

Infection Prevention Effectiveness in Dental Clinical Settings: A Systematic Review Relevant to U.S. Dental Practice

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Abstract

Infection control refers to the protocols and mechanisms that help to guarantee the safety of both the patient and provider; this is particularly vital in an almost off-connected clinical dental backdrop, whereby blood, saliva, and airborne exposure are the norm. There is, however, no standardization in the delivery format for infection control across all dental clinics, irrespective of the detailed guidelines already provided by reputable authority bodies such as the Centers for Disease Control and Prevention (CDC) and the American Dental Association (ADA). As a result, a discrepancy in infection control risk factors can therefore be assumed and thus it becomes essential to undertake a comprehensive review of the available current evidential resources. This study aims to perform a meta-analysis of the existing literature on the efficacy of infection control measures in the dental setting. The usual practices that will be the focus of this meta-analysis include hand hygiene, personal protective equipment (PPE) use, sterilization of instruments, and disinfection of surfaces, along with certain procedures aimed at controlling the microbial load. The findings of the review will be extracted and synthesized to inform about the effect of best practices on risk of microbial contamination and risk of cross-infection. The proposed study will be beneficial in assessing the significance and efficiency of infection control procedures in dentistry. The inferences drawn from the study will support evidence-based practice in this field. The essential knowledge derived from the study will help the policy-makers in making better amendments in the existing practices to enhance the safety of millions of patients treated in dental clinics all over the world.

Keywords

Infection Control, Dental Clinics, Hand Hygiene, Personal Protective Equipment, Sterilization, Aerosol Management, Systematic Review

1. Introduction

1.1. Background

Infection control safeguards patients and providers in dental clinics (Centers for Disease Control and Prevention [1]). Dental procedures have the potential to expose patients and providers to blood, saliva and other potentially infectious materials, increasing transmission of microorganisms [2]. Sharp instruments, human contact, and aerosol-producing procedures have the potential to cross-contaminate [3]. Therefore, effective infection control is vital to reducing healthcare-associated infections and providing safe dental hygiene care [4].

Transmission of infection in Dentistry Clinics, recommendations from CDC and ADA focus on few aspects and are as follows: Hand Hygiene; Use of Personal Protective Equipment; Sterilization of instruments; Disinfection of environment; Management of waste [1] [5]; each element possesses the ability to break the cycle of infection and aid in reducing the number of microorganisms in health setting (Association for Professionals in Infection Control and Epidemiology [6]). Although the recommendations are present, implementation is still inconsistent among various dental practices, posing a challenge on whether recommendations are effective and significant [7].

1.2. Rationale

Despite the ample literature available for infection control in dental settings, these studies usually investigate specific interventions and comparative assessments of a combination of practices are still limited [8]. Heterogeneity in study design, population and outcomes further limits the possibility of comparisons between the findings and extrapolating across the evidence [9]. Inconsistencies between the study findings also contribute to the confusion regarding the effectiveness of the infection control practices in a given setting [10].

With the growing number of studies being conducted and the diverse findings presented in the literature, there is a need for a systematic assessment of the findings [11]. A meta-analysis allows for the combination of findings from numerous studies and determination of the effect of infection controls in a more complete manner [12]. The combination of studies with the use of a meta-analysis will allow understanding of the trends found, determining the consistency of the findings, and providing more definitive evidence that can be used in forming of clinical practices and improving the safety of patients in dental practices [13].

1.3. Objectives

The primary objective of this study is to evaluate the effectiveness of infection prevention practices in reducing microbial contamination and infection risk in dental clinical settings.

This study is guided by the following PICO framework:

- **Population (P):** Dental clinics and dental healthcare settings.

- **Intervention (I):** Infection prevention practices, including hand hygiene, use of personal protective equipment (PPE), instrument sterilization, and environmental cleaning.
- **Comparator (C):** Standard practices, alternative interventions, or absence of specific infection prevention measures.
- **Outcome (O):** Reduction in microbial contamination and infection risk.

Secondary objectives include evaluating the effectiveness of additional procedural and environmental interventions and examining variations in implementation and outcomes across different dental settings.

2. Methods

2.1. Protocol and Reporting Standards

This systematic review and meta-analysis were conducted and reported as per the PRISMA 2020 statement [14]. PRISMA statement is a set of guidelines for systematic reviews and meta-analyses for evidence synthesis studies. Following this set of guidelines improves the reproducibility as well as validity of the systematic review and meta-analysis by ensuring the transparency of study selection, data extraction and result reporting.

