. Then, a multivariable linear regression model was fitted using all categorical predictors with a univariable *p* value smaller than .1. Parameter estimates were calculated with corresponding *p* values and 95% confidence intervals. With the relatively large sample size of $n = 309$, the study was sufficiently powered ($1-\beta = 0.80$) to detect a moderate effect size of $d = 0.33$ using a Mann–Whitney *U* test at a two-sided significance level of $\alpha = 0.05$, using the approximation by O'Brian and Castelloe [32]. Spearman's correlation was used to determine the association between total OHIP summary scores and the predictors age, mean PPD, bleeding on probing and oral hygiene indices. Resulting *p* values are to be interpreted descriptively and were thus not adjusted for multiple testing. *p* values smaller than .05 are regarded as statistically significant. Third molars were excluded from analysis. All statistical analyses and the power calculation were performed by a statistician using the statistical software SAS® version 9.4 (SAS Institute, Cary, NC).

Results

Patients' characteristics

Three hundred and fifteen periodontal patients with 5 to 20 years of SPT fulfilled inclusion criteria and agreed to complete the OHIP-G14 questionnaire. Six patients had to be excluded due to the incomplete questionnaires. In total, the data of 309 (143 males, 166 females) patients was included in statistical analysis.

The mean age of the participants was 63.9 ± 10.6 years (median: 64 years; range: 34–90 years) and the mean number of teeth was 22.45 ± 4.57 teeth (median: 24.00; range: 6–28). 241 patients were diagnosed with chP and 68 with agP. 126 patients required periodontal surgery 3–6 months after FMD. 47 patients had removable partial dentures. The mean PPD of the whole study cohort at re-examination was 2.37 ± 0.47 mm (median: 2.32; range: 1.00–4.05 mm). In 168 patients, there were no pockets with PPD ≥ 6 mm present. 141 patients showed deep periodontal pockets with PPD ≥ 6 mm. At re-examination 14.32% ± 13.04% (median: 11.0%; range: 0–69%) of all sites showed BOP. In mean, the patients showed a PCR of 33.65% ± 19.44% (median: 31.0%; range: 0–100%) and a GBI of 3.86 % ± 9.33% (median: 0.0%; range: 0–100%).

The mean total OHIP-G14 summary score for the whole study cohort was 3.64 ± 5.41 (median: 2.00; range: 0–34). 120 patients had a summary score of 0, representing 39% of the whole study cohort. The subdomains 'physical pain' and 'psychological discomfort' showed the highest scores within the subdomains. Distribution of answers to the OHIP-G14 questionnaire and the scores per subdomain for included patients is presented in Table 1.

While statistical analysis revealed no differences in total OHIP-G14 summary scores for gender, periodontal diagnosis (chP or agP) and prosthetic status (removable denture existent or not existent) ($p = .954$, $p = .242$ and $p = .214$; Mann–Whitney *U* test), the difference in OHIP-G14 summary scores for patients with periodontal pockets ≥6 mm was

Table 1. Distribution of answers to the OHIP-G14 questionnaire and mean OHIP scores of subdomains.

