

Correspondence

✉ Muhammad Anas,
anas.khan.jadoon137@gmail.com

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Declarations

No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Evaluating the Current State of Esthetic Dentistry Knowledge and Training Among Dental Students and Dentist in Pakistan

Muhammad Farrukh¹, Mariam Younus Paracha², Muhammad Anas³, Jawad Ahmed Shahok⁴, Nisha Prem Kumar⁴, Kumail Ali⁴

1 Margalla Institute of Health Sciences, Rawalpindi, Pakistan

2 Jinnah Medical and Dental College, Karachi, Pakistan

3 Bacha Khan Dental College, Mardan, Pakistan; Khyber Medical University, Peshawar, Pakistan

4 Liaquat University of Medical & Health Sciences, Jamshoro, Pakistan

ABSTRACT

Background: Esthetic dentistry has gained increasing importance due to heightened patient awareness of smile aesthetics and its psychosocial impact, placing greater demands on dental professionals to deliver predictable and high-quality esthetic outcomes. **Objective:** To evaluate the level of knowledge, perception, and training needs related to esthetic dentistry among dental students and general dental practitioners in Pakistan. **Methods:** A cross-sectional quantitative survey was conducted among 385 dental students and general dentists using a validated, self-administered questionnaire. Data were analyzed using descriptive statistics and inferential tests including chi-square, ANOVA, correlation analysis, and logistic regression, with significance set at $p<0.05$.

Results: A total of 235 responses were analyzed. Most participants recognized the impact of dental esthetics on appearance (97.9%) and social interaction (96.6%). Awareness of basic esthetic concepts was high; however, familiarity with advanced principles such as the golden proportion was limited (32.3%). Interest in further esthetic dentistry training was reported by 94% of respondents. Years of clinical experience showed a positive correlation with knowledge of esthetic terminology ($r=0.41$, $p<0.01$). **Conclusion:** Although dental professionals in Pakistan demonstrate strong awareness of the importance of esthetics, significant gaps exist in advanced esthetic knowledge and clinical application, underscoring the need for structured educational and continuing professional development programs.

Keywords

Esthetic dentistry, Smile design, Dental education, Cosmetic dentistry, Pakistan

INTRODUCTION

Esthetic dentistry has emerged as a central component of contemporary dental practice, driven by increasing patient awareness, rising social expectations, and advances in restorative materials and digital technologies (1). The appearance of the smile is now widely recognized as a determinant of social confidence, interpersonal communication, and psychological well-being, making dental esthetics an integral element of oral healthcare rather than a purely elective concern (2–4). As societal emphasis on facial appearance continues to intensify—particularly through social media exposure—patients increasingly seek dental treatments that enhance harmony, symmetry, and overall smile attractiveness (1,4). Consequently, dentists are expected not only to restore function but also to deliver outcomes that meet evolving esthetic standards.

Achieving optimal esthetic outcomes requires a multidisciplinary approach involving orthodontics, prosthodontics, and restorative dentistry, with careful consideration of tooth position, proportion, color, and gingival architecture (5–7). Among these factors, smile design principles—particularly the proportional relationships of the maxillary anterior teeth—play a decisive role in perceived dental attractiveness. The golden proportion has historically been proposed as a guideline for anterior tooth width relationships, suggesting a mathematically harmonious arrangement that contributes to smile balance (8–10). Although contemporary research acknowledges variability in esthetic preferences across populations and cultures, familiarity with such theoretical frameworks remains essential for informed clinical decision-making and individualized treatment planning (5,10).

Rapid technological advancements have further transformed esthetic dentistry, introducing digital smile design, CAD/CAM systems, advanced ceramic materials, and refined shade-matching protocols that enhance predictability and patient satisfaction (8,11). However, effective utilization of these innovations depends heavily on adequate training and conceptual understanding. In many developing countries, including Pakistan, esthetic dentistry is expanding rapidly in response to patient demand, yet structured training in advanced esthetic principles is inconsistently integrated into undergraduate curricula and continuing professional development programs (12,13). As a result, dentists may possess strong awareness of the importance of esthetics while lacking sufficient competence in applying complex esthetic concepts in clinical practice.

