Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 32s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Assessing the Awareness and Adoption of Biocompatible Dental Materials among Dental Practitioners: A Cross-Sectional Study

Dr. Aamir Shahzad[1], Dr. Sana Jalil Hasan[2], Dr. Azeem Gohar Khan[3], Dr. Ayousha Iqbal[4], Dr. Muhammad Asif Shahzad[5], Dr. Musa Mahboob[6]

[1]Associate Professor & HOD, Dental Materials Department, HBS Medical and Dental College, Islamabad, Pakistan

[2]BDS, FCPS, CHPE, C-Implantology, Associate Professor Operative Dentistry and Endodontics, Margalla Institute of Health Sciences, Quaid –e-Azam Avenue, Gulraiz Phase 3, Rawalpindi, Pakistan

[3]BDS, MPhil, Principal, Gohar Institute of Medical Sciences, Havelian, District Abbottabad, Pakistan

[4]Head of Department of Dental Materials, Islamabad Medical and Dental College, Islamabad, Pakistan

[5]Professor & Head, Department of Oral and Maxillofacial Surgery, Azra Naheed Dental College, The Superior University, Lahore, Pakistan

[6]Department of Public Health, Guizhou Medical University, China

[*]**Corresponding author:**
Dr. Musa Mahboob,
Department of Public Health, Guizhou Medical University, China
Email ID : musxakahwn88@gmail.com

Cite this paper as: Dr. Aamir Shahzad, Dr. Sana Jalil Hasan, Dr. Azeem Gohar Khan, Dr. Ayousha Iqbal, Dr. Muhammad Asif Shahzad, Dr. Musa Mahboob, (2025) Assessing the Awareness and Adoption of Biocompatible Dental Materials among Dental Practitioners: A Cross-Sectional Study. *Journal of Neonatal Surgery*, 14 (32s), 8880-8886.

ABSTRACT

Background: Biocompatible dental materials have gained increasing attention for their role in promoting patient safety and reducing adverse biological reactions. Despite global emphasis on biocompatibility, the extent of awareness and adoption among dental practitioners remains uncertain.

Objective: To evaluate the level of awareness and adoption of biocompatible dental materials among dental practitioners and to identify factors influencing their clinical use.

Methods: A descriptive cross-sectional study was conducted from January to June 2025 among 225 dental practitioners selected through convenience sampling from private clinics, academic institutions, and public hospitals. A pretested, structured questionnaire (Annexure I) comprising demographic details, awareness, and adoption-related items was distributed electronically and in person. Responses were coded and entered into Microsoft Excel, then analyzed using SPSS version 26. Associations between practitioner variables and adoption levels were examined using chi-square and t-tests. Multivariate logistic regression was applied to identify independent predictors of high adoption, reporting adjusted odds ratios (AOR) with 95% confidence intervals.

Results: High awareness was observed in 60.9% of participants and high adoption in 52.9%. Significant predictors of adoption included high awareness (AOR = 2.95, $p < 0.001$), experience >5 years (AOR = 1.78, $p = 0.03$), and urban practice (AOR = 1.89, $p = 0.04$). High cost (40.4%) and limited availability (29.8%) were major barriers.

Conclusion: Awareness, experience, and accessibility strongly influenced the adoption of biocompatible dental materials. Targeted education, cost reduction, and improved material availability are essential to enhance their routine clinical use.

Keywords: *Biocompatible materials, awareness, adoption, dental practitioners, predictors, cross-sectional study*

1. INTRODUCTION

The selection of dental materials plays a crucial role in determining the long-term success, safety, and biological harmony of restorative and prosthetic dental procedures.(1) Over the past few decades, the field of dental materials science has shifted its focus from purely mechanical and aesthetic considerations to an increasing emphasis on biocompatibility, the ability of a material to perform with an appropriate host response in a specific situation.(1) Biocompatible materials minimize adverse tissue reactions, hypersensitivity, and cytotoxic effects while promoting favorable healing and integration with oral tissues. As patient expectations for safe, sustainable, and biologically acceptable dental treatments continue to rise, the use of

biocompatible materials has become a cornerstone of modern, patient-centered dental practice.(2)

