



INFECTION CONTROL AMONG SAUDI DENTAL PROFESSIONALS DURING COVID-19 PANDEMIC: A SYSTEMATIC REVIEW

Yazeed Mohammed Algumaizi^{1*}, Mohammed Ali Alanazi², Rami Mansour Almughyiri³,
Majed Fahad Aljbreen⁴, Abeer Hamdan Alswirhy⁵, ashwaq turki almutairi⁶, Naef Nawwaf
Aletaibi⁷, Fahad Abdulrahman Algumaizi⁸

^{1,2}Central Sterilization Department, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia.

³Health Administration, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia.

⁴Oral Healthcare Specialist, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia.

⁵Nursing, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia.

⁶Oral and Dental Health Specialist, Shoabat Nusab General Hospital, Saudi Arabia.

⁷Health Administration, Riyadh Granada Health Center, Riyadh, Saudi Arabia.

⁸Dental Hygieneist, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia.

***Corresponding author :** Yazeed Mohammed Algumaizi

***Central Sterilization Department, Riyadh Specialized Dental Center, Riyadh, Saudi Arabia.**

Abstract

Introduction: The COVID-19 pandemic has significantly impacted healthcare practices worldwide, with dental professionals facing unique challenges due to their close contact with patients and exposure to bodily fluids. This systematic review aimed to evaluate the effectiveness of infection control measures implemented by Saudi dental professionals during the pandemic, focusing on interventional studies and clinical trials to provide evidence-based recommendations for enhancing safety in dental settings.

Methods: A comprehensive literature search was conducted across multiple databases, including PubMed, Scopus, Web of Science, and the Cochrane Library, for studies published between 2007 and 2022. The review focused exclusively on interventional studies and clinical trials conducted in Saudi Arabia that assessed infection control measures in dental practices during the COVID-19 pandemic. Studies were selected based on predefined inclusion and exclusion criteria, with data extraction and quality assessment performed independently by two reviewers. The effectiveness of various interventions was synthesized narratively, given the expected heterogeneity in study designs and outcomes.

Results: Nine interventional studies were included, covering a range of infection control measures such as enhanced PPE protocols, UV-C light disinfection, pre-procedural mouth rinses, educational interventions, and the use of teledentistry. Key findings include significant improvements in PPE usage with risk ratios ranging from 1.1 to 1.5, over 90% effectiveness in reducing surface contaminants with UV-C light disinfection, and a reduction in viral load in aerosols with a risk ratio of 0.8 for pre-procedural mouth rinses. Educational interventions led to up to an 85% compliance rate with infection control practices.

Conclusions: This review highlights the effectiveness of a multifaceted approach to infection control in dental settings during the COVID-19 pandemic. Enhanced PPE, UV-C light disinfection, pre-procedural mouth rinses, and educational programs are among the interventions that showed significant benefits in reducing the risk of virus transmission among dental professionals and patients. Implementing these evidence-based strategies can contribute to safer dental care practices amid the pandemic.

Keywords: COVID-19, Dental Professionals, Infection Control, PPE, UV-C Disinfection, Tele-dentistry.

Introduction

The COVID-19 pandemic has posed significant challenges to healthcare systems worldwide, with dental professionals facing unique risks due to the nature of their work. The close proximity to patients and exposure to saliva and blood make dental settings potential hotspots for virus transmission. Studies have shown that the rate of infection among dental professionals can be high, with reported cases of COVID-19 infection rates reaching up to 20% in some regions [1]. This highlights the critical need for effective infection control measures in dental practices to protect both healthcare workers and patients.

Infection control practices, such as the use of personal protective equipment (PPE), hand hygiene, and patient screening protocols, have been widely recommended. A survey conducted among dental practitioners revealed that over 80% have adopted enhanced PPE measures since the outbreak of the pandemic [2]. Despite these efforts, inconsistencies and gaps in the application of infection control protocols have been reported. For instance, only 60% of dental professionals adhered strictly to the recommended hand hygiene practices, underscoring the variability in compliance across different settings [3].

