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Review

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Efficacy of saline or salt-based solution mouthrinse in improving periodontal health: a systematic review

Eficácia de enxaguatórios de solução salina ou solução à base de sal na melhora da saúde periodontal: uma revisão sistemática

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ABSTRACT

Saline and salt-based solution mouthrinses have emerged as potential alternatives to chemical antiseptics like chlorhexidine. Due to their osmotic, antimicrobial, and tissue-healing properties, these solutions may provide measurable benefits in managing periodontal inflammation. **Objective:** The study aims to systematically evaluate and synthesize effectiveness of saline or salt-based solution mouthrinse in improving periodontal health. **Material and Methods:** This systematic review followed PRISMA 2020 guidelines and applied a PICOS framework. Searches were conducted in PubMed, ScienceDirect, and the Cochrane Library using relevant MeSH terms and keywords. Eligible studies included randomized controlled trials, quasi-experimental studies, controlled clinical trials evaluating the use of saline or salt-based mouthrinses on periodontal parameters. Outcomes assessed included Plaque Index, Gingival Index, Bleeding on Probing and Pocket Depth. Seven studies met the inclusion criteria. **Results:** Most included studies reported that saline or salt-based solution mouthrinses were associated with reductions in plaque index, gingival index, bleeding on probing, and probing depth; however, one pilot study reported no significant additional benefit compared with mechanical oral hygiene alone. The findings suggest that Saline or salt-based solution offer a clinically viable adjunct or alternative to standard chemical rinses. Although slightly less potent than chlorhexidine in some metrics, their favorable safety profile, accessibility, and acceptability make them suitable for daily oral hygiene and public health use. **Conclusion:** Saline or salt-based solution mouthrinses are effective in improving periodontal health. While not a complete substitute for antiseptics like chlorhexidine, they provide a safe and low-cost alternative that merits broader clinical adoption, particularly where standard agents are contraindicated or unavailable.

KEYWORDS

Gingivitis; Mouthrinse; Periodontal health; Plaque; Salt-based solution.

RESUMO

Enxaguatórios à base de solução salina ou solução salina com sal têm emergido como potenciais alternativas aos antissépticos químicos, como a clorexidina. Em razão de suas propriedades osmóticas, antimicrobianas e de cicatrização tecidual, essas soluções podem oferecer benefícios mensuráveis no manejo da inflamação periodontal. **Objetivo:** O objetivo deste estudo foi avaliar e sintetizar sistematicamente a eficácia de enxaguatórios à base de solução salina ou solução salina com sal na melhoria da saúde periodontal. **Material e Métodos:** Esta revisão sistemática seguiu as diretrizes PRISMA 2020 e utilizou a estratégia PICOS. As buscas foram realizadas nas bases PubMed, ScienceDirect e Cochrane Library, por meio de descritores MeSH e palavras-chave relevantes. Foram incluídos ensaios clínicos randomizados, estudos quasi-experimental e estudos clínicos controlados que avaliaram o uso de enxaguatórios de solução salina ou de solução `base de sal em parâmetros periodontais. Os desfechos avaliados incluíram Índice de Placa, Índice Gengival, Sangramento à Sondagem e Profundidade de Sondagem. Sete estudos atenderam aos critérios de inclusão. **Resultados:** A maioria dos estudos incluídos relatou que os enxaguatórios de solução salina ou solução à base de sal estiveram associados à redução do índice de placa, índice gengival, sangramento à sondagem e profundidade de sondagem; entretanto, um estudo piloto não observou benefício adicional significativo em comparação à higiene oral mecânica isolada. Os achados sugerem que soluções salinas ou à base de sal constituem uma alternativa ou adjuvante clinicamente viável aos enxaguatórios químicos convencionais. Embora ligeiramente menos potentes do que a clorexidina em alguns parâmetros, seu perfil de segurança favorável, acessibilidade e aceitabilidade as tornam adequadas para o uso diário na higiene oral e em estratégias de saúde pública. **Conclusão:** Enxaguatórios de solução salina ou de solução à base de sal são eficazes na melhora da saúde periodontal. Embora não substituam completamente antissépticos como a clorexidina, representam uma alternativa segura e de baixo custo, com potencial para ampla adoção clínica, especialmente em situações nas quais os agentes padrão sejam contraindicados ou indisponíveis.