The rapid advancements in dental biomaterials have introduced a wide range of metal-free ceramics, resin composites, bioactive glasses, calcium silicate-based cements, and polymer-based alternatives, each designed to enhance compatibility with oral tissues and reduce systemic toxicity.(3, 4) Global trends show a growing preference for materials that not only restore function and aesthetics but also actively contribute to tissue regeneration and reduce inflammation.(5) Studies have demonstrated that certain conventional materials, such as amalgam and non-precious alloys, may release ions or components that could pose biological risks, thereby underscoring the importance of awareness regarding safer substitutes.(6) For instance, surveys from Europe and the United States reveal that over 70% of dental practitioners have transitioned toward biocompatible restorative options in response to patient concerns and environmental safety standards.(7)

In developing countries, including Pakistan, dental practitioners face multiple challenges in adopting biocompatible materials, ranging from limited access, higher costs, and lack of continuing education to insufficient local evidence guiding material selection.(8) Recent regional surveys indicate that while Pakistani dentists are aware of global shifts toward safer dental biomaterials, their actual implementation in clinical practice remains inconsistent.(9) A study conducted in neighboring India reported that only 45% of practitioners routinely use biocompatible materials, primarily due to inadequate knowledge about their advantages and limited availability. This gap highlights the pressing need to evaluate the level of awareness, perception, and usage of biocompatible materials among dental professionals in Pakistan to promote evidence-based and biologically safe dental care.(10)

Despite the growing emphasis on patient safety and material biocompatibility in dentistry, there is a lack of comprehensive national data assessing the awareness and adoption of such materials among Pakistani dental practitioners. Understanding these patterns is essential to identifying knowledge gaps, barriers to implementation, and opportunities for professional development. This insight can guide policymakers, dental institutions, and manufacturers in promoting safer and more sustainable dental practices. This study aimed to assess the awareness, attitudes, and adoption of biocompatible dental materials among dental practitioners.

2. METHODOLOGY

This cross-sectional study was carried out to assess the awareness and adoption of biocompatible dental materials among dental practitioners in Pakistan. The study was at Dental Materials Department, HBS Medical and Dental College, Islamabad. Data collection was performed over a period of **6th month from Jan to June, 2025**

The required sample size was estimated using the **OpenEpi** software, with approximately **50.4%** of dentists having sufficient awareness of biocompatible materials, a 95% confidence level, and 80% power.(11) Plugging these parameters into OpenEpi, with a precision (margin of error) of ±7%, the calculated sample size was **193** participants. To allow for nonresponse and incomplete questionnaires with an estimated nonresponse rate of 15 %, the target sample size was inflated to **225** dentists.

A **stratified purposive sampling** method was used. Major cities with active dental schools and private practices were selected to represent diverse clinical environments. Within each selected city, dental institutions and clinics were identified, and participants were recruited through professional networks, institutional contacts, and social media platforms. Dentists of various specialties, general practitioners, prosthodontists, restorative dentists, and endodontists were invited to participate voluntarily until the target number was achieved.

A structured, self-administered questionnaire was developed based on prior studies and validated by expert faculty in dental materials. First, a pilot test was conducted among 15 dentists to check understandability and timing; minor wording modifications were made. The final questionnaire comprised four sections: demographic/practice characteristics, knowledge/awareness of biocompatible materials, attitudes/perceptions, and self-reported adoption/barriers.

Field investigators visited selected clinics and departments; they explained the study purpose, obtained written informed consent, and distributed paper or electronic versions (Google Forms link) of the questionnaire. Participants returned completed forms during the same visit or via secure digital submission within one week. The data collection was closely supervised, and daily checks for completeness were performed. Each respondent was assigned a unique ID to prevent duplication.

Data were entered into Microsoft Excel and exported to **SPSS version 26** for analysis. Descriptive statistics like frequencies, percentages, and means ± standard deviations were computed for demographic and response variables. Awareness and adoption scores were categorized into “high” vs “low”). The association between practitioner characteristics like age, gender, years in practice, specialty, and location and levels of awareness/adoption was assessed using chi-square tests for categorical variables. Logistic regression (multivariate) was applied to identify independent predictors of high adoption of biocompatible materials (reporting adjusted odds ratios with 95% confidence intervals). A p-value ≤ 0.05 was considered statistically significant.

