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Analysis of the gradient differences in oral health-related quality of life (OHRQoL) among patients with gingivitis and periodontitis after undergoing Phase I treatment

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ABSTRACT

Background: Periodontal diseases, ranging from gingivitis to periodontitis, can significantly impact a patient's oral health-related quality of life (OHRQoL). While previous studies have established that periodontal treatment improves OHRQoL, limited research has analyzed the gradient differences in improvement between patients with varying disease severity. This study aimed to evaluate and compare the changes in OHRQoL among patients with gingivitis versus periodontitis following Phase I (non-surgical) periodontal treatment.

Methods: A prospective cohort study was conducted with 124 participants (64 with gingivitis and 60 with periodontitis) who underwent Phase I periodontal therapy. OHRQoL was assessed using the Oral Health Impact Profile-14 (OHIP-14) questionnaire at baseline and 6 weeks post-treatment. Clinical parameters including plaque index (PI), gingival index (GI), probing pocket depth (PPD), bleeding on probing (BOP), and clinical attachment loss (CAL) were recorded. Statistical analyses were performed using paired t-tests, independent t-tests, and multiple regression analysis.

Results: Both groups showed significant improvements in all clinical parameters and OHIP-14 scores after Phase I therapy ($p<0.001$). However, the magnitude of improvement in OHRQoL differed significantly between groups. Periodontitis patients demonstrated a greater percentage reduction in OHIP-14 total scores (52.8% ± 14.3%) compared to gingivitis patients (27.4% ± 11.2%) ($p<0.001$). The most substantial improvements for periodontitis patients were observed in the psychological discomfort and physical disability domains, while gingivitis patients showed the greatest improvements in the physical pain domain. Regression analysis revealed that baseline disease severity, represented by CAL and PPD, was the strongest predictor of OHRQoL improvement.

Conclusion: Phase I periodontal therapy yields significant improvements in OHRQoL for both gingivitis and periodontitis patients, with a more pronounced effect in patients with periodontitis. These findings suggest that the impact of periodontal treatment on quality of life follows a gradient pattern, with greater benefits observed in patients with more severe baseline disease.

Keywords: *Gingivitis; Periodontitis; Oral health-related quality of life; OHIP-14; Non-surgical periodontal therapy; Phase I treatment*

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1. INTRODUCTION

Periodontal diseases are highly prevalent inflammatory conditions affecting the supporting tissues of the teeth, with global estimates suggesting that severe periodontitis affects approximately 11% of the world's population [1]. These diseases exist along a continuum, from gingivitis, characterized by reversible inflammation confined to the gingiva, to periodontitis, which involves irreversible destruction of the periodontal ligament and alveolar bone [2]. Besides the clinical presentation and potential for tooth loss, the role of periodontal disease has increasingly been recognized in affecting outcomes that focus on the individual, such as oral health-related quality of life (OHRQoL) [3].OHRQoL is a complex construct that

involves a person's perception of the way oral conditions influence their physical, psychological, and social well-being [4]. It has been shown previously that periodontal diseases have a negative impact on OHRQoL with the magnitude of the negative impact related to the severity of the condition [5, 6]. A current systematic review and meta-analysis has shown that periodontitis is associated

with reduced OHRQoL compared with periodontal health and that there is a positive correlation between the severity of periodontitis and the impairment of OHRQoL [7].Periodontal treatment has been shown to be effective in improving clinical measures and oral health-related quality of life (OHRQoL) [8, 9]. Phase I periodontal treatment, or non-surgical periodontal treatment (NSPT), involves the elimination of etiologic factors through oral hygiene instruction, scaling and root planing, and the elimination of plaque-retentive factors [10]. This treatment approach serves as the foundation of periodontal care and may be sufficient to manage mild to moderate cases [11].

While the effectiveness of NSPT in improving clinical outcomes is well-documented, the differential impact of this treatment on OHRQoL among patients with varying disease severity remains incompletely understood [12, 13]. Several studies have evaluated changes in OHRQoL following periodontal treatment, but few have specifically compared these changes between gingivitis and periodontitis patients [14, 15]. Understanding these gradient differences is crucial for informing clinical decision-making, managing patient expectations, and potentially developing targeted interventions to enhance OHRQoL outcomes [16].A study by Mendez et al. [17] reported significant improvements in OHRQoL following supragingival and subgingival periodontal treatments, with particularly notable improvements after the supragingival phase. However, this study did not stratify results based on baseline disease severity. Similarly, Irani et al. [18] found that non-diabetic patients with gingivitis and periodontitis showed significant improvements in OHRQoL following periodontal treatment, but direct comparisons between these groups were limited.The present study aims to address this research gap by specifically analyzing and comparing the gradient differences in OHRQoL improvement between patients with gingivitis and periodontitis following Phase I periodontal therapy. We hypothesized that both groups would experience significant improvements in OHRQoL, but that the magnitude of this improvement would differ based on baseline disease severity, with periodontitis patients potentially showing greater relative gains [19].