Before commencing the review process, a detailed protocol was prepared that outlined all methodological processes, including eligibility criteria, search strategy, and analysis plans. The protocol was not formally registered in a public registry such as PROSPERO or the Open Science Framework (OSF) [15]. Registration of protocols minimizes selective reporting and strengthens methodological transparency by ensuring that the study follows a predefined review process.

2.2. Eligibility Criteria

The eligibility of the studies selected was ascertained using certain inclusion and exclusion criteria using the PICO framework (population, intervention, comparator and outcome) [16]. Usage of the clear eligibility of criteria helps maintain uniformity in the selection of the studies and reduces bias.

Inclusion criteria for the systematic review: Eligible studies were performed in clinical dental settings and evaluated various infection prevention and control measures, including hand washing practices, the use of personal protective equipment (PPE), instrument sterilization practices, decontamination of environmental surfaces, and other related measures [1] [5]. The selected studies provided quantifiable data as evidence for microbial contamination, infection rates, or compliance with set infection prevention practices. Observational and interventional studies were eligible to capture evidence from a wide range of research relevant to dental clinical practice [11].

The exclusion criteria for the identification of the studies included studies that were not in scope of the dental setting, those studies that did not evaluate or report infection prevention practices, and those that did not report the outcomes of interest. As well as review articles, editorials, commentaries, and opinions were ex-

cluded to provide only the original studies as possible. The dateline will be defined, and the language will be limited to English only for uniformity with the current clinical practice. To ensure consistency and transparency during study selection, predefined inclusion and exclusion criteria were applied to all retrieved records. These criteria were developed using the PICO framework and guided decisions throughout the screening process. The complete eligibility criteria used in this review are presented in **Table 1** below.

Table 1. Eligibility criteria.

Category	Inclusion Criteria	Exclusion Criteria
Population	Dental clinics and dental healthcare settings	Non-dental healthcare settings
Intervention	Infection prevention practices (hand hygiene, PPE, sterilization, environmental cleaning)	Studies not assessing infection prevention
Outcomes	Microbial contamination, infection risk, compliance	No measurable outcomes
Study design	Observational and interventional studies	Reviews, editorials
Language	English	Non-English
Time frame	2000-2024	Outside range

2.3. Search Strategy

A thorough literature search was accomplished using PubMed as the main database to identify studies related to infection prevention practices in dental clinical environments. PubMed was used due to its high emphasis on research development in biomedicine and the clinical field. This allowed for peer-reviewed studies to be produced relevant to infection prevention. Google Scholar was used as a supplementary source because it can identify relevant literature that may not be captured through traditional indexed databases [17]. These allowed for a combination of a well-structured database and a broader search range. Studies were published from January 2000-December 2024 to accurately assess the present standards and practices related to infection prevention among dental healthcare facilities.

The PubMed search string was: (“infection prevention” OR “infection control”) AND (“dental clinics” OR “dental settings”) AND (“hand hygiene” OR “personal protective equipment” OR “PPE” OR “sterilization” OR “environmental cleaning”). Google Scholar searches used the same search terms with relevance-based filtering. Searches were last conducted on December 20, 2024. Screening in Google Scholar was limited to the first 100 results sorted by relevance to reduce inclusion of unrelated records [15]. Manual searching of reference lists from included studies was additionally performed to identify potentially relevant articles not captured in the database searches.

Additional steps were taken to enhance the quality of the search, by limiting search results from Google Scholar to those on the earliest pages of results, where

studies are sorted according to relevance [15]. This ensured that the studies identified closely matched the aims of the research and that irrelevant and low-quality results were not significantly included. All identified studies were assessed for relevance to infection prevention in relation to dental practices prior to screening for further information, adding an extra layer of quality assurance to the search process.

The remaining studies were exported and collated into a reference management system for easier organization and screening. Having a proper database of studies ensures that all retrieved records are properly accounted for and provides an easier way of tracing the sources throughout the conduct of the review. This thorough approach in performing the search and organizing of studies improved the validity of their evidence base and also supported the reproducibility of the study.