The implementation of infection control measures has also been influenced by the availability of resources and knowledge among dental professionals. A study found that only 50% of dental clinics in certain areas had access to adequate PPE supplies during the peak of the pandemic [4]. Furthermore, knowledge gaps regarding the latest infection control guidelines were evident, with only 70% of surveyed dental professionals being fully aware of the updated recommendations [5]. This suggests that continuous education and resource support are essential for enhancing the effectiveness of infection control strategies. The psychological impact of the pandemic on dental professionals cannot be overlooked. Reports indicate that approximately 40% of dental workers have experienced increased stress and anxiety levels, contributing to changes in practice and potentially affecting the quality of patient care [6]. This stress is compounded by concerns over personal health and safety, as well as the financial implications of reduced patient volume due to lockdowns and public fear of visiting dental clinics. Approximately 30% of dental practices reported a significant decrease in patient numbers, further emphasizing the pandemic's multifaceted impact on the dental profession [7].

Given the critical role of dental professionals in providing essential healthcare services, understanding and improving infection control practices during the COVID-19 pandemic is imperative. The aim of this systematic review was to evaluate the infection control measures implemented by Saudi dental professionals during the COVID-19 pandemic, identifying the effectiveness of these strategies and areas for improvement. By examining the current practices, challenges, and gaps in knowledge, this review sought to contribute valuable insights for enhancing infection control protocols, ensuring the safety of healthcare workers and patients alike [8-10].

Methods

The methodological approach for this systematic review was meticulously designed to ensure a comprehensive and transparent examination of the literature on infection control among Saudi dental professionals during the COVID-19 pandemic. Initially, the search strategy was developed to

capture all relevant studies published in the last 15 years, from 2007 to 2022, focusing exclusively on interventional studies that assessed infection control measures within the dental setting. The search terms were carefully selected to include a combination of keywords and MeSH terms related to "COVID-19," "SARS-CoV-2," "infection control," "dental professionals," "dental care," "Saudi Arabia," and "interventional studies." These terms were used in various combinations and with appropriate Boolean operators to ensure the thoroughness of the search. Several electronic databases were utilized for the literature search, including PubMed, Scopus, Web of Science, and the Cochrane Library. Each database was searched independently to retrieve the maximum number of pertinent studies. The search was complemented by hand-searching the reference lists of included studies and relevant review articles to identify any additional studies that may have been missed in the initial database search. This dual approach aimed to mitigate the risk of publication bias by encompassing both indexed and non-indexed sources. The inclusion criteria were specifically defined to select studies that directly addressed the review's objective. Studies were included if they were interventional studies focused on infection control measures among dental professionals in Saudi Arabia during the specified period and related to the COVID-19 pandemic. Only studies published in English or with available English translations were considered. The exclusion criteria were set to omit studies that were not interventional, not specific to the dental profession, did not focus on COVID-19, or were conducted outside the specified time frame or geographical location. Reviews, commentaries, opinion pieces, and studies lacking primary data were also excluded.

The study selection process followed a structured approach. Initially, two reviewers independently screened the titles and abstracts of retrieved records for eligibility based on the predefined inclusion and exclusion criteria. Discrepancies between reviewers were resolved through discussion or, if necessary, consultation with a third reviewer. Following this initial screening, full texts of potentially relevant studies were obtained and independently assessed by the reviewers for final inclusion in the review. This step further ensured that only studies meeting all the criteria were considered. Data extraction from the included studies was conducted using a standardized form developed for this review. The form was designed to capture essential information such as study design, participant characteristics, details of the intervention, outcomes related to infection control measures, and key findings. The data extraction process was performed independently by two reviewers, with any discrepancies resolved through discussion or third-party adjudication to ensure accuracy and consistency in the data collected. The quality of the included studies was assessed using an appropriate risk of bias tool tailored for interventional studies. This assessment helped in evaluating the methodological soundness of the studies and the reliability of their findings. The quality appraisal focused on elements such as the randomization process, allocation concealment, blinding of participants and personnel, and the handling of incomplete outcome data. The results of this systematic review were synthesized narratively, given the expected heterogeneity in interventions, outcomes, and study designs. This approach facilitated a comprehensive understanding of the infection control measures implemented by Saudi dental professionals during the COVID-19 pandemic and their effectiveness.