Existing literature from Pakistan and neighboring regions suggests that dental professionals generally recognize the impact of dental appearance on self-esteem and social interactions, but significant variation exists in their understanding of smile harmony, tooth proportions, and modern esthetic techniques (5,6,12). While some studies have explored perceptions of smile esthetics or preferences for anterior tooth proportions, there remains a paucity of empirical evidence assessing comprehensive knowledge, familiarity with advanced esthetic terminology, and perceived adequacy of training among both dental students and general dentists in Pakistan (5,12). Importantly, few studies have directly compared these groups or examined how professional experience influences awareness of higher-level esthetic concepts such as porcelain bonding restorations, shade matching complexities, and digital esthetic workflows.

This knowledge gap has important implications for clinical quality and patient outcomes. Without standardized training and evidence-based application of esthetic principles, there is a risk of inconsistent treatment results, unmet patient expectations, and suboptimal utilization of modern

restorative technologies. Understanding the current state of esthetic dentistry knowledge and training among future and practicing dentists is therefore essential to inform curriculum development, targeted workshops, and continuing education initiatives tailored to the needs of the Pakistani dental workforce.

Accordingly, the objective of this study was to evaluate the level of knowledge, awareness, and perceptions regarding esthetic dentistry among dental students and general dentists in Pakistan, with particular emphasis on smile design principles, advanced esthetic concepts, and perceived training needs, in order to identify existing gaps and inform strategies for educational and professional development.

MATERIALS AND METHODS

This study employed a cross-sectional observational design to assess knowledge, awareness, and perceptions related to esthetic dentistry among dental students and general dental practitioners in Pakistan. The cross-sectional approach was selected as it allows efficient measurement of prevailing knowledge levels and attitudes within a defined population at a single point in time, which is appropriate for exploratory evaluation of educational and professional gaps in a rapidly evolving clinical field (14). The study was conducted across multiple regions of Pakistan, including both urban and semi-urban settings, to enhance geographic and demographic representation. Data collection was carried out over a defined study period in 2024–2025 using an online survey platform to facilitate nationwide participation.

The study population comprised undergraduate dental students enrolled in accredited dental colleges and general dental practitioners actively engaged in clinical practice in Pakistan. Participants were eligible if they were currently studying dentistry or practicing as general dentists and were able to comprehend and respond to the questionnaire independently. Individuals who declined participation, submitted incomplete questionnaires, or reported conditions that could compromise valid responses to esthetic-related visual or conceptual questions, such as uncorrected visual impairment or color vision deficiency, were excluded to minimize measurement bias. A non-probability convenience sampling strategy was adopted due to the absence of a centralized national registry and the exploratory nature of the study, with efforts made to recruit participants from diverse institutions and practice settings to reduce selection bias.

The sample size was determined using a standardized sample size estimation approach for cross-sectional studies, assuming a 95% confidence level and a 5% margin of error, with the target population consisting of dental students and general dentists nationwide. This calculation yielded a required sample size of 385 participants to ensure adequate statistical power and precision. Anticipating non-response, recruitment efforts exceeded the minimum target. Participants were recruited through institutional networks, professional dental groups, and direct electronic invitations. The survey link was disseminated digitally, and participation was entirely voluntary. Prior to accessing the questionnaire, all participants were presented with an electronic informed consent statement outlining the study purpose, procedures, confidentiality assurances, and the right to withdraw at any time without consequence. Only participants who provided consent were permitted to proceed.

Data were collected using a structured, self-administered questionnaire developed following an extensive review of existing literature on esthetic dentistry education, smile design principles, and practitioner perceptions (5,6,12). The instrument consisted of items capturing demographic characteristics, including age, gender, academic status, years of professional experience, and practice location, followed by sections assessing knowledge of esthetic dentistry concepts, familiarity with commonly used esthetic terminologies, awareness of contemporary esthetic treatments and technologies, perceived importance of esthetics in restorative dentistry, and interest in further training. Knowledge-related variables were operationalized using self-rated scales and dichotomous awareness items, while perception variables were measured using categorical and Likert-type responses. Prior to full deployment, the questionnaire underwent pilot testing on a sample of dental professionals to assess clarity, relevance, and internal consistency, and revisions were made accordingly to enhance content validity and reliability.