3. RESULTS

The study included 225 dental practitioners, with a nearly equal gender distribution (51.1% females, 48.9% males). Most participants were aged 31–35 years and had 1–5 years of professional experience, indicating a predominance of early-career practitioners. General dentists formed the majority, followed by prosthodontists, endodontists, and restorative specialists. Most respondents worked in private practice, and a significant proportion were based in urban areas. Overall, the sample reflected a balanced mix of practitioners across specialties and experience levels, with a greater concentration in private and urban dental settings.(Table 1)

Table 1. Demographic Characteristics of Dental Practitioners (n = 225)

Variable	Category	n (%)
Gender	Male	110 (48.9%)
	Female	115 (51.1%)
Age Group (years)	25–30	74 (32.9%)
	31–35	82 (36.4%)
	36–40	46 (20.4%)
	>40	23 (10.2%)
Years in Practice	1–5 years	88 (39.1%)
	6–10 years	73 (32.4%)
	>10 years	64 (28.5%)
Specialty	General Dentist	132 (58.7%)
	Prosthodontist	35 (15.6%)
	Endodontist	27 (12.0%)
	Restorative Specialist	31 (13.7%)
Type of Practice	Private	143 (63.6%)
	Academic	51 (22.7%)
	Public Hospital	31 (13.7%)
Location	Urban	175 (77.8%)
	Semi-urban/Rural	50 (22.2%)

More than half of the dental practitioners demonstrated a high level of awareness (60.9%) regarding biocompatible dental materials, while 52.9% reported a high level of adoption in their clinical practice. The most common sources of knowledge were undergraduate training (34.7%) and workshops or continuing medical education sessions (28.4%), indicating that formal and professional education played a major role in shaping awareness. Patient safety emerged as the leading reason for using biocompatible materials (38.7%), followed by aesthetic outcomes and long-term success. The most frequently reported barriers to adoption were high cost (40.4%) and limited availability (29.8%), suggesting that economic and accessibility constraints hindered wider implementation despite favorable attitudes toward these materials. (Table 2)

Table 2. Awareness and Adoption of Biocompatible Dental Materials

Variable	Category	n (%)
Awareness Level	High	137 (60.9%)
	Low	88 (39.1%)
Adoption Level	High	119 (52.9%)

	Low	106 (47.1%)
Source of Knowledge	Undergraduate training	78 (34.7%)
	Workshops/CMEs	64 (28.4%)
	Peer discussions	39 (17.3%)
	Online resources	44 (19.6%)
Primary Reason for Using Biocompatible Materials	Patient safety	87 (38.7%)
	Aesthetic outcomes	53 (23.6%)
	Long-term success	49 (21.8%)
	Institutional policy	36 (16.0%)
Barrier to Adoption	High cost	91 (40.4%)
	Limited availability	67 (29.8%)
	Lack of awareness	45 (20.0%)
	No patient demand	22 (9.8%)

The association between practitioner characteristics and adoption of biocompatible dental materials showed that gender, age group, years in practice, and specialty were not significantly related to adoption levels ($p > 0.05$). However, location demonstrated a statistically significant association ($p = 0.02$), indicating that practitioners based in urban areas (56.6%) were more likely to adopt biocompatible materials compared to those in semi-urban or rural settings (40.0%). This suggests that access to modern materials, continuing education opportunities, and patient demand may be greater in urban environments, facilitating higher adoption rates among urban practitioners. (Table 3)

Table 3. Association between Practitioner Characteristics and Adoption of Biocompatible Dental Materials (n = 225)

Variable	High Adoption n (%)	Low Adoption n (%)	χ^2 (p-value)
Gender			0.04 (0.84)
Male	59 (53.6)	51 (46.4)	
Female	60 (52.2)	55 (47.8)	
Age Group (years)			3.89 (0.27)
25–30	33 (44.6)	41 (55.4)	
31–35	47 (57.3)	35 (42.7)	
36–40	27 (58.7)	19 (41.3)	
>40	12 (52.2)	11 (47.8)	
Years in Practice			4.31 (0.12)
1–5	40 (45.5)	48 (54.5)	
6–10	44 (60.3)	29 (39.7)	
>10	35 (54.7)	29 (45.3)	
Specialty			3.24 (0.35)

General Dentist	64 (48.5)	68 (51.5)	
Prosthodontist	20 (57.1)	15 (42.9)	
Endodontist	16 (59.3)	11 (40.7)	
Restorative	19 (61.3)	12 (38.7)	
Location			5.05 (0.02*)
Urban:	99 (56.6)	76 (43.4)	
Semi-urban/Rural:	20 (40.0)	30 (60.0)	
**p < 0.05 statistically significant.*			