2. MATERIALS AND METHODS

2.1 Study design and participants

The prospective cohort study was conducted within the Department of Periodontology of the University Hospital between January 2023 and December 2023. The protocol of the study complied with the recommendations of the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) initiative specific for cohort studies. The Institutional Review Board approved the protocol for the study (IRB approval number: PERIO-2023-011), and the procedures complied with the ethical standards of the Declaration of Helsinki (as updated in 1975 and 2013). Written informed consent of all participants was obtained before their entry into the study after a clear explanation of the procedures involved, the potential benefits, and the risks involved.Eligible participants were adults aged 18-65 years diagnosed with either gingivitis or periodontitis according to the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions [2]. Gingivitis was defined as gingival inflammation without attachment loss, characterized by redness, edema, and bleeding on probing. Periodontitis was defined as interdental clinical attachment loss (CAL) detectable at ≥2 non-adjacent teeth, or buccal or oral CAL ≥3 mm with pocketing >3 mm detectable at ≥2 teeth. The diagnosis was confirmed by two experienced periodontists through comprehensive clinical and radiographic examinations.Participant recruitment was conducted through multiple channels, including referrals from the general dental clinic, advertisements in the hospital, and community outreach programs. Initial screening involved a review of medical and dental history, followed by a comprehensive periodontal examination to confirm eligibility based on the inclusion and exclusion criteria. Exclusion criteria included: (1) systemic diseases that could influence periodontal status; (2) history of periodontal treatment within the past 6 months; (3) antibiotic use within the past 3 months; (4) pregnancy or lactation; (5) smoking (>10 cigarettes/day) or use of other tobacco products; (6) fewer than 20 natural teeth; (7) need for emergency dental treatment; (8) presence of orthodontic appliances; (9) use of medications known to affect periodontal tissues (e.g., phenytoin, cyclosporine, calcium channel blockers); and (10) inability to comply with study procedures or attend follow-up appointments. Sample size calculation was performed using G*Power software (version 3.1, Heinrich-Heine-Universität Düsseldorf, Germany). Based on previous studies [17, 20], we anticipated a medium effect size (Cohen's d = 0.5) for the difference in OHIP-14 score changes between groups. With a significance level of 0.05 and power of 0.8, a minimum of 51 participants per group was required. Accounting for a potential 15% dropout rate, we aimed to recruit at least 60 participants per group.

2.2 Clinical examination

All clinical examinations were performed by two calibrated periodontists (kappa > 0.85 for intra- and inter-examiner reliability) who were not involved in providing treatment to the participants. Calibration exercises were conducted prior to the study initiation and repeated at the midpoint to ensure consistency in measurements. The examiners were blinded to

the participants' questionnaire responses throughout the study.

Clinical examinations were conducted in a standardized manner under optimal lighting conditions, using a mouth mirror and a UNC-15 periodontal probe (Hu-Friedy, Chicago, IL, USA). The following clinical parameters were recorded at baseline and 6 weeks post-treatment:

1. Plaque Index (PI) [21]: Assessed at four sites per tooth (mesiobuccal, mid-buccal, distobuccal, and lingual) on a scale of 0-3, with higher scores indicating greater plaque accumulation. The mean score across all sites was calculated for each participant.
2. Gingival Index (GI) [22]: Evaluated at the same four sites per tooth on a scale of 0-3, with higher scores indicating more severe gingival inflammation. The mean score was calculated similarly to PI.
3. Probing Pocket Depth (PPD): Measured as the distance from the gingival margin to the base of the periodontal pocket at six sites per tooth (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual). Measurements were recorded to the nearest millimeter.
4. Bleeding on Probing (BOP): Assessed at the same six sites per tooth and recorded as present or absent within 30 seconds after probing. BOP was calculated as the percentage of sites exhibiting bleeding relative to the total number of sites examined.
5. Clinical Attachment Loss (CAL): Measured as the distance from the cemento-enamel junction to the base of the periodontal pocket at the same six sites per tooth. In cases where the cemento-enamel junction was obscured, a fixed reference point was established and documented for consistent measurements.

Additionally, full-mouth periapical radiographs were obtained at baseline for all participants to assess bone levels and confirm diagnosis. A standardized paralleling technique with film holders was employed to ensure reproducibility.

For the periodontitis group, disease severity was categorized according to the 2017 classification as Stage I (initial), Stage II (moderate), Stage III (severe), or Stage IV (advanced), based on CAL, radiographic bone loss, and tooth loss [23]. The staging process incorporated both the severity (based primarily on interdental CAL) and complexity factors (such as maximum probing depth, furcation involvement, and tooth mobility).

2.3 OHRQoL assessment

OHRQoL was evaluated using the Oral Health Impact Profile-14 (OHIP-14) questionnaire [24], which has been validated in multiple languages and is widely used in periodontal research. The questionnaire was administered in the participants' native language, with translations validated through a standard forward-backward translation process for non-English speakers. The OHIP-14 consists of 14 items across seven domains: functional limitation (items 1-2), physical pain (items 3-4), psychological discomfort (items 5-6), physical disability (items 7-8), psychological disability (items 9-10), social disability (items 11-12), and handicap (items 13-14). Each item is scored on a 5-point Likert scale (0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often, 4 = very often), reflecting the frequency of impacts experienced in the previous month. The total OHIP-14 score ranges from 0 to 56, with higher scores indicating poorer OHRQoL.Participants completed the OHIP-14 questionnaire at baseline (prior to treatment) and at the 6-week follow-up appointment. To minimize potential bias, the questionnaire was administered in a quiet, private setting by a research assistant who was not involved in clinical examinations or treatment provision. Participants were encouraged to answer all questions honestly and were assured that their responses would not influence their treatment. The percentage reduction in OHIP-14 scores was calculated as: [(Baseline score - Follow-up score) / Baseline score] × 100%.

2.4 Phase I periodontal therapy

All participants received standardized Phase I periodontal therapy tailored to their diagnosis. The treatment was performed by experienced dental hygienists who were calibrated prior to the study and supervised by periodontists. The hygienists were blinded to the participants' questionnaire responses but were aware of their clinical diagnosis to provide appropriate treatment.

The Phase I therapy included:

1. Detailed oral hygiene instructions: Participants received personalized instructions on proper brushing technique (modified Bass technique), interdental cleaning with dental floss and/or interdental brushes, and tongue cleaning. These instructions were reinforced with demonstrations on models, intraoral demonstrations, and take-home written materials with illustrations. Participants were advised to brush their teeth twice daily and clean interdentally once daily.
2. Full-mouth supragingival scaling and polishing: Using ultrasonic scalers (Cavitron, Dentsply Sirona, York, PA, USA) and hand instruments (Gracey curettes, Hu-Friedy, Chicago, IL, USA), all supragingival calculus and plaque were removed. Polishing was performed using rubber cups and fluoride-containing prophylaxis paste.

3. For the periodontitis group, additional subgingival scaling and root planing (SRP): This procedure was performed under local anesthesia (2% lidocaine with 1:100,000 epinephrine), using a combination of ultrasonic and hand instruments. The treatment was completed in two sessions (right and left sides) within a two-week period to minimize the risk of cross-contamination between treated and untreated sites. Each session lasted approximately 60-90 minutes, depending on the severity of disease and number of teeth.

