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Original Article

Assessment of Knowledge and Practices in Fixed Prosthodontics among Dentists in Yemen: A Cross-Sectional Study

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ABSTRACT

Background: Fixed prosthodontics is essential for restoring oral function and aesthetics, yet its success depends on dentists' adherence to evidence-based practices.

Objective: This study was aimed to assess the knowledge and practices of fixed prosthodontics among Yemeni dentists in 2025, evaluating material preferences, adherence to international guidelines, and barriers to optimal care.

Methods: A cross-sectional study was conducted among 350 dentists using stratified random sampling in both urban (76.8%) and rural (23.2%) Yemen. Data were collected via a validated questionnaire assessing theoretical knowledge, clinical practices, and barriers. Descriptive and inferential statistics were analyzed using SPSS version 26.0.

Results: Only 41.2% of dentists knew the correct occlusal reduction for zirconia crowns (1.0 mm). Advanced-degree holders (18.6% of participants) scored 28% higher on knowledge assessments ($p < 0.001$). Porcelain-fused-to-metal (PFM) crowns were the most commonly used material (58.7%), with rural dentists using them 3.2 times more frequently than urban counterparts (78.9% vs. 48.3%; $p = 0.003$). Guideline adherence was low (49.5%), though prosthodontists complied 4.7× more than general dentists ($p < 0.001$). Cost (82.4%), lack of training (67.1%), and patient affordability (59.3%) were primary barriers. Rural practitioners faced 2.1× higher complication rates ($p = 0.007$). Predictors of advanced practice included a master's degree (OR = 4.2), urban practice (OR = 3.1), and continuous education training (OR = 2.8), which correlated strongly with zirconia adoption ($p < 0.05$).

Conclusion: Yemeni dentists exhibit significant gaps in knowledge and adherence, driven by socioeconomic and educational disparities. Interventions such as subsidized materials, mandatory continuing education, and specialty training are essential to align practices with global standards.

Keywords: Fixed prosthodontics, Yemen, zirconia, guideline adherence, barriers, dental education.

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INTRODUCTION

Fixed prosthodontics is a fundamental branch of dentistry that focuses on the restoration and replacement of damaged or missing teeth using fixed dental prostheses such as crowns, bridges, and implant-supported restorations [1]. These treatments play a vital role in restoring oral function, aesthetics, and overall patient satisfaction. The success of fixed prosthodontic procedures depends heavily on the dentist's knowledge, clinical skills, and adherence to evidence-based practices [2].

Globally, advances in dental materials and techniques such as zirconia, lithium disilicate, and digital prosthodontics have greatly improved treatment outcomes [3]. However, the adoption of these innovations varies considerably, especially in low-resource settings where access to advanced training and materials may be limited [4]. One of the valuable restorations utilized in both restorative and cosmetic dentistry is the porcelain fused to metal (PFM) dental crown. This is due to PFM crowns' ability to combine the precision and strength of a metal crown with the beauty of porcelain [5].

In Yemen, ongoing socio-economic challenges, compounded by a decade of conflict, have severely disrupted healthcare infrastructure, leaving dental professionals with fragmented resources, intermittent electricity, and scarce supplies of modern materials [6,7]. The war has also precipitated a brain drain of specialists, with only 1.1% of practicing dentists in Yemen trained as prosthodontists [8], further exacerbating disparities in care.

While studies in Saudi Arabia and Egypt have examined gaps in prosthodontic knowledge and practices, their findings are contextually limited by relatively stable healthcare systems, better-funded dental infrastructures, and greater access to continuing education [9,10]. In contrast, Yemen's unprecedented socio-political collapse—marked by war, economic blockade, and the near-total erosion of dental training systems—creates a distinct environment where systemic crises compound traditional barriers (e.g., cost, training gaps). For instance, Saudi/Egyptian studies highlight financial constraints as a moderate barrier to adopting advanced materials [11]. However, Yemen's import restrictions and 300–400% cost inflation [12] render even basic materials such as PFM crowns increasingly

inaccessible. Moreover, while regional studies note rural-urban disparities in training access, Yemen's conflict has intensified this divide, with rural dentists often relying on outdated techniques due to severed supply chains and the exodus of prosthodontic specialists [8]. Crucially, no prior study has quantified how these extreme conditions distort clinical decision-making (e.g., material substitutions, irreversible pulp therapy for crown prep due to lack of alternatives) or assessed dentists' adherence to guidelines amid such constraints.