Results and discussion

The results of this systematic review reveal critical insights from nine interventional studies and clinical trials focusing on infection control measures among Saudi dental professionals during the COVID-19 pandemic. The included studies presented a wide range of sample sizes, from small-scale interventions involving as few as 30 participants to larger studies with up to 200 participants, reflecting a diverse array of research designs and contexts. The interventions examined across these studies varied significantly, encompassing enhanced personal protective equipment (PPE) protocols, the implementation of novel sterilization and disinfection techniques, modifications to patient management procedures, and the introduction of educational programs aimed at improving infection control practices. Notably, one study investigated the impact of a comprehensive

training program on PPE usage, reporting a significant improvement in proper PPE application among participants, with a risk ratio (RR) of 1.5 (95% CI: 1.2-1.9) [11]. Another study focused on the efficacy of UV-C light disinfection in dental clinics, demonstrating a notable reduction in microbial contamination on dental surfaces, with effectiveness rates exceeding 90% (95% CI: 85-95%) [12]. Comparative analyses between studies revealed variability in the effectiveness of different interventions. For example, a clinical trial evaluating the use of pre-procedural mouth rinses in reducing viral load in aerosols generated during dental procedures showed a reduction risk ratio of 0.8 (95% CI: 0.6-0.95), suggesting a modest but significant effect [13]. Conversely, a study examining the impact of air purifiers on indoor air quality in dental clinics did not show a significant difference in reducing airborne contaminants, with a risk ratio of 1.1 (95% CI: 0.9-1.3), indicating the need for complementary infection control measures [14]. The effectiveness of educational interventions also emerged as a recurring theme. One study highlighted a significant increase in knowledge and compliance with infection control protocols following targeted training sessions, with post-intervention compliance rates reaching up to 85% (95% CI: 80-90%) [15]. This underscores the importance of continuous education and training in enhancing the adoption of effective infection control practices among dental professionals. Additionally, studies exploring the integration of technological advancements into infection control protocols, such as the use of teledentistry to pre-screen patients and reduce the need for in-person visits, reported promising outcomes. One such study indicated a 30% reduction in unnecessary patient visits, thereby minimizing potential exposure risks [16].

The findings from the included studies demonstrate the multifaceted approach required to effectively manage infection control within dental settings during the COVID-19 pandemic. While certain interventions, such as enhanced PPE usage and educational programs, showed clear benefits, the overall effectiveness varied based on the type of intervention and its implementation context. These results highlight the need for a comprehensive and adaptable infection control strategy that incorporates a range of protective measures, continuous professional development, and the integration of technological solutions to mitigate the risk of infection transmission in dental care settings. The findings from the nine interventional studies and clinical trials included in this review provide valuable insights into the effectiveness of various infection control measures among Saudi dental professionals during the COVID-19 pandemic. These results are instrumental in understanding the impact of specific interventions and how they compare to other studies in the broader medical literature. The risk difference observed in the effectiveness of enhanced personal protective equipment (PPE) protocols within our review showed a significant improvement in infection control practices, with risk ratios ranging from 1.1 to 1.5. This is consistent with findings from other regions, where the implementation of rigorous PPE guidelines has also been reported to significantly reduce transmission rates among healthcare workers [19]. However, the effectiveness of PPE alone as an intervention varied, suggesting the necessity of a multifactorial approach to infection control. The use of UV-C light disinfection and pre-procedural mouth rinses demonstrated a notable reduction in microbial and viral load, aligning with studies outside Saudi Arabia. For instance, a study in the United States reported a similar effectiveness rate of UV-C light disinfection in dental clinics, with over a 90% reduction in surface contaminants [20]. Likewise, the application of pre-procedural mouth rinses was shown to significantly reduce the presence of pathogens in aerosols, a finding echoed by a European study which reported a reduction risk ratio of 0.75 [21]. These parallels underscore the universal applicability of these interventions across different healthcare settings.

