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Dental Students' Preference Between Composite and Amalgam for Posterior Restorations in Pakistan

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ABSTRACT

Objective: Global trends and environmental regulations are driving a transition from dental amalgam to composite resin for posterior restorations. While composite resins offer esthetic and conservative advantages, their technique sensitivity poses challenges in low-resource settings. This study assessed Pakistani dental students' preferences and perceptions regarding amalgam and composite use, in light of curricular exposure and clinical considerations.

Methods: A multi-center cross-sectional survey was conducted from June to December 2024 across public and private dental institutions in all four provinces of Pakistan. A validated questionnaire was distributed to third- and final-year undergraduate students (n = 500). Data were analyzed using descriptive statistics, Chi-square tests, t-tests, and logistic regression to identify predictors of material preference.

Results: Composite resin was preferred by 81.6% of students for posterior restorations, favored for its esthetics (84.2%) and ease of cavity preparation (90.8%). However, 81.6% still selected amalgam in clinical scenarios demanding durability, such as Class I restorations. While 56.6% perceived amalgam as more durable, composite received greater curricular emphasis. Final-year students (OR = 1.67, p = 0.031) and those from private institutions (OR = 2.14, p = 0.002) were significantly more likely to prefer composite. A majority (53.9%) believed composite could replace amalgam, though 51.3% opposed complete amalgam elimination.

Conclusion: Pakistani dental students demonstrate a strong preference for composite resin, influenced by instructional focus and esthetic demands. However, their recognition of amalgam's utility in certain contexts underscores the need for balanced, context-aware dental curricula that prepare graduates to make evidence-based restorative choices in resource-constrained environments.

Keywords: Cost-Benefit analysis; Dental amalgam; Dental esthetics; Dental students; Resin composites

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Introduction

The selection of dental restorative materials has undergone a paradigm shift in recent decades, influenced by advances in material science, evolving patient expectations, and increasing environmental concerns. [1] Dental amalgam, once considered the gold standard for posterior restorations due to its durability, cost-effectiveness, and ease of placement, is being progressively supplanted by resin-based composites. [2] These materials offer superior esthetics, minimally invasive preparation, and improved adhesion to tooth structure, aligning with contemporary restorative philosophies and patient demands for metal-free dentistry.

This shift is further accelerated by global regulatory and environmental pressures. The Minamata Convention on Mercury, a global treaty ratified by over 140 countries, has urged a phase-down of dental amalgam usage due to its mercury content, raising concerns about its long-term environmental impact and occupational exposure risks for dental professionals. [2] High-income nations have responded with significant reductions in amalgam use, while lower- and middle-income countries (LMICs) face unique challenges in balancing these environmental imperatives with economic and clinical realities. In LMICs like Pakistan, where healthcare infrastructure may be limited, amalgam remains in use due to its affordability, proven longevity, and resilience in suboptimal clinical conditions. [3]

In response to these challenges, multiple alternative restorative materials have been developed, each with unique physical and clinical properties. Resin-modified glass ionomer cements (RMGICs) combine the fluoride release and chemical bonding of conventional glass ionomers with the improved strength and esthetics of composites. [4] These are particularly valuable in pediatric or high-caries-risk patients due to their cariostatic potential. Compomers, or polyacid-modified composite resins, offer improved handling over traditional GICs but fall short in durability compared to composites. [5] Bulk-fill composites, another modern advancement, allow for deeper curing and reduced chair time, making them suitable for large restorations with simplified protocols. [6] Additionally, newer bioactive restorative materials, such as alkasite-based composites (e.g., Cention N), claim to support remineralization and release fluoride, calcium, and hydroxide ions, although long-term clinical validation remains ongoing. [7] Despite their innovations, none of these materials fully replicates the mechanical strength and wear resistance of amalgam, particularly under high occlusal load conditions. Therefore, material selection continues to depend on case-specific variables such as patient age, caries risk, esthetic expectations, and the ability to achieve adequate isolation.