This study hypothesizes that the unique socio-economic conditions in the region will result in distinct clinical dental practices. Specifically, we posit that material scarcity will increase reliance on outdated techniques, such as a higher utilization of porcelain-fused-to-metal (PFM) crowns over contemporary materials like zirconia or lithium disilicate, with cost being the primary barrier. Furthermore, urban-rural disparities are expected to exceed those reported in neighboring countries, manifesting as a higher adoption of digital workflows among urban practitioners despite limited access, contrasted by rural dentists employing unconventional adaptations like using acrylic temporizations as definitive restorations. Finally, disruptions caused by conflict are hypothesized to correlate with practices that diverge from international guidelines, including the prolonged use of temporary cements due to the scarcity of definitive luting agents. By mapping these crisis-driven deviations, this study provided the first empirical framework for tailoring prosthodontic training and aid interventions to Yemen's extreme realities, while contributing to global literature on dental care in conflict zones. This study was aimed to assess the knowledge and practices of fixed prosthodontics among Yemeni dentists in 2025, evaluating material preferences, adherence to international guidelines, and barriers to optimal care.

METHODOLOGY

Study Design

A cross-sectional analytical design was employed to assess the knowledge and practices of fixed prosthodontics among dentists in Yemen in 2025. This approach provided a snapshot of current practices while identifying correlations between



demographic variables and clinical competencies [13].

Study Setting and Population

The study was conducted across various geographic regions within the Republic of Yemen, including both urban centers (e.g., Sana'a, Aden, and Taiz) and rural areas. The target population comprised licensed dentists actively practicing in Yemen, encompassing general dental practitioners and prosthodontic specialists.

The inclusion criteria for the study were licensed dentists with a minimum of one year of clinical experience, those who routinely perform fixed prosthodontic procedures such as crowns, bridges, or implant restorations, and individuals willing to provide informed consent to participate. The exclusion criteria included dental students and interns, as well as dentists who were not currently practicing within Yemen.

Sampling Strategy

The sample size was calculated using Cochran's formula for finite populations [10], considering a 95% confidence level ($Z = 1.96$), a 5% margin of error, an estimated population of 1,200 licensed dentists, and an assumed proportion of 50% due to the lack of prior data. The minimum required sample size was determined to be 292, which was increased to 350 to account for an anticipated 20% non-response rate.

A stratified random sampling technique was employed to ensure adequate representation across key strata, including governorate (based on the regional distribution of dentists), practice type (public versus private sectors), and specialty (general practitioners versus prosthodontists).

Addressing Rural Underrepresentation

To address rural underrepresentation, it is important to note that despite the stratification efforts, rural dentists constituted only 23.2% of the final sample ($n = 81/350$), which is slightly below the estimated 30% distribution of rural dentists in Yemen [7]. To mitigate this imbalance and reduce potential sampling bias, several measures were implemented. First, rural strata were oversampled by 15% during recruitment; however, the response rate among rural dentists was lower (58%) compared to 82% among urban dentists. Second, post-stratification weighting

was applied during data analysis to correct for the urban–rural disproportionality. Third, rural-specific subgroup analyses were conducted, as detailed in the Results section, and these confirmed that significant trends in rural areas—such as a 3.2-fold increase in the use of PFM restorations—remained evident even after adjustment.

Data Collection

A validated, self-administered questionnaire, adapted from a previously established instrument [4], was employed for data collection. The instrument was structured into four distinct sections to comprehensively assess participant profiles and practices. The first section captured demographic and professional background information, including items such as years of experience in fixed prosthodontics. The second component evaluated knowledge through 20 pilot-tested multiple-choice questions (e.g., "Which cement provides the highest bond strength for zirconia crowns?"), which demonstrated good internal reliability (Cronbach's $\alpha = 0.82$). The third section gauged clinical practices utilizing Likert-scale items focused on treatment planning and material selection (e.g., frequency of lithium disilicate crown use for anterior teeth). Finally, the fourth section identified perceived barriers to adherence to modern standards by asking participants to rate the influence of factors such as cost, training, and resources on a 5-point scale.

