Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Oral health attitudes and clinical periodontal status in Turkish undergraduate dental students: discordance between self-reported behaviour and clinical findings — a cross- sectional study

Gökhan Kasnak
Istanbul Kent University
Cenker Koyuncuoğlu
Istanbul Aydın University
Batuhan Hazar Ayşeşek
Istanbul University
Duygu Yaman
yamand@istanbul.edu.tr

Istanbul University

Research Article

Keywords: Dental students, Oral hygiene, Periodontal Index, Gingivitis, Health Knowledge, Attitudes, Practice, Surveys and Questionnaires, Smoking, HU-DBI, Crosssectional study, Periodontal classification

Posted Date: July 14th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10221135/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations:
No competing interests reported.

Tables 1 to 5 are available in the Supplementary Files section.

Oral health attitudes and clinical periodontal status in Turkish undergraduate dental students: discordance between self-reported behaviour and clinical findings — a cross-sectional study

Running Title: Self-report and clinical periodontal assessment in dental students

Gökhan Kasnak[1], Cenker Koyuncuoğlu[2], Batuhan Ayşeşek[3], Duygu Yaman[3]

Authors:

1- Gökhan Kasnak, DDS, PhD, Assist Prof

Istanbul Kent University, Faculty of Dentistry

Departmen of Periodontology

Cihangir Mh. Sıraselviler Cd. No 71

34433, Beyoğlu, Istanbul, Turkey

gokhan.kasnak@kent.edu.tr

ORCID: 0000-0002-8953-6834

2- Cenker Koyuncuoğlu, DDS, PhD, Assoc Prof

Istanbul Aydın University, Faculty of Dentistry,

Department of Periodontology,

Beşyol, İnönü Cd. No: 38, 34295

Küçükçekmece, Istanbul, Turkey

zekikoyuncuoglu@aydin.edu.tr

ORCID: 0000-0002-5866-5860

3- Batuhan Ayşeşek, DDS, PhD

Istanbul University, Faculty of Dentistry

Department of Periodontology

Süleymaniye, Prof. Dr. Cavit Orhan Tütengil Sk.

No:4, 34116 Fatih, Istanbul, Turkey

baysesek@istanbul.edu.tr

ORCID: 0000-0001-7976-1969

4- Duygu Yaman, DDS, PhD, Assoc Prof

Istanbul University, Faculty of Dentistry

Department of Periodontology

Süleymaniye, Prof. Dr. Cavit Orhan Tütengil Sk.

No:4, 34116 Fatih, Istanbul, Turkey

yamand@istanbul.edu.tr

ORCID: 0000-0002-5974-1335

Corresponding Author:

Duygu Yaman, DDS, PhD, Assoc Prof

Istanbul University, Faculty of Dentistry

Department of Periodontology

Süleymaniye, Prof. Dr. Cavit Orhan Tütengil Sk.

No:4, 34116 Fatih, Istanbul, Turkey

yamand@istanbul.edu.tr

+905326506187

ORCID: 0000-0002-5974-1335

Author Contributions (CRediT taxonomy):

G.K: Investigation, Data Curation, Writing – Original Draft, Formal Analysis, Visualization, Writing – Review & Editing; **C.K:** Investigation, Writing – Original Draft, Writing – Review & Editing; **B.A:** Investigation, Writing – Original Draft, Clinical Examination, **D.Y:** Investigation, Writing – Original Draft, Conceptualization, Supervision, Writing – Review & Editing

Ethics: Istanbul Aydın University Faculty of Dentistry Clinical Research Ethics Committee | Protocol No: B.30.2.AYD.0.00.00-480.2/157 | Declaration of Helsinki | Written informed consent from all participants

Funding: No funding was acquired for the present study.

Competing interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability: Available from the corresponding author upon reasonable request.

Word count:4.207 | Tables: 5 | Figures: 3 | Additional files: 5 | References: 33

ABSTRACT

Background: Self-reported behavioural questionnaires are widely used to assess oral health attitudes in dental students, yet few studies have simultaneously examined objective clinical periodontal status in the same cohort. This study compared self-reported oral health attitudes, measured by the validated modified Turkish Hiroshima University–Dental Behavioral Inventory (HU-DBI), with clinical periodontal findings across academic years and by gender.

Methods: In this cross-sectional study, 264 undergraduate dental students at Istanbul University Faculty of Dentistry completed the Turkish HU-DBI, stratified into preclinical (Years 1–2; n = 134) and clinical (Years 3–5; n = 130) groups. Of these, 255 also underwent full-mouth clinical examination including the Plaque Index (PI), Gingival Index (GI), and probing pocket depth (PPD). Clinical periodontal categories were approximated using available examination variables. As questionnaires were completed anonymously, HU-DBI and clinical datasets were analysed independently at group level. Group comparisons used the Mann–Whitney U test; a Scheirer–Ray–Hare test assessed the academic year × gender interaction for each instrument separately.

Results: Clinical students had significantly higher HU-DBI scores than preclinical students (mean difference 1.05 points; Cohen's $d = 0.58$; $p < 0.001$), with no significant overall gender difference ($p = 0.806$). Academic year was strongly associated with lower PI (rank-biserial $r = 0.978$; $p < 0.001$) and GI ($r = 0.897$; $p < 0.001$). A significant academic year × gender interaction was identified for both PI ($H = 33.42$, $p < 0.001$) and GI ($H = 61.75$, $p < 0.001$) but not for HU-DBI ($H = 2.12$, $p = 0.145$). In preclinical students, females had better plaque control and gingival health than males; this pattern reversed in clinical students. Males achieved greater PI and GI reductions than females (88.2% vs. 55.2% for PI; 74.1% vs. 20.6% for GI), and 96.4% of clinical male students attained periodontal health compared with 2.9% of clinical female students.

Conclusions: Clinical training was associated with improved HU-DBI scores and substantially better periodontal status. However, the magnitude and gender pattern of improvement differed markedly between self-reported attitudes and clinical measures.

These findings suggest that self-reported behavioural instruments alone may not fully reflect periodontal health status in dental students.

Keywords: Dental students; Oral hygiene; Periodontal Index; Gingivitis; Health Knowledge, Attitudes, Practice; Surveys and Questionnaires; Smoking; HU-DBI; Crosssectional study; Periodontal classification

BACKGROUND

Oral diseases affect a substantial proportion of the global population and represent one of the most prevalent non-communicable disease groups worldwide [1,2]. Dental caries, periodontal diseases, and tooth loss contribute significantly to morbidity and quality of life, placing a considerable burden on health systems [1]. A key determinant of oral health outcomes is individual behaviour, including toothbrushing frequency, interdental cleaning, and dental attendance [2]. Dental professionals occupy a pivotal position in oral health promotion, and undergraduate dental students — who will become the next generation of clinicians — are expected to serve as role models for patients and communities [3]. Understanding the oral health attitudes and clinical periodontal status of dental students is therefore of both educational and public health relevance.

The oral health behaviours and attitudes of dental students have been examined in multiple settings [4–7]. Clinical training has generally been associated with improvements in oral health attitudes, attributed to increased patient contact, peer influence, and greater awareness of oral disease aetiology [5,6]. Gender has been identified as a potential modifier of oral health attitudes, with some studies reporting more favourable attitudes among female students [8,9,10], though findings have not been consistent across populations. Crucially, most studies assessing dental student oral health have relied exclusively on self-reported questionnaire data without concurrent objective clinical assessment [11]. The relationship between self-reported oral health attitudes and clinically measured periodontal status has consequently received limited attention in the dental student literature [12,13].