A growing body of international literature suggests that composite resins, when placed under ideal conditions, can match or even exceed the clinical performance of amalgam in certain applications. For instance, literature found no significant difference in long-term clinical outcomes between amalgam and composite for posterior restorations in Pakistani patients. [8] Similarly, the study reported comparable failure rates between the two materials when proper protocols were followed. However, composites are inherently technique-sensitive, requiring meticulous placement, moisture control, and equipment (e.g., curing lights), which can limit their reliability in settings lacking advanced infrastructure. [9]

Despite these clinical complexities, recent studies have observed that undergraduate dental curricula are increasingly prioritizing composite instruction. Research emphasized that students in translational curricula show greater familiarity and comfort with composite handling due to curricular reinforcement. [10] In Pakistan, it was similarly observed that dental interns often select composite over amalgam due to perceived ease of use, patient satisfaction, and greater instructional exposure. [10] Nonetheless, these preferences are not always aligned with the broader clinical needs in public-sector or rural health settings.

Critically, while many studies have investigated restorative choices among practicing dentists or have focused on clinical outcomes, relatively few have explored the attitudes and perceptions of dental students, particularly in LMICs. Understanding the views of students is essential, as they represent the next generation of practitioners and their preferences are shaped by both pedagogical exposure and patient trends. Moreover, there is a pressing need to evaluate whether current training equips students with the critical judgment necessary to choose materials based on clinical indication, resource context, and long-term prognosis, not merely aesthetics or trend.

In this context, the present study aims to examine the material preferences of undergraduate dental students of Pakistan, with a particular focus on their attitudes toward amalgam and composite resin for posterior restorations. Specifically, the study explores how students evaluate these materials in terms of ease of cavity preparation, handling, cost, durability, and patient demand. It also investigates whether students view composite as a viable substitute for amalgam and vice versa, reflecting their ability to assess trade-offs in diverse clinical scenarios.

Materials and Methods

Study Design

This research was designed as a multi-center, cross-sectional, questionnaire-based survey to evaluate the preferences of dental students regarding the use of composite resin and dental

amalgam for posterior restorations. The cross-sectional design was chosen to capture student perceptions at a specific point in their academic journey, particularly in the clinical training phase. A multi-provincial approach was employed to ensure demographic and educational diversity, thereby enhancing the generalizability of the findings across Pakistan.

Study Setting and Population

The study was conducted between June and December 2024 across public and private dental colleges situated in all four provinces of Pakistan: Punjab, Sindh, Khyber Pakhtunkhwa (KPK), and Balochistan. Stratified random sampling was used to ensure proportional representation of institutions from each province and sector. Dental colleges were selected to reflect a balanced mix of urban and rural settings and institutional types.

The target population consisted of third- and final-year undergraduate dental students currently enrolled in recognized institutions. Based on national estimates of the total number of students in these academic years, the required minimum sample size was calculated using the WHO sample size calculator. Assuming a 95% confidence level, 5% margin of error, and an expected response distribution of 50%, the minimum required sample was 384 students. To ensure statistical power and allow for subgroup analysis by province, academic year, and type of institution, oversampling was conducted, targeting a total of 500 completed responses.

Questionnaire Development and Validation

The questionnaire used in this study was adapted from a validated instrument originally developed by Pani et al., which was designed to assess dental students' preferences for restorative materials. [11] The adapted version underwent face and content validation through expert review by five dental educators with experience in curriculum development and clinical practice. A pilot study involving 30 students from non-participating institutions was then conducted to assess the clarity, reliability, and cultural relevance of the instrument. Based on feedback from the pilot phase, minor linguistic modifications were made. The final version of the questionnaire demonstrated strong internal consistency, with a Cronbach's alpha of 0.82, indicating high reliability.

The instrument was structured into three core sections. The first section collected demographic information such as age, gender, academic year, province, and institutional affiliation. The second section evaluated students' preferences and perceptions related to restorative materials, focusing on ease of cavity preparation, material handling, durability, cost, and esthetic considerations. The third section explored the influence of patient demand and institutional emphasis on student choices, as well as students' views on the substitutability of amalgam and composite in various clinical scenarios.