Guideline Adherence Operationalization

Adherence was defined as selecting materials/techniques aligned with the guidelines discussed in the European Society of Cosmetic Dentistry (ESCD) Annual Meeting held in 2024 in Belgrade, Serbia (e.g., zirconia for posterior crowns, adhesive protocols for veneers). Non-adherence included workarounds due to scarcity (e.g., using temporary cements, definitively).

To minimize response bias, several strategic measures were implemented. The survey instrument was first pilot-tested with a cohort of 30 dentists (excluded from the main analysis) to enhance clarity and validity. Anonymity was rigorously assured to all participants to mitigate social desirability bias. Furthermore, a mixed-mode distribution strategy was employed to ensure equitable access; electronic surveys (via Google Forms) were utilized in urban



areas, while paper-based surveys were distributed in rural regions with limited internet connectivity to prevent coverage bias.

Data Analysis

Data analysis was performed using both descriptive and inferential statistical methods. Descriptive statistics are presented as frequencies and means $\pm$ standard deviations. Inferential analyses included Chi-square tests to compare demographic variables and logistic regression to identify predictors of guideline adherence. Qualitative data from open-ended responses were subjected to thematic analysis using NVivo (version 12.0). All statistical analyses were conducted with SPSS, version 26.0 (IBM Corp.), with a predetermined significance level of $p < 0.05$.

Ethical Considerations

The Institutional Review Board at the University of Science and Technology has approved the study (Ethical Approval no. (UST/DENT/2025-03). Participants provided informed consent; anonymity was ensured.

Rationale for Methodological Choices

The methodological choices for this study were guided by the imperative to ensure robust data collection within a resource-limited context. A cross-

sectional design was selected for its cost-effectiveness in assessing the prevalence of practices across the population [15]. To ensure the findings were representative of the diverse operational environments, a stratified sampling approach was employed, specifically designed to capture disparities between urban and rural settings. To mitigate participation barriers in underserved rural areas, a mixed-mode distribution strategy for the survey was implemented. Finally, the use of a previously validated data collection tool was prioritized to enhance the reliability of our results and facilitate direct comparability with existing regional studies [9].

RESULTS

Demographic Characteristics

A total of 350 dentists participated (Table 1). The majority were male (68.6%, $n = 240$), aged 25–35 years (62.3%, $n = 218$), and general practitioners (81.4%, $n = 285$). Urban practitioners constituted 76.8% ($n = 269$), with the highest concentrations in Aden (54.2%) and Sana'a (22.6%). Rural dentists were underrepresented (23.2%, $n = 81$) despite oversampling efforts. Table 1 shows the detailed demographic characteristics.

Table 1: Participant Demographics, ($n = 350$).

Variable	Category	Frequency (%)
Gender	Male	240 (68.6%)
	Female	110 (31.4%)
Age (years)	25–35	218 (62.3%)
	36–45	98 (28.0%)
Qualification	Bachelor	285 (81.4%)
	Master/PhD	65 (18.6%)
Practice Region	Urban	269 (76.8%)
	Rural	81 (23.2%)

Knowledge of Fixed Prosthodontics

The results revealed significant gaps in knowledge regarding specific clinical procedures. Only 41.2% of respondents identified the correct minimum occlusal reduction for a zirconia crown (1.0 mm). While a majority (67.8%) demonstrated theoretical understanding of the Ferrule effect, a substantial proportion (33.2%) reported an inability to apply

this principle in a clinical setting. Possession of an advanced postgraduate degree was a significant predictor of knowledge, with holders scoring 28% higher on average ($p < 0.001$; OR = 2.4, 95% CI: 1.6–3.5).

Clinical Practices

Material Preferences



Porcelain-fused-to-metal (PFM) crowns were the most commonly reported restoration, utilized by 58.7% of respondents overall. A significant geographic disparity was observed, with practitioners in rural areas being 3.2 times more likely to use PFM crowns than their urban

counterparts (78.9% vs. 48.3%; $p = 0.003$). Conversely, the use of zirconia was significantly lower overall (22.1%) and markedly reduced in rural settings (8.6%) compared to urban practices (27.1%; $p < 0.001$) (Table 2).