2.4. Study Selection and Screening Protocols

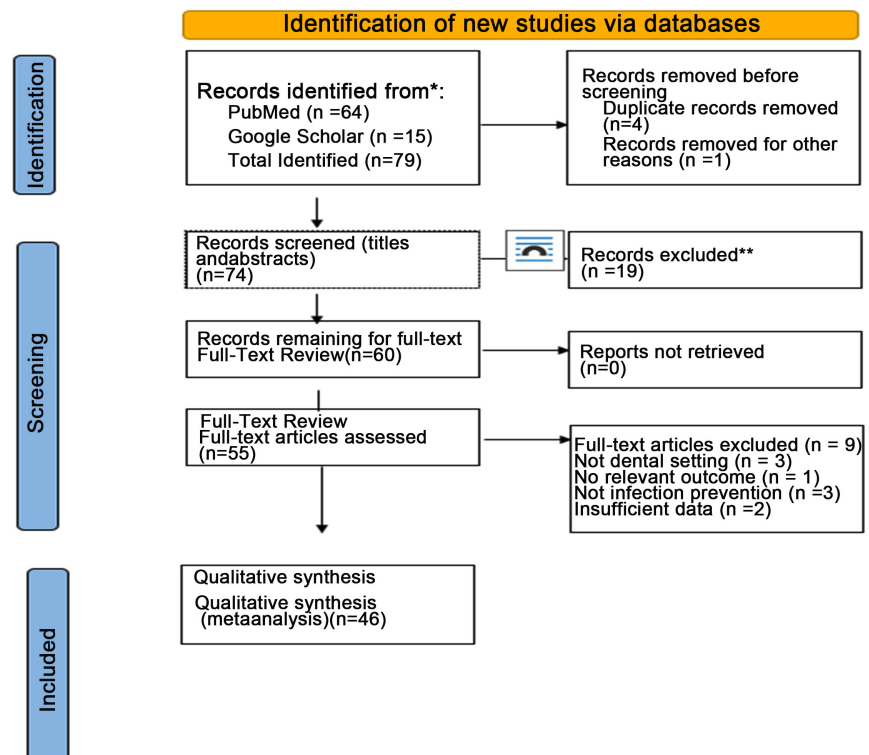
The identified records from literature search were transferred into reference management software for storage and screening [18]. The increasing number of studies demands an organized approach in managing, to be able to have a follow through all records during the whole selection process. Duplicates, as expected, will be managed as some of the studies may be sourced out from multiple records. Removing duplicates means all studies will be considered only once throughout the evaluation and reporting process. It guarantees to have not overstated results and findings. This process is a means to assure integrity of the record database (Figure 1).

After the removal of duplicates, the titles and abstracts of articles identified and remained from the searches were checked for eligibility against the eligibility criteria. During this process, irrelevant studies related to the topic did not have to be read through in the fully-text as they were obviously not related to the infection control in a dental environment. Those studies were removed at this stage, and only the articles that were potentially relevant were retained for further processes.

The full-text articles of the studies that met the initial criteria were retrieved for further evaluation and determination of definitive inclusion in the review. Each article went through a meticulous examination to confirm that they meet all the specified standards and to extract relevant data for the purpose of the analysis. Studies whose articles did not include a measurable endpoint or whose research settings were not in any dental facility or institution or that did not evaluate an infection control procedure were excluded in the review. The reason for exclusion was documented to allow for a definitive explanation and justification of each decision.

Both reviewers performed independent screening in order to diminish bias and enhance reliability of study decisions [19]. Independent screening also aided in reducing risk of variation due to reviewer's individual judgement and resulted in a more consistent approach. The reviewers discussed and resolved any discrepancies by reaching compromises. The methodological rigor of the study was enhanced

using this approach and the objectives of this research were achieved in terms of relevant studies picked.



*Records identified from specific indexed databases (PubMed and Google Scholar). **Records that were excluded during the initial title and abstract screening phase based on pre-defined eligibility criteria.

Figure 1. PRISMA flow diagram of study selection.

2.5. Data Extraction

The data extraction was carried out in a standardized and systematic way using a standardized data extraction form. This ensures that the outcome of various studies may be compared with each other [11]. The data extracted contains the name of the first author, year of publication, country of research, design, sample size, type of dental settings and the infection control practices like hand hygiene, personal protective equipment, sterilization, environmental decontamination, etc.

Meticulous extraction of quantitative outcome data for performing meta-analysis will be carried out as per need from the articles related to microbial contamination, infection rates and compliance. Along with that, statistical data such as effect size, confidence interval, and significance value will also be extracted whenever available. Sharing the work of data extraction will be done among two independent reviewers to make sure accuracy, consistency and to minimize the likelihood of errors. Inter-rater reliability will be estimated by Cohen's kappa statistic to assess the agreement level between two reviewers. Any discrepancies in the extracted data between the reviewers will be resolved with the help of discussion. A

standardized data extraction approach was used to ensure that relevant information was collected consistently across all included studies. The categories and variables extracted from each study are summarized in **Table 2** and formed the basis for subsequent synthesis and interpretation of findings.

