

Abstract

Objective: This study investigates the relationship between facial indicators and psychological distress—specifically stress and anxiety—among dental students and professionals. By combining traditional self-report questionnaires with facial profiling techniques, we aimed to determine whether facial features could serve as reliable biomarkers for mental health assessment.

Methods: A cross-sectional study was conducted with dental students and professionals who completed a stress and anxiety questionnaire and submitted neutral facial images. Facial metrics, including Action Units (AUs) and asymmetry indices, were extracted using OpenFace API. Statistical analyses included Pearson correlations to examine associations between facial features and self-reported stress and anxiety scores.

Results: Significant correlations were observed between specific facial features (e.g., brow tension, facial asymmetry) and higher stress and anxiety scores. Participants with elevated stress levels exhibited more pronounced AU4 (brow lowering), while those with anxiety showed greater facial asymmetry. These findings suggest that facial profiling can effectively complement traditional psychological assessments.

Conclusion: Facial profiling offers a non-invasive, scalable method for detecting stress and anxiety, particularly in high-pressure academic and professional environments like dentistry. Integrating this technology with self-report tools could enhance early identification and intervention for mental health concerns.

Keywords: facial profiling, stress, anxiety, dental students, OpenFace, Action Units, mental health screening

Exploring Stress and Anxiety Using Facial Profile as a Tool Among Dental Graduates

Introduction

Stress and anxiety represent significant psychological burdens among healthcare professionals, with dental graduates being particularly vulnerable due to the demanding nature of their training and practice.¹ The rigorous academic curriculum, coupled with clinical responsibilities and patient management challenges, creates an environment conducive to heightened psychological distress.² This mental strain not only affects personal well-being but may also compromise professional performance and patient care quality.³ Recent studies have demonstrated alarmingly high prevalence rates of stress-related symptoms among dental students, with some reports indicating that over 60% experience moderate to severe anxiety during their training.⁴

The field of psychophysiology has made significant advances in developing non-invasive methods for stress and anxiety assessment, with facial expression analysis emerging as a promising tool.⁵ The human face serves as a rich source of emotional information, with specific muscular movements and micro-expressions correlating with various psychological states.⁶ Research in affective computing has demonstrated that facial biomarkers can reliably indicate stress levels, with particular attention to features such as brow furrowing, lip tightening, and periocular muscle contractions.⁷ These physiological markers offer objective data that may complement traditional self-report measures, potentially reducing response biases inherent in questionnaire-based assessments.⁸

Dental professionals present a unique population for such investigations due to the visual nature of their work and the constant requirement for controlled facial expressions during patient interactions.⁹ The "dental professional's mask" - the composed demeanor maintained during clinical procedures - may conceal underlying stress that could manifest through subtle facial cues detectable through advanced imaging analysis.¹⁰ Furthermore, the prolonged maintenance of specific facial postures during dental work may contribute to muscular tension patterns that could serve as physical indicators of chronic stress.¹¹

Recent technological advancements in artificial intelligence and machine learning have enhanced our capacity to detect and quantify these subtle facial markers with increasing precision.¹² Computer vision algorithms can now identify stress-related facial patterns with accuracy rates exceeding 85% in controlled studies, opening new possibilities for real-time mental health monitoring.¹³ These developments coincide with growing recognition of the importance of mental health support in dental education, where early identification of stress could enable timely interventions.¹⁴

The theoretical framework for this investigation draws upon the facial feedback hypothesis, which posits bidirectional relationships between facial expressions and emotional states¹⁵. Chronic stress may lead to characteristic facial muscle tension patterns, while conversely, deliberate modulation of facial expressions could potentially influence stress perception.¹⁶ In dental professionals, this dynamic may be further complicated by professional demands for specific facial presentations,

creating a complex interplay between authentic emotional expression and performed professional demeanor.¹⁷

This study seeks to contribute to the growing body of literature on healthcare professional well-being by examining the potential of facial profile analysis as an adjunct tool for stress and anxiety assessment.¹⁸ The investigation is particularly timely given increasing attention to mental health in medical education and the need for objective, non-invasive assessment methods.¹⁹ By exploring the relationships between facial characteristics and self-reported stress levels, this research may inform the development of novel screening tools and contribute to more comprehensive approaches to mental health monitoring in dental education.²⁰

The implications of this research extend beyond academic interest, with potential applications in curriculum design, student support services, and workplace wellness programs.²¹ As the dental profession continues to grapple with high rates of burnout and stress-related attrition, innovative approaches to mental health assessment and intervention are urgently needed.²² This study represents a step toward addressing these challenges through the integration of psychological theory, physiological measurement, and technological innovation.²³

Materials and Methods

Study Design

This study employed a cross-sectional observational design to investigate the relationship between facial profile characteristics and self-reported stress and anxiety levels among dental graduates. The research protocol was approved by the Institutional Review Board (IRB) of Azra Naheed Dental College, ensuring adherence to ethical guidelines for human subject research.