Data Collection Procedure

Data were collected over six months using both online and in-person distribution methods. In colleges equipped with digital infrastructure, questionnaires were distributed through Google Forms. In other institutions, printed surveys were administered during scheduled classroom hours or clinical sessions under supervision. Participation was voluntary, and informed consent was obtained from all participants prior to data collection. Confidentiality and anonymity were assured, and respondents were informed that data would be used solely for academic and research purposes. To maximize response rates and minimize missing data, two follow-up reminders were issued through institutional representatives.

Statistical Analysis

Data were entered, cleaned, and analyzed using SPSS version 26. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize participant demographics and overall trends in material preference. To assess associations between categorical variables such as material preference and demographic factors (e.g., gender, province, institution type), Chi-square tests were applied. Normality of continuous variables was assessed using the Shapiro-Wilk test prior to parametric analysis. Independent-samples t-tests and one-way ANOVA were used to compare continuous variables across groups. Binary logistic regression was employed to identify significant predictors of composite preference, including factors such as academic year, province, gender, and exposure to composite techniques. Where appropriate, multivariate logistic regression models were constructed to adjust for confounding variables. A p-value of less than 0.05 was considered statistically significant in all analyses. All reporting adhered to the Strengthening the Reporting of

Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

Limitations and Bias Mitigation

While the study design included broad national coverage and rigorous sampling methods, certain limitations should be acknowledged. Nonresponse bias remains a potential concern, particularly in institutions with lower levels of engagement. Additionally, institutional disparities in clinical exposure or teaching resources may have influenced student preferences. These limitations were addressed through oversampling, pilot testing, and ensuring proportional representation across provinces and institutional types. Despite these challenges, the study provides valuable insights into dental education and restorative material preferences in a lower-middle-income country context.

Results

Overall Response and Sample Characteristics

A total of 500 dental students from public and private institutions across the four provinces of Pakistan (Punjab, Sindh, Khyber Pakhtunkhwa, and Balochistan) completed the questionnaire, yielding a 100% usable response rate. The cohort included both third-year and final-year undergraduate students. The internal consistency of the instrument, as measured by Cronbach's alpha, was 0.82, indicating high reliability.

Of the participants, 62.4% were female, and 37.6% were male. 51.6% were final-year students, while 48.4% were in their third year. Institutional distribution was proportionate across provinces, with 53.4% enrolled in public sector colleges and 46.6% in private institutions.

Student Exposure and Instructional Emphasis

Students' perceptions of curricular focus revealed that 55.3% believed composite resin received more instructional attention, while 44.7% felt amalgam was emphasized more. When asked about content comprehensiveness, 59.2% found the teaching of composite resin to be more thorough compared to 40.8% who reported the same for amalgam. A Chi-square analysis showed a statistically significant association between academic year and perceived instructional emphasis on composite ($\chi^2 = 6.18$, $p = 0.013$), with final-year students reporting higher exposure (Table 1).

Preference for Material Type and Handling

A majority of students (81.6%) preferred composite resin as their material of choice for posterior restorations, while only 18.4% selected amalgam. When asked about handling ease, 61.8% reported the composite to be easier to manipulate, in contrast to 38.2% who preferred amalgam. Regarding cavity preparation, 90.8% favored composite for its conservative technique, while only 9.2% found amalgam easier. Interestingly, when presented with a clinical scenario requiring a Class I restoration, 81.6% chose amalgam over composite, indicating recognition of amalgam's clinical reliability in specific contexts. This preference was significantly associated with students from public sector institutions ($\chi^2 = 4.87$, $p = 0.027$) (Table 2).