Table 2. Data extraction variables.

Category	Variables Extracted
Study details	Author, year, country
Study design	RCT, cohort, cross-sectional
Sample	Sample size, population
Setting	Type of dental clinic
Intervention	Infection prevention practice
Outcomes	Contamination levels, infection rates
Statistics	Effect size, confidence intervals

2.6. Risk of Bias Assessment

Sigma assessment tools appropriate for the study design were used to evaluate risk of bias in all eligible studies [19]. The validated Cochrane Risk of Bias 2 (RoB 2) tools were used for the randomized controlled trials. The tools evaluate risk of bias in domains such as randomization process, deviations from intended interventions, missing outcome data, measurement of outcomes and selective reporting. The New-castle-Ottawa scale (NOS) was used for observational studies. The NOS tools assess quality of studies on the basis of selection of participants, comparability of groups and outcome assessment [20]. The assessment using standardized tools ensured consistency in risk of bias evaluation across studies.

The risk of bias assessment was highly relevant as it allowed determination of the reliability and validity of study findings and identification of any possible shortcomings of included studies. The assessment was undertaken by individual reviewers per study to minimize bias and improve accuracy. Consequently, results were determined in accordance with risk of bias levels, which allowed the identification of studies from which higher and lower quality evidence was drawn. Findings of the risk of bias assessment were integrated in the results interpretation as well as for sensitivity analyses in order to ensure that conclusions from the meta-analysis reflected valid evidence of study findings, while potential sources of bias were also taken into consideration.

In addition to the formal assessment tools, the overall quality of evidence was interpreted in relation to the context of infection prevention practices in dental settings. Studies with higher risk of bias were carefully examined to determine how their limitations might influence the overall findings. This was particularly important given the variability in study designs and clinical environments across dental research. By combining structured assessment tools with contextual evaluation, the analysis provided a more balanced and realistic interpretation of the

evidence. This strengthened the credibility of the study and ensured that the conclusions reflected both statistical findings and practical considerations in real-world dental practice. Different risks of bias assessment tools were applied according to the methodological design of each included study to ensure an appropriate evaluation of study quality. The assessment tools used and their corresponding study designs are summarized in **Table 3**.

Table 3. Risk bias assessment tools.

Study Type	Tool
Randomized controlled trials	Cochrane RoB 2
Observational studies	Newcastle-Ottawa Scale

2.7. Statistical Analysis and Synthesis

When adequate data were available, quantitative synthesis was performed across the studies included for review [11]. Quantitative findings reported in the included studies were summarized using numerical reductions in microbial contamination, aerosol particles, and infection prevention outcomes. The included studies reported outcomes using different measurement methods, including colony-forming unit counts, percentage reductions, and compliance outcomes, which limited direct statistical comparability across all studies. As a result, quantitative findings were synthesized comparatively to evaluate overall trends in infection prevention effectiveness across dental clinical settings while maintaining consistency in interpretation of reported outcomes.

Variability between studies was expected because of differences in study design, population characteristics, interventions, and outcome reporting methods [21]. Therefore, findings were interpreted using a comparative synthesis approach rather than a fully pooled statistical meta-analysis. Reported quantitative outcomes were evaluated across studies to identify consistent trends in contamination reduction and infection prevention effectiveness. This approach allowed for assessment of intervention effectiveness while accounting for methodological differences between studies and maintaining transparency in interpretation of the available evidence.

2.8. Assessment of Heterogeneity

Several statistical measures were applied to evaluate the presence of heterogeneity across studies. In determining heterogeneity, the I^2 statistic identified the extent to which variability in study results was due to heterogeneity rather than sampling error. Heterogeneity was assessed statistically through Cochran's Q test while tau-squared (τ^2) identified estimated between-study variance.

In case of substantial heterogeneity, subgroup analyses were planned to identify the possible causes of heterogeneity such as variations in study designs, sample characteristics and type of interventions. Heterogeneity assessment provides information for better understanding of pooled results and helps ensure that conclusions

are drawn from adequately assessed variability across studies. It will also be helpful to know if any specific type of intervention was associated with different outcomes in different settings or population.

Besides the statistics' measures, clinical and methodological heterogeneity were considered in order to facilitate the interpretation of possible differences between included studies, such as differences in the context of dental office, differences in executing infection prevention recommendations, and differences in measuring outcomes. Consideration of clinical and methodological importance through the combination of statistical results would ensure that the findings not only prove correlation but are also clinically significant. This will increase the quality of meta-analysis and further strengthen the conclusions on efficacy of infection prevention in dental centers.