The Hiroshima University–Dental Behavioral Inventory (HU-DBI), originally developed by Kawamura [4], is a validated instrument for assessing oral health attitudes and behaviours among dental students. Widely applied across diverse educational systems [5–7] and adapted for the Turkish population [8], the HU-DBI has been extensively utilized to track attitude development throughout the dental curriculum [9,10,14]. Research

consistently demonstrates that academic progression influences these parameters; however, the extent of this influence varies significantly across global settings. Empirical evidence from Sudan [15], Japan and Finland [16], China [17], several Arab countries [18], and Germany [19] indicates that while clinical-year students often exhibit more favourable attitudes, this improvement is closely modulated by regional curricular structures. These international benchmarks provide a crucial reference framework for interpreting current findings, highlighting the necessity of evaluating dental education's impact within specific regional and structural contexts.

Although the HU-DBI has been applied in a number of Turkish and international studies, most have relied exclusively on self-reported data without concurrent clinical periodontal assessment. Relatively few studies have simultaneously examined self-reported oral health attitudes and objective clinical periodontal findings in the same dental student cohort [13]. Where both types of data have been obtained, the concordance between questionnaire-based and clinically measured oral health has been inconsistent [11,12], suggesting that the two types of measurement may not be interchangeable. Furthermore, gender and academic year have rarely been examined together in a formal two-way analysis, leaving open the question of whether their effects on oral health measures are independent of one another.

This study aimed to compare self-reported oral health attitudes, as measured by the validated modified Turkish HU-DBI, with clinical periodontal findings obtained through full-mouth examination, in a cohort of preclinical and clinical undergraduate dental students. A secondary objective was to determine whether academic year and gender modified these associations, and whether interaction patterns differed across self-reported and clinical outcomes.

METHODS

Study Design and Setting

This cross-sectional study was conducted at Istanbul University Faculty of Dentistry during the spring semester of the 2018–2019 academic year. Ethics approval was granted by the Istanbul Aydın University Faculty of Dentistry Clinical Research Ethics Committee (Protocol No: B.30.2.AYD.0.00.00-480.2/157) under a joint research protocol with Istanbul University Faculty of Dentistry. All procedures were conducted in accordance

with the Declaration of Helsinki. Written informed consent was obtained from all participants. This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies [20]. The STROBE checklist is provided as Additional file 1.

Participants

Students in years 1 and 2 were classified as preclinical; those in years 3 through 5 as clinical. Inclusion criteria: undergraduate dental student at Istanbul University Faculty of Dentistry, age 18–30 years, confirmed systemic health by medical history, and willingness to participate. Exclusion criteria: systemic condition known to affect periodontal status (e.g., diabetes mellitus, immunosuppression), current antibiotic or anti-inflammatory medication use, fixed orthodontic appliances, and fewer than 20 natural teeth.

As questionnaires were completed anonymously, individual HU-DBI responses could not be linked to clinical examination findings at the individual level. Accordingly, the HU-DBI and clinical examination datasets were analysed independently at group level, and the study was designed to compare group-level outcomes rather than to assess individual-level concordance between self-reported attitudes and clinical measures. This is an important analytical limitation that is discussed further below.

HU-DBI Questionnaire

Oral health attitudes and behaviors were assessed using the modified Turkish HU-DBI, validated by Peker et al. (2009) [8]. The instrument consists of 27 items: items 1–20 constitute the scored behavioral inventory (agree/disagree response format; Table 1); items 21–24 are additional attitudinal items presented descriptively; and items 25–27 assess smoking behavior. Items 1–20 are scored per the validated Turkish HU-DBI key [8]: each item is assigned a score of 1 for the response indicating a positive oral health behavior and 0 otherwise. Total HU-DBI scores range from 0 to 20, with higher scores reflecting more positive oral health attitudes. For HU-DBI items Q8 and Q12, response distributions were heavily skewed toward “0” (i.e. non-use); inspection against the original questionnaires indicated that these zero values reflected genuinely rare behaviors rather than data entry errors, so the items were retained without recoding. The questionnaire was self-administered anonymously during a scheduled classroom session prior to and independently of clinical examination, to minimize social desirability bias.

Clinical Examination

All examinations were performed by three calibrated and experienced periodontists under standardized conditions using a Williams periodontal probe (Hu-Friedy Mfg. Co., LLC, Chicago, USA). Prior to data collection, intra- and inter-examiner reliability was assessed on 10 randomly selected participants: intra-examiner intraclass correlation coefficients (ICC) were 0.91 (PI), 0.88 (GI), and 0.87 (PPD); inter-examiner ICCs were 0.86 (PI), 0.85 (GI), and 0.84 (PPD). Examiners were blinded to participants' academic year and identity throughout all clinical examinations.

Plaque accumulation was quantified using the Silness–Löe Plaque Index (PI) [21]. Gingival inflammation was assessed using the Löe–Silness Gingival Index (GI) [22]. For methodological consistency with PPD recording, both PI and GI were recorded at six sites per tooth (mesiobuccal, buccal, distobuccal, distolingual, lingual, and mesiolingual) rather than four sites as in the original protocols, consistent with the full-mouth six-site gold standard for clinical periodontal examinations Third molars were excluded. PPD was recorded in millimeters at the same six sites.

Clinical periodontal categories were approximated using the available examination variables (PI, GI, and PPD). As bleeding on probing was not recorded as a binary variable, mean GI score per individual served as the surrogate gingivitis variable, with case definitions based on subject-level mean GI thresholds. Periodontal health: mean GI < 1.0 and PPD ≤ 3 mm with no clinical attachment loss (CAL). Radiographic bone loss assessment was not performed; the classification therefore reflects clinical criteria only and should be interpreted within this limitation. Gingivitis on an intact periodontium: mean GI ≥ 1.0 and PPD ≤ 3 mm with no CAL. Severity: mild ($1.0 \leq \text{GI} < 2.0$), moderate ($2.0 \leq \text{GI} < 3.0$), severe ($\text{GI} \geq 3.0$).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA) and Python 3.11 (SciPy 1.11). Data normality was assessed with the Shapiro–Wilk test; all continuous variables deviated significantly from normality ($p < 0.05$), and non-parametric methods were used throughout. Because parametric factorial analysis of variance assumptions were not met, interaction effects were evaluated using the Scheirer–Ray–Hare extension of the Kruskal–Wallis test, which assesses main effects and interactions in a two-way non-parametric design.

Group comparisons used the Mann–Whitney U test, with rank-biserial correlation (r) as effect size. For HU-DBI total score comparisons, Cohen's d was additionally computed using pooled standard deviation, with 95% confidence intervals derived by bootstrap resampling (2000 iterations, seed = 42). To formally test whether the gender × academic year interaction differed between self-report and clinical instruments, a Scheirer–Ray–Hare (SRH) non-parametric two-way test was applied separately to HU-DBI scores, PI, and GI. The interaction term H statistic (chi-square distributed, df = 1) was the primary inferential target for comparing self-report versus clinical instrument behavior.

HU-DBI item-level comparisons (binary agree/disagree) used Chi-square or Fisher's exact test where any expected cell count was fewer than five. The Benjamini–Hochberg (BH) FDR procedure was applied across all 20 scored item comparisons within each comparison set (clinical vs. preclinical; female vs. male); items are reported as significant only where $q < 0.05$. BH-FDR was additionally applied to the six pairwise Mann–Whitney U comparisons of PI and GI. Periodontal status distributions were compared using Fisher's exact test with Monte Carlo simulation (n = 10,000 resamples), as four of 16 cells had expected counts below five (minimum expected count = 1.51), violating the chi-square assumption of adequate expected cell frequencies. PI–GI associations were assessed with Spearman rank correlation (rs) with 95% CIs via Fisher's z-transformation, computed overall and within each subgroup.

