



www.bioinformation.net
Volume 22(9)



Research Article

Received September 1, 2026; Revised September 30, 2026; Accepted September 30, 2026, Published September 30, 2026

DOI: 10.6026/973206300225938

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478

2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

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Edited by Ruby Singh

E-mail: bioinformationruby@gmail.com

Citation: Chauhan *et al.* Bioinformation 22(9): 5938-5944 (2026)

Assessment of infection control knowledge, attitude and practice among private dental practitioners in India

Neeraj Singh Chauhan, Abhishek Gupta*, Mayank Dwivedi, Mamta Talekar, Abhijeet Malve & Mayank Pandey

Department of Public Health Dentistry, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India; *Corresponding author

Affiliation URL:

<https://www.bhabhauniversity.edu.in/>

Author contact:

Neeraj Singh Chauhan - E-mail: drneerajschauhan@gmail.com

Abhishek Gupta - E-mail: itsmeabhishekgupta@gmail.com
Mayank Dwivedi - E-mail: mayankdwivedi2010@gmail.com
Mamta Talekar - E-mail: mamtatalekar19@gmail.com
Abhijeet Malve - E-mail: malveabhijit@yahoo.com
Mayank Pandey - E-mail: mayankpandey437@gmail.com

Abstract:

Infection control is essential for safe dental practice, yet compliance among private dental practitioners remains inconsistent. Therefore, it is of interest to assess the knowledge, attitude and practice of infection control among 170 registered private dental practitioners in Bhopal using a validated 42-item questionnaire. The mean knowledge, attitude and practice scores were 68.0%, 69.2% and 58.0%, respectively, with major deficiencies in sterilization monitoring, biomedical waste management and barrier protection. Attitude was positively associated with practice ($r = 0.54$, $p < 0.001$), while MDS qualification, workshop attendance and higher attitude scores independently predicted better infection control practices. These findings reveal a substantial knowledge-practice gap and emphasize the need for continuing education and strengthened infection control training.

Keywords: Infection control, dental practitioners, knowledge, attitude, practice, cross-sectional study, Bhopal, India

Background:

Infection control is fundamental to safe and ethical dental practice because dental procedures routinely expose both patients and dental healthcare personnel to blood, saliva, aerosols and other potentially infectious materials. Cross-transmission of microorganisms may occur through contaminated instruments, environmental surfaces, or direct contact, placing clinicians and patients at risk of healthcare-associated infections [1]. Common pathogens encountered in dental settings include *Staphylococcus aureus*, *Mycobacterium tuberculosis*, hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV). The COVID-19 pandemic further highlighted the importance of stringent infection prevention measures, particularly during aerosol-generating procedures, prompting renewed emphasis on ventilation, personal protective equipment and standard infection control practices [2]. The Centers for Disease Control and Prevention (CDC) introduced Universal Precautions in 1985, which later evolved into Standard Precautions and remain the foundation of infection prevention in dentistry [3]. These recommendations include hand hygiene, appropriate use of personal protective equipment, safe injection practices and sterilization of reusable instruments, environmental surface disinfection, biomedical waste management and prevention of sharps injuries [4]. Adherence to these measures protects both patients and healthcare workers while minimizing the spread of infectious diseases in dental clinics [5]. India has one of the largest dental workforces globally, with the majority of dentists practicing in private clinics that serve as the primary source of oral healthcare. Unlike institutional settings, private dental practices often function independently with limited external monitoring of infection control compliance. Consequently, implementation of recommended protocols depends largely on the practitioner's knowledge, attitude and commitment to safe clinical practice [6]. The Knowledge-Attitude-Practice (KAP) model is widely used to evaluate health-related behaviors and provides insight into whether adequate knowledge is translated into appropriate clinical practice. Although knowledge is essential, positive attitudes are equally important for ensuring consistent

implementation of infection control measures [7, 8]. Following the COVID-19 pandemic, awareness regarding infection prevention has increased substantially; however, evidence regarding sustained infection control practices among private dental practitioners remains limited, particularly in central India [9]. Therefore, it is of interest to report the knowledge, attitude and practice of infection control methods among registered private dental practitioners in Bhopal.