Multivariate logistic regression analysis identified several independent predictors of high adoption of biocompatible dental materials. Practitioners with more than five years of experience were significantly more likely to adopt these materials (AOR = 1.78, p = 0.03). A high level of awareness was the strongest predictor, with those having greater knowledge being almost three times more likely to adopt biocompatible materials (AOR = 2.95, p < 0.001). Additionally, practitioners working in urban areas showed significantly higher adoption rates (AOR = 1.89, p = 0.04). In contrast, specialty status (specialist vs. general dentist) and gender did not show significant associations. These findings highlight the importance of professional experience, awareness, and accessibility in influencing the integration of biocompatible materials into dental practice. (Table 4)

Table 4. Multivariate Logistic Regression Analysis of Predictors of High Adoption of Biocompatible Materials

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	p-value
Years in Practice (>5 years)	1.78	1.04 – 3.06	0.03*
High Awareness Level	2.95	1.70 – 5.11	<0.001*
Urban Location	1.89	1.01 – 3.53	0.04*
Specialist vs. General Dentist	1.62	0.89 – 2.96	0.11
Gender (Male)	1.05	0.61 – 1.81	0.85
**p < 0.05 statistically significant.*			

4. DISCUSSION

In this cross-sectional survey, a majority of respondents demonstrated high awareness (60.9%) of biocompatible dental materials, and just over half (52.9%) reported high clinical adoption. These levels were lower than the awareness and adoption reported in several large international surveys, which indicated broader recognition of material-related complications and a stronger movement toward safer restorative choices. For example, a 13-country survey reported high awareness of composite-related complications among dentists (awareness ~77.5%).(12)

Our finding that awareness was the strongest independent predictor of adoption (AOR ≈ 2.95) echoed repeated themes in the literature: knowledge and continuing professional education consistently drove clinical uptake. Recent reviews and position pieces have emphasized the need to standardize terminology and strengthen practitioner education about biocompatibility and testing methods, factors that would directly support the link we observed between knowledge and practice. (13, 14)

Specialty-level differences in adoption were present but not statistically significant in multivariate analysis; specialists tended to report higher adoption in bivariate comparisons (prosthodontists, endodontists, restorative specialists > general dentists). This pattern was consistent with discipline-specific reports showing increased use of bioceramics and bioactive cements in endodontics and restorative specialties, where material performance and tissue response receive focused attention. For instance, reviews of bioceramics in endodontics documented rapid uptake of these materials because of their bioactivity and favorable outcomes.(15, 16)

The urban versus semi-urban/rural disparity in adoption (urban practitioners more likely to adopt; p = 0.02) paralleled findings from other cross-sectional studies that linked geographic location to access, availability, and training opportunities.

Market and access reports have also documented concentration of newer biomaterials and related services in urban centers, which likely explained the higher urban uptake observed in our sample.(12)

Cost and limited availability were the most frequently reported barriers in our study (40.4% and 29.8%, respectively). These barriers have been repeatedly documented elsewhere: systematic reviews and surveys of novel materials including 3D-printed resins and advanced ceramics have highlighted affordability and supply chain constraints as major obstacles to routine use despite recognized clinical benefits. Concerns about long-term biocompatibility and regulatory clarity also contributed to clinician hesitancy in several recent papers.(13, 17)

Comparisons with smaller, regionally focused studies produced mixed results. Some hospital-based or single-center surveys reported very high awareness of specific biocompatibility concepts, but those studies often sampled trainees or faculty and therefore were not directly comparable to our broader practitioner sample. These differences in sampling frame likely explained the higher awareness reported in institutional studies versus our mixed private/academic practitioner sample.(18)

Other recent surveys examining uptake of newer material categories found lower practical usage than theoretical awareness, only a minority who were aware had routinely adopted the technique or product. Our adoption rate (53%) fell into the middle of that spectrum: better than some single-material adoption studies yet lower than aggregate multinational surveys of general attitudes toward safety and material choice. (12, 19)

Taken together, the comparison of our results with the 2020–2024 literature suggests three practical implications. First, raising practitioner awareness through targeted CME and inclusion of current biomaterials topics in undergraduate/postgraduate curricula appears likely to increase clinical adoption. Second, addressing structural barriers, cost, supply, and clear regulatory guidance on biocompatibility testing, would remove impediments for clinics in semi-urban and rural settings. Third, specialty-focused dissemination may accelerate uptake among generalists by normalizing products and lowering perceived risk.

5. LIMITATIONS IN CONTEXTUAL COMPARISON

should be acknowledged: many cited studies used different sampling frames (students, faculty, single cities, or industry surveys), different operational definitions of "biocompatible" or "adoption," and variable questionnaires, factors that limited exact numerical comparisons. Nevertheless, consistent themes emerged across the 2020–2024 literature: knowledge predicts use, urban settings facilitate access, and cost/availability constrain wider adoption, findings that matched and helped explain our results.