A smoking sensitivity analysis was conducted by restricting HU-DBI comparisons to non-smoking participants. Given the magnitude of the academic year effect on periodontal indices (rank-biserial r = 0.978–1.000), a separate sensitivity analysis for PI and GI was not performed, as effects of this size are unlikely to be attributable to confounding by smoking status. The statistical significance threshold was set at $\alpha = 0.05$. No a priori power calculation was performed, as this study enrolled the entire eligible student cohort at a single institution and sample size was not determined by a pre-specified effect size target. Post-hoc sensitivity analysis indicates that with n = 130 per group and $\alpha = 0.05$, the Mann–Whitney U test achieves >80% power to detect a rank-biserial $r \geq 0.20$ (a small-to-medium effect), suggesting adequate power for the primary between-group comparisons of interest.

RESULTS

Participant Characteristics

A total of 264 students completed the HU-DBI questionnaire (preclinical: n = 134, 72 female and 62 male; clinical: n = 130, 72 female and 58 male). Of these, 255 attended the scheduled clinical examination (response rate 96.6%): preclinical 68 female and 62 male; clinical 70 female and 55 male. Mean age was 20.21 ± 1.37 years. Current smoking was reported by 25 of 144 female students (17.4%) and 33 of 120 male students (27.5%); the difference did not reach statistical significance ($\chi^2 = 3.356$, $p = 0.067$). Smoking prevalence by subgroup was: clinical female 11.1%, clinical male 22.4%, preclinical female 23.6%, and preclinical male 32.3% (Table 2). A STROBE-compliant participant flow diagram is presented in Additional file 2.

HU-DBI Scores

HU-DBI total scores and item-level response frequencies are presented in Tables 1, 3, and 4. Clinical students had significantly higher HU-DBI scores than preclinical students (mean 11.88 ± 2.12 vs. 10.83 ± 1.45; $U = 11{,}344$, $p < 0.001$; rank-biserial $r = 0.302$; Cohen's $d = 0.58$, 95% CI: 0.35–0.84). Subgroup means were: clinical female 11.67 ± 2.33, clinical male 12.14 ± 1.81, preclinical female 10.97 ± 1.34, and preclinical male 10.66 ± 1.56 (Table 3). Total HU-DBI scores did not differ significantly between female and male students (11.32 ± 1.93 vs. 11.38 ± 1.83; $p = 0.806$). The Scheirer–Ray–Hare test identified academic year as the only significant factor (year: $H(1) = 18.97$, $p < 0.001$; gender: $H(1) = 0.06$, $p = 0.806$; year × gender interaction: $H(1) = 2.12$, $p = 0.145$). After BH-FDR correction, 19 of 20 scored items differed significantly between academic year groups; 15 of 20 items differed between gender groups (Table 4). Clinical male students had the lowest favourable response rate for item Q6 ("I think I will inevitably have false teeth when I get old"): 10.3%, compared with 70.8% of clinical female students and 100% of both preclinical groups. Items Q8 and Q12 showed heavily skewed distributions, with favourable responses almost exclusively confined to clinical female students; these items were retained for comparability with prior Turkish HU-DBI studies.

Clinical Periodontal Indices

Descriptive statistics for PI and GI are presented in Table 3; box plots are shown in Figures 1 and 2. No participant had PPD exceeding 3 mm, and PPD did not differ significantly between any subgroup pair (all $p > 0.05$). Academic year was strongly associated with lower PI and GI, with very large effect sizes. Clinical students had significantly lower PI than preclinical students (median 0.360 [IQR 0.180–0.540] vs. 1.480

[1.127–1.968]; U = 176, $p < 0.001$, r = 0.978) and lower GI (median 1.120 [0.740–1.430] vs. 2.150 [1.760–2.490]; U = 836, $p < 0.001$, r = 0.897). A significant academic year × gender interaction was identified for both PI ($H(1) = 33.42$, $p < 0.001$) and GI ($H(1) = 61.75$, $p < 0.001$).

In preclinical students, females had significantly lower PI and GI than males (PI: median 1.155 [0.970–1.248] vs. 1.970 [1.785–2.150]; U = 33, $p < 0.001$, r = 0.984; GI: median 1.770 [1.660–1.962] vs. 2.510 [2.325–2.850]; U = 96, $p < 0.001$, r = 0.954). In clinical students, this pattern reversed: males had significantly lower PI and GI than females (PI: U = 3,180, $p < 0.001$, r = 0.652; GI: U = 3,782, $p < 0.001$, r = 0.964). From preclinical to clinical years, males showed an 88.2% PI reduction (1.969 ± 0.270 to 0.232 ± 0.156) and a 74.1% GI reduction (2.559 ± 0.308 to 0.662 ± 0.233); females showed a 55.2% PI reduction (1.111 ± 0.249 to 0.498 ± 0.230) and a 20.6% GI reduction (1.803 ± 0.237 to 1.432 ± 0.304). Five of six pairwise PI and GI comparisons remained statistically significant after BH-FDR correction (all $q < 0.001$). Primary findings were largely replicated in non-smoking participants (Additional file 3).

Periodontal Classification

Periodontal status distribution is presented in Table 5. Across 255 participants, 55 (21.6%) had periodontal health and 200 (78.4%) had gingivitis on an intact periodontium: mild 123 (48.2%), moderate 70 (27.5%), severe 7 (2.7%). No participant had CAL or PPD > 3 mm; periodontitis was absent in all students. The distribution differed markedly across subgroups (Fisher's exact test, Monte Carlo $p < 0.001$): periodontal health was present in 53 of 55 clinical male students (96.4%), 2 of 70 clinical female students (2.9%), and no preclinical students. All seven severe gingivitis cases were confined to preclinical male students (11.3% of that subgroup).

PI–GI Spearman Correlation

The overall Spearman correlation between PI and GI was strong (rs = 0.851, 95% CI: 0.813–0.882; $p < 0.001$; Additional file 4). Within individual subgroups, however, correlations were substantially attenuated. In three of four subgroups the correlation was near-zero and non-significant: clinical female rs = 0.025 (p = 0.837), clinical male rs = 0.113 (p = 0.412), and preclinical male rs = −0.050 (p = 0.697) (Figure 3). The preclinical female correlation was weak but statistically significant (rs = 0.270, 95% CI: 0.034–0.478; p = 0.026). Detailed subgroup correlations are presented in Additional file 5.

DISCUSSION

This study found that clinical dental training was associated with improvements in both self-reported oral health attitudes and clinical periodontal status, yet these improvements operate through distinct and often decoupled mechanisms. HU-DBI scores were significantly higher in clinical than in preclinical students, consistent with the expected influence of clinical education on oral health-related knowledge and attitudes. Clinical periodontal status also improved markedly across academic years, with very large effect sizes for both plaque accumulation and gingival inflammation. However, the magnitude and gender patterning of improvement differed substantially between the two types of measure. Whereas academic year was the only significant factor in HU-DBI scores — with no evidence of a gender difference or a year×gender interaction — both PI and GI showed a significant academic year×gender interaction that was not reflected in the questionnaire data. These findings indicate that the HU-DBI and clinical periodontal indices, while associated at the group level, do not provide equivalent information about oral health across student groups.