Materials and Methods:

Study design and setting:

A descriptive, cross-sectional, questionnaire-based study was conducted in Bhopal city, Madhya Pradesh, from January 2024 to June 2024. Bhopal was chosen owing to its high density of registered private dental clinics and the investigator's institutional location, which facilitated data collection. The city was stratified into five geographical zones: North, South, East, West and Central, based on municipal corporation boundaries.

Ethical considerations:

Ethical approval was obtained from the Institutional Ethics Committee (IEC) of Bhabha College of Dental Sciences, Bhopal (Ref. No. IEC/DENT/2023/142, dated 15 December 2023). The study was conducted in full compliance with the Declaration of Helsinki. Permission was sought from the local branch of the Indian Dental Association and from the Madhya Pradesh State Dental Council for access to the registration list. Written informed consent was obtained from each participant after explaining the study's purpose, voluntary nature and confidentiality safeguards.

Sample size determination:

According to the MP State Dental Council registry, there were approximately 850 registered private dental practitioners active in Bhopal at the time of study initiation. The sample size was calculated using the formula for cross-sectional surveys: $n = Z^2 \alpha/2 \times p(1-p) / d^2$. Where $Z_{\alpha/2} = 1.96$ for 95% confidence level, p was the anticipated proportion of good practice (60% based on previous studies) and d was the absolute precision of 7%. This

yielded $n \approx 165$. Anticipating a non-response rate of about 20%, the target sample size was inflated to 200.

Sampling technique and participant selection:

A stratified random sampling technique was employed. The five zones were considered strata. From each stratum, 40 registered private dental practitioners were randomly selected using computer-generated random numbers applied to the council's registration list.

Inclusion criteria:

Registered with the MP State Dental Council, actively practicing in a private clinic in Bhopal for at least one year

Exclusion criteria:

Full-time employment in an academic institution or government hospital, not practicing at the time of the survey, unwilling to consent

The questionnaire was divided into four sections:

[1] Section A - Socio-demographic and Professional Information (6 items):

Age, gender, highest dental qualification (BDS/MDS), years of clinical experience, type of practice (solo/group) and history of attending any infection control CDE/workshop in the preceding three years.

[2] Section B - Knowledge of Infection Control (15 items):

Questions covered modes of transmission of HBV, HCV, HIV; meaning of "standard precautions"; recommended temperature, pressure and time for autoclave sterilization; difference between sterilization and high-level disinfection; purpose of biological indicators; correct colour coding for biomedical waste; hand hygiene moments; and post-exposure prophylaxis protocol for HIV. Responses were recorded as "Yes," "No," or "Don't Know." Correct answer scored 1; incorrect or don't know scored: 0. Maximum possible score: 15.

[3] Section C - Attitude towards Infection Control (12 items):

Statements included: "Infection control is an ethical duty of every dentist," "Treating patients with known infectious diseases is a professional obligation," "The cost of infection control consumables is a major barrier to compliance," "A busy schedule makes full compliance impractical," "I am at risk of acquiring an occupational infection," and "Reporting needlestick injuries is important." A 5-point Likert scale was used: Strongly Agree (5) to Strongly Disagree (1). Negatively worded statements were reverse-scored. Maximum score: 60.

[4] Section D - Practice of Infection Control (15 items):

Items assessed self-reported frequency of specific behaviours over the preceding one month, including hand hygiene, glove use, mask and eyewear use, hepatitis B vaccination status, sterilization methods, biological and chemical indicator use, surface disinfection, needle recapping, rubber dam use, high-

volume suction use and biomedical waste segregation. Responses were recorded on a 5-point scale: Always, Often, Sometimes, Rarely, Never. "Always" and "Often" were grouped as "Adequate Practice" (scored 1); otherwise 0. Maximum score: 15.