Treatment quality was ensured through periodic assessment by supervising periodontists. No adjunctive treatments (e.g., local or systemic antibiotics, antiseptic mouthwashes) were prescribed to avoid confounding the results. However, participants were advised to take over-the-counter analgesics (e.g., acetaminophen) if needed for post-treatment discomfort. All participants received a follow-up phone call 24-48 hours after each treatment session to address any concerns or complications. They were scheduled for a 6-week post-treatment evaluation, during which the same clinical parameters were reassessed, and the OHIP-14 questionnaire was readministered.

2.5 Statistical analysis

Statistical analyses were performed using SPSS version 26.0. The sample size was verified to ensure adequate statistical power for the planned analyses. Normality of data distribution was assessed using the Shapiro-Wilk test and visual inspection of histograms. When the assumption of normality was violated, appropriate non-parametric tests were applied. Categorical variables were described as frequencies and percentages, while continuous variables were presented as means and standard deviations (SD) or medians and interquartile ranges (IQR) as appropriate. Missing data were minimal (<5%) and were handled using the last observation carried forward method. Baseline demographic and clinical characteristics were compared between the gingivitis and periodontitis groups using independent t-tests for continuous variables and chi-square tests for categorical variables. Paired t-tests were used to compare clinical parameters and OHIP-14 scores before and after treatment within each group. Independent t-tests were employed to compare the changes in OHIP-14 scores between groups.

When necessary, Bonferroni corrections were applied to adjust for multiple comparisons.To identify factors associated with improvement in OHRQoL, multiple linear regression analysis was performed with the percentage reduction in OHIP-14 score as the dependent variable and age, gender, baseline clinical parameters, and diagnosis (gingivitis vs. periodontitis) as independent variables. The assumptions of linearity, normality of residuals, homoscedasticity, and absence of multicollinearity were verified. Standardized coefficients (β) with 95% confidence intervals were calculated to determine the relative importance of each predictor. For all analyses, a p-value < 0.05 was considered statistically significant. All statistical tests were two-tailed.

3. RESULTS

3.1 Participant characteristics

A total of 144 participants were initially enrolled in the study. During the follow-up period, 20

participants (11 from the gingivitis group and 9 from the periodontitis group) were lost to follow-up or did not complete the treatment protocol. The most common reasons for dropout included relocation (n=7), inability to attend follow-up appointments due to scheduling conflicts (n=6), development of conditions requiring antibiotic therapy (n=4), and personal reasons (n=3).

The final analysis included 124 participants: 64 with gingivitis and 60 with periodontitis. The flow of participants through the study is illustrated in Figure 1.

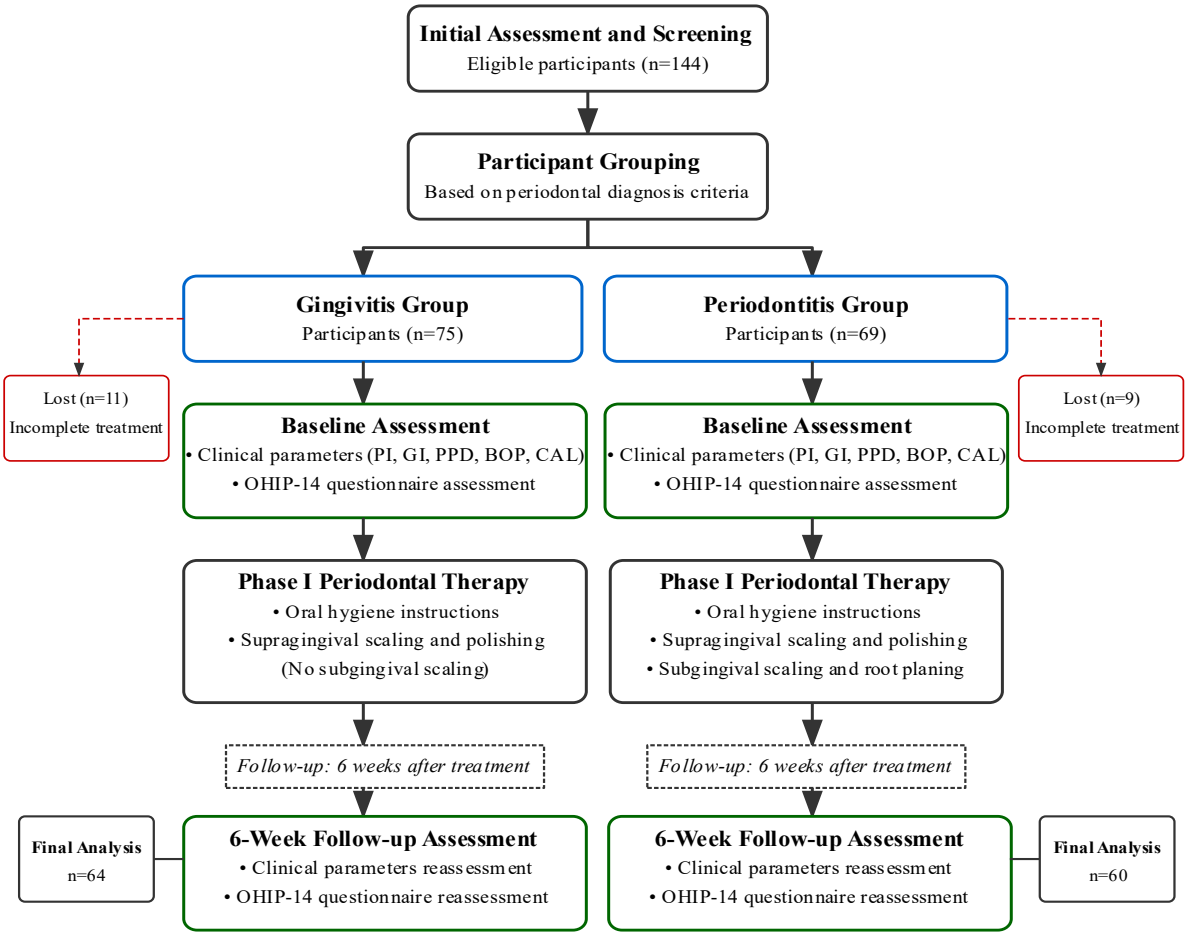

Figure 1. Research Flow Diagram of OHRQoL in Gingivitis and Periodontitis Patients After Phase I Treatment

The demographic and baseline clinical characteristics of the participants are presented in Table 1. The mean age was 36.7 ± 12.3 years in the gingivitis group and 48.2 ± 10.6 years in the periodontitis group, with a significantly higher age in the periodontitis group ($p < 0.001$). This age difference is consistent with the natural history of periodontal disease, as periodontitis typically develops after prolonged exposure to risk factors [25]. The gender distribution was similar between groups ($p = 0.713$), with females comprising slightly more than half of the participants in both groups (54.7% in the gingivitis group and 58.3% in the periodontitis group).