Several measures were implemented to reduce bias and improve data integrity. An anonymous survey format was used to minimize social desirability bias and encourage honest responses. Mandatory response settings were applied to key variables to limit missing data, and automated logic checks within the survey platform reduced entry errors. To address potential confounding, demographic and professional variables such as academic level and years of experience were collected and incorporated into inferential analyses. Data were exported directly from the survey platform into statistical software to prevent transcription errors, and all datasets were stored securely with restricted access.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 27. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarize participant characteristics and response distributions. Inferential analyses were conducted based on variable type and distribution, with chi-square tests used to examine associations between categorical variables, independent t-tests and one-way analysis of variance employed to compare mean knowledge scores across groups, and logistic regression analysis performed to identify predictors of awareness of advanced esthetic concepts while adjusting for potential confounders. Assumptions for parametric testing were evaluated prior to analysis. Missing data were assessed for randomness and were minimal due to survey design; therefore, complete-case analysis was applied. Statistical significance was set at a p-value of less than 0.05, and appropriate measures of association were reported to support interpretability and reproducibility.

Ethical approval for the study was obtained from the Ethical Review Board of PRIDE, Pakistan (Approval No. PRIDE/ERB/2025/005). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, ensuring respect for participant autonomy, confidentiality, and data protection. No personally identifiable information was collected, and all responses were analyzed in aggregated form. To ensure reproducibility, the study protocol, questionnaire, and analysis plan were standardized prior to data collection, and the dataset supporting the findings is available from the corresponding author upon reasonable request.

RESULTS

A total of 235 responses (Response rate 61%) were collected from undergraduate dental students and dental practitioners across Pakistan. The study population consisted of 50.6% undergraduate dental students and 49.4% general dentists. The following statistical analyses were conducted to assess participants' knowledge, perceptions, and opinions regarding esthetic dentistry.

The analysis of overall knowledge ratings on dental esthetic standards revealed a distribution of responses. When asked to rate their knowledge on a scale of 1 to 10, 21.7% of respondents rated their knowledge at 7, 20% rated it at 5, and 18.3% rated it at 8. A one-way ANOVA test was performed to compare knowledge ratings among different respondent groups (undergraduate students, general dentists). The results showed no significant difference in the overall knowledge of dental esthetic standards between the groups ($p > 0.05$).

The majority of participants, 97.9%, agreed that misalignment of teeth affects the appearance, while only 2.1% disagreed. A chi-square test confirmed that this perception was strongly endorsed by the study participants ($p < 0.001$).

Regarding the impact of dental appearance on social interactions, 96.6% of respondents believed that dental appearance affects social interactions, with 3.4% disagreeing. The chi-square test again indicated a statistically significant relationship ($p < 0.001$), suggesting that dental esthetics are widely perceived as important for social interactions.

A high percentage of respondents, 86.8%, reported awareness of various cosmetic dental treatments, while 13.2% were not aware of the available treatments. A significant relationship was found between respondents' awareness and their professional background ($\chi^2 = 4.29$, $p = 0.038$), with dental students demonstrating higher awareness compared to general practitioners. When asked about their interest in further esthetic dentistry training, 94% of participants expressed interest in learning more through workshops or conferences. A 6% minority showed no interest in further esthetic training. A t-test revealed no significant difference in interest levels based on respondent occupation ($t(233) = 1.43$, $p = 0.155$).

In terms of familiarity with esthetic dentistry terminology, 68.5% of respondents were familiar with gummy smile, 67.2% with diastema, 62.1% with mid-line shift, and 32.3% with the golden proportion. The most commonly known terms were gummy smile and diastema, whereas more advanced concepts, such as the golden proportion, had lower recognition rates. A correlation analysis showed a positive association between knowledge of esthetic terms and years of experience ($r = 0.41$, $p < 0.01$).

A majority of respondents, 71.1%, were aware of the importance of porcelain bonding restoration, while 28.9% were unaware. Logistic regression analysis showed that dental students were significantly more likely to be aware of porcelain bonding restoration compared to general dentists (OR = 2.5, $p < 0.05$). Regarding the importance of shade matching in restorative treatments, 70.6% of respondents held a medium opinion, 15.7% found it difficult, and 13.6% found it easy. A chi-square test showed a significant association between the opinion on shade matching and the level of professional training ($\chi^2 = 6.45$, $p = 0.02$), with postgraduate students demonstrating greater awareness of shade matching complexities. When asked about the role of esthetics in restorative treatments, 80.9% of participants agreed that esthetics play a major role in restorative dentistry, while 13.2% believed esthetics played a neutral role, and 6% disagreed. A one-way ANOVA revealed a significant difference in opinions on esthetics' importance between undergraduate and postgraduate respondents ($p < 0.001$), with postgraduates assigning more importance to esthetics in restorative care.