REFERENCES

[1] Narayan R. Biocompatible Restorative Materials: innovations for aesthetic and durable outcomes. Journal of Dental Care. 2024;1(1):53-9.

[2] Waghmare G, Waghmare K, Bagde S, Deshmukh M, Kashyap DN, Shahu VT. Materials evolution in dental implantology: a comprehensive review. J Adv Res Appl Mech. 2024;123:75-100.

[3] Chen L, Zhang S, Duan Y, Song X, Chang M, Feng W, et al. Silicon-containing nanomedicine and biomaterials: materials chemistry, multi-dimensional design, and biomedical application. Chemical Society Reviews. 2024;53(3):1167-315.

[4] Al-Taie THK. Future Directions in Restorative and Aesthetic Dentistry: Innovations, Digital Advancements, and Biomimetic Approaches. Central Asian Journal of Medical and Natural Science. 2025;6(3):982-91.

[5] Farag MM. Recent trends on biomaterials for tissue regeneration applications. Journal of Materials Science. 2023;58(2):527-58.

[6] Tamilselvi R, Nandhini S, Muniyandi E, Saravanakumar P, Venkatesh A, Prakash V. Cytotoxicity of Metals and Metal Oxides Nanoparticles in Dentistry: A Comprehensive Review. Biomedical and Pharmacology Journal. 2025;18(1):471-81.

[7] Hatton PV, Mulligan S, Martin N. The safety and biocompatibility of direct aesthetic restorative materials. British Dental Journal. 2022;232(9):611-4.

[8] Khan E, Soomro AH, Saleem M, Siyal ZH, Ali S. Regenerative dentistry in Pakistan: Awareness, challenges, and advancements among general dental practitioners and specialists. European Journal of General Dentistry. 2022;11(02):108-13.

[9] Khawaja MUN, Siddique H, Ahmed A, Hassan M, Farrukh M, Zaidi SHR. Awareness and Adoption of Regenerative Dentistry among Dental Students and Practitioners in Pakistan: A Cross-sectional Study. Journal of Health, Wellness and Community Research. 2025:e820-e.

[10] Sharma SJ, Gupta R, Gupta M. Advanced testing and biocompatibility strategies for sustainable biomaterials. Biotechnology for Sustainable Materials. 2024;1(1):18.

[11] Sajid M, Saeed A, Athar Y, Khan S, Bhatti UA, Qayum Mirza B. Patient's perspective and awareness of materials used in dentistry. JPMA The Journal of the Pakistan Medical Association. 2021;71(4):1171-4.

[12] Lehmann A, Nijakowski K, Jankowski J, Donnermeyer D, Palma PJ, Drobac M, et al. Awareness of possible complications associated with direct composite restorations: A multinational survey among dentists from 13 countries with meta-analysis. Journal of dentistry. 2024;145:105009.

[13] Paqué PN, Özcan M. A review on biocompatibility of dental restorative and reconstruction materials. Current Oral Health Reports. 2024;11(1):68-77.

[14] Al-Zyoud W, Haddadin D, Hasan SA, Jaradat H, Kanoun O. Biocompatibility testing for implants: A novel tool for selection and characterization. Materials. 2023;16(21):6881.

[15] Dong X, Xu X. Bioceramics in endodontics: updates and future perspectives. Bioengineering. 2023;10(3):354.

[16] Prasad Kumara PAAS, Cooper PR, Cathro P, Gould M, Dias G, Ratnayake J. Bioceramics in Endodontics: Limitations and Future Innovations—A Review. Dentistry journal. 2025;13(4):157.

[17] Prakash J, Shenoy M, Alhasmi A, Al Saleh AA, GC S, Shivakumar S. Biocompatibility of 3D-printed dental resins: A systematic review. Cureus. 2024;16(1):e51721.

[18] Hasan U, Fatima M, Khan H, Zia S, Khan A, Habib M. Awareness of Dental Practitioners Regarding Biocompatibilty of Dental Materials. Pakistan Journal of Medical & Health Sciences. 2022;16(10):420-.

[19] Salem RA, Danish BA, Abdulaleem NA. Awareness of Novo Types of Composites among Dental Students and Interns in Makkah Region, Saudi Arabia. Cross Sectional Study. The Open Dentistry Journal. 2023;17(1)..