Table 2: Material Preferences by Practice Setting among the study participants

Material	Urban (%)	Rural (%)	p-value
PFM*	48.3	78.9	0.003
Zirconia	27.1	8.6	<0.001
All-ceramic	24.6	12.5	0.021

*PFM: Porcelain-fused-to-metal.

Multivariable Analysis of Material Predictors

After adjusting for potential confounders including age, qualification, and practice setting, multivariate logistic regression analysis revealed that geographic location and advanced education were significant independent predictors of material choice. Rural practice location was a strong independent predictor of PFM crown use (OR = 3.8, 95% CI: 2.1–6.9; $p < 0.001$). Conversely, possession of a Master's or PhD degree was significantly associated with a higher likelihood of zirconia crown adoption (OR = 2.9, 95% CI: 1.5–5.6; $p = 0.002$).

Only 49.5% adhered to international standards (e.g., chamfer margins). In addition, Prosthodontists were 4.7× more likely to comply than general dentists ($p < 0.001$). The study identified significant financial and educational barriers to optimal practice, with high material cost (82.4%), lack of training (67.1%), and patient affordability (59.3%) cited as the most prevalent obstacles; these barriers were stratified by experience, with newer practitioners (<5 years) predominantly citing training deficits (74%), while their more experienced counterparts (>10 years) emphasized cost (63%). Correlation analyses revealed that these barriers had a measurable impact on clinical behavior, showing a strong positive association between urban practice location and the use of digital workflows ($\rho = 0.53$, $p < 0.001$), and between material cost and the use of PFM crowns ($\rho = 0.61$, $p < 0.001$). Conversely, a strong negative correlation was observed between cost barriers and adherence to clinical guidelines ($\rho = -0.57$, $p < 0.001$). Multivariate regression confirmed that holding a Master's degree (OR = 4.2, 95% CI: 2.1–8.3; $p < 0.001$),

practicing in an urban setting (OR = 3.1, 95% CI: 1.7–5.6; $p = 0.003$), and participating in continuing education (OR = 2.8, 95% CI: 1.4–5.4; $p = 0.011$) were significant independent predictors of advanced practice. These factors contributed to a notable geographic variation, with rural practitioners experiencing significantly higher complication rates, including a 34% crown debonding rate (vs. 22% urban; $p = 0.007$) and 2.1 times higher overall complications ($\rho = 0.39$). Thematic analysis of qualitative responses reinforced these quantitative findings, with the most frequent terms being cost (82%), training (67%), and materials (59%). Illustrative quotes, such as a prosthodontist stating, "Zirconia is ideal, but we can't afford the furnace," and a general dentist noting, "Patients refuse crowns when they hear the price," underscore the profound influence of financial and infrastructural constraints on both clinical decision-making and patient acceptance of essential treatments.

DISCUSSION

This study reveals significant knowledge gaps in fixed prosthodontics among Yemeni dentists, particularly among general practitioners (81.4% of respondents), with only 41.2% correctly identifying occlusal reduction requirements for zirconia crowns. This deficiency aligns with findings from other low-resource settings [8] but is more pronounced in Yemen, likely due to disruptions in continuing education (CE) caused by prolonged conflict and limited institutional support [7,18]. Dentists with advanced degrees (master's/PhD) scored 28% higher on knowledge assessments ($p < 0.001$), reinforcing the role of specialized training in clinical competency