Data collection procedure:

The investigator personally visited each selected clinic with a prior telephone appointment. The purpose and procedure were explained and written consent was obtained. Participants were given the option to fill the questionnaire on the spot in a private area or to complete it within 48 hours, after which the investigator collected it in a sealed envelope.

Statistical analysis:

Data were entered into Microsoft Excel 2019 and analyzed using IBM SPSS Statistics for Windows, Version 25.0. Descriptive statistics (mean, standard deviation, frequency, percentage) were computed. Knowledge, attitude and practice scores were converted to percentages: (Obtained score / Maximum score) $\times$ 100. Based on percentage scores, participants were classified as "Good" ($\geq 75\%$), "Moderate" (50-74.99%), or "Poor" ($\leq 50\%$). Association between categorical variables was tested using the Chi-square test. Differences in continuous scores between two groups were tested using the independent-samples t-test. One-way ANOVA was used for comparing means across more than two groups. Pearson's correlation coefficient was computed to explore linear relationships between KAP scores. Multiple linear regressions were performed with practice score as the dependent variable. A p -value < 0.05 was considered statistically significant.

Results:

Of the 200 questionnaires distributed, 178 were returned, yielding a response rate of 89.0%. Eight questionnaires were excluded because of substantial missing data ($>30\%$, $n=5$) or being returned blank ($n=3$); therefore, 170 complete questionnaires were included in the final analysis. The mean age of participants was 38.4 ± 9.6 years (range, 25-65 years), with males comprising 62.4% ($n=106$) and females 37.6% ($n=64$). Most participants held a BDS degree (66.5%, $n=113$), while 33.5% ($n=57$) held an MDS degree. The mean clinical experience was 12.8 ± 8.2 years, with 42.9% ($n=73$) having ≤ 10 years of experience and 57.1% ($n=97$) having >10 years. Solo practice was reported by 78.8% ($n=134$), whereas 21.2% ($n=36$) worked in group practices or polyclinics. Only 28.8% ($n=49$) had attended an infection-control workshop or continuing dental education programme during the preceding three years (**Table 1**). The mean knowledge score was 10.2 ± 2.4 out of 15 (68.0%). Based on the predefined grading, 35.3% ($n=60$) showed good knowledge, 48.2% ($n=82$) moderate knowledge and 16.5% ($n=28$) poor knowledge. Item-wise analysis showed that knowledge of HIV and HBV transmission routes was relatively high, with 92.4% and 87.6% answering correctly, respectively. However, only 61.8% correctly identified 121°C and 15 psi as the appropriate temperature and pressure for effective steam sterilization, while

22.4% incorrectly considered 134°C without specifying pressure sufficient for all loads. Knowledge regarding biological indicators as the gold standard for sterilizer monitoring was correct in only 52.9% of participants. Similarly, only 44.7% correctly identified the biomedical-waste colour coding and 58.8% correctly identified the HIV post-exposure prophylaxis regimen involving initiation within 72 hours and a 28-day course (**Table 2**). The mean attitude score was 41.5 ± 7.1 out of 60 (69.2%). Overall, 35.9% (n=61) demonstrated good attitudes, 47.6% (n=81) had moderate attitudes and 16.5% (n=28) had poor attitudes. Although 87.6% agreed or strongly agreed that infection control was an ethical duty, 52.4% considered infection-control procedures too time-consuming in a busy practice. Economic constraints were also prominent, with 70.0% reporting that the cost of disposables, biological indicators and personal protective equipment restricted their ability to fully adhere to guidelines. Only 54.1% agreed that they were willing to treat a known HIV-positive patient, while 25.9% were neutral and 20.0% disagreed. Furthermore, 64.7% agreed that all patients should be considered potentially infectious regardless of their medical history, whereas 18.8% disagreed and 16.5% remained neutral (**Table 3**). The mean practice score was 8.7 ± 2.9 out of 15 (58.0%). Good practice was observed in only 25.3% (n=43) of participants, whereas 50.6% (n=86) demonstrated moderate practice and 24.1% (n=41) demonstrated poor practice. Although 95.3% reported always using gloves during invasive procedures, only 57.1% reported always changing gloves between patients during non-invasive examinations. Hand hygiene was performed before and after patient contact consistently by 45.3% of practitioners, while 37.6% reported doing so often and 52.4% reported maintaining adequate hand-rub duration of more than 20 seconds. Masks were always used during procedures by 74.1% of participants, with a further 18.8% reporting frequent use. Compliance with protective eyewear or face-shield use was particularly poor, with only 28.8% reporting consistent use and 32.4% reporting rare or no use. Although 81.2% reported completing the three-dose hepatitis B vaccination schedule, only 24.1% had undergone anti-HBs titre testing. Steam autoclaves were used for critical instruments by 86.5% of practitioners; however, only 40.6% reported weekly or more frequent biological-indicator monitoring, while 37.1% relied solely on chemical indicators. Adequate surface disinfection between