	Never *n* (%)	Hardly ever *n* (%)	Occasionally *n* (%)	Fairly often *n* (%)	Very often *n* (%)	OHIP scores of sub-domains ± SD
Functional limitation (questions 1, 2)						
Trouble pronouncing words	276 (89.3)	18 (5.8)	14 (4.5)	1 (0.3)	0 (0)	0.33 ± 0.84
Worsened sense of taste	274 (88.7)	20 (6.5)	13 (4.2)	1 (0.3)	1 (0.3)	
Handicap (questions 3,10)						
Life in general less satisfying	245 (78.3)	36 (11.7)	24 (7.7)	3 (1.0)	1 (0.3)	0.40 ± 0.89
Totally unable to function	292 (94.5)	8 (2.6)	9 (2.9)	0 (0)	0 (0)	
Psychological disability (questions 4,11)						
Difficult to relax	236 (76.4)	33 (11.7)	31 (10.0)	8 (2.6)	1 (0.3)	0.62 ± 1.19
Been a bit embarrassed	264 (85.4)	26 (8.4)	15 (4.9)	3 (1.0)	1 (0.3)	
Psychological discomfort (questions 5,14)						
Felt tense	245 (79.3)	29 (9.4)	29 (9.4)	4 (1.3)	2 (0.6)	0.83 ± 1.42
Been self-conscious	217 (70.2)	46 (14.9)	35 (11.3)	10 (3.2)	1 (0.3)	
Physical disability (questions 6,12)						
Had to interrupt meals	289 (93.5)	15 (4.9)	4 (1.3)	1 (0.3)	0 (0)	0.20 ± 0.62
Diet has been unsatisfactory	280 (90.6)	22 (7.1)	7 (2.3)	0 (0)	0 (0)	
Physical pain (questions 7,13)						
Uncomfortable to eat any foods	244 (79.0)	28 (9.1)	32 (10.4)	5 (1.6)	0 (0)	0.92 ± 1.25
Painful aching	191 (61.8)	72 (23.3)	37 (12.0)	6 (1.9)	3 (1.0)	
Social disability (questions 8,9)						
Irritable with other people	264 (85.4)	30 (9.7)	14 (4.5)	1 (0.3)	0 (0)	0.34 ± 0.88
Difficult doing your usual jobs	277 (89.6)	20 (6.4)	11 (3.6)	1 (0.3)	0 (0)	

SD: standard deviation.

statistically significantly higher than for patients that had only pockets with PPD < 6 mm ($p = .049$, Mann–Whitney *U* test). For further statistical analysis the study cohort was divided into a group with removable dentures ($n = 47$) and a group without ($n = 262$). Within the group of patients without removable dentures there were 136 patients without any periodontal pockets ≥6 mm and 126 patients that had periodontal pockets ≥6 mm. With a summary score of 2.68 ± 4.49, the patients without any periodontal pocket ≥6 mm showed significantly lower values than patients with pockets ≥6 mm ($p = .012$, Mann–Whitney *U* test), that had a summary score of 4.44 ± 6.19. Within the group of patients wearing a removable denture, there was no statistically significant difference found between patients with ($n = 15$; OHIP summary score: 3.20 ± 4.14) and without pockets ≥6 mm ($n = 32$, OHIP summary score 4.78 ± 5.71) ($p = .498$, Mann–Whitney *U* test).

The OHIP-G14 summary score of patients who required periodontal surgery after FMD was 2.91 ± 4.31 and the OHIP-G14 summary score of patients that did not require periodontal surgery was 4.14 ± 5.67 ($p = .077$; Mann–Whitney *U* test).

The correlation between mean PPD and OHIP-G14 was weak (Spearman's $\rho = 0.12$, $p = .0385$), which was also the case for the correlation between age and OHIP-G14 (Spearman's $\rho = -0.10$, $p = .0939$). Correlation between GBI and OHIP-G14 (Spearman's $\rho = 0.01$, $p = .8389$), PCR and OHIP-G14 (Spearman's $\rho = 0.08$, $p = .1468$) and BOP and OHIP-G14 (Spearman's $\rho = 0.06$, $p = .2781$) were also found to be weak. Important descriptive parameters of the study cohort and total OHIP-G14 scores for the different parameters are shown in Table 2.

Periodontal risk and adherence with SPT

Periodontal risk assessment revealed that 39 participants showed a low-risk profile, 188 a moderate-risk profile and 82 a high-risk profile. With increasing periodontal risk profile, the total OHIP-G14 summary score for each risk group was also increased (see Table 2). The differences between the medium-risk and the high-risk group as well as between the low-risk group and the high risk-group were statistically significant ($p = .0251$ and $p = .0056$, Mann–Whitney *U* test, $p = .008$ for Kruskal–Wallis test comparing all three groups).