[18]. However, Yemen's higher education system has faced severe challenges, including faculty shortages and inconsistent accreditation [7], which may explain the wider knowledge disparities compared to regional peers like Saudi Arabia [4] and Egypt [10]. While zirconia and lithium disilicate dominate prosthodontics in high-income settings [16], Yemeni dentists predominantly use PFM crowns (58.7%), primarily due to cost constraints [17]. Rural practitioners employed PFM 3.2 times more frequently than urban counterparts ($p = 0.003$), reflecting disparities in material access exacerbated by Yemen's fragmented supply chains [6,7]. Even in urban areas, digital workflows were limited (27.1% adoption vs. 8.6% rural), contrasting sharply with high-income countries where CAD/CAM is standard [13]. This urban-rural divide mirrors trends in neighboring countries but is intensified by Yemen's infrastructure collapse, which restricts equipment maintenance and material distribution [7,12]. Only 49.5% of Yemeni dentists followed international preparation guidelines (e.g., ferrule effect, margin design), compared to 70–85% in Saudi Arabia [20]. Prosthodontists demonstrated 4.7 times higher compliance than general dentists ($p < 0.001$) [13], underscoring the need for structured specialty training. However, Yemen's ongoing conflict has disrupted dental education, with rural areas experiencing 2.1 times higher complication rates (e.g., crown debonding) due to substandard materials and inadequate training [7]. Thematic analysis identified cost (82.4%) and training gaps (67.1%) as key barriers, consistent with regional studies [10,12] but amplified by Yemen's socio-political instability. While PFM remains the default in resource-limited settings [10,17], Yemen's unique challenges necessitate context-specific solutions. Metal-ceramic restorations using base-metal alloys or monolithic zirconia procured via subsidized programs could offer cost-effective alternatives [3,18]. CAD/CAM-fabricated PMMA or hybrid composites may also bridge material gaps if integrated into public clinics or teaching hospitals [16,20]. However, such interventions require stable policy frameworks, currently lacking due to Yemen's fragmented governance [7]. Regional partnerships (e.g., with Saudi Arabia or Egypt) could facilitate material procurement and CE programs, as seen in similar post-conflict settings [4,10].

Limitations

This study has several limitations that may affect the interpretation and generalizability of its findings.

Urban Sampling Bias

The disproportionate representation of urban dentists (76.8% of respondents) likely underestimates the material shortages, training gaps, and guideline non-adherence prevalent in rural areas, where infrastructure deficits are more severe [6,7]. Based on rural-urban disparities observed in similar studies [6,10], this bias may inflate reported knowledge scores by 15–20% and overestimate advanced material usage by 2.3-fold. Future research should employ stratified random sampling or deliberate oversampling of rural practitioners (targeting $\geq 40\%$ representation) to better capture nationwide trends.

Self-Reported Data and Response Bias

Questionnaire-based assessments risk overestimating clinical competency, as self-reported knowledge may not correlate with actual practice [22]. A 2024 meta-analysis found such methods inflate guideline adherence rates by 12–18% compared to clinical audits [23]. To improve validity, future studies should triangulate data through:

1. Direct observation of crown preparations (e.g., using standardized typodont assessments).
2. Patient record reviews for material choices and complication rates.
3. Peer evaluations of clinical work [15,22].
4. Cross-Sectional Design and Causality Gaps.

The study design precludes causal inferences—for example, whether observed knowledge gaps stem from inadequate pregraduate training or lack of continuing education [15,18]. Longitudinal tracking of cohorts (e.g., recent graduates vs. experienced dentists) or interventional studies (e.g., assessing CE program impacts over 12–24 months) could clarify these relationships.

Underrepresentation of Prosthodontic Specialists



With only 1.1% of respondents being prosthodontists, the findings disproportionately reflect general dentists' practices, potentially underestimating optimal techniques by 30–40% (based on specialist vs. generalist performance gaps in regional studies [8,13]). Future research should collaborate with professional associations (e.g., the Yemeni Dental Syndicate) and target specialist conferences to recruit a representative sample (aiming for ≥10% prosthodontist inclusion).

CONCLUSION

This study reveals critical gaps in Yemen's fixed prosthodontic care: Almost 41.2% of dentists knew the correct occlusal reduction for zirconia, while The rest adhered to preparation guidelines. PFM crowns dominated, reflecting cost barriers and training deficits. Rural complication rates were higher than urban. These findings demand urgent policy action to improve materials access and training, even amid Yemen's conflict.

Recommendations

The current study has several recommendations as follow:

1. Education & Training

- Integrate evidence-based prosthodontics into dental curricula via university partnerships.
- Launch mobile CE programs (WHO platform) on zirconia/LiDi and digital workflows.
- Prioritize rural training through FDI/WHO train-the-trainer initiatives.

2. Policy & Infrastructure

- Subsidize resin-matrix ceramics in 3 high-need governorates by 2025.
- Establish 2 regional CAD/CAM centers by 2026 via NGO/industry partnerships.
- Exempt taxes on essential prosthodontic materials for public clinics.

3. Research & Monitoring

- Conduct longitudinal studies on subsidized materials' clinical outcomes.
- Create a national prosthodontic registry (Yemeni Dental Council) to track trends.

Conflict of Interest

The authors declare that there is no conflict of interest.

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