Table 1. Demographic and baseline clinical characteristics of the study participants

Characteristic	Gingivitis (n=64)	Periodontitis (n=60)	p-value
Age (years), mean ± SD	36.7 ± 12.3	48.2 ± 10.6	<0.001*
Gender, n (%)			0.713
Male	29 (45.3)	25 (41.7)	
Female	35 (54.7)	35 (58.3)	
Clinical parameters, mean ± SD			
PI	1.87 ± 0.48	1.94 ± 0.51	0.411
GI	1.95 ± 0.39	2.03 ± 0.41	0.282
PPD (mm)	2.58 ± 0.32	4.83 ± 1.27	<0.001*
CAL (mm)	0.36 ± 0.29	3.72 ± 1.58	<0.001*

BOP (%)	58.3 ± 16.7	74.2 ± 19.5	<0.001*
Periodontitis severity, n (%)			N/A
Stage I	N/A	11 (18.3)	
Stage II	N/A	25 (41.7)	
Stage III	N/A	18 (30.0)	
Stage IV	N/A	6 (10.0)	
Baseline OHIP-14 score, mean ± SD	18.5 ± 8.3	31.7 ± 11.6	<0.001*

*Notes: *Statistically significant ($p < 0.05$)*

SD: Standard deviation; PI: Plaque Index; GI: Gingival Index; PPD: Probing Pocket Depth; CAL: Clinical Attachment Loss; BOP: Bleeding on Probing; OHIP-14: Oral Health Impact Profile-14.

As expected, the periodontitis group exhibited significantly higher values for PPD, CAL, and BOP at baseline compared to the gingivitis group (all $p < 0.001$), while PI and GI were comparable between groups ($p = 0.411$ and $p = 0.282$, respectively). This suggests that both groups had similar levels of plaque accumulation and gingival inflammation, but the periodontitis group had experienced progressive periodontal tissue destruction, as evidenced by the increased PPD and CAL values. These findings are in line with current understanding of periodontal disease pathogenesis, where individual susceptibility factors play a crucial role in determining disease progression beyond gingivitis [26]. The distribution of periodontitis stages showed that the majority of periodontitis patients were classified as having Stage II (41.7%) or Stage III (30.0%) disease, representing moderate to severe forms of periodontitis. A smaller proportion had Stage I (18.3%) or Stage IV (10.0%) disease. This distribution reflects the typical pattern seen in periodontal practices, with most patients presenting with established disease rather than initial or end-stage conditions [27]. The baseline OHIP-14 score was significantly higher in the periodontitis group (31.7 ± 11.6) compared to the gingivitis group (18.5 ± 8.3) ($p < 0.001$), indicating poorer OHRQoL in patients with more severe disease. This observation aligns with previous cross-sectional studies that have demonstrated a positive association between periodontal disease severity and OHRQoL impairment [28, 29]. The magnitude of difference (13.2 points) exceeds the minimal important difference for the OHIP-14 instrument reported in the literature (approximately 5 points), suggesting that this difference is not only statistically significant but also clinically meaningful [30].

3.2 Changes in clinical parameters

Both groups showed significant improvements in all clinical parameters following Phase I periodontal therapy (Table 2). In the gingivitis group, the mean PI decreased from 1.87 ± 0.48 to 0.65 ± 0.27 ($p < 0.001$), representing a 65.2% reduction. Similarly, in the periodontitis group, the mean PI decreased from 1.94 ± 0.51 to 0.72 ± 0.33 ($p < 0.001$), indicating a 62.9% reduction. The magnitude of PI reduction was comparable between groups, suggesting that both treatment approaches were equally effective in removing plaque. This finding is consistent with previous research demonstrating the efficacy of professional dental cleaning in reducing plaque levels regardless of periodontal disease severity [31].

Table 2. Changes in clinical parameters after Phase I periodontal therapy

Parameter	Group	Baseline	Post-treatment	Change	p-value
PI	Gingivitis	1.87 ± 0.48	0.65 ± 0.27	1.22 ± 0.37	<0.001*
	Periodontitis	1.94 ± 0.51	0.72 ± 0.33	1.22 ± 0.41	<0.001*
GI	Gingivitis	1.95 ± 0.39	0.71 ± 0.29	1.24 ± 0.34	<0.001*
	Periodontitis	2.03 ± 0.41	0.87 ± 0.32	1.16 ± 0.39	<0.001*
PPD (mm)	Gingivitis	2.58 ± 0.32	2.17 ± 0.28	0.41 ± 0.26	<0.001*
	Periodontitis	4.83 ± 1.27	3.21 ± 0.84	1.62 ± 0.75	<0.001*
CAL (mm)	Gingivitis	0.36 ± 0.29	0.33 ± 0.27	0.03 ± 0.11	0.094
	Periodontitis	3.72 ± 1.58	3.54 ± 1.49	0.18 ± 0.26	<0.001*
BOP (%)	Gingivitis	58.3 ± 16.7	14.6 ± 7.8	43.7 ± 15.2	<0.001*

Periodontitis	74.2 ± 19.5	23.8 ± 12.6	50.4 ± 17.8	<0.001*

*Notes: *Statistically significant ($p < 0.05$)*

Values are presented as mean ± standard deviation PI: Plaque Index; GI: Gingival Index; PPD: Probing Pocket Depth; CAL: Clinical Attachment Loss; BOP: Bleeding on Probing.