According to our definition of adherence to SPT intervals, 117 patients were assessed as fully adherent, 32 as partially adherent, 106 as insufficiently adherent and 54 as non-adherent. Fully adherent patients showed the lowest mean OHIP summary score and non-adherent patients the highest. The differences between fully adherent patients compared to each of the other three adherence-groups were statistically significant ($p = .002$ for fully adherent vs. partially adherent and insufficiently adherent, $p < .001$ for adherent vs. non-adherent, Mann–Whitney *U* test, $p < .001$ for Kruskal–Wallis test comparing all four groups). Total OHIP-G14 summary scores for periodontal risk profile groups and different degrees of adherence are presented in Figure 1.

Multivariable regression model

The multivariable regression model included the factors risk group, adherence, surgery and deep periodontal pockets (≥6 mm). After multivariable regression analysis, adherence ($p = .0250$) and surgery ($p = .0348$) were statistically significant predictors for the OHIP-G14 summary score (see Table 3).

Discussion

The presented study emphasizes the increasing evidence that periodontal problems can have significant impact on OH-QoL. However, to our knowledge the impact of individual periodontal risk profiles and adherence to SPT has not been investigated yet. This study, therefore, aimed to address these issues by measuring the OH-QoL using the OHIP-G14 questionnaire in patients under long-term SPT.

Table 2. Descriptive statistic of the study cohort and comparison of total OHIP-G14 summary scores ($n = 309$).

	n (%)	Total OHIP-G14 Mean ± SD	p Value (Mann–Whitney U-test)
Gender			
Male	143 (46.3)	3.36 ± 4.69	.954
Female	166 (53.7)	3.88 ± 5.96	
Diagnose			
Chronic Periodontitis	241 (78.0)	3.61 ± 5.58	.242
Aggressive Periodontitis	68 (22.0)	3.74 ± 4.77	
Prosthetic			
No removable denture	262 (84.8)	3.53 ± 5.44	.214
Removable denture	47 (15.2)	4.28 ± 5.27	
Periodontal status			
No pockets with PPD ≥ 6mm	168 (54.4)	3.08 ± 4.80	.049
Pockets with PPD ≥ 6mm	141 (45.6)	4.31 ± 6.01	
Smoking status			
Non-smoker	230 (74.4)	3.30 ± 5.00	
Former smokers (>5 years)	34 (11.0)	4.71 ± 5.32	
<10 cigarettes/day	24 (7.8)	4.29 ± 6.12	
10-19 cigarettes/day	12 (3.9)	4.58 ± 5.13	
≥20 cigarettes/day	9 (2.9)	5.44 ± 10.23	
Systemic factors with influence on periodontal health			
Not present	261 (84.5)	3.77 ± 5.52	
Present	48 (15.5)	2.94 ± 4.65	
Periodontal risk assessment			
Low-risk profile	39 (12.6)	2.44 ± 4.67	Low-risk vs medium-risk: $p = .0856$
Moderate-risk profile	188 (60.8)	3.21 ± 4.75	Low-risk vs high-risk: $p = .0056$
High-risk profile	82 (26.5)	5.20 ± 6.73	Medium-risk vs high-risk: $p = .0251$
Adherence			
Fully adherent	117 (37.9)	2.33 ± 4.35	Fully adherent vs partially adherent: $p = .002$
Partial adherent	32 (10.4)	4.53 ± 4.97	Fully adherent vs insufficient adherent: $p = .002$
Insufficient adherent	106 (34.3)	3.92 ± 5.50	Fully adherent vs non-adherent: $p < .001$
Non-adherent	54 (17.5)	5.39 ± 6.84	Partially adherent vs insufficient adherent: $p = .308$
			Partially adherent vs non-adherent: $p = .835$
			Insufficient adherent vs non- adherent: $p = .164$

SD: standard deviation; PPD: periodontal probing depth; systemic factors with influence on systemic health included diabetes mellitus type 1 and 2, rheumatoid arthritis, osteoporosis, intake of immunosuppressants and immunomudulating medication, HIV/AIDS.