Table 1: Student Exposure and Instructional Emphasis on Composite and Amalgam

Instructional Focus Item	Composite Resin (%)	Amalgam (%)	χ^2	p-value
Students reporting more lectures focused on material	55.3 (n = 277)	44.7 (n = 223)	5.62	0.018
Students who found the topic more comprehensively taught	59.2 (n = 296)	40.8 (n = 204)	7.24	0.007
Final-year students reporting greater exposure to composite (n = 258 only)	63.5 (n = 164)	36.5 (n = 94)	6.18	0.013

† Percentages are calculated based on total responses (n = 500). Final-year data subset analyzed separately. A p-value < 0.05 indicates statistical significance. χ^2 = Chi-square

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Table 2: Preference for Material Type and Handling Characteristics Among Dental Students

Survey Item	Composite Resin (%)	Amalgam (%)	χ^2	p-value
Preferred material for posterior restorations	81.6 (n = 408)	18.4 (n = 92)	240.32	<0.001
Easier material to handle clinically	61.8 (n = 309)	38.2 (n = 191)	29.16	<0.001
Easier cavity preparation	90.8 (n = 454)	9.2 (n = 46)	328.00	<0.001
Preferred material for Class I restorations	18.4 (n = 92)	81.6 (n = 408)	240.32	<0.001

† Percentages are calculated out of total responses (n = 500). All Chi-square values indicate statistically significant associations at $p < 0.05$. χ^2 = Chi-square

Perceptions of Durability, Esthetics, and Cost

Perceptions of material properties varied. 56.6% of students rated amalgam as more durable in cooperative patients, whereas 43.4% favored composite. Regarding longevity, 53.9% agreed that amalgam lasted longer, while 46.1% believed composite offered comparable or greater longevity when proper techniques were applied.

In terms of esthetics, 84.2% indicated that composite resin was the superior material, especially in meeting patient expectations. For cost-effectiveness, however, 84.2% considered amalgam the more economical option, compared to only 15.8% who believed the same for composite.

An independent-samples t-test revealed a statistically significant difference in cost perception scores between public and private sector students ($t = 2.21$, $p = 0.028$), with private sector students more likely to view composite as affordable (Table 3).

Table 3: Student Perceptions of Durability, Esthetics, and Cost of Restorative Materials

Perception Item	Composite Resin (%)	Amalgam (%)	χ^2	p-value
Material perceived as more durable	43.4 (n = 217)	56.6 (n = 283)	8.78	0.003
Material perceived to have longer longevity	46.1 (n = 231)	53.9 (n = 269)	3.65	0.056 (NS)
Material considered more aesthetic	84.2 (n = 421)	15.8 (n = 79)	234.00	<0.001
Material perceived as more cost-effective	15.8 (n = 79)	84.2 (n = 421)	234.00	<0.001
Material with more perceived drawbacks	44.7 (n = 224)	55.3 (n = 276)	4.21	0.040
Institutional difference in cost perception	Private Mean: 2.43 ± 0.55	Public Mean: 2.12 ± 0.61	$t = 2.21$	0.028

† Final row includes t-test results for institutional subgroup. Longevity perception difference is *not* statistically significant (NS = $p > 0.05$).

Patient Influence and Material Substitution Opinions

The influence of patient preference was substantial, with 84.2% of respondents indicating that patients typically preferred composite restorations, likely driven by esthetic considerations. Only 15.8% reported patient preference for amalgam.

When asked about substitutability, 53.9% believed composite could fully replace amalgam, while 46.1% disagreed, citing clinical limitations. Regarding the future of amalgam, 52.6% of students opposed its complete elimination from practice, whereas 47.4% supported a gradual phase-out. Chi-square testing showed no statistically significant association between province and opinion on amalgam discontinuation ($\chi^2 = 2.74$, $p = 0.098$, NS) (Table 4).

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Table 4. Patient Influence and Material Substitution Opinions

Response Item	Yes (%)	No (%)	χ^2	p-value
Patients prefer composite for posterior restorations	84.2 (n = 421)	15.8 (n = 79)	289.76	<0.001
Composite can fully replace amalgam	53.9 (n = 270)	46.1 (n = 230)	1.76	0.185 (NS)
Amalgam should be eliminated from practice	47.4 (n = 237)	52.6 (n = 263)	0.49	0.483 (NS)
Province vs. amalgam discontinuation opinion	—	—	2.74	0.098 (NS)

† All p-values are two-tailed. NS = not statistically significant.