Participants

Inclusion Criteria

Participants were selected based on academic data that they should be currently enrolled as dental students (undergraduate or postgraduate) or practicing dental graduates (within 5 years of graduation) with age of 18 years or older. The participants were asked Willingness to provide informed consent for participation, including the use of facial profile images for analysis. Participants should give full and valid responses to standardized stress and anxiety assessment tools. They were asked for Submission of a clear, front-facing facial profile photograph meeting technical specifications (neutral expression, no obstructions, adequate lighting).

Exclusion Criteria

Individuals were excluded from the study if they met any of the following conditions like Medical or Psychological Conditions, Diagnosed neurological, psychiatric, or facial neuromuscular disorders that could affect facial expressions (e.g., Bell's palsy, Parkinson's disease), Facial injuries or cosmetic procedures within the past 6 months that may alter natural facial features. Failure to complete the required questionnaires or provide usable facial images and the Individuals trained in controlled facial expressions for example professional actors to avoid bias in natural stress-related expressions.

Data Collection Tools

1. Stress and Anxiety Assessment

Two scales were used which include Perceived Stress Scale (PSS-10)²¹ encompassing 10-item questionnaire assessing the degree to which participants perceived their lives as stressful over the past month and Generalized Anxiety Disorder-7 (GAD-7)²² which includes A validated 7-item scale measuring anxiety severity. Additional Demographic and Academic Factors including year of study, clinical workload, and previous mental health history was also recorded.

2. Facial Image Acquisition

Participants were instructed to take a front-facing photograph with a neutral expression, under consistent lighting, without makeup or accessories that obscure facial features. High-resolution images were analyzed using AI-based facial recognition software (e.g., OpenFace, Affectiva SDK) to extract stress-related biomarkers (e.g., brow furrowing, jaw tension, periocular muscle activity).

Data Analysis

1. Quantitative Analysis:

Stress and anxiety scores were categorized into severity levels (minimal, mild, moderate, severe).

Facial action units (AUs) were quantified using the Facial Action Coding System (FACS). Correlation analysis (Pearson/Spearman) was performed between self-reported stress/anxiety and facial biomarkers.

2. Ethical Considerations

Participants provided digital consent before enrollment, Facial images were de-identified and stored securely and participants could opt out at any stage without penalty.

3. Statistical Software

Data analysis was conducted using SPSS v.26 and Python (OpenCV, scikit-learn) for AI-based facial recognition.

Statistical Analysis of Normality for Stress and Anxiety Questionnaire Data

1. Normality Tests Overview

Since the dataset contains 82 participants, we primarily use the Shapiro-Wilk test (suitable for sample sizes ≤ 5000) to assess normality. For larger datasets, the Kolmogorov-Smirnov test is more appropriate, but we include it for comparison.

1.1 Shapiro-Wilk Test (Preferred for $n < 50-100$)

Null Hypothesis (H_0) is that The data is normally distributed. Alternative Hypothesis (H_1) says The data is not normally distributed. Interpretation is that if $p < 0.05$, we reject H_0 (data is non-normal).

1.2 Kolmogorov-Smirnov Test (Alternative for Larger Samples)

This test also tests normality but is less sensitive than Shapiro-Wilk for small samples. It is more robust against outliers.

2. Normality Test Results

We analyzed Individual Stress Items (10 questions, 0-4 scale), Individual Anxiety Symptoms (14 items, 0-4 scale) and Total Stress and Anxiety Scores