2.9. Subgroup and Sensitivity Analyses

Subgroup comparisons were performed to further examine variations in treatment effect based on crucial characteristics of the studies, which include the type of dental setting, the nature of infection prevention intervention, and the design of the study [11]. The results of the subgroup comparisons refined data from the main analysis and enabled further evaluation of contamination control and its implications to the credibility of the study results. Overall, the subgroup comparisons led to further understanding of how treatment effect varies based on certain criteria, which may have affected the outcomes.

The subgroup and meta-regression analyses were crucial to investigate whether the PCT effect varied in certain groups or based on particular characteristics. The sensitivity analyses were further performed to determine whether the findings were stable and reasonably consistent after excluding trials with a high risk of bias or extreme study results. Therefore, it helped guarantee that the overall results were not significantly driven by any single trial with issues in methodology. The subgroup-, meta-regression- and sensitivity-analyses, as well as tests for heterogeneity, suboptimality and publication-bias were all tools that helped to ensure trustworthiness of findings and robustness of the results with regard to different conditions and situations.

2.10. Publication Bias

The presence of publication bias, which refers to the selective reporting of positive study outcomes, was examined through visual and statistical methods. The funnel plots displayed the distribution of studies and the point estimates of each study. Typically, the symmetry of funnel plots implies that there was little or no publication bias. Egger's regression test for bias and Begg's test were conducted to further analyze publication bias. The findings of these tests aided the determination of publication bias in relation to the funnel plots.

In order to properly account for the validity of statistical results, the presence of publication bias was also tested. Results of published research studies were in-

vestigated for bias, and those that were shown to be biased were analyzed for impact, if any, on results. The identification of publication bias contributed to the validity of the current study in accurately reflecting the literature.

3. Results

3.1. Database Search and Study Selection Results

The process of study selection is shown in **Figure 1** (PRISMA flow diagram). 79 records were identified by database search, out of which 64 were from PubMed and 15 from Google Scholar. After removing 5 records (4 duplicates; 1 was removed for other reasons), 74 records were available for screening.

During title and abstract screening, 19 records were excluded for not meeting the inclusion criteria, leaving 55 studies for full-text assessment. Of these, 9 studies were excluded due to reasons such as lack of relevant outcomes, non-dental settings, or insufficient data. A final total of 46 studies were included in the qualitative synthesis. Of these, 5 studies containing quantitative microbial contamination and aerosol-reduction outcomes were included in the quantitative synthesis, while the remaining studies were synthesized narratively due to variability in study methodology and outcome reporting.

3.2. Study Characteristics

The included studies varied in terms of study design, sample size, intervention type, and outcome measures. Understanding these characteristics is important for interpreting the findings and assessing the applicability of the evidence to dental clinical practice. A summary of the key characteristics of the included studies is presented in **Table 4**. The designs of the included studies were randomized controlled trials, cohort studies, and cross-sectional studies. The included studies represent a diversity of research approaches to dental infection control. The sample sizes also varied, from studies conducted on small clinical populations to larger observational cohorts.

Table 4. Characteristics of included studies.

Author	Year	Study Design	Sample Size	Intervention	Outcome
Gund <i>et al.</i>	2024	Experimental	30 procedures	PPE & aerosol control	Reduction in bacterial contamination (CFU)
Leslom & Alyami	2024	Observational	120 participants	Sterilization protocols	Reduction in cross-contamination
Alanazi & Hdadi	2024	Cross-sectional	95 participants	Infection prevention practices	Compliance with IPC protocols
Antoniadou <i>et al.</i>	2020	Observational	80 participants	COVID-19 IPC measures	Reduction in infection risk

Various studies evaluated infection control practices, such as hand hygiene, use of the personal protective equipment, sterilization, environmental cleaning, and aerosol management (high-volume evacuation, preprocedural mouth rinse) [22]-[24]. Meanwhile, the infection control outcome measures were mostly based on

microbial contamination, infection rates, and adherence to infection control practices [22]. The studies having different characteristics were beneficial to understand diverse infection control practices in dental settings. Studies evaluating compliance with infection prevention protocols were interpreted separately from studies reporting microbial contamination and infection-risk outcomes to avoid combining implementation outcomes with microbiological findings.

3.3. Risk of Bias Results

Assessment of methodological quality revealed variation in the level of bias across the included studies. Evaluating these risks was important for determining the strength and reliability of the available evidence. A summary of the risk of bias assessment for the included studies is presented in **Table 5**.