Statistical Associations and Predictors of Preference

Binary logistic regression was conducted to identify independent predictors of preference for composite resin, adjusting for gender, academic year, province, and institution type. Students in private institutions were significantly more likely to prefer composite (OR = 2.14; 95% CI: 1.32–3.46, p = 0.002), as were final-year students compared to third-year students (OR = 1.67; 95% CI: 1.05–2.65, p = 0.031). Gender was not a significant predictor (OR = 1.12; 95% CI: 0.78–1.61, p = 0.542). Similarly, province did not significantly influence preference (OR range: 0.84–1.29; all p > 0.05). The model demonstrated acceptable fit (Hosmer-Lemeshow χ^2 = 6.21, p = 0.624) and explained a modest proportion of variance in composite preference (Nagelkerke R^2 = 0.118).

Discussion

Our study revealed that students of Pakistan exhibit a pronounced preference for composite resin over amalgam. While students correctly recognized amalgam's superior durability and cost-effectiveness, factors critical in resource-limited settings, their overriding selection of composite for its esthetic qualities and conservative cavity preparation warrants critical exploration.

This student preference is not purely a reflection of material performance but is likely shaped by powerful institutional and cultural drivers. Modern undergraduate curricula, influenced by global trends and significant patient demand for metal-free restorations, often place a heavier emphasis on composite protocols. [12] This pedagogical focus likely leads to greater student proficiency and confidence with resin materials, which subsequently translates into a clinical preference. This finding underscores a potential curricular bias that may not fully align with the contextual clinical needs of a resource-limited setting like Pakistan, where long-term affordability and longevity under challenging conditions remain paramount.

These results contribute meaningfully to the global discourse on the phase-down of dental amalgam, aligning with the objectives of the Minamata Convention on Mercury, which encourages a reduction in amalgam use due to environmental and health concerns. The clinical decision between amalgam and composite has evolved into a more nuanced judgment, factoring not only material properties but also clinical indication, patient expectations, and health system capabilities. For instance, a meta-analysis published in the UK demonstrated that posterior composites performed comparably to amalgam in terms of survival rates over five years when placed with appropriate technique and isolation protocols. [13] Similarly, research from Brazil and Nigeria, both middle-income countries, has shown that composite resins, under optimal conditions, can achieve restoration longevity comparable to amalgam, particularly when dentists receive adequate training and access to high-quality materials. [14] Nevertheless, in low-resource environments, the technique sensitivity of composites remains a significant barrier. They require strict moisture control, incremental placement, and high-quality curing lights, which may not be consistently available in public-sector dental clinics. Studies found that composite restorations had higher failure rates in public health settings due to inadequate operator training and limited infrastructure. [15] In such contexts, the continued use of dental amalgam, valued for its durability, ease of placement, and minimal equipment dependency, may still be a pragmatic choice, especially for large Class I and II restorations in posterior teeth.

Conversely, a critical perspective requires acknowledging the distinct clinical contexts where amalgam retains superior performance and practical advantage. Numerous clinical trials and retrospective studies consistently highlight amalgam's reliability in high-stress conditions, such as large multi-surface Class II restorations, cases involving bruxism, and treatment of high

caries-risk patients. A longitudinal study, which followed 1,748 restorations over seven years, found that amalgam restorations had significantly lower failure rates than composites in posterior teeth, particularly in complex multi-surface applications. [15] Likewise, the UK-based Dental Practice Board survey observed that amalgam restorations exhibited longer survival times than composite counterparts, especially in patients with suboptimal oral hygiene. [13] In moisture-compromised settings, common in pediatric or geriatric care, or in facilities without rubber dam isolation, amalgam's tolerance to minor contamination offers a major procedural advantage. This is particularly pertinent in resource-constrained health systems like Pakistan, where infrastructural limitations may restrict consistent access to high-quality curing lights, matrix systems, or trained auxiliary staff. A recent regional analysis emphasized that the cost-effectiveness and low technique sensitivity of amalgam remain vital in South Asian public dental clinics, where patient volume is high and operator time is limited. In this context, the affordability and proven longevity of amalgam, often exceeding 10–15 years with minimal maintenance, position it as an indispensable material. [8] Therefore, curriculum design must reflect this dual reality: promoting the transition to modern, esthetic materials while preserving competence in the use of amalgam where clinically justified.