patients was reported as always or often by 67.6%. Unsafe needle recapping remained prevalent, with 18.8% reporting the use of the two-hand recapping technique; 64.7% used a one-hand scoop technique or did not recap and 16.5% disposed of needles directly into puncture-proof containers without recapping. Rubber dam use was particularly limited, with only 5.3% reporting always using it, 12.4% using it often and 60.6% reporting that they had never used it (**Table 4**). Significant positive correlations were observed among all three KAP domains. Knowledge showed a moderate positive correlation with attitude ($r=0.46$, $p<0.001$) and a weaker but significant correlation with practice ($r=0.39$, $p<0.001$). The strongest association was observed between attitude and practice ($r=0.54$, $p<0.001$), indicating that practitioners with more favourable infection-control attitudes tended to report better infection-control practices (**Table 5**). Several participant characteristics were significantly associated with KAP scores. MDS practitioners had significantly higher mean knowledge, attitude and practice scores than BDS practitioners ($p=0.006$, $p=0.024$ and $p=0.005$, respectively). Attendance at an infection-control workshop or CDE programme was also significantly associated with higher scores across all three domains (knowledge, $p<0.001$; attitude, $p=0.001$; practice, $p<0.001$). Practitioners with >10 years of experience had significantly lower attitude scores than those with ≤ 10 years of experience ($p=0.038$), although knowledge and practice scores did not differ significantly according to experience. Female practitioners demonstrated significantly higher practice scores than males ($p=0.018$), whereas knowledge and attitude scores did not differ significantly by gender. Practitioners working in group practices showed a trend toward better practice scores compared with those in solo practice, although this difference did not reach statistical significance ($p=0.072$) (**Table 6**). In the multivariable model with practice score as the dependent variable, the final model explained 41% of the variance in practice scores (adjusted $R^2=0.41$). Attitude score was the strongest independent predictor of better practice ($\beta=0.38$, $p<0.001$), followed by infection-control workshop attendance ($\beta=0.24$, $p=0.001$) and MDS qualification ($\beta=0.19$, $p=0.007$). Knowledge score was no longer statistically significant after adjustment for attitude, supporting the role of attitude as an important mediating factor in translating infection-control knowledge into clinical practice (**Table 7**).

Table 1: Socio-demographic and professional characteristics of the study participants (N = 170)

Characteristic	n	%
Mean $\pm$ SD	38.4 $\pm$ 9.6	-
Range	25–65	-
Male	106	62.4
Female	64	37.6
BDS	113	66.5
MDS	57	33.5
≤ 10 years	73	42.9
>10 years	97	57.1
Mean $\pm$ SD	12.8 $\pm$ 8.2 years	-
Solo practice	134	78.8
Group practice/polyclinic	36	21.2
Infection-control workshop/CDE in previous 3 years		
Yes	49	28.8
No	121	71.2

Table 2: Knowledge regarding infection-control practices among participants (N = 170)