The mean GI showed similar improvements in both groups, decreasing from 1.95 ± 0.39 to 0.71 ± 0.29 ($p < 0.001$) in the gingivitis group and from 2.03 ± 0.41 to 0.87 ± 0.32 ($p < 0.001$) in the periodontitis group. The reduction in gingival inflammation can be attributed to both the removal of local irritants (plaque and calculus) and improved oral hygiene practices by the participants, as demonstrated in previous investigations [32].

The slightly higher post-treatment GI in the periodontitis group (0.87 versus 0.71) may reflect the persistent low-grade inflammation associated with deeper pockets and attachment loss, which can be more challenging to completely resolve [33]. Regarding PPD, the mean reduction was significantly greater in the periodontitis group (1.62 ± 0.75 mm) compared to the gingivitis group (0.41 ± 0.26 mm) ($p < 0.001$). This difference is expected, as periodontitis patients had deeper baseline pockets that provided greater potential for reduction following therapy.

The magnitude of PPD reduction in the periodontitis group (approximately 1.6 mm) is consistent with previous reports on the efficacy of non-surgical periodontal therapy [34] and exceeds the threshold for clinical significance established in the literature (1.0 mm) [35].CAL showed minimal change in the gingivitis group (0.03 ± 0.11 mm, $p = 0.094$), which is expected given the absence of attachment loss in gingivitis. In contrast, a small but significant improvement was observed in the periodontitis group (0.18 ± 0.26 mm, $p < 0.001$). The modest CAL gain in the periodontitis group is consistent with the biological understanding of periodontal healing following non-surgical therapy, where epithelial adaptation rather than true regeneration is the predominant healing pattern [36].

The clinical significance of this small CAL improvement should be interpreted cautiously, as measurement variability of ±0.5 mm is inherent in periodontal probing [37]. Both groups exhibited substantial reductions in BOP, with the gingivitis group showing a decrease from 58.3 ± 16.7% to 14.6 ± 7.8% ($p < 0.001$) and the periodontitis group showing a decrease from 74.2 ± 19.5% to 23.8 ± 12.6% ($p < 0.001$). The residual bleeding was slightly higher in the periodontitis group, which may be attributed to the persistence of subgingival biofilm in deeper pockets that are more difficult to access, even after thorough instrumentation [38]. Nevertheless, the reduction in BOP exceeding 50% in both groups indicates a clinically significant reduction in gingival inflammation, as BOP is considered one of the most reliable indicators of active periodontal inflammation [39].

3.3 Changes in OHRQoL

The changes in OHIP-14 total and domain scores are presented in Table 3. Both groups showed significant improvements in overall OHRQoL after Phase I periodontal therapy, as evidenced by the reduction in OHIP-14 total scores ($p < 0.001$). In the gingivitis group, the mean OHIP-14 total score decreased from 18.5 ± 8.3 to 13.4 ± 6.7, representing a 27.4 ± 11.2% reduction. In the periodontitis group, the mean OHIP-14 total score decreased from 31.7 ± 11.6 to 14.9 ± 7.5, representing a 52.8 ± 14.3% reduction. As shown in Figure 2, the percentage reduction in OHIP-14 total score was significantly greater in the periodontitis group compared to the gingivitis group ($p < 0.001$), indicating a more substantial improvement in OHRQoL for patients with more severe baseline disease.

Table 3. Changes in OHIP-14 scores after Phase I periodontal therapy

OHIP-14 Domain	Group	Baseline	Post-treatment	Absolute change	Percentage reduction (%)	p-value
Functional limitation	Gingivitis	2.4 ± 1.4	1.9 ± 1.2	0.5 ± 0.8	20.8 ± 17.3	<0.001*
	Periodontitis	4.2 ± 1.8	2.5 ± 1.4	1.7 ± 1.1	40.5 ± 22.6	<0.001*
Physical pain	Gingivitis	4.3 ± 1.7	2.7 ± 1.4	1.6 ± 1.1	37.2 ± 18.5	<0.001*
	Periodontitis	5.7 ± 1.5	3.1 ± 1.3	2.6 ± 1.3	45.6 ± 17.8	<0.001*
Psychological discomfort	Gingivitis	3.1 ± 1.9	2.4 ± 1.6	0.7 ± 0.9	22.6 ± 16.7	<0.001*
	Periodontitis	5.3 ± 1.8	2.1 ± 1.4	3.2 ± 1.5	60.4 ± 19.2	<0.001*
Physical disability	Gingivitis	2.8 ± 1.7	2.1 ± 1.4	0.7 ± 0.8	25.0 ± 18.4	<0.001*
	Periodontitis	5.1 ± 1.9	2.2 ± 1.3	2.9 ± 1.4	56.9 ± 20.3	<0.001*

Psychological disability	Gingivitis	2.6 ± 1.8	1.9 ± 1.5	0.7 ± 0.9	26.9 ± 19.8	<0.001*
	Periodontitis	4.6 ± 1.9	2.0 ± 1.4	2.6 ± 1.3	56.5 ± 21.4	<0.001*
Social disability	Gingivitis	1.8 ± 1.6	1.4 ± 1.3	0.4 ± 0.7	22.2 ± 21.3	<0.001*
	Periodontitis	3.6 ± 2.0	1.7 ± 1.4	1.9 ± 1.2	52.8 ± 25.1	<0.001*
Handicap	Gingivitis	1.5 ± 1.4	1.0 ± 1.1	0.5 ± 0.7	33.3 ± 25.4	<0.001*
	Periodontitis	3.2 ± 1.9	1.3 ± 1.2	1.9 ± 1.3	59.4 ± 26.8	<0.001*
OHIP-14 Total	Gingivitis	18.5 ± 8.3	13.4 ± 6.7	5.1 ± 3.2	27.4 ± 11.2	<0.001*
	Periodontitis	31.7 ± 11.6	14.9 ± 7.5	16.8 ± 7.1	52.8 ± 14.3	<0.001*

*Notes: *Statistically significant ($p < 0.05$)*

Values are presented as mean ± standard deviation OHIP-14: Oral Health Impact Profile-14.