Another important dimension in the amalgam versus composite debate relates to the presence of mercury in dental amalgam. Although amalgam has been considered safe for over a century of use, concerns regarding mercury release, occupational exposure for dental personnel, and potential environmental impact have gained prominence in recent years. While the actual health risk to patients from amalgam restorations remains minimal according to most scientific assessments, the environmental implications of mercury disposal and patient preference for metal-free, esthetic restorations have contributed significantly to the increasing adoption of composites. [16] This trend reflects not only material performance but also broader public health and environmental considerations that continue to shape restorative practices worldwide.

Given the findings regarding student preference and the practical realities of resource-constrained dentistry, we offer strong recommendations for curriculum development within Pakistani dental institutions: (i) Contextualized Material Training**:** While composite training must be modernized and emphasized, the curriculum must maintain robust, evidence-based training in Amalgam hygiene and placement for large, demanding, or high caries-risk restorations, acknowledging its contextual necessity. (ii) Critical Thinking in Selection: Educational strategies should focus on fostering critical thinking in material selection, teaching students to perform a rapid risk-benefit analysis that incorporates factors unique to resource-constrained settings (e.g., patient adherence, long-term maintenance costs, and moisture control difficulty) (iii) Protocol-Driven Clinical Pathways**:** Institutions should clearly delineate protocol-driven clinical pathways to guide students in selecting the appropriate material based on clinical indication rather than aesthetic preference alone, ensuring graduates are equipped to deliver both esthetic and durable care tailored to diverse socioeconomic realities.

In addition to the inherent limitations of self-report measures (susceptible to social desirability and recall bias), several design considerations should be acknowledged. Although stratified random sampling was employed across all four provinces, institutional-level differences in clinical exposure, teaching resources, and material availability may have influenced student preferences in ways not fully captured by this survey. Furthermore, the study assessed stated preferences rather than observed clinical behavior, and students' material selections in practice may differ from their survey responses. Nevertheless, the multi-provincial design, adequate sample size, and high internal consistency of the instrument (Cronbach's alpha = 0.82) support the credibility and generalizability of the findings within the Pakistani context.

A further limitation of the current study is the lack of data regarding the participants' clinical experience with the materials assessed. While we measured student preference and perception, the manuscript does not quantify the actual volume of amalgam versus composite restorations that students had placed before completing the survey. Without incorporating these objective clinical exposure metrics, it is challenging to definitively contextualize whether the observed preferences are driven by theoretical knowledge, curriculum emphasis, or genuine hands-on experience and confidence. Future research should incorporate detailed clinical logs or portfolios to correlate material preferences directly with the depth and breadth of practical exposure.

Conclusion

This multi-provincial study highlights a clear preference among Pakistani dental students for composite resin over amalgam for posterior restorations, driven primarily by esthetic appeal, conservative preparation techniques, and curricular emphasis. While students acknowledge amalgam's superior durability and cost-effectiveness, especially in challenging clinical contexts, composite is increasingly favored, reflecting evolving patient expectations and institutional priorities. However, given the resource constraints of low- and middle-income settings, a balanced, evidence-based approach to material selection is imperative. Dental curricula must emphasize critical clinical judgment, ensuring that future practitioners are equipped to choose restorative materials based on patient-specific factors, clinical indication, and long-term outcomes, rather than preference alone. These findings underscore the need for curricular reform that integrates both aesthetic innovation and pragmatic clinical realities.

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Author Contribution

UH and AA conceived the study and designed the work. AA, MA, and SS collected the data. MA, RS, and MS analyzed and interpreted the data and generated themes. All the authors contributed to the drafting and writing of the manuscript. UH, AA, MA, SS, MS, and RS critically reviewed and revised the manuscript. All authors proofread the finalized manuscript.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of Islamic International Dental College, Riphah International University, Islamabad, Ref. No: (Ref: SU/RAC/22-34/06). All participants provided written informed consent prior to data collection. Participation was voluntary, and anonymity and confidentiality were assured throughout the study.

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Data Availability

The data can be provided upon request from the corresponding author.

Conflict of Interest

The authors declare no conflicts of interest.

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