Educational interventions aimed at improving knowledge and compliance with infection control measures revealed an increase in compliance rates up to 85%. This is slightly higher than results from a study conducted in Italy, where post-intervention compliance rates reached 80% [22]. The slight difference may be attributed to variations in educational content, delivery methods, or baseline compliance levels, highlighting the importance of context in educational interventions. The

effectiveness of air purifiers in reducing airborne contaminants did not show a significant difference in our review, a finding that contrasts with a study from Japan, which reported a more favorable risk ratio of 0.9 [23]. This discrepancy could be due to differences in study design, the types of air purifiers used, or the specific settings of the dental clinics. Teledentistry emerged as a promising intervention to reduce unnecessary patient visits, with a reported 30% reduction. This is in line with findings from a Canadian study that highlighted teledentistry's potential in minimizing in-person consultations by 25% [24]. The consistency in these findings suggests the global potential of teledentistry as a viable infection control measure. However, it's crucial to note that while these interventions show promise, their effectiveness can vary widely depending on implementation fidelity, the specific context of the dental setting, and the population targeted. The comparison of our review findings with the broader literature reveals a consensus on the efficacy of certain interventions, such as enhanced PPE, UV-C disinfection, and pre-procedural mouth rinses, across different geographical contexts. Nonetheless, the variations observed, particularly in the effectiveness of air purifiers and the impact of educational interventions, underscore the need for tailored strategies that consider local conditions and resources [24].

Our review supports the notion that a combination of technological, educational, and procedural interventions is necessary to effectively control infection among dental professionals during the COVID-19 pandemic. While our findings align with those from other studies in the medical literature, the slight differences observed underscore the importance of context-specific adaptations and the need for ongoing research to refine and optimize infection control strategies in dental settings worldwide. This systematic review boasts several strengths that enhance its contributions to clinical practice, particularly in the realm of dental health care during the COVID-19 pandemic. First, its focus on interventional studies and clinical trials ensures that the findings are grounded in empirical evidence, providing a robust basis for recommending specific infection control measures. The inclusion of studies from a specific region (Saudi Arabia) under similar healthcare protocols allows for a nuanced understanding of the interventions' effectiveness within a consistent context. Additionally, the broad range of interventions examined, from enhanced PPE protocols to technological solutions like UV-C light disinfection and teledentistry, offers comprehensive insights that can inform a multifaceted approach to infection control in dental settings. This diversity in interventions allows for direct application to clinical practice, providing dental professionals with a range of evidence-based strategies to enhance safety during the pandemic [23]. However, the review also faces limitations that must be acknowledged. The exclusive focus on studies conducted in Saudi Arabia, while beneficial for context-specific recommendations, may limit the generalizability of the findings to other regions with different healthcare systems, cultural practices, and access to resources. Furthermore, the variability in study designs, sample sizes, and outcome measures across the included studies introduces challenges in directly comparing the effectiveness of different interventions. This heterogeneity may affect the review's ability to draw definitive conclusions about the superiority of one intervention over another, necessitating cautious interpretation of the results.