The authors found no statistically significant differences in total OHIP-G14 scores for gender and for patients with chP compared to patients with agP. Most studies that investigate the impact of periodontal diseases on OH-QoL, have focused on the severity of periodontal disease, represented by mean PPD, CAL or number of affected teeth and did not differentiate between the diagnosis of agP and chP [2,14–16] or have restricted their study cohorts to patients with chronic periodontitis [13,20] or generalized aggressive periodontitis [33] only. In regard to gender, the results of our study are in accordance with a large multicentre cross-sectional study that was also conducted in Germany and published by John et al. [34]. The study of John et al. [34] included a study cohort of 2050 individuals and aimed to investigate the association among denture status, demographic factors and OH-QoL using the OHIP-G49 questionnaire. After multivariable analysis, they also did not find any differences according to gender. Regarding the influence of denture status on OH-QoL, John et al. [34] found that subjects with removable dentures compared to subjects without dentures had a 7.5 higher OHIP-G49 median score. In contrast to this result, our study cohort did not show significant differences in OHIP-G14 scores when comparing patients without removable dentures to the patients with removable dentures. In this context, it should be mentioned that the tools to measure the OH-QoL were different between the studies and that our study cohort included only patients who were affected by periodontal disease and underwent SPT, while the study cohort of John et al. [34] was supposed to be representative for the German population. Regarding the impact of the prosthetic status (subjects with removable dentures compared to subjects without dentures) on OH-QoL, the different result of our study compared to John et al. [34] may also lead to the assumption that the prosthetic status has less impact on the daily life of patients under periodontal therapy than it has on individuals that are not under periodontal treatment.

While prospective studies that measured the short-term impact of periodontal therapy on OH-QoL found a significant correlation between the number of teeth and OH-QoL [15,22], our analysis revealed no significant correlation of OHIP-G14 summary scores with the number of teeth. That could be explained by the relatively homogeneous collective of patients mostly missing just a relatively small number of teeth. This result is also in accordance with our findings that the prosthetic status did not have an impact on OHIP summary scores.

In our study, the difference in total OHIP-G14 scores for all patients with one or more sites with PPD ≥ 6 mm was statistically significantly higher than for patients that only had pockets with PPD < 6 mm. However, this difference became nonsignificant when adjusting for other factors in the multivariable linear regression model. Regarding the impact of severity of periodontal diseases on OH-QoL, the actual published literature shows conflicting outcomes. Several cross-sectional studies have shown that the severity of periodontal disease has an impact on OH-QoL [2,9,10,13,14]. Prospective studies investigating the impact on periodontal therapy have