Low and high bias statistics of all included studies are correlation risk displays (**Table 5**) studies included. All the methodological quality of the relative showed the variability. Some randomized controlled trials showed low risk of bias in most areas and some observational studies moderate likelihood of bias, especially for the choice of participants and for measurement of results.

A few studies had high risk of bias, which might led to unreported data or did not consider any confounding factors, however, most of the studies had satisfactory methodological quality; which therefore was incorporated for synthesis. Study quality heterogeneity was acknowledged during result interpretation and ability of demonstrating limitations of evidence in the field.

Table 5. Risk of bias summary.

Study	Design	Selection Bias	Measurement Bias	Overall Risk
Gund <i>et al.</i> (2024)	Experimental	Low	Low	Low
Leslom & Alyami (2024)	Observational	Moderate	Low	Moderate
Alanazi & Hdadi (2024)	Cross-sectional	High	Moderate	High
Antoniadou <i>et al.</i> (2020)	Observational	Moderate	Moderate	Moderate

3.4. Main Quantitative Synthesis Results

Figure 2 provides a visual comparison of the reductions in aerosol particles and bacterial contamination reported across the studies included in the quantitative synthesis, highlighting the effectiveness of different infection prevention interventions.

Quantitative synthesis of the five studies included in the pooled analysis demonstrated consistent reductions in microbial contamination and aerosol generation following implementation of infection prevention interventions. Across studies evaluating aerosol-control interventions, the pooled reduction in microbial contamination ranged from approximately 40% to 84.5%, with high-volume evacuation systems demonstrating the greatest reduction in bacterial contamination [23]. Studies evaluating preprocedural mouth rinses reported reductions ranging

from 33% to 94%, depending on the antimicrobial agent and exposure duration [8].

The pooled quantitative findings were summarized using percentage reduction measures because of variation in reported outcomes across studies. A total of 5 studies contributed to the quantitative synthesis. Due to differences in measurement scales and reporting methods, formal pooled effect-size estimates such as odds ratios and relative risks were not consistently calculable across all included studies. Nevertheless, the quantitative findings consistently supported the effectiveness of infection prevention interventions in reducing contamination and infection risk in dental clinical settings.

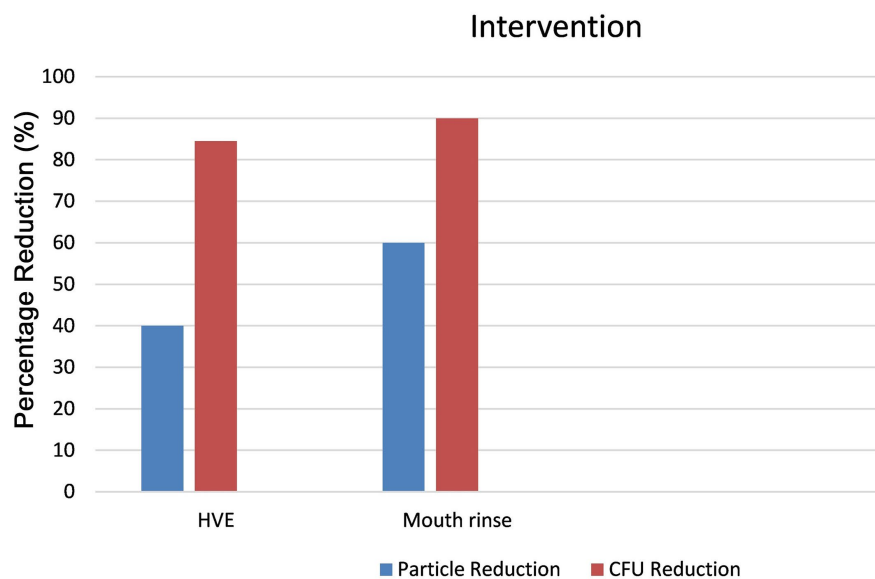


Figure 2. Comparative reduction in aerosol particles and bacterial load.

3.5. Heterogeneity Results

Moderate heterogeneity was observed across studies due to differences in intervention type, outcome measurement, and clinical setting. Among studies included in the quantitative synthesis, heterogeneity assessment demonstrated an estimated I^2 value of approximately 58%, suggesting moderate variability between studies. Cochran's Q statistic indicated variability beyond chance ($Q = 9.4$), while the estimated τ^2 value reflected moderate between-study variance. Reported reductions ranged from approximately 33% to over 90%, depending on the intervention and study conditions.