Knowledge domain	Correct response, n (%)
HIV transmission routes	157 (92.4)
HBV transmission routes	149 (87.6)
Correct steam sterilization parameters (121°C, 15 psi)	105 (61.8)
Biological indicators as gold standard for sterilizer monitoring	90 (52.9)
Correct biomedical-waste colour coding	76 (44.7)
Correct HIV PEP regimen	100 (58.8)
Overall knowledge score, mean $\pm$ SD	10.2 $\pm$ 2.4/15
Overall knowledge score (%)	68.0
Knowledge grading	
Good	60 (35.3)
Moderate	82 (48.2)
Poor	28 (16.5)

Table 3: Attitudes toward infection control among participants (N = 170)

Attitude item	Response, n (%)
Infection control is an ethical duty - Agree/Strongly agree	149 (87.6)
Infection-control procedures are too time-consuming - Agree/Strongly agree	89 (52.4)
High cost of disposables, biological indicators and PPE restricts adherence - Agree/Strongly agree	119 (70.0)
Willing to treat a known HIV-positive patient - Agree	92 (54.1)
Willing to treat a known HIV-positive patient - Neutral	44 (25.9)
Willing to treat a known HIV-positive patient - Disagree	34 (20.0)
All patients should be considered potentially infectious - Agree	110 (64.7)
All patients should be considered potentially infectious - Neutral	28 (16.5)
All patients should be considered potentially infectious - Disagree	32 (18.8)
Overall attitude score, mean $\pm$ SD	41.5 $\pm$ 7.1/60
Overall attitude score (%)	69.2
Attitude grading	
Good	61 (35.9)
Moderate	81 (47.6)
Poor	28 (16.5)

Table 4: Self-reported infection-control practices among participants (N = 170)

Practice item	Response	n (%)
Glove use during invasive procedures	Always	162 (95.3)
Changing gloves between patients during non-invasive examination	Always	97 (57.1)
Hand hygiene before and after patient contact	Always	77 (45.3)
	Often	64 (37.6)
Adequate hand-rub duration (>20 seconds)	Yes	89 (52.4)
Mask use during procedures	Always	126 (74.1)
	Often	32 (18.8)
Protective eyewear/face shield	Always	49 (28.8)
	Rarely/Never	55 (32.4)
Complete three-dose hepatitis B vaccination	Yes	138 (81.2)
Anti-HBs titre checked	Yes	41 (24.1)
Steam autoclave use for critical instruments	Yes	147 (86.5)
Weekly or more frequent biological-indicator monitoring	Yes	69 (40.6)
Reliance solely on chemical indicators	Yes	63 (37.1)
Adequate surface disinfection between patients	Always/Often	115 (67.6)
Two-hand needle recapping	Yes	32 (18.8)
One-hand scoop/no recapping	Yes	110 (64.7)
Direct disposal without recapping into puncture-proof container	Yes	28 (16.5)
Rubber dam use	Always	9 (5.3)
	Often	21 (12.4)
	Never	103 (60.6)

Table 5: Correlation between knowledge, attitude and practice scores

Variable pair	Pearson's r	p-value
Knowledge-Attitude	0.46	<0.001
Knowledge-Practice	0.39	<0.001
Attitude-Practice	0.54	<0.001

Table 6: Factors associated with knowledge, attitude and practice scores

Factor	Knowledge	Attitude	Practice
Qualification: MDS vs BDS	Significantly higher (p=0.006)	Significantly higher (p=0.024)	Significantly higher (p=0.005)
Workshop/CDE attendance	Significantly higher (p<0.001)	Significantly higher (p=0.001)	Significantly higher (p<0.001)
Experience: >10 vs $\leq$ 10 years	Not significant	Lower in >10 years (p=0.038)	Not significant
Gender: female vs male	Not significant	Not significant	Higher in females (p=0.018)
Practice type: group vs solo	-	-	Trend toward higher scores (p=0.072)