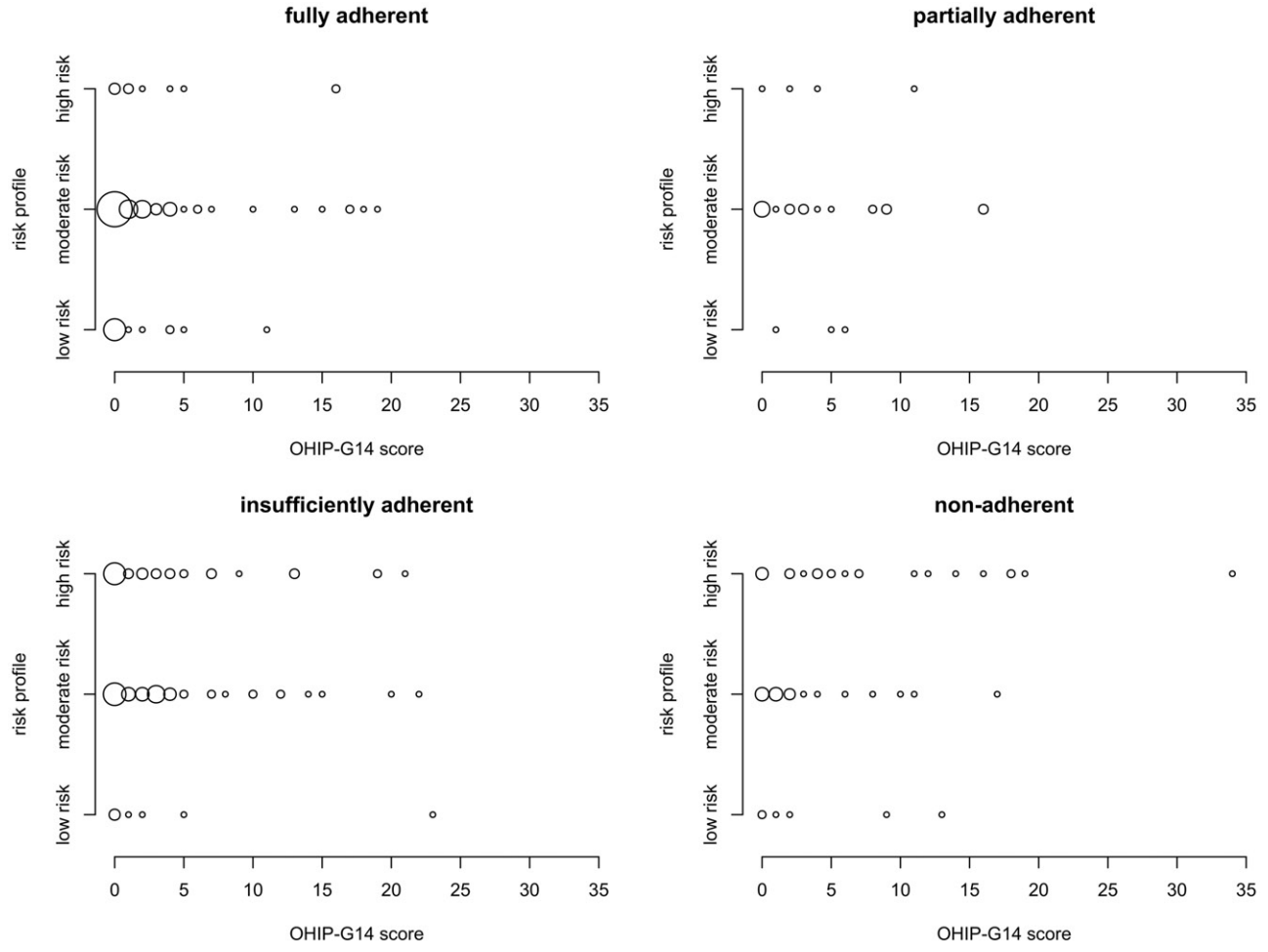

Figure 1. Scatterplots of total OHIP-G14 summary scores for the different adherence groups and different risk profiles. Point sizes are proportional to number of patients with the corresponding OHIP-score. Fully adherent (total $n = 117$): low-risk $n = 22$, moderate-risk $n = 83$, high-risk $n = 12$. Partially adherent (total $n = 32$): low-risk $n = 3$, moderate-risk $n = 25$, high-risk $n = 4$. Insufficient adherent (total $n = 106$): low-risk $n = 8$, moderate-risk $n = 57$, high-risk $n = 41$. Non-adherent (total $= 54$) low-risk $n = 6$, moderate-risk $n = 23$, high-risk $n = 25$.

Table 3. Results for multivariable linear regression analysis with estimates and 95% confidence intervals, respectively.