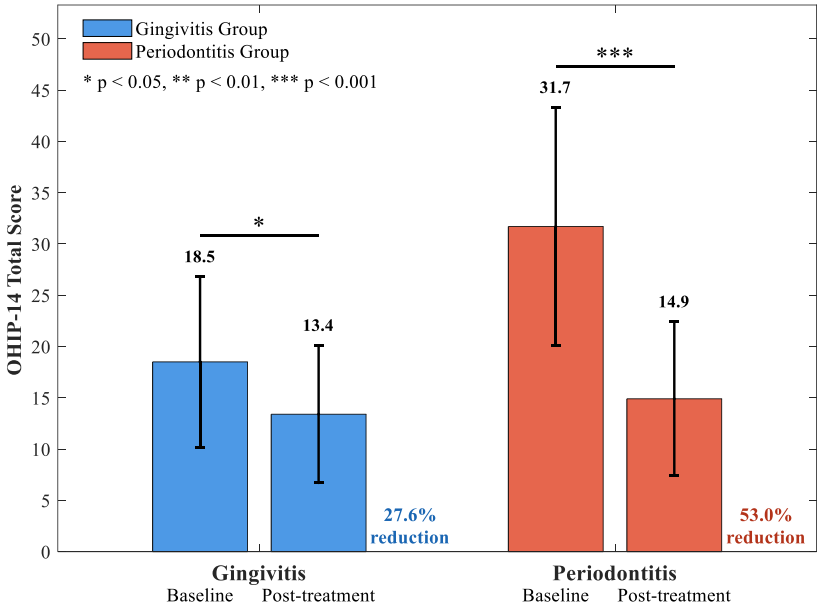

Figure 2. Comparison of OHIP-14 Total Scores Before and After Treatment in Gingivitis and Periodontitis Patients

Further analysis of the OHRQoL improvement pattern revealed that the reduction in OHIP-14 scores followed a dose-response relationship with disease severity. When the periodontitis group was stratified by disease stage, the percentage reduction in OHIP-14 scores increased progressively from Stage I (42.5 ± 12.1%) to Stage IV (64.7 ± 15.2%), reinforcing the gradient effect observed between the gingivitis and periodontitis groups. This progressive improvement with increasing disease severity may be explained by the greater room for improvement in more severely affected patients and the more noticeable resolution of symptoms following treatment [40]. Regarding domain-specific changes, both groups showed significant improvements across all seven domains (all $p < 0.001$). In the group with gingivitis, the greatest improvements were observed in the physical pain domain, with a decrease of 37.2 ± 18.5%, followed by the improvements in the handicap domain, with a decrease of 33.3 ± 25.4%. The finding shows that relief from gingivitis primarily relates to symptoms of pain, like sensitivity in gums and pain during brushing, commonly complained of by those afflicted with this disorder. The improvement seen in the handicap domain can mean a reduced feeling of disadvantage or embarrassment related to symptoms like bleeding gums and halitosis, which are the hallmark features of gingivitis.

In contrast, the periodontitis cohort demonstrated the most significant improvement in the psychological discomfort (60.4 ± 19.2%), followed by handicap (59.4 ± 26.8% reduction), and physical disability (56.9 + 20.3% reduction) domains. The significant improvement of psychological discomfort is an indicator that patients with periodontitis had significant relief of anxiety and self-consciousness of the oral health condition after treatment. This is of specific importance considering that fears of tooth loss and concern regarding disease worsening are common psychological issues for patients with periodontitis. When comparing domain-specific improvements between groups, the periodontitis group showed

significantly greater percentage reductions in all domains except physical pain, where the difference was not statistically significant (p = 0.087). Figure 3 illustrates the domain-specific percentage improvements in both groups, highlighting the gradient pattern across different aspects of OHRQoL. The most pronounced between-group differences were observed in the psychological discomfort domain (60.4% vs. 22.6%, p < 0.001) and the social disability domain (52.8% vs. 22.2%, p < 0.001), suggesting that periodontitis has a broader impact on psychosocial aspects of quality of life compared to gingivitis.

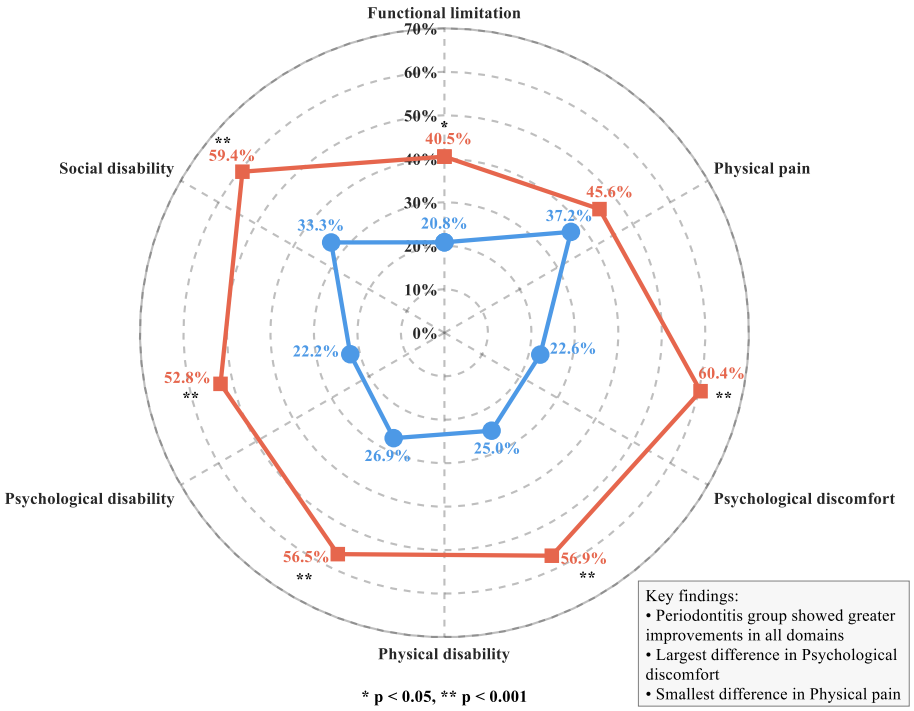

Figure 3. Comparison of Improvement Percentages in Seven Domains of OHIP-14

The post-treatment OHIP-14 scores were comparable between the groups (13.4 ± 6.7 for gingivitis vs. 14.9 ± 7.5 for periodontitis, p = 0.236), despite the significant difference at baseline. This convergence of OHRQoL levels after treatment suggests that effective periodontal therapy can potentially normalize the quality of life experience for patients with different severities of periodontal disease, bringing them to a similar level of oral health well-being.