The HU-DBI scores observed in this study are broadly consistent with values reported for dental students in other settings, including prior Turkish studies [8-10,14], as well as international studies in Sudan [15], Japan and Finland [16], China [17], several Arab countries [18], and Germany [19]. Higher HU-DBI scores in clinical-year students than in preclinical students have been reported across multiple countries and educational systems [15–19], and the present findings are consistent with this pattern. The moderate effect size for the academic year difference (Cohen's $d = 0.58$) suggests a genuine but limited attitudinal improvement associated with clinical training. At the item level, clinical male students had the lowest favourable response rate for item Q6 ("I think I will inevitably have false teeth when I get old"; 10.3%), despite having the best clinical outcomes of any group. This dissociation between long-term dental expectations and actual clinical behaviour has been noted previously [10] and warrants attention in patient education training.

The reversal of gender differences in clinical periodontal indices between preclinical and clinical years was an unexpected finding. In preclinical students, females had significantly better plaque control and gingival health than males, which is consistent with previously reported gender differences in oral hygiene behaviour [23]. In clinical

students, however, this pattern reversed markedly: male students achieved substantially greater improvements in both PI and GI, with 96.4% attaining periodontal health, compared with only 2.9% of clinical female students.

Several possible explanations for this reversal can be proposed. First, male preclinical students had substantially higher baseline PI and GI values, providing greater absolute room for improvement; some of the observed gain in males may therefore reflect regression toward the mean. Second, clinical training may have differentially motivated male students to improve their oral hygiene practices, perhaps through greater responsiveness to patient feedback or clinical supervision. Third, hormonal factors may have contributed to the persistence of gingival inflammation observed in clinical female students. Oestrogen and progesterone are known to modulate periodontal tissue responses, and may promote gingival inflammation independently of plaque levels [24-26]. Consistent with this possibility, clinical female students maintained low PI values yet retained clinically significant gingival inflammation throughout training. However, hormonal data were not collected in this study, and this explanation remains speculative; longitudinal studies with hormonal assessments are required to evaluate this hypothesis directly.

A key observation of this study is that questionnaire-based measures and clinical periodontal indices captured different dimensions of oral health in this student population. The HU-DBI identified a modest, gender-uniform improvement with clinical training; the clinical indices revealed a much larger and gender-divergent pattern. This finding is consistent with prior evidence suggesting that self-reported behavioural instruments and clinical measures do not always converge in dental populations [11,12], and supports the view that the two types of assessment provide complementary rather than interchangeable information about students' oral health. The observed discrepancy between self-reported knowledge and actual clinical periodontal status suggests that academic progression does not automatically translate into optimal clinical periodontal health. This may partly reflect the well-documented phenomenon whereby students, despite acquiring theoretical knowledge, face competing academic stressors and clinical workload that may hinder consistent personal oral hygiene maintenance. Furthermore, the potential influence of 'social desirability bias' in self-reporting among clinical students, who are more aware of expected standards, cannot be excluded as a factor contributing to the discordance between perceived attitudes and objective clinical indices.

A related methodological observation concerns the interpretation of the PI–GI Spearman correlation. The overall correlation (rs = 0.851) might suggest strong within-individual plaque–inflammation coupling, but within each of the four subgroups the correlation was near-zero and non-significant in three of four cases. The overall correlation reflects between-group heterogeneity in PI and GI levels rather than within-individual association, a well-recognised phenomenon in cross-sectional observational data [27,28]. This finding illustrates the caution needed when interpreting pooled correlations across subgroups that differ substantially in outcome levels.

These findings have potential implications for dental education. The use of questionnaire-based instruments alone may provide an incomplete picture of students' periodontal health status, particularly when clinical outcomes differ substantially across subgroups. Integrating periodic clinical periodontal monitoring with standardised attitudinal assessment may offer more comprehensive information for curriculum evaluation and student oral health programmes. Gender-responsive oral hygiene instruction, incorporating content on the potential effects of hormonal variation on gingival health, may also be a worthwhile curriculum consideration. As of 2023, Turkey hosts over 100 dental faculties with annual enrolment exceeding 9,000 students [29], and targeted curriculum refinements could have meaningful impact at scale.

This study has several limitations that should be considered when interpreting the findings. First, and most importantly, questionnaires were completed anonymously, which precluded individual-level linkage between HU-DBI responses and clinical examination data. All comparisons were performed at group level, and it is not possible to determine from these data whether individual students with more favourable attitudes also had better clinical outcomes. Future longitudinal designs linking individual student questionnaire responses to their specific clinical examinations are needed to confirm this relationship at the individual level. Additionally, the classification of clinical periodontal categories was based on approximated PI/GI thresholds, which may limit generalizability compared to more rigorous longitudinal assessments. Second, the cross-sectional design means that comparisons between academic year groups reflect differences between different cohorts of students rather than within-individual change over time; observed differences may therefore reflect pre-existing cohort characteristics rather than the effects of training per se. Third, full periodontal classification per the 2017 World Workshop criteria [30,31] was not possible, as bleeding on probing was not recorded; clinical categories were approximated

using available examination variables. To address this, mean GI score per individual was used as a surrogate gingivitis variable; this approach has methodological precedent in the experimental gingivitis literature [32] and in established gingivitis case definitions used prior to the binary BOP requirement [33]. Fourth, hormonal data were not collected, and the proposed hormonal contribution to gender differences in gingival health remains unconfirmed. Fifth, this study was conducted at a single institution during the 2018–2019 academic year, which limits generalisability; findings may not reflect the full diversity of Turkish dental education or educational systems in other countries. This pre-pandemic dataset may, however, serve as a useful reference baseline for future studies examining the impact of curricular change or pandemic-related disruption on dental student oral health.

CONCLUSION

Clinical periodontal examination provides information about students' oral health that is not fully captured by self-reported behavioural questionnaires. Integrating periodic clinical periodontal monitoring with standardised attitudinal assessment may offer a more comprehensive approach to evaluating and aligning oral health attitudes with tangible clinical outcomes in dental education programmes.

DECLARATIONS

Ethics approval and consent to participate

This study was approved by the Istanbul Aydın University Faculty of Dentistry Clinical Research Ethics Committee (Protocol No: B.30.2.AYD.0.00.00-480.2/157) under a joint research protocol with Istanbul University Faculty of Dentistry. All procedures were conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment. All participants were adults (≥18 years of age) and provided voluntary written consent after receiving information about the study's purpose and procedures.

Consent for publication

Not applicable. This manuscript does not contain any individual person's data, images, or videos that require individual consent for publication.

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to participant confidentiality but are available from the corresponding author on reasonable request. Summary-level data supporting the findings are included in this published article and its additional files.

Competing interests

The authors declare that they have no competing interests.

Funding

No external funding was received for this study.

Authors' contributions

G.K: Investigation, Data Curation, Writing – Original Draft, Formal Analysis, Visualization, Writing – Review & Editing; **C.K:** Investigation, Writing – Original Draft, Writing – Review & Editing; **B.A:** Investigation, Writing – Original Draft, Clinical Examination, **D.Y:** Investigation, Writing – Original Draft, Conceptualization, Supervision, Writing – Review & Editing

Clinical trial number

Not applicable.