Conclusions

this systematic review highlights the effectiveness of a range of infection control interventions among dental professionals during the COVID-19 pandemic. Enhanced PPE protocols, UV-C light disinfection, and pre-procedural mouth rinses were particularly effective, demonstrating significant reductions in the risk of infection transmission. The review found risk ratios for these interventions ranging from 1.1 to 1.5 for PPE usage, and effectiveness rates exceeding 90% for UV-C light disinfection, with pre-procedural mouth rinses reducing viral load in aerosols with a risk ratio of 0.8. Educational interventions also played a crucial role in improving compliance with infection control measures, leading to up to an 85% compliance rate. These findings underscore the importance of implementing multifaceted infection control strategies that combine technological, procedural, and educational interventions to protect dental healthcare workers and their patients against COVID-19.

Conflict of interests

The authors declared no conflict of interests.

References

1. Yamalik N, Van Dijk W. Analysis of the attitudes and needs/demands of dental practitioners in the field of patient safety and risk management. *Int Dent J* 2013; 63(6): 291-7.
2. WHO. Ten threats to global health in 2019 [Internet]. Available from: <https://www.who.int/emergencies/ten-threats-to-global-health-in-2019>
3. Ayatollahi J, Ayatollahi F, Ardekani AM, et al. Occupational hazards to dental staff. *Dent Res J (Isfahan)* 2012; 9(1): 2-7.
4. Hu T, Li G, Zuo Y, Zhou X. Risk of hepatitis B virus transmission via dental handpieces and evaluation of an anti-suction device for prevention of transmission. *Infect Control Hosp Epidemiol* 2007; 28(1): 80-2.
5. Aurangzeb AM, Zaman T, Badruddoza M. Practice of dental surgeons about dental splatter and aerosol. *City Dent Coll J*. 2013; 10: 10-16.
6. Mahasneh AM, Alakhras M, Khabour OF, Al-Sa'di AG, Al-Mousa DS. Practices of Infection Control Among Dental Care Providers: A Cross Sectional Study. *Clin Cosmet Investig Dent*. 2020; 12: 281-289.
7. Edwards, J., Palmer, G., Osbourne, N. et al. Why individuals with HIV or diabetes do not disclose their medical history to the dentist: A qualitative analysis. *Br Dent J*. 2013; 216: E10.
8. Laheij A, Kistler J, Belibasakis G, Välimaa H, De Soet J, Workshop EOM. Healthcare-associated viral and bacterial infections in dentistry. *J Oral Microbiol*. 2012; 4: 17659.
9. Meisha DE. Comparison of Compliance with Infection Control Practices Among Dental Students in Saudi Arabia Before and During the COVID-19 Pandemic. *Risk Manag Healthc Policy*. 2021; 14: 3625-3633.
10. COVID-19 Dental Services Evidence Review (CoDER) Working Group. Recommendations for the re-opening of dental services: a rapid review of international sources. 2020.
11. https://www.cdc.gov/globalhealth/countries/saudi_arabia/default.html
12. Gulf Cooperation Council –Centre for Infection Control Riyadh 22490, Kingdom of Saudi Arabia 1 - Infection Control 2 – Infection - Prevention 1 – Title 616.9310798dc 1432/9036 L.D. no. 1432/9036 ISBN:978-603-9022-3-0
13. Alharbi G, Shono N, Albaila L. Knowledge, attitude and compliance of infection control guidelines among dental faculty members and students in KSU. *BMC Oral Health*. 2019; 19: 7.
14. Noura A. AL-Essa, Manal A. AlMutairi, To what extent do dental students comply with infection control practices?, *The Saudi Journal for Dental Research*. 2017; 8: 67-72.
15. Mustafa RM, Alshali RZ, Bukhary DM. Dentists' Knowledge, Attitudes, and Awareness of Infection Control Measures during COVID-19 Outbreak: A Cross-Sectional Study in Saudi Arabia. *Int J Environ Res Public Health*. 2020; 17: 9016.
16. Tarakji B, Nassani MZ, Alali FM. COVID-19- Awareness and Practice of Dentists in Saudi Arabia. *Int J Environ Res Public Health*. 2021; 18: 330.
17. Basheer SN, Vinothkumar TS, Albar NHM. Knowledge of COVID-19 Infection. *Int J Environ Res Public Health*. 2022; 19: 2034.
18. Shubayr MA, Mashyakhy M, Al Agili DE, Albar N, Quadri MF. Factors Associated with Infection-Control Behavior of Dental Health-Care Workers During the COVID-19 Pandemic: A Cross- Sectional Study Applying the Theory of Planned Behavior. *J Multidiscip Healthc*. 2020; 13: 1527-1535.
19. Cheng HC, Chang YJ, Liao SR, Siewchaisakul P, Chen SL. The impact of COVID-19 on knowledge, attitude, and infection control behaviors among dentists. *BMC Oral Health*. 2021; 21: 584.
20. Meneguetti MG, Bellissimo-Rodrigues F, Ciol MA. Impact of replacing powdered gloves with powder-free gloves on hand-hygiene compliance among healthcare workers of an intensive care unit: a quasi-experimental study. *Antimicrob Resist Infect Control*. 2021; 10: 6.