3.4 Factors associated with OHRQoL improvement

Multiple linear regression analysis was performed to identify factors associated with the percentage reduction in OHIP-14 total score (Table 4). The most significant predictor of OHRQoL improvement was baseline CAL (β = 0.371, p < 0.001), followed by baseline PPD (β = 0.285, p = 0.003). Baseline OHIP-14 score was also a significant predictor (β = 0.241, p = 0.008), indicating that patients with poorer initial OHRQoL experienced greater relative improvements. Figure 4 shows the correlation between baseline clinical parameters (CAL and PPD) and OHIP-14 improvement, illustrating the positive relationship between disease severity and potential for quality of life enhancement.

Table 4. Multiple linear regression analysis for factors associated with percentage reduction in OHIP-14 total score

Variable	Standardized coefficient (β)	95% CI	p-value
Age	0.083	-0.092, 0.258	0.347
Gender (male vs. female)	0.057	-0.103, 0.217	0.481
Baseline PI	0.081	-0.079, 0.241	0.318
Baseline GI	0.094	-0.066, 0.254	0.247
Baseline PPD	0.285	0.097, 0.473	0.003*
Baseline CAL	0.371	0.182, 0.560	<0.001*

Baseline BOP	0.105	-0.057, 0.267	0.202
Baseline OHIP-14 score	0.241	0.064, 0.418	0.008*

*Notes: *Statistically significant ($p < 0.05$)*

CI: Confidence Interval; PI: Plaque Index; GI: Gingival Index; PPD: Probing Pocket Depth; CAL: Clinical Attachment Loss; BOP: Bleeding on Probing; OHIP-14: Oral Health Impact Profile-14.

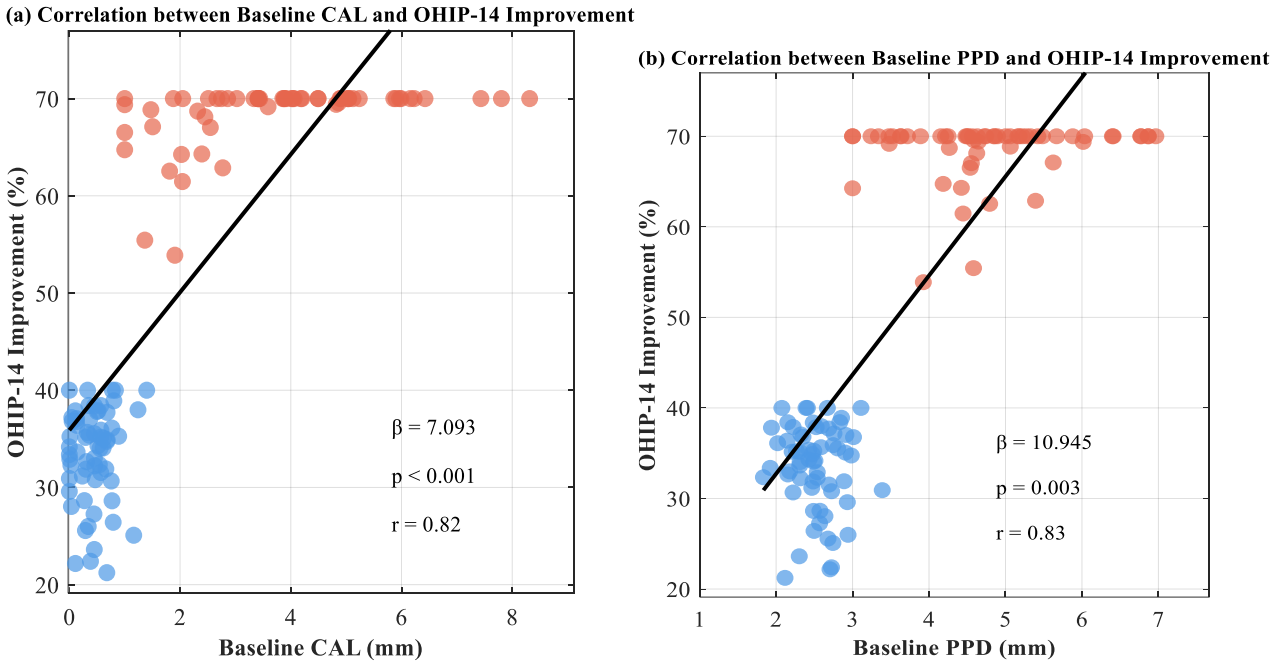

Figure 4. Correlation Between Baseline Clinical Parameters and OHIP-14 Improvement (a) Correlation between Baseline CAL and OHIP-14 Improvement (b) Correlation between Baseline PPD and OHIP-14 Improvement

Interestingly, neither age nor gender was significantly associated with OHRQoL improvement ($p = 0.347$ and $p = 0.481$, respectively). This finding suggests that the benefits of periodontal therapy on quality of life are not significantly influenced by these demographic factors, which is consistent with previous research showing that periodontal treatment outcomes are primarily determined by disease characteristics rather than patient demographics. Baseline PI, GI, and BOP did not emerge as significant predictors in the multivariate model, suggesting that the extent of inflammation alone may not determine the degree of OHRQoL improvement. Instead, the structural parameters of periodontal disease (CAL and PPD) appeared to be more influential.

This distinction may be related to the different nature of these parameters: while PI, GI, and BOP reflect the current inflammatory status, CAL and PPD represent the cumulative tissue damage from past disease activity, which may have more profound effects on patients' quality of life. The regression model explained approximately 53% of the variance in OHRQoL improvement (adjusted $R^2 = 0.527$), indicating that while clinical parameters are important predictors, other factors not captured in this analysis may also influence changes in quality of life following periodontal treatment. These might include psychological factors, coping mechanisms, social support, and individual expectations, which have been shown to modulate patient-reported outcomes in various healthcare contexts.