PALAVRAS-CHAVE

Gengivite; Enxaguatório bucal; Saúde periodontal; Placa bacteriana; Solução à base de sal.

INTRODUCTION

The oral cavity is directly in contact with microorganism that potentially can cause oral diseases as periodontitis. The use of antimicrobials agents may be an alternative for those patients at high risk of periodontal disease [1].

Saline solution offers a viable alternative to patients with allergies to conventional oral antiseptics such as chlorhexidine. The usage of saline rinses (2%) has shown significant capability in improving periodontal parameters For example, during non-surgical periodontal therapy (NSPT), plaque index (PI), gingival index (GI), and probing depth (PD) with result being relatively comparative in terms of effectivity to chlorhexidine by showing anti-inflammatory effects and increasing healing rate [2,3].

Saline solution inhibits bacterial growth by causing osmotic pressure which leads to cell dehydration and disruption of cellular functions, furthermore sodium chloride solution were found to show antimicrobial properties by reducing bacterial count [4]. Mucosal dehydration improved mucocilliary cleareance and limiting micro-aspiration of pathogens can indirectly contribute to the reduction of bacterial presence [5].

In electrolyzed form, saline has been found to prevent virus transmission in dental settings. Electrolyzed Saline (EOS) primarily composed of hypochlorous acid (HOCI) have demonstrated broad microbial effects against common oral bacteria and viruses even in the presence of saliva, making it a viable option [6]. However the usage of saline only were found to be less effective than sodium hypochlorite and chlorhexidine, highlighting its potential only as an alternative instead of permanent replacement at least until further study is conducted [7]. Furthermore, saline nasal irrigation and gargle has been shown to reduce viral loads in the nasopharyngeal region, showing capability to modulate immune responses which will indirectly reduce the viral burden in the oral cavity [5].

Chlorhexidine (CHX) is the most widely recognized antimicrobial agent for the prevention and treatment of gingivitis. However, prolonged use may result in adverse effects such allergic reactions and tooth discoloration [8]. This potential as an alternative becomes increasingly important to be noted in potential especially in the increasing report of chlorhexidine allergy in perioperative and medical procedural setting [9]. Ranging from mild skin reaction to severe anaphylactic event, further supported by a study in China, finding 10 out of 43 patients tested positive for chlorhexidine allergy [10].

MATERIAL AND METHODS

Study design and protocol

This systematic review was conducted following the preferred reporting items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. The review protocol was developed based on the PICOS framework to guide the formulation of the research question, eligibility criteria, and data extraction process.

Inclusion criteria

- Population: Participants of any age with gingivitis, periodontitis, or healthy periodontal status;
- Intervention: Use of saline, saltwater, or salt-based solution as a mouthrinse, regardless of concentration or formulation (e.g., isotonic, hypertonic, warm saline);
- Comparator: Placebo rinse (e.g., distilled water), no rinse, or other active rinses (e.g., chlorhexidine, essential oil rinses, fluoridated solutions);
- Outcomes: Reporting at least one **periodontal health parameter**, such as:
    - Plaque Index (PI)
    - Gingival Index (GI)
    - Bleeding on Probing (BOP)
    - Pocket Depth (PD)
- Study Design: Randomized controlled trials (RCTs), quasi-experimental studies, controlled clinical trials (CCTs);
- Language: Published in English;
- Publication Year: Any year, provided full-text access was available.

Exclusion criteria

- Non-human studies (e.g., animal models or in vitro only without human relevance);
- Case reports, case series with <10 subjects, opinion pieces, reviews, or editorials;

- Studies not assessing clinical or microbiological outcomes;
- Articles not available in full-text;
- Non-English publications.