Looking toward the future, 84.3% of respondents predicted that the demand for esthetic dentistry would increase significantly, while 14.5% anticipated a slight increase. This response was consistent across demographic groups, with no significant differences found between various categories ($p = 0.121$). Finally, 62.6% of respondents believed that a combination of professional dental treatment, good oral hygiene, and natural facial features were the most important factors for achieving a beautiful smile. In comparison, 17.9% thought good oral hygiene habits alone were most important, and 17.4% favoured professional dental treatment alone. A chi-square test confirmed a significant preference for a holistic approach to achieving a beautiful smile ($\chi^2 = 8.15$, $p = 0.017$).

Table 1: Summary of Key Results

Question	Response (%)	Statistical Test
Misalignment of teeth affects appearance	97.9% (Agree)	$p < 0.001$ (Chi-Square)
Dental appearance affects social interactions	96.6% (Agree)	$p < 0.001$ (Chi-Square)
Awareness of cosmetic dental treatments	86.8% (Aware)	$p = 0.038$ (Chi-Square)
Interest in learning more about esthetic dentistry	94% (Interested)	$p = 0.155$ (t-test)
Familiarity with esthetic dentistry terms	Gummy Smile: 68.5%, Diastema: 67.2%	$r = 0.41$ (Pearson Correlation)
Awareness of porcelain bonding restoration	71.1% (Aware)	$p < 0.05$ (Logistic Regression)
Importance of shade matching for restorations	70.6% (Medium)	$p = 0.02$ (Chi-Square)
Role of esthetics in restorative treatments	80.9% (Major Role)	$p < 0.001$ (ANOVA)
Future demand for esthetic dentistry	84.3% (Increase Significantly)	$p = 0.121$ (ANOVA)
Most important factors for a beautiful smile	62.6% (Combination)	$p = 0.017$ (Chi-Square)

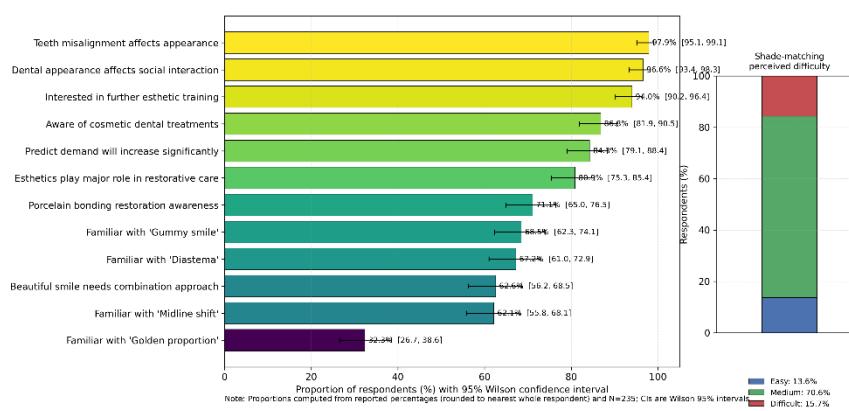


Figure 1 Knowledge gradient in esthetic dentistry among Pakistani dental students and practitioners (N = 235).

Across N=235 respondents, the figure demonstrates a marked "knowledge gradient" in esthetic dentistry: near-universal endorsement of esthetic impact (misalignment affects appearance: 97.9% [95% CI: 95.1–99.1]; dental appearance affects social interaction: 96.6% [93.4–98.3]) coexists with substantially lower penetration of advanced esthetic concepts (golden proportion familiarity: 32.3% [26.7–38.6]), indicating a clinically relevant gap between perceived importance and technical conceptual mastery. Training receptivity is high (interest in further esthetic training: 94.0% [90.2–96.4]) alongside broad procedural awareness (cosmetic treatment awareness: 86.8% [81.9–90.5]), yet domain-specific competency

signals remain uneven (porcelain bonding restoration awareness: 71.1% [65.0–76.5]). The integrated shade-matching distribution further refines interpretation by showing that most respondents rate shade matching as medium difficulty (70.6%), while 15.7% report it as difficult and 13.6% as easy, consistent with a clinically meaningful perception of technical complexity even in commonly encountered esthetic tasks.