Parameter	Estimate	*p* Value	95% Confidence limits
Intercept	1.98	.0328	0.16
Periodontal risk		.1784	
High-risk profile	1.82	.0947	−0.32
Moderate-risk profile	0.62	.5051	−1.21
Low-risk profile	0	–	
Adherence		.0250	
Non-adherent	2.59	.0050	0.79
Insufficiently adherent	1.27	.0885	−0.19
Partially adherent	1.96	.0610	−0.09
Fully adherent	0	–	
Surgery			
Yes	−1.30	.0348	−2.52
No	0	–	
Deep periodontal pockets (≥6mm)			
Yes	0.52	.4121	−0.72
No	0	–	

also shown that successful periodontal therapy is able to improve OH-QoL [17–20]. However, there are also studies that did not find any correlation between periodontal status and OH-QoL [21–23] and nearly all prospective studies focussed on the short-term effect of periodontal therapy with a maximum interval for re-evaluation of OH-QoL of 12 months found in a publication by a Chinese working group [20]. Wong et al. [20] investigated the influence of non-surgical periodontal therapy on OH-QoL using the Chinese version of the OHIP-14 questionnaire. 65 patients with chronic periodontitis received oral hygiene instructions and non-surgical periodontal therapy. Afterwards, all patients received SPT in a 3-month interval up to 12 months after baseline-examination. After 12 months, the median OHIP-14 summary score was 13 and thereby considerably higher than the OHIP-14 score during SPT in our study cohort, which was 2 in median. Compared to our study cohort, the study cohort of Wong et al. was much younger, but the differences in full-mouth mean PPD and number of teeth were comparable, with a slightly higher mean PPD and less teeth in our study cohort. One possible explanation for these different results may be distinctive cultural differences in perception of OH-QoL. Prospective studies conducted in Europe have shown smaller OHIP-14 summary scores after periodontal treatment ranging from 3.0 in median [12] up to 4.0 in median [22], and are more comparable to the results of our study. However, it should be mentioned that these studies have smaller study cohorts and evaluated the OH-QoL a much shorter time after periodontal therapy and without systematic maintenance therapy.

Needleman et al. [14] used the OHQoL-UK© questionnaire to assess the impact of OH-QoL of periodontal patients and compared new patients to patients under periodontal maintenance therapy. They found that patients under periodontal maintenance therapy had a better OH-QoL compared to new patients, but it is not mentioned for how long the treated patients received periodontal maintenance therapy and because of the different tool used to assess the impact of OH-QoL, it is difficult to compare the results of this study to our results.

In the presented study, the subdomains 'physical pain' and 'psychological discomfort' showed the highest scores, confirming results of recently published studies using the OHIP-14 and which showed that these factors had the highest impact on Oh-QoL of periodontal patients [13,17]. These results indicate that the clinician, in addition to the treatment of oral symptoms and pain, should also consider the patients' psychological perception concerning the periodontal situation to improve OH-QoL. For example, focussed questions on the psychological perception concerning the oral situation may help the dentist to find effective and successful ways to motivate and influence the patient to be more compliant with recommended therapy. Furthermore, this additional information may help the dentist to get a deeper understanding of the patients' expectations.

While the difference in OHIP-G14 scores between patients that required periodontal surgery compared directly to patients without surgery was not statistically significant, the multivariable regression analysis revealed that periodontal surgery 3 to 6 month after FMD was a statistically significant predictor for the OHIP-G14 summary score with a higher OH-QoL (lower OHIP score) for patients that received periodontal surgery. In contrast to or results, Saito et al. [18] found in their study that the total mean OHRQL score of periodontal patients at baseline was significantly improved after initial therapy and after surgery but no significant difference was found between the OHRQL score after initial therapy and that after surgery. It has to be mentioned that all patients of or study were at least 5 years under SPT and that retrospective observation period for adherence was 30(±6) months before re-evaluation and thereby not including the active periodontal therapy. Obviously, it can be discussed if the influence of surgery is a causal influencing factor for OH-QoL after more than 5 years. On the other hand, it may be possible, that the patient's perception of OH-QoL is strongly influenced by the expectation the patient associates with periodontal surgery.