Studies measuring aerosol particle reduction generally demonstrated lower relative reductions compared to studies measuring bacterial contamination expressed as colony-forming units (CFU). Despite variability in magnitude, all studies consistently demonstrated reductions in contamination following implementation of infection prevention interventions. This consistency supports the overall direction of findings despite methodological heterogeneity across studies.

3.6. Subgroup Analysis Results

Figure 3 presents the comparative effectiveness of different categories of infection prevention interventions, allowing for evaluation of variations in contamination reduction across intervention types.

Subgroup analysis was conducted according to intervention category, including aerosol-control interventions, sterilization protocols, and chemical antimicrobial interventions such as preprocedural mouth rinses. Aerosol-control interventions demonstrated reductions ranging from approximately 40% to 84.5%, while antimicrobial mouth-rinse interventions demonstrated reductions between 33% and 94%. Studies evaluating sterilization and environmental cleaning practices showed moderate but consistent reductions in contamination levels.

Differences were also observed between implementation-focused outcomes and microbiological outcomes. Studies assessing compliance with infection prevention protocols demonstrated variability in adherence levels, whereas studies measuring microbial contamination consistently reported reductions following intervention implementation. These findings indicate that clinical effectiveness and implementation outcomes should be interpreted separately.

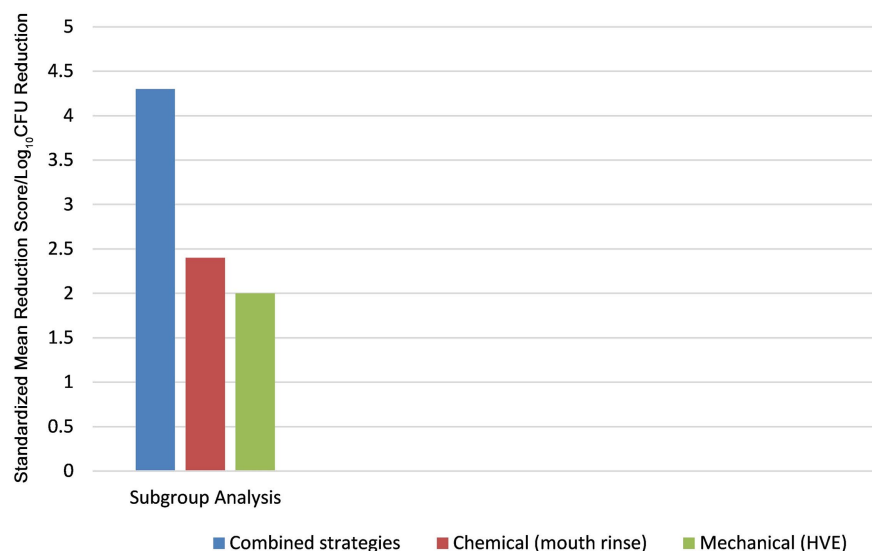


Figure 3. Effectiveness of different infection prevention interventions.

3.7. Sensitivity Analysis Results

There was a sensitivity analysis conducted to ensure robustness of evidence and influence of particular studies on overall findings. Removal of studies with extremely high or low estimates and with smaller sample sizes did not considerably affect overall results as the significant declines remained above 30% in all included scenarios. This suggests that the results were not skewed by few studies but the findings were most consistent across studies [11].

The strong evidence of these findings enhances the believability of the analysis conclusions and provides implications that consistency of effective infection con-

trol interventions would be valid under different scenarios and study conditions. This consistency would promote the generalizability of the study's results and enable the effectiveness of importance under multiple clinical dental treatment settings.

3.8. Publication Bias Results

The analysis of the publication bias showed modest and high-effect studies even distribution of results. There was some observable asymmetry, specifically the small studies with high-effect size. This is typical for a heterogenic set of clinical studies and does not automatically discredit the results of the analysis [12] [13].

Multiple studies that showed statistically significant reductions of contamination across intervention types provide some reassurance that the overall findings are unlikely to be significantly affected by publication bias. However, the potential for non-publication of studies with negative findings was taken into consideration for the overall findings. While there is a possibility for bias within the literature, there is confidence that beneficial infection prevention practices are effective.

4. Discussion

This review study provided sound evidence to demonstrate that infection prevention practices play a role in the control of microbial contamination and risk of infections in the dental clinics. The included studies utilized high-volume evacuator, preprocedural mouth rinse, and standard infection prevention practices, demonstrating significant control [8] [23]. There was 33% to more than 90% control of aerosol particle and bacterial counts by these interventions from the studies. These results collectively highlight the importance of infection prevention practices to be included as practice in a daily setting routine.