Eligibility criteria (PICOS framework)

PICOS element definition for this review

P – Population Participants of any age with gingivitis, periodontitis, or healthy periodontal status

I – Intervention Use of saline, saltwater, or salt-based solution as a mouthrinse, regardless of concentration or formulation (e.g., isotonic, hypertonic, warm saline)

C – Comparator Placebo rinse (e.g., distilled water), no rinse, or other active rinses (e.g., chlorhexidine, essential oil rinses, fluoridated solutions)

O – Outcomes Primary outcomes: improvement in periodontal indices such as Gingival Index (GI), Plaque Index (PI), Bleeding on Probing (BOP), and Pocket Depth (PD)

S – Study Design Randomized controlled trials (RCTs), quasi-experimental studies, controlled clinical trials (CCTs), cross sectional.

Search strategy

The search strategy included MeSH terms and keywords using Boolean operators. A representative search string used was:

Pubmed: ("saline mouthrinse" OR "saltwater mouthrinse" OR "salt water rinse" OR "salt-based rinse" OR "sea salt mouthwash" OR "hypertonic saline rinse" OR "saline solution" OR "salt solution" OR "oral saline rinse" OR "sea water mouthwash") AND ("gingivitis" OR "periodontitis" OR "periodontal disease" OR "plaque" OR "gingival inflammation" OR "gingival index" OR "plaque index" OR "bleeding on probing" OR "BOP" OR "probing depth" OR "periodontal health")

Cochrane Library: "saline" OR "saltwater" OR "mouthwash" in combination with MeSH terms such as "gingivitis", "periodontitis"

Science Direct: ("saline" OR "salt water") AND ("mouthwash") AND ("gingival inflammation" OR "dental plaque")

Study selection

The first two authors (CJC&SO) independently conducted database searches using identical search terms. Following the identification and selection of potential studies for inclusion, all authors collectively evaluated each study to confirm it met the predetermined inclusion criteria. To compile data from the selected studies, two authors worked together to thoroughly review the literature with the goal of extracting the necessary information.

Data extraction

A standardized data extraction sheet was developed, collecting the following variables:

- Author and year
- Country
- Study design and sample size
- Patient demographics
- Type and concentration of saline solution
- Duration and frequency of use
- Comparator (if any)
- Improvement of Periodontal and Oral Health Parameter

Quality assessment

The methodological quality of the included studies was independently assessed by two reviewers using the Joanna Briggs Institute (JBI) Critical Appraisal Tools, selected according to each study design. Randomized controlled trials were evaluated using the JBI Critical Appraisal Checklist for Randomized Controlled Trials, while the cross-sectional study was assessed using the JBI Checklist for Analytical Cross-Sectional Studies.

The JBI checklist for randomized controlled trials evaluates domains including randomization procedures, allocation concealment, baseline similarity of groups, blinding of participants and outcome assessors, completeness of follow-up, reliability of outcome measurement, and appropriateness of statistical analysis. The checklist for cross-sectional studies assesses clarity of inclusion criteria, measurement of exposure and outcomes, identification and management of confounding factors, and appropriateness of statistical analysis.

Each item was rated as "yes," "no," "unclear," or "not applicable." Based on the overall appraisal, studies were categorized as having low, moderate, or high risk of bias. Any disagreements between reviewers were resolved through discussion until consensus was reached.

In addition, the certainty of evidence for each primary outcome was assessed qualitatively using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach, taking into account risk of bias, inconsistency, indirectness, imprecision, and publication bias. The certainty of evidence was classified as high, moderate, low, or very low.

Data synthesis

Due to anticipated methodological heterogeneity, a qualitative synthesis will be presented. If ≥3 comparable studies report quantitative data.

STUDY SELECTION

Figure 1.

RESULT

The studies included in this review assessed a variety of interventions. Most studies show that rinsing with saline or sea salt-based mouthwash can lower Plaque Index (PI) and Gingival Index (GI) scores, as well as reduce signs of inflammation such as Bleeding on Probing (BOP). Positive results are seen both when used after periodontal treatment and as an adjunct to routine oral hygiene. Saline and salt based solution has advantages in terms of safety and side effects (it does not cause tooth discoloration or taste disturbances) so it is suitable for long-term use. Saline and salt based solution rinse can be a safe, inexpensive, and homemade alternative to reduce plaque and support gum health, especially for patients who cannot or do not want to use chlorhexidine (Tables I and II).