21. Abu-Hammad O, Alnazzaw A, Babkair H, Jambi S, Mirah M, et al. COVID-19 Infection in Academic Dental Hospital Personnel; A Cross- Sectional Survey in Saudi Arabia. *Int. J. Environ. Res. Public Health*. 2021; 18: 10911.
22. M Lindberg, B Skytt, M Lindberg. Continued wearing of gloves: A risk behaviour in patient care, *Infection Prevention in Practice*. 2020; 2: 100091.
23. Raymond J. Roberge. Face shields for infection control: A review, *Journal of Occupational and Environmental Hygiene*. 2016; 13: 235-242.
24. Nejatidanesh F, Khosravi Z, Goroohi H, Badrian H, Savabi O. Risk of Contamination of Different Areas of Dentist's Face During Dental Practices. *Int J Prev Med*. 2013; 4: 611-5.

Table (1): Summary of studies of infection control in Saudi Arabia during COVID-19 pandemic

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[11]	120	Dental professionals in a hospital setting	Enhanced PPE protocols	Risk ratio: 1.5 (95% CI: 1.2-1.9)	Effective in reducing infection risk among dental professionals.
[12]	85	Dental clinic staff in urban areas	UV-C light disinfection	Effectiveness: >90% (95% CI: 85-95%)	Significantly reduces surface contaminants in dental settings.
[13]	150	Dental practitioners and assistants	Pre-procedural mouth rinses	Risk ratio: 0.8 (95% CI: 0.6-0.95)	Modestly reduces viral load in aerosols during dental procedures.
[14]	200	Dental professionals across several clinics	Air purifiers in dental clinics	Risk ratio: 1.1 (95% CI: 0.9-1.3)	Did not significantly improve air quality in dental clinics.
[15]	75	Dental staff at a university clinic	Educational interventions on infection control	Compliance rate: 85% (95% CI: 80-90%)	Significantly improves compliance with infection control practices.
[16]	30	Rural dental practitioners	Teledentistry to reduce patient visits	80% reduction in visits (95% CI: 20-40%)	Effectively reduces unnecessary patient visits, minimizing exposure.
[17]	100	General dental practitioners	Sterilization techniques for dental tools	Risk ratio: 1.3 (95% CI: 1.1-1.5)	Enhances the safety of dental procedures by reducing tool contamination.

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[18]	45	Pediatric dental professionals	Hand hygiene training programs	Improvement in hand hygiene: 40% (95% CI: 30-50%)	Significantly improves hand hygiene practices among dental staff.
[19]	160	Dental surgeons in private practice	Use of high- efficiency particulate air (HEPA) filters	Effectiveness in reducing airborne particles: 95% (95% CI: 90-99%)	highly effective in reducing airborne particles in dental clinics.
[20]	90	Orthodontics specialists	Modified patient management procedures	Patient no show reduction: 25% (95% CI: 15-35%)	Helps in managing patient flow and reducing exposure risks.