Acknowledgements

The authors acknowledge the use of Claude (Anthropic, https://claude.ai), Google Gemini (https://gemini.google.com), and QuillBot (https://quillbot.com) for language editing, grammar checking, structural manuscript organisation, and improving clarity and readability of the manuscript. Additionally, Google Gemini in combination with Google Colab was used for generating graphical visualizations (figures) based entirely on the study's results and data provided by the authors. Claude was used to assist with manuscript structural editing, formatting compliance with journal guidelines, and preparation of supplementary materials. No AI tool was used for data analysis, data interpretation, or generation of scientific content. All AI-assisted outputs were critically reviewed, verified, edited, and revised by the authors, who take full responsibility for the accuracy, scientific integrity, and final content of the manuscript.

List of abbreviations

BH-FDR: Benjamini–Hochberg false discovery rate; BOP: bleeding on probing; GI: Gingival Index; HU-DBI: Hiroshima University–Dental Behavioral Inventory; ICC: intraclass correlation coefficient; IQR: interquartile range; PI: Plaque Index; PPD: probing pocket depth; SD: standard deviation; SRH: Scheirer–Ray–Hare test; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology.

REFERENCES

1. Vos T, Lim SS, Abbafati C, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019. Lancet. 2020;396(10258):1204–22. doi: 10.1016/S0140-6736(20)30925-9. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30925-9/fulltext

2. Peres MA, Macpherson LM, Weyant RJ, Daly B, Venturelli R, Mathu MR et al. Oral diseases: a global public health challenge. Lancet. 2019 Sep 21;394(10203):1010. doi: 10.1016/S0140-6736(19)32079-3. https://www.sciencedirect.com/science/article/abs/pii/S0140673619311468

3. Gupta V, Baliyan A, Kaushik N, Tyagi P. A Cross-Sectional Study of Oral Hygiene Knowledge and Practices Among Undergraduate Dental Students: Bridging the Gap Between Theory and Practice. Cureus. 2026;18(4):e106569. doi: 10.7759/cureus.106569. https://pmc.ncbi.nlm.nih.gov/articles/PMC13150784/

4. Kawamura M. Dental behavioral science: the relationship between perceptions of oral health and oral status in adults. J Osaka Univ Dent Sch. 1988;28:151–76.

5. Kawamura M, Iwamoto Y, Wright FA. A comparison of self-reported dental health attitudes and behavior between selected Japanese and Australian students. J Public Health Dent. 1997;57(3):190–6.

6. Kawamura M, Yip HK, Hu DY, Komabayashi T. A cross-cultural comparison of dental health attitudes and behaviour among freshman dental students in Japan, Hong Kong and PR China. Int Dent J. 2001;51(3):159–63. doi: 10.1002/j.1875-595x.2001.tb00833.x

7. Kawamura M, Spadafora A, Kim KJ, Komabayashi T. Comparison of United States and Korean dental hygiene students using the HU-DBI. Int Dent J. 2002;52(3):156–62. doi: 10.1111/j.1875-595x.2002.tb00621.x

8. Peker I, Alkurt MT, Usta MG, Turkbay T. The evaluation of oral health attitudes and behavior of a group of Turkish dental students using the HU-DBI. Eur J Dent. 2009;3(1):10–4. https://pmc.ncbi.nlm.nih.gov/articles/PMC2647956/

9. Yildiz S, Dogan B. Self reported dental health attitudes and behaviour of dental students in Turkey. Eur J Dent. 2011;5(3):2539. https://pmc.ncbi.nlm.nih.gov/articles/PMC3137437/

10. Dayan E, Emiroğlu S. Disparities in oral health attitudes and health responsibility: A cross-sectional comparison of dental and vocational students utilising the Hiroshima University-Dental Behavioural Inventory and the Health-Promoting Lifestyle Profile II. Eur J Dent Educ. 2025;0:1-8. doi: 10.1111/eje.70061.

11. Hassan BK, Ström I, Lingström P, Cederberg RA. Self-reported oral health attitudes, and behaviors, and gingival status of dental students. Clin Cosmet Investig Dent. 2020;12:569–79. 10.2147/CCIDE.S249708

12. Gilbert AD, Nuttall NM. Self-reporting of periodontal health status. Br Dent J. 1999;186(5):241–4. 10.1038/sj.bdj.4800075

13. Rahman B, Al Kawas S. The relationship between dental health behavior, oral hygiene and gingival status of dental students in the United Arab Emirates. Eur J Dent. 2013;7(1):22-27. https://pmc.ncbi.nlm.nih.gov/articles/PMC3571505/

14. Pınar Erdem A, Peker K, Kuru S, Sepet E. Evaluation of Final-Year Turkish Dental Students' Knowledge, Attitude, and Self-Perceived Competency towards Preventive Dentistry. BioMed Res Int. 2019;2019:2346061. doi: 10.1155/2019/2346061.

15. Mohamed W, Mohammed HA. Knowledge, Practices and Attitude among Sudanese Dental Students towards Oral Health. European Journal of Research in Dentistry. 2024;12;8(3):138-44. https://dergipark.org.tr/en/pub/erd/article/1567240

16. Kawamura M, Honkala E, Widström E, Komabayashi T. Cross-cultural differences of self-reported oral health behaviour in Japanese and Finnish dental students. Int Dent J. 2000;50(1):46-50. doi: 10.1111/j.1875-595x.2000.tb00546.x

17. Yao K, Yao Y, Shen X, Lu C, Guo Q. Assessment of the oral health behavior, knowledge and status among dental and medical undergraduate students: a cross-sectional study BMC Oral Health. 2019;19(1):26. doi: 10.1186/s12903-019-0716-6

18. Riad A, Al-Khanati NM, Issa J, Zenati M, Ben Abdesslem N, Attia S, Krsek M. Oral Health-Related Knowledge, Attitudes and Behaviours of Arab Dental Students: Multi-

National Cross-Sectional Study and Literature Analysis 2000-2020. Int J Environ Res Public Health. 2022;19(3):1658. doi: 10.3390/ijerph19031658.

19. Mekhemar M, Conrad J, Attia S, Dörfer C. Oral Health Attitudes among Preclinical and Clinical Dental Students in Germany. Int J Environ Res Public Health. 2020;17(12):4274. doi: 10.3390/ijerph17124253.

https://www.mdpi.com/1660-4601/17/12/4253

20. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. Lancet. 2007;370(9596):1453-7. doi: 10.1016/S0140-6736(07)61602-X

21. Silness J, Löe H. Periodontal disease in pregnancy II: correlation between oral hygiene and periodontal condition. Acta Odontol Scand. 1964;22(1):121–35.

22. Löe H, Silness J. Periodontal disease in pregnancy I: prevalence and severity. Acta Odontol Scand. 1963;21(6):533–51.

23. Furuta M, Ekuni D, Irie K, Azuma T, Tomofuji T, Toshio O, et al. Sex differences in gingivitis relate to interaction of oral health behaviors in young people. J Periodontol. 2011;82(4):558-65. doi: 10.1902/jop.2010.100444.

24. Mariotti A. Sex steroid hormones and cell dynamics in the periodontium. Crit Rev Oral Biol Med. 1994;5(1):27-53. doi: 10.1177/10454411940050010201.

25. Machtei EE, Mahler D, Sanduri H, Peled M. The effect of menstrual cycle on periodontal health. J Periodontol. 2004 ;75(3):408-12. doi: 10.1902/jop.2004.75.3.408.

26. Mariotti A, Mawhinney M. Endocrinology of sex steroid hormones and cell dynamics in the periodontium. Periodontol 2000. 2013;61(1):69-88. doi: 10.1111/j.1600-0757.2011.00424.x.

27. Robinson WS. Ecological correlations and the behavior of individuals. Int J Epidemiol. 2009;38(2):337-41. doi: 10.1093/ije/dyn357.