4. DISCUSSION

This prospective cohort study investigated the gradient differences in OHRQoL improvement among patients with gingivitis versus periodontitis following Phase I periodontal therapy. Our findings demonstrate that both groups experienced significant improvements in clinical parameters and OHRQoL, but the magnitude of improvement differed based on baseline disease severity, with periodontitis patients showing a more substantial enhancement in OHRQoL. The observed improvements in clinical parameters following Phase I therapy align with previous research demonstrating the effectiveness of NSPT in reducing plaque, gingival inflammation, and probing depths [8]. As expected, the reduction in PPD was more pronounced in the periodontitis group, reflecting the greater potential for improvement in patients with deeper baseline pockets. The minimal change in CAL is consistent with the nature of Phase I therapy, which primarily

targets inflammation rather than regenerating lost periodontal tissues [9].

The improvement in OHRQoL following periodontal treatment has been documented in several studies. A systematic review by Shanbhag et al. [7] concluded that both surgical and non-surgical periodontal therapies lead to significant enhancements in OHRQoL. Our findings extend this knowledge by demonstrating a gradient effect, where the magnitude of OHRQoL improvement correlates with baseline disease severity. The substantial reduction in OHIP-14 scores observed in the periodontitis group (52.8 ± 14.3%) is comparable to findings reported by Makino-Oi et al. [10], who noted a 50% reduction in OHIP-14 scores following non-surgical periodontal therapy in patients with chronic periodontitis. The results of the gingivitis group that supported a reduction of 27.4 ± 11.2% correspond with the findings of Mendez et al. [17], who reported a decrease of 27.3% in OHIP-14 scores after supragingival treatment among patients with gingivitis.

The observed gradient effect, with periodontitis patients experiencing greater relative improvements in OHRQoL, has several potential explanations. First, patients with more severe disease have more room for improvement, both clinically and in terms of quality of life [11]. Second, the resolution of symptoms such as pain, swelling, and bleeding may be more noticeable and impactful for individuals with more advanced disease [12]. Third, periodontitis patients might have had greater concerns about potential tooth loss and its consequences, leading to a more pronounced psychological benefit when treatment successfully addressed these concerns [13]. The examination of the separate domains revealed significant differences between the gingivitis and periodontitis groups. In patients with gingivitis, the greatest improvements were noted in terms of physical pain, most likely reflecting symptom alleviation in the form of gingival bleeding and tenderness [14]. Among the subjects with periodontitis, however, the greatest improvements were those in the areas of psychological discomfort, physical impairment, and psychological disability. This would suggest that periodontitis has a broader impact on quality of life, not just affecting physical symptoms but also psychological status and everyday functioning [15, 16].

Our regression analysis identified baseline CAL and PPD as the strongest predictors of OHRQoL improvement, reinforcing the relationship between disease severity and potential for improvement. This finding has important clinical implications, as it suggests that patients with more advanced disease, who may be most impacted by their condition, also stand to gain the most from treatment in terms of quality of life [19]. The baseline OHIP-14 proved to be a significant predictor that is consistent with findings reported by Wong et al. [20], with high baseline OHIP-14 scores predicting greater improvement following periodontal treatment. This reinforces the importance of using patient self-reporting for the purposes of assessing treatment needs and guiding the creation of treatments [28].

Our study has several limitations that should be acknowledged. The follow-up period of 6 weeks, while suitable for assessing initial healing and resolution of inflammation, may not capture long-term changes in OHRQoL [29]. Additionally, our sample was drawn from a single center, potentially limiting the generalizability of our findings [30]. Socioeconomic factors, which can influence both disease progression and quality of life perceptions, were not comprehensively assessed in this study [31]. Future research should explore longer-term changes in OHRQoL following periodontal treatment [32] and investigate potential strategies to enhance OHRQoL outcomes, particularly in domains showing less substantial improvements [33]. Qualitative research might provide deeper insights into patients' experiences and perceptions [34].

The existing evidence clarifies that periodontal therapy in Phase I yields significant OHQHRoL improvement among people with both periodontitis and gingivitis, with the most remarkable effects observed in patients with more severe baseline conditions. More specifically, patients with periodontitis had a 52.8% reduction in OHIP-14 scores compared with a 27.4% reduction in patients with gingivitis, thus showing a clear gradient in the effectiveness of the treatment. The same effect presented across domains in a consistent manner with the most pronounced changes in psychological discomfort (60.4% vs. 22.6%) as well as social disability (52.8% vs. 22.2%), which indicates that the benefit of periodontal treatment extends far beyond clinical markers into significant improvement in the functional capacity and emotional health of patients.

The multidimensional impact of periodontal therapy on quality of life is further evidenced by domain-specific improvements. While gingivitis patients demonstrated greatest benefits in physical pain domains (37.2% reduction), periodontitis patients showed more comprehensive improvements across psychological, physical, and social dimensions. Regression analysis confirmed baseline disease severity markers (CAL: $\beta = 0.371$, $p < 0.001$; PPD: $\beta = 0.285$, $p = 0.003$) as the strongest predictors of OHRQoL improvement. The convergence of post-treatment OHIP-14 scores between groups (13.4 ± 6.7 for gingivitis vs. 14.9 ± 7.5 for periodontitis, $p = 0.236$), despite significant baseline differences, suggests that effective periodontal therapy can potentially normalize quality of life experiences

regardless of initial disease severity.

5. CONCLUSION

The clinical implications of these findings include the recognition of non-surgical periodontal therapy as valuable not merely for controlling inflammation, but as an effective intervention for enhancing multiple dimensions of patient quality of life. Clinicians may consider incorporating OHRQoL assessments into routine periodontal examinations to

comprehensively evaluate treatment outcomes from both professional and patient perspectives. Future research directions include longitudinal investigations beyond the 6-week follow-up period and the development of targeted interventions for domains showing less substantial improvements. The complex interrelationships between disease severity, treatment response, and quality of life revealed in this investigation highlight the importance of patient-centered approaches in periodontal care.

6. DECLARATIONS

Conflict of Interest

The authors declare no conflict of interest.

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