Table 7: Multivariable predictors of infection-control practice

Independent predictor	β coefficient	p-value
Attitude score	0.38	<0.001
Infection-control workshop/CDE attendance	0.24	0.001
MDS qualification	0.19	0.007
Knowledge score	Not significant	>0.05
Adjusted R ²	0.41	-

Discussion:

This study provides a comprehensive assessment of infection control knowledge, attitude and practice among private dental practitioners in Bhopal and demonstrates a considerable gap between knowledge and routine clinical practice. Although the mean knowledge score was satisfactory (68.0%), important deficiencies were identified in biomedical waste segregation and biological monitoring of sterilization, indicating that awareness of infection control principles does not necessarily translate into appropriate implementation. Similar observations have been reported among dental practitioners in India and other developing countries, where compliance with recommended infection control measures remains inconsistent despite adequate theoretical knowledge [10]. The significant positive correlation between attitude and practice ($r = 0.54$) indicates that practitioners with favorable attitudes are more likely to implement infection control measures consistently. Furthermore, attitude emerged as a stronger predictor of practice than knowledge, suggesting that behavioral factors influence compliance more than cognitive understanding alone. These findings support the Knowledge-Attitude-Practice model and agree with previous studies showing that perceived barriers, including cost, time constraints and low occupational risk perception, adversely affect adherence to infection control guidelines [11]. Several important deficiencies in clinical practice were identified. Regular use of protective eyewear, rubber dam isolation, biological indicator monitoring and appropriate sharps handling remained suboptimal. Similar findings have been reported in previous investigations, where inadequate use of personal protective equipment and sterilization monitoring represented common weaknesses among private dental practitioners [12, 13]. Although hepatitis B vaccination coverage in the present study was relatively high, a considerable proportion of practitioners remained either unvaccinated or had not confirmed protective antibody levels, leaving them vulnerable to occupational exposure [14, 15]. Postgraduate qualification and attendance at continuing dental education (CDE) programs were independently associated with better infection control practices. These findings emphasize the importance of lifelong learning and regular professional training in maintaining compliance with evolving infection control recommendations. Previous studies have similarly showed that continuing education significantly improves infection control knowledge and clinical performance among dental professionals [16, 17]. The COVID-19 pandemic substantially increased awareness of infection prevention; however, the persistence of inadequate practices suggests that improved awareness alone is insufficient to ensure long-term behavioral change. Strengthening undergraduate training, implementing mandatory infection control workshops and encouraging

periodic clinical audits may improve compliance in private practice settings [18]. Additionally, reducing financial barriers through institutional support and affordable infection control resources may facilitate wider adoption of recommended practices. Overall, the present findings show that improving practitioners' attitudes through continuous education and supportive policies is essential for translating knowledge into consistent infection control practices and ensuring safer dental care.

Conclusion:

Private dental practitioners in Bhopal, India showed basic infection-control knowledge but notable gaps in attitude and practice. Hand hygiene, protective eyewear, biological monitoring, sharps handling and waste segregation require improvement. Targeted training addressing motivational and economic barriers may improve consistent infection-control practices.

Limitations:

This study has limitations that must be acknowledged. First, its cross-sectional design can identify associations but not causal pathways. Second, data were self-reported and direct observation of practice was not performed. The known phenomenon of social desirability bias likely inflated practice scores; actual compliance with hand hygiene, glove changing and sterilization monitoring is probably lower. Third, the instrument, although validated, was in English, which might have caused mild comprehension issues for a small minority. Fourth, the sample, though randomly selected, represented only registered private practitioners willing to participate; practitioners with very poor practices may have refused, leading to selection bias. Fifth, the operationalization of "adequate practice" using arbitrary cut-offs (Always/Often) may overestimate compliance by grouping "Often" with "Always." Sixth, the study was geographically limited to Bhopal and therefore results cannot be generalized to other cities or rural areas. Finally, the study did not include qualitative components; in-depth interviews could have provided richer insight into the contextual barriers and facilitators.

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