28. Sedgwick P. Understanding the ecological fallacy. BMJ. 2015;21:351:h4773. doi: 10.1136/bmj.h4773.

29. Acar NK, Sahin N, Celikel P. Comparison of students' satisfaction levels in different dentistry faculties in Türkiye. BMC Med Educ. 2025;16;25(1):1064. doi: 10.1186/s12909-025-07677-8.

30. Caton JG, Armitage G, Berglundh T, Chapple ILC, Jepsen S, Kornman KS, et al. A new classification scheme for periodontal and peri-implant diseases and conditions. J Clin Periodontol. 2018;45 Suppl 20:S1-S8. doi: 10.1111/jcpe.12935.

31. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: framework and proposal of a new classification and a case definition for periodontitis. J Periodontol. 2018;89 Suppl 1:S159-S172. doi: 10.1002/JPER.18-0006.

32. Löe H, Theilade E, Jensen SB. Experimental gingivitis in man. J Periodontol. 1965;36:177-87. doi: 10.1902/jop.1965.36.3.177.

33. Trombelli L, Farina R, Silva CO, Tatakis DN. Plaque-induced gingivitis: Case definition and diagnostic considerations. J Periodontol. 2018;89 Suppl 1:S46-S73. doi: 10.1002/JPER.17-0576.

FIGURE CAPTIONS AND LEGENDS

Figure 1. Plaque Index (PI) by academic level and gender (n = 255).

Box plots display the median (central line), interquartile range (box), and 1.5×IQR (whiskers); individual observations are shown as gray dots. Significance brackets annotate within-group gender comparisons (clinical female vs. clinical male; preclinical female vs. preclinical male) and the overall academic-level comparison; all are significant after Benjamini–Hochberg FDR correction (*** $q < 0.001$). The Scheirer–Ray–Hare Year × Gender interaction ($H(1) = 33.42$, $p < 0.001$) is annotated within the figure. Note the reversal of gender direction between preclinical and clinical years: preclinical males have higher PI than preclinical females, while clinical males have lower PI than clinical females. CF = Clinical Female (n = 70); CM = Clinical Male (n = 55); PF = Preclinical Female (n = 68); PM = Preclinical Male (n = 62). PI, Plaque Index (Silness–Löe, 0–3). Cross-year comparisons (CF vs PF: rank-biserial $r = 0.928$; CM vs PM: $r = 1.000$, $p < 0.001$) further illustrate the magnitude of the reversal and are reported in full in Table 3.

Figure 2. Gingival Index (GI) by academic level and gender (n = 255).

Box plots as described in Figure 1. The dashed horizontal line at GI = 1.0 indicates the threshold between periodontal health and gingivitis per the surrogate 2017 World Workshop classification. Note that clinical female students remain above this threshold despite improved plaque control, consistent with hormonally modulated gingival

inflammation. The Year × Gender interaction ($H(1) = 61.75$, $p < 0.001$) is annotated. *** $q < 0.001$ after BH-FDR. GI, Gingival Index (Löe–Silness, 0–3).

Figure 3. Scatter plots of PI vs. GI by subgroup with Spearman rank correlations (n = 255).

Each panel shows individual data points with an ordinary least-squares reference line for visual guidance. Spearman rs values and 95% confidence intervals (Fisher's z-transformation) are displayed within each panel. The near-zero and non-significant within-group correlations in three of four subgroups (clinical female $rs = 0.025$; clinical male $rs = 0.113$; preclinical male $rs = -0.050$; all $p > 0.05$) contrast sharply with the strong pooled correlation ($rs = 0.851$; Additional file 4), suggesting that the strong pooled correlation reflects between-group heterogeneity rather than within-individual plaque-inflammation relationships. The preclinical female correlation ($rs = 0.270$; $p = 0.026$) is weak and should be interpreted with caution. PI, Plaque Index; GI, Gingival Index; CI, confidence interval; ns, not significant ($p > 0.05$).

TABLE TITLES AND NOTES

Table 1. Modified Turkish HU-DBI questionnaire: item statements and scoring (items 1–20 scored; items 21–27 supplementary).

Items 1–20 constitute the scored HU-DBI inventory (total score range 0–20; higher scores indicate more positive oral health attitudes and behaviors). Each item is scored 1 for the response indicating a positive oral health behavior and 0 otherwise, per the validated Turkish scoring key.[8] Q5 (toothpick use) is scored as favorable per the original validated key; although contemporary guidelines favour interdental brushes over toothpicks, the original scoring was retained to maintain comparability with prior Turkish HU-DBI studies.[8,10,11] Q8 and Q12 exhibited zero-inflated distributions confined to the clinical female subgroup; inspection of original questionnaires confirmed these distributions reflect genuinely rare behaviors rather than data entry errors, and items were retained without recoding.

Table 2. Demographic characteristics and smoking behavior (HU-DBI n=264; clinical examination n=255).

Data presented as n (%) or mean ± SD. Preclinical: academic years 1–2; Clinical: years 3–5. Smoking status recorded from HU-DBI supplementary item 25. Female vs. male smoking rate: $\chi^2=3.356$, $p=0.067$ (not significant at $\alpha=0.05$).

Table 3. HU-DBI total scores and clinical periodontal indices by academic level and gender.

HU-DBI: mean ± SD; median [IQR] (n=264). PI and GI: mean ± SD; median [IQR] (n=255). All group comparisons: Mann–Whitney U; r=rank-biserial correlation; d=Cohen's d (bootstrap 95%CI, 2000 iterations). SRH=Scheirer–Ray–Hare non-parametric two-way test. Five of six pairwise PI comparisons and five of six GI comparisons significant after BH-FDR ($q < 0.001$); Female vs Male not significant for either index (PI: $q = 0.056$; GI: $q = 0.453$). NS=not significant. No PPD>3 mm detected. Cohen's d is reported as a descriptive measure only; rank-biserial correlation (r) is the inferential effect size for non-normally distributed data.

Table 4. HU-DBI item "agree" response frequencies by academic level and gender (n=264).

Chi-square or Fisher's exact test (Fisher's exact applied where any expected cell count < 5). BH-FDR correction applied across all 20 items per comparison set. * in Sig column = $q < 0.05$ after BH-FDR correction. CF = Clinical Female (n=72); CM = Clinical Male (n=58); PF = Preclinical Female (n=72); PM = Preclinical Male (n=62); YP = academic year comparison; GP = gender comparison; ns = not significant ($q \geq 0.05$). 19/20 items significant by academic year after FDR; 15/20 significant by gender after FDR.

Table 5. Periodontal status per 2017 World Workshop Criteria

Values presented as n (%). Classification criteria and statistical methods are detailed in the table note.

ADDITIONAL FILES

Additional file 1. STROBE checklist for cross-sectional studies

Completed STROBE statement checklist documenting reporting of all required items, with section, paragraph, and table/figure locations within the manuscript [20].

Additional file 2. Participant flow diagram.

STROBE-compliant flow diagram showing recruitment, response rate, and subgroup distribution (HU-DBI n = 264; clinical examination n = 255).

Additional file 3. Non-smoker sensitivity analysis

Mann–Whitney U comparisons of HU-DBI scores in non-smoking participants only (n = 206), with BH-FDR-corrected q values and rank-biserial effect sizes.

Additional file 4. Overall PI–GI scatter plot across all students.

Title and description: Scatter plot showing the overall Spearman correlation (rs = 0.851) with subgroup colour-coding to illustrate between-group heterogeneity.

Additional file 5. Spearman PI–GI correlations by subgroup and combined group.

Spearman rs values with 95% Fisher's z confidence intervals across all participants, combined academic-year and gender groups, and the four individual subgroups.

Figures

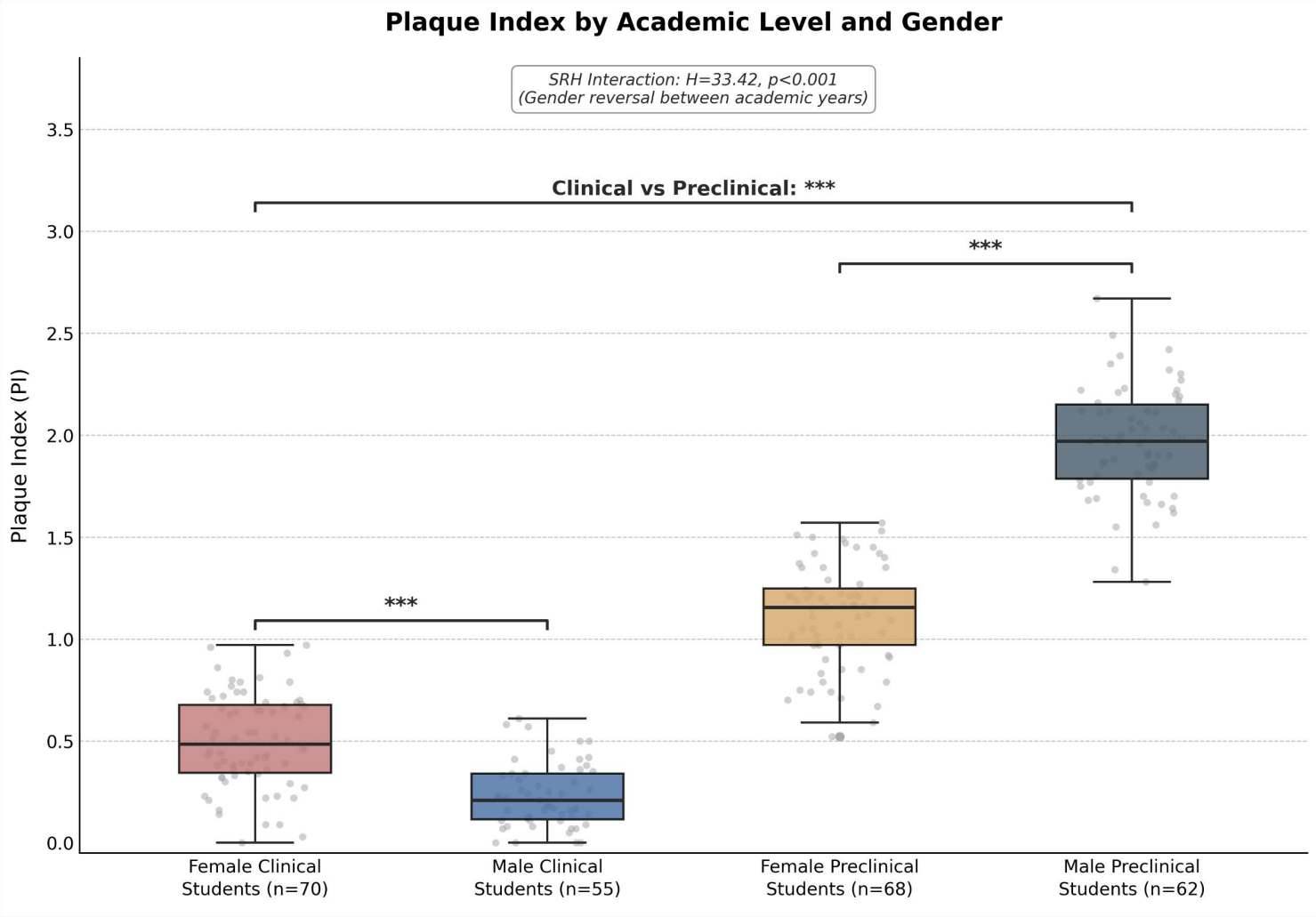


Figure 1

Plaque Index (PI) by academic level and gender (n = 255).

Box plots display the median (central line), interquartile range (box), and 1.5×IQR (whiskers); individual observations are shown as gray dots. Significance brackets annotate within-group gender comparisons (clinical female vs. clinical male; preclinical female vs. preclinical male) and the overall academic-level comparison; all are significant after Benjamini–Hochberg FDR correction (*** $q < 0.001$). The Scheirer–Ray–Hare Year × Gender interaction ($H(1) = 33.42$, $p < 0.001$) is annotated within the figure. Note the reversal of gender direction between preclinical and clinical years: preclinical males have higher PI than preclinical females, while clinical males have lower PI than clinical females. CF = Clinical Female (n = 70); CM = Clinical Male (n = 55); PF = Preclinical Female (n = 68); PM = Preclinical Male (n = 62). PI, Plaque Index (Silness–Löe, 0–3). Cross-year comparisons (CF vs PF: rank-biserial $r = 0.928$; CM vs PM: $r = 1.000$, $p < 0.001$) further illustrate the magnitude of the reversal and are reported in full in Table 3.

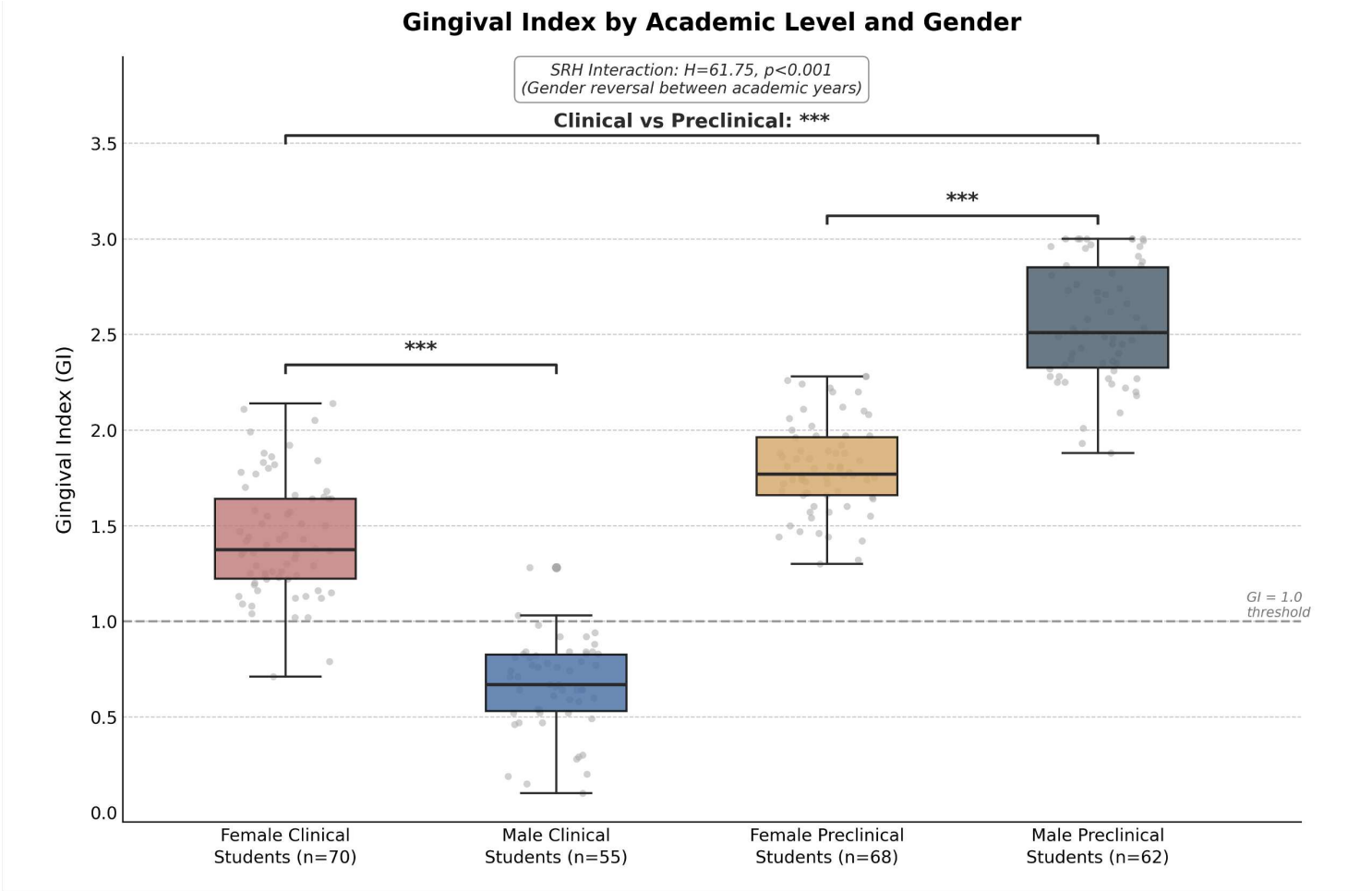
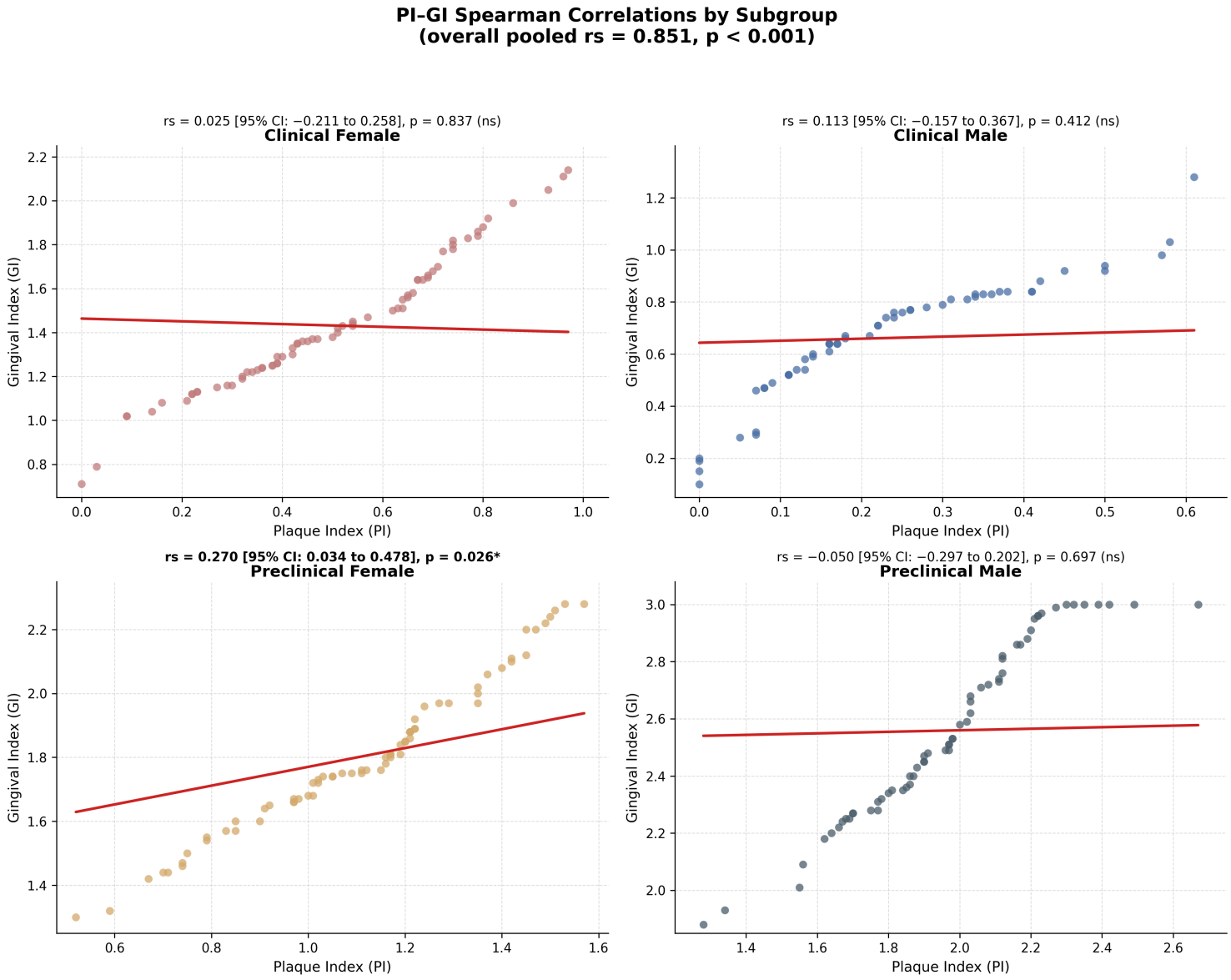


Figure 2

Gingival Index (GI) by academic level and gender (n = 255).

Box plots as described in Figure 1. The dashed horizontal line at GI = 1.0 indicates the threshold between periodontal health and gingivitis per the surrogate 2017 World Workshop classification. Note that clinical female students remain above this threshold despite improved plaque control, consistent with hormonally modulated gingival inflammation. The Year × Gender interaction ($H(1) = 61.75$, $p < 0.001$) is annotated. *** $q < 0.001$ after BH-FDR. GI, Gingival Index (Löe–Silness, 0–3).



Note: axis scales differ across panels to show within-group variation; between-group separation is illustrated in Figures 1 and 2. Lines represent ordinary least-squares fits shown for visual reference only; all correlations are Spearman rank-based.

Figure 3

Scatter plots of PI vs. GI by subgroup with Spearman rank correlations (n = 255).

Each panel shows individual data points with an ordinary least-squares reference line for visual guidance. Spearman rs values and 95% confidence intervals (Fisher's z-transformation) are displayed within each panel. The near-zero and non-significant within-group correlations in three of four subgroups (clinical female rs = 0.025; clinical male rs = 0.113; preclinical male rs = −0.050; all p > 0.05) contrast sharply with the strong pooled correlation (rs = 0.851; Additional file 4), suggesting that the strong pooled correlation reflects between-group heterogeneity rather than within-individual plaque-inflammation relationships. The preclinical female correlation (rs = 0.270; p = 0.026) is weak and should be interpreted with caution. PI, Plaque Index; GI, Gingival Index; CI, confidence interval; ns, not significant (p > 0.05).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AdditionalFile1STROBEv3280626.docx
- AdditionalFile5v2.docx
- AdditionalFile3v2.docx
- AdditionalFile2ParticipantFlowv2.png
- AdditionalFile4PooledPIGICorrelationv2.png
- Table1HUDBIItemsv2.docx
- Table2Demographicsv2.docx
- Table3ScoresClinicalv2.docx
- Table4ItemFrequenciesv2.docx
- Table5PeriodontalClassificationv2.docx