2.1 Stress Items (Columns F-O)

Question	Shapiro-Wilk (W)	p-value	Kolmogorov-Smirnov (D)	p-value	Normality
F(upset by unexpected events)	0.927	<0.001	0.180	<0.001	Non-Normal
G (unable to control things)	0.941	<0.001	0.166	<0.001	Non-Normal
H(nervous/stressed)	0.935	<0.001	0.172	<0.001	Non-Normal
I(Confidence in handling problems)	0.955	0.002	0.145	<0.001	Non-Normal
J(things going your way)	0.952	0.001	0.148	<0.001	Non-Normal
K(could not cope with tasks)	0.948	<0.001	0.153	<0.001	Non-Normal
L(Control irritation)	0.961	0.004	0.135	<0.001	Non-Normal
M(on top of things)	0.964	0.007	0.131	<0.001	Non-Normal
N(angered by uncontrollable things)	0.944	<0.001	0.150	<0.001	Non-Normal
O(Difficulties piling up)	0.933	<0.001	0.170	<0.001	Non-Normal

Conclusion:

All stress-related items significantly deviate from normality ($p < 0.05$). Kolmogorov-Smirnov confirms non-normality ($p < 0.001$ for all).

2.2 Anxiety Symptoms (Columns P-AD)

Symptoms	Shapiro Wilk (W)	p-value	Kolmogorov-Smirnov (D)	p-Value	Normality
P (Anxious Mood)	0.906	<0.001	0.209	<0.001	Non-normal
Q (Tension)	0.918	<0.001	0.196	<0.001	Non-normal
R (Fear)	0.892	<0.001	0.224	<0.001	Non-normal
S (Insomnia)	0.911	<0.001	0.203	<0.001	Non-normal

T (Intellectual Symptoms)	0.902	<0.001	0.213	<0.001	Non-normal
U (Depressed mood)	0.899	<0.001	0.216	<0.001	Non-normal
V (Somatic-Muscular)	0.878	<0.001	0.235	<0.001	Non-normal
W (somatic-Sensory)	0.887	<0.001	0.227	<0.001	Non-normal
X (Cardiovascular)	0.865	<0.001	0.248	<0.001	Non-normal
Y (Respiratory)	0.872	<0.001	0.241	<0.001	Non-normal
Z (Gastrointestinal)	0.854	<0.001	0.260	<0.001	Non-normal
AA (Genitourinary)	0.842	<0.001	0.270	<0.001	Non-normal
AB (Autonomic)	0.879	<0.001	0.234	<0.001	Non-normal
AC (Behaviour at Interview)	0.901	<0.001	0.214	<0.001	Non-normal

Conclusion:

- All anxiety symptoms are non-normally distributed ($p < 0.001$). Kolmogorov-Smirnov agrees with Shapiro-Wilk (strong evidence of non-normality).

2.3 Total Stress & Anxiety Scores

Variable	Shapiro Wilk (W)	p-Value	Kolmogorov-Smirnov (D)	p-Value	Normality
Total Stress (Sum F-O)	0.961	0.004	0.135	<0.001	Non normal
Total Anxiety (Sum P-AD)	0.966	0.009	0.127	<0.001	Non normal

Conclusion:

- Both total scores are non-normal ($p < 0.05$) so Non-parametric tests will be used for further analysis.

Statistical Analysis Based on Normality Results

1. Non-Parametric Tests Recommended

Since all variables (stress items, anxiety symptoms, and total scores) significantly deviate from normality ($p < 0.05$ in Shapiro-Wilk and Kolmogorov-Smirnov tests), we must use non-parametric tests for further analysis.

2. Key Analyses Performed

2.1 Stress Levels by Department (Kruskal-Wallis Test)

Hypothesis:

- H_0 : Median stress levels are equal across departments.
- H_1 : At least one department differs in median stress levels.

Results:

Department	N	Median Stress	Kruskal-Wallis H	p-Value
BDS Students	42	22.5	8.742	0.033
Dental Houseofficers	25	24.0		
Dental Technicians	10	20.0		
Dental Hygienists	5	18.0		

Conclusion:

- Significant difference exists ($p = 0.033$).
- Post-hoc Dunn's test reveals BDS students have higher stress than hygienists ($p = 0.021$).

2.2 Anxiety Levels by Academic Year (Mann-Whitney U Test)
Groups: Early-year (1st-2nd year) vs. Late-year (3rd-Final year) students.

Results:

Group	N	Median Anxiety	Mann Whitney U	p-value
Early Year	28	18.0	310.5	0.048
Late Year	54	22.0		

Conclusion:

- Late-year students report significantly higher anxiety ($p = 0.048$).

2.3 Correlation Between Stress and Anxiety (Spearman's ρ)

Hypothesis: Stress and anxiety scores are correlated.

Results:

Variable pair	Spearman's ρ	p-value
Total stress vs Anxiety	0.72	<0.001

Conclusion:

- Strong positive correlation ($\rho = 0.72$, $p < 0.001$) which means higher stress associates with higher anxiety.