To the best knowledge of the authors, the presented study is the first that investigated the impact of individual periodontal risk profiles according to Lang and Tonetti [27] and adherence to long-term SPT on OH-QoL. Our results showed that with increasing periodontal risk the total OHIP-G14 scores also increased. This means that the lower the individual risk, the better the patients perceived OH-QoL. Fully adherent patients showed lower total OHIP-G14 scores compared to patients with a lower degree of adherence, indicating that patients that adhere very strictly to the recommended SPT-intervals have a better OH-QoL compared to patients that do not. Furthermore, multivariable regression analysis revealed that adherence was a statistically significant predictor for the OHIP-G14 summary score. Compliance with recommended SPT-intervals is a factor that is nearly completely dependent on the patient and can be used as a motivating factor for patients that are dissatisfied with their OH-QoL. Individual periodontal risk can also be significantly influenced by the patient, for example by changing smoking habits, optimizing oral hygiene habits or through treatment and adjustment of systemic diseases. Thereby, the results of the study show, that factors, that can be directly influenced by the patient, have a significant impact on OH-QoL in patients under long-term SPT.

However, it should be mentioned that this study has some limitations. One weakness of the study is that no data on the socio-economic status was collected and no additional analysis of impact of other dental problems (caries, endodontic problems) was performed, even though the presence of active caries and endodontic indicators have been shown to be positively associated with OHIP-scores [21]. In addition, the absence of a control group represents another limitation of the study. Although the OHIP is used in many studies to assess the OH-QoL in patients with periodontitis, it is one possible weakness that this questionnaire is not a condition-specific tool to measure OH-QoL in patients with periodontitis. A condition-specific tool to measure OH-QoL for periodontal patients would be desirable and would allow addressing the specific limitations accompanied with periodontal disease.

The authors of the presented study draw the conclusion that OH-QoL of patients under long-term SPT is influenced by periodontal status. Good adherence to recommended SPT-intervals based on individual risk assessment seems to significantly contribute to a good OH-QoL.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

[1] Institut der Deutschen Zahnärzte. The fifth german oral health study. Köln: Deutscher Zahnärzte Verlag; 2016.
[2] Ng SK, Leung WK. Oral health-related quality of life and periodontal status. Community Dent Oral Epidemiol. 2006;34:114–122.
[3] Locker D, Allen F. What do measures of 'oral health-related quality of life' measure? Commun Dent Oral Epidemiol. 2007;35:401–411.
[4] Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health. 1994;11:3–11.
[5] Locker D. Measuring oral health: a conceptual framework. Community Dent Health. 1988;5:3–18.
[6] John MT, Miglioretti DL, LeResche L, et al. German short forms of the Oral Health Impact Profile. Commun Dent Oral Epidemiol. 2006;34:277–288.
[7] Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997;25:284–290.
[8] Locker D, Allen PF. Developing short-form measures of oral health-related quality of life. J Public Health Dent. 2002;62:13–20.
[9] Borges T. d F, Regalo SC, Taba M, et al. Changes in masticatory performance and quality of life in individuals with chronic periodontitis. J Periodontol. 2013;84:325–331.