DISCUSSION

The present study provides a comprehensive assessment of the current state of knowledge, perception, and training needs in esthetic dentistry among dental students and general practitioners in Pakistan. The findings demonstrate a consistently high level of awareness regarding the importance of dental esthetics in appearance and social interaction, while simultaneously revealing substantial gaps in the understanding of advanced esthetic concepts. This divergence between perceived importance and technical depth represents a critical educational and clinical concern within the Pakistani dental community.

An overwhelming majority of respondents acknowledged that dental alignment and appearance significantly influence facial esthetics and social interactions. This aligns with growing global evidence that dental appearance plays a decisive role in psychosocial well-being, interpersonal communication, and professional confidence (18–20). In societies with increasing exposure to social media and digital self-representation, such as Pakistan, patient expectations regarding smile esthetics have intensified, placing greater responsibility on dental professionals to deliver predictable and esthetically pleasing outcomes (21). The near-universal agreement observed in this study underscores that esthetic considerations are no longer optional but are central to contemporary dental care.

Despite this strong conceptual awareness, the study identified notable deficiencies in familiarity with advanced esthetic principles. While commonly encountered terms such as gummy smile, diastema, and midline shift were recognized by over 60% of participants, only one-third were familiar with the golden proportion. This finding mirrors international studies reporting that mathematically driven esthetic frameworks are less consistently integrated into undergraduate curricula and clinical training compared with descriptive esthetic concepts (22,23). Given that anterior tooth proportion analysis remains a cornerstone of smile design, limited familiarity with such principles may compromise treatment planning accuracy and esthetic predictability, particularly in restorative and prosthodontic cases.

The observed positive correlation between years of clinical experience and knowledge of esthetic terminology suggests that esthetic competence is often acquired informally through clinical exposure rather than structured education. While experiential learning is valuable, reliance on unsystematic knowledge acquisition can lead to variability in clinical outcomes and inconsistent patient satisfaction (24). This finding highlights the need for standardized, competency-based esthetic dentistry training at both undergraduate and continuing professional development levels. Incorporation of evidence-based esthetic frameworks into curricula may help reduce reliance on trial-and-error learning and improve consistency in clinical decision-making.

Awareness of porcelain bonding restorations and shade-matching complexities further illustrates this educational gap. Although a majority of respondents reported awareness of porcelain bonding, nearly one-third lacked familiarity, and most participants perceived shade matching as moderately to highly challenging. These findings are clinically significant, as inaccuracies in bonding protocols and shade selection are among the leading causes of esthetic restoration failure and patient dissatisfaction (25,26). The perception of shade matching as a technically demanding task reinforces the need for enhanced training in color science, digital shade-matching systems, and material selection—areas increasingly emphasized in modern esthetic dentistry worldwide (27).

Encouragingly, the study revealed an exceptionally high level of interest in further esthetic dentistry training, with 94% of respondents expressing willingness to participate in workshops or conferences. This receptiveness represents a critical opportunity for academic institutions, professional bodies, and regulatory authorities to introduce targeted continuing education programs focused on smile design, digital workflows, and interdisciplinary esthetic treatment planning. Similar initiatives in other regions have demonstrated measurable improvements in practitioner confidence, technical accuracy, and patient-reported outcomes (28,29).

Collectively, these findings suggest that esthetic dentistry in Pakistan is at a transitional stage—characterized by strong conceptual appreciation but insufficient technical depth in advanced esthetic principles. Addressing this imbalance through curriculum reform, structured postgraduate training, and evidence-based continuing education will be essential to meeting the rising demand for high-quality esthetic dental care and ensuring optimal patient outcomes.

CONCLUSION

In conclusion, this study demonstrates that while dental students and practitioners in Pakistan possess a high level of awareness regarding the importance of esthetics in dentistry and its social and psychological implications, significant gaps persist in their understanding of advanced esthetic principles and clinical application. The limited familiarity with concepts such as the golden proportion, combined with perceived difficulties in procedures like shade matching and porcelain bonding, highlights the need for more structured, competency-based education in esthetic dentistry. Given the strong interest in further training and the anticipated growth in demand for esthetic treatments, integration of advanced esthetic concepts into undergraduate curricula and expansion of continuing professional development programs are essential to equip dental professionals with the skills required to deliver predictable, high-quality esthetic outcomes.

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