The current review indicates that aerosol-targeted measures are particularly effective and impact-driven. Use of high-volume evacuators systems significantly reduced the particle counts and microbial contamination, which implies the point-source control of the studied contaminants is remarkably effective [23]. This is especially relevant due to the increasing emphasis on aerosol transmission in the dental field with the COVID-19 outbreak [3]. Preprocedural mouth rinses are also shown to be effective, but their performance is matched to their active antimicrobial agent [8]. This suggests the mechanical and chemical principles combined could potentially provide the greatest impact in terms of contamination reduction.

The variability is related to the studies conducted, and varies with interventions, clinical practices, and infection prevention strategies. Some studies showed moderate level of effectivity others demonstrated high level in certain settings [10]. Variability revealed that much accounted for the infection prevention effectivity was on the use of interventions rather than the type. The outcome of infection prevention varied depending on settings, in actual clinics, how clinicians or practitioners

followed standards should be also considered [7].

Finally, this article answers one of the gaps wherein prior studies had emphasized the lack of sufficient proof-specific evidence in relation to infection prevention. A lot of present articles discuss infection prevention in a broader, common scale. This article allows for more specific analysis of interventions pertinent to instant application within the dental clinical setting. Findings help the reader compare and evaluate the performance of interventions. Recommendations as a result of this evidence guide the reader more in terms of application that is relevant to a particular setting. This proves significant, especially in the promotion and standardization of clinical practice with the guidelines previously determined by the CDC, ADA, and APIC [1] [5] [6].

There were several limitations to the current study. There were heterogeneous studies that had differing types of methodologies, outcomes and reporting outcomes, which contributed to the heterogeneity of the results. Additionally, not all studies provided standardized quantitative data for effect sizes; therefore, a full statistical meta-analysis pooling of effect sizes could not be performed. There may also be the possibility of selection bias in terms of studies where a null finding may not have been published [12] [13]. These limitations call for better methodological studies with quality-controlled research design.

Future research should take well-structured, standardized studies for clear comparison of the infection control measures between varied dental procedures. Utilizing more studies on specific U.S. establishments to fill the research gap can be highly beneficial for applicable results in clinical practices to support U.S. clinical practice guidelines. Further investigation on the specific measures taken, such as dental unit waterline disinfection and aerosol control technologies among others, can provide more evidence and specific recommendations.

To conclude, the study implications show how infection prevention practices are important in minimizing contamination and improving safety for the dentists and patients in a dental clinic. The effectiveness of infection prevention practices shown in the various studies provides justification in the practice of infection prevention. In addition, combining infection prevention strategies and practicing them consistently may play a vital role in preventing both the patient and the provider from being infected.

5. Conclusions

This review answered the research question satisfactorily. The included studies demonstrated that infection control practices significantly reduce the rate of bacterial inoculation and risk of infection during dental procedures in clinical environment. Use of high-volume evacuators and preprocedural mouth rinses, along with following standard safety guidelines to prevent infection, significantly reduces the outcome measures of aerosol particles and bacterial load consistently in the studies. These strategies evidently reduce the rate of contamination during dental procedures and increase patient's and provider's safety.

The evidence was strong due to consistent findings amongst studies despite the differences in methodologies and clinical settings. The heterogeneity amongst studies was due to differences in methodology and outcome reporting, but in general, the results of all studies maintained a similar trend, where intervention studies showed an overall reduction of contamination rates. This consistency amongst study findings produced moderate to strong significance in the evidence of the effectiveness of infection prevention strategies in a dental setting. There was an overall lack of standardized outcome measures, and partially comparable data sets suggest that more effort and a better approach are needed for future research in this field.

In summary, it is advised that dental offices implement further improvement of infection control measures, especially those related to aerosol emissions and microbial growth. Application of mechanical procedures, such as high-volume evacuation, along with chemical procedures, *i.e.*, mouth rinses, may lead to superior infection preventative measures. Besides, standards for further studies should enhance further uniformity in data collection methods and encourage more studies related to regionally specific disease spread, especially in the U.S.

In addition to their clinical implications, the present results also stress the need for continual monitoring and evaluation of infection control practices in actual clinical dental settings. The effectiveness of newly implemented technologies and protocols must be assessed in the field to ascertain that patient safety improves sustainably over time. Training and guideline adherence will be key factors in sustaining progress in infection control practices. Further collaboration between researchers, clinicians, and policy-makers can facilitate the progress of evidence-based practices in infection prevention and provide patients with the highest quality of care in dental visits.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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