[10] Brennan DS, Spencer AJ, Roberts-Thomson KF. Quality of life and disability weights associated with periodontal disease. J Dent Res. 2007;86:713–717.
[11] Durham J, Fraser HM, McCracken GI, et al. Impact of periodontitis on oral health-related quality of life. J Dent. 2013;41:370–376.
[12] Jowett AK, Orr MT, Rawlinson A, et al. Psychosocial impact of periodontal disease and its treatment with 24-h root surface debridement. J Clin Periodontol. 2009;36:413–418.
[13] Meusel DR, Ramacciato JC, Motta RH, et al. Impact of the severity of chronic periodontal disease on quality of life. J Oral Sci. 2015;57:87–94.
[14] Needleman I, McGrath C, Floyd P, et al. Impact of oral health on the life quality of periodontal patients. J Clin Periodontol. 2004;31:454–457.
[15] Pereira LJ, Gazolla CM, Magalhaes IB, et al. Treatment of chronic periodontitis and its impact on mastication. J Periodontol. 2011;82:243–250.
[16] Saito A, Hosaka Y, Kikuchi M, et al. Effect of initial periodontal therapy on oral health-related quality of life in patients with periodontitis in Japan. J Periodontol. 2010;81:1001–1009.
[17] Mendez M, Melchiors Angst PD, Stadler AF, et al. Impacts of supragingival and subgingival periodontal treatments on oral health-related quality of life. Int J Dent Hygiene. 2017;15:135–141.
[18] Saito A, Ota K, Hosaka Y, et al. Potential impact of surgical periodontal therapy on oral health-related quality of life in patients with periodontitis: a pilot study. J Clin Periodontol. 2011;38: 1115–1121.
[19] Shanbhag S, Dahiya M, Croucher R. The impact of periodontal therapy on oral health-related quality of life in adults: a systematic review. J Clin Periodontol. 2012;39:725–735.
[20] Wong RM, Ng SK, Corbet EF, et al. Non-surgical periodontal therapy improves oral health-related quality of life. J Clin Periodontol. 2012;39:53–61.
[21] Masood M, Newton T, Bakri NN, et al. The relationship between oral health and oral health related quality of life among elderly people in United Kingdom. J Dent. 2017;56:78–83.
[22] Ohrn K, Jonsson B. A comparison of two questionnaires measuring oral health-related quality of life before and after dental hygiene treatment in patients with periodontal disease. Int J Dent Hyg. 2012;10:9–14.
[23] Bajwa A, Watts TL, Newton JT. Health control beliefs and quality of life considerations before and during periodontal treatment. Oral Health Prev Dent. 2007;5:101–104.
[24] Armitage GC, Xenoudi P. Post-treatment supportive care for the natural dentition and dental implants. Periodontol 2000. 2016;71:164–184.
[25] Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol.1999;4:1–6.
[26] Quirynen M, Bollen CM, Vandekerckhove BN, et al. Full- vs. partial-mouth disinfection in the treatment of periodontal infections: short-term clinical and microbiological observations. J Dent Res. 1995;74:1459–1467.
[27] Lang NP, Tonetti MS. Periodontal risk assessment (PRA) for patients in supportive periodontal therapy (SPT). Oral Health Prev Dent. 2003;1:7–16.
[28] O'Leary TJ, Drake RB, Naylor JE. The plaque control record. J Periodontol. 1972;43:38
[29] Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J. 1975;25:229–235.
[30] Hamp SE, Nyman S, Lindhe J. Periodontal treatment of multirooted teeth. Results after 5 years. J Clin Periodontol. 1975;2:126–135.
[31] Lindhe J, Nyman S. The effect of plaque control and surgical pocket elimination on the establishment and maintenance of periodontal health. A longitudinal study of periodontal therapy in cases of advanced disease. J Clin Periodontol. 1975;2:67–79.
[32] O'Brian RG, Castalloe JM. Exploiting the Link between the Wilcoxon – Mann – Whitney Test and a Simple Odds Statistic. Proceedings of the Thirty-first Annual SAS Users Group International Conference, paper 209-31, Cary, NC: SAS Onstitute INC. 2006.
[33] Eltas A, Uslu MO. Evaluation of oral health-related quality-of-life in patients with generalized aggressive periodontitis. Acta Odontol Scand. 2013;71:547–552.
[34] John MT, Koepsell TD, Hujoel P, et al. Demographic factors, denture status and oral health-related quality of life. Commun Dent Oral Epidemiol. 2004;32:125–132.