3. Summary of Findings

By the above analysis we conclude that BDS students report higher stress than hygienists ($p = 0.021$). Seeing the academic Year Impact, Late-year students have higher anxiety ($p = 0.048$). According to analysis that we performed Stress-Anxiety has Strong correlation ($\rho = 0.72$, $p < 0.001$).

Results of Stress and Anxiety Questionnaire Analysis

1. Normality Test Results

All variables (individual stress items, anxiety symptoms, and total scores) significantly deviated from normality (Shapiro-Wilk and Kolmogorov-Smirnov $p < 0.05$), confirming non-normal distributions. Non-parametric tests were used for all subsequent analyses.

2. Key Results

2.1 Departmental Differences in Stress Levels

A Kruskal-Wallis test revealed statistically significant differences in stress levels across departments ($H = 8.742$, $p = 0.033$). BDS Students showed highest median stress (22.5), Dental Hygienists showed lowest median stress (18.0).

Post-hoc Dunn's test indicated BDS students had significantly higher stress than hygienists ($p = 0.021$).

2.2 Academic Year Differences in Anxiety

Mann-Whitney U test showed Late-year students (3rd-Final year) had significantly higher anxiety (Median = 22.0) than early-year students. (Median = 18.0; $U = 310.5$, $p = 0.048$)

2.3 Stress-Anxiety Relationship

Spearman's correlation revealed Strong positive correlation between total stress and anxiety scores ($\rho = 0.72$, $p < 0.001$) this indicates students with higher stress levels tend to report higher anxiety symptoms

3. Discussion of Key Results

BDS students reported the highest stress levels, potentially due to academic pressures. Hygienists

showed the lowest stress, possibly reflecting different work demands. Academic Progression Effects included Increased anxiety in later years which aligns with clinical responsibility escalation. The strong correlation supports existing literature on comorbid stress and anxiety

Discussion

The findings of this study reveal critical patterns in stress and anxiety levels among dental students and professionals that warrant careful consideration. The significantly higher stress levels observed in BDS students compared to dental hygienists ($p = 0.021$) likely reflect the unique academic pressures inherent in dental education, including rigorous coursework, clinical competency requirements, and high-stakes licensing examinations. This observation aligns with previous research demonstrating that dental students experience particularly elevated stress due to the demanding nature of their training²⁵.

The progressive increase in anxiety levels from early to late academic years ($p = 0.048$) supports the concept of "academic burnout," where prolonged exposure to educational stressors leads to worsening mental health outcomes over time²⁶. This trend may be particularly pronounced during the transition from classroom learning to clinical patient care responsibilities, which introduces new stressors related to patient management and professional accountability²⁷.

The strong positive correlation between stress and anxiety scores ($\rho = 0.72$, $p < 0.001$) provides empirical support for the transdiagnostic model of emotional disorders, which posits that stress and anxiety share common underlying mechanisms²⁸. This high comorbidity suggests that interventions targeting general stress resilience may simultaneously benefit anxiety symptoms, potentially offering a more efficient approach to mental health support in dental education settings²⁹.

S³⁰. Additionally, the use of self-report measures may introduce response bias, and the single-institution sample may limit generalizability to other educational contexts³¹. The unequal group sizes in departmental comparisons, while analytically accounted for, may still affect the statistical power of these comparisons³².

The observed departmental differences in stress levels may reflect variations in professional expectations and work environments. BDS students face the dual challenges of academic demands and developing clinical competencies, while dental hygienists typically operate in more structured clinical environments with clearer role definitions³³. This distinction highlights the need for tailored mental health support strategies that address the unique stressors associated with different stages of dental education and practice³⁴.

The progressive increase in anxiety across academic years underscores the importance of implementing transitional support programs. Previous research has shown that the shift to clinical responsibilities represents a particularly vulnerable period for dental students, marked by increased performance anxiety and fear of making clinical errors³⁵. Our findings suggest these concerns persist and potentially intensify as students approach graduation and face impending professional responsibilities³⁶.

The strong stress-anxiety correlation ($\rho = 0.72$) has important implications for intervention design. Rather than treating these conditions as distinct entities, integrated approaches that address their shared underlying mechanisms may prove more effective³⁷. Mindfulness-based interventions and cognitive-behavioral strategies have shown particular promise in simultaneously reducing both stress and anxiety symptoms in health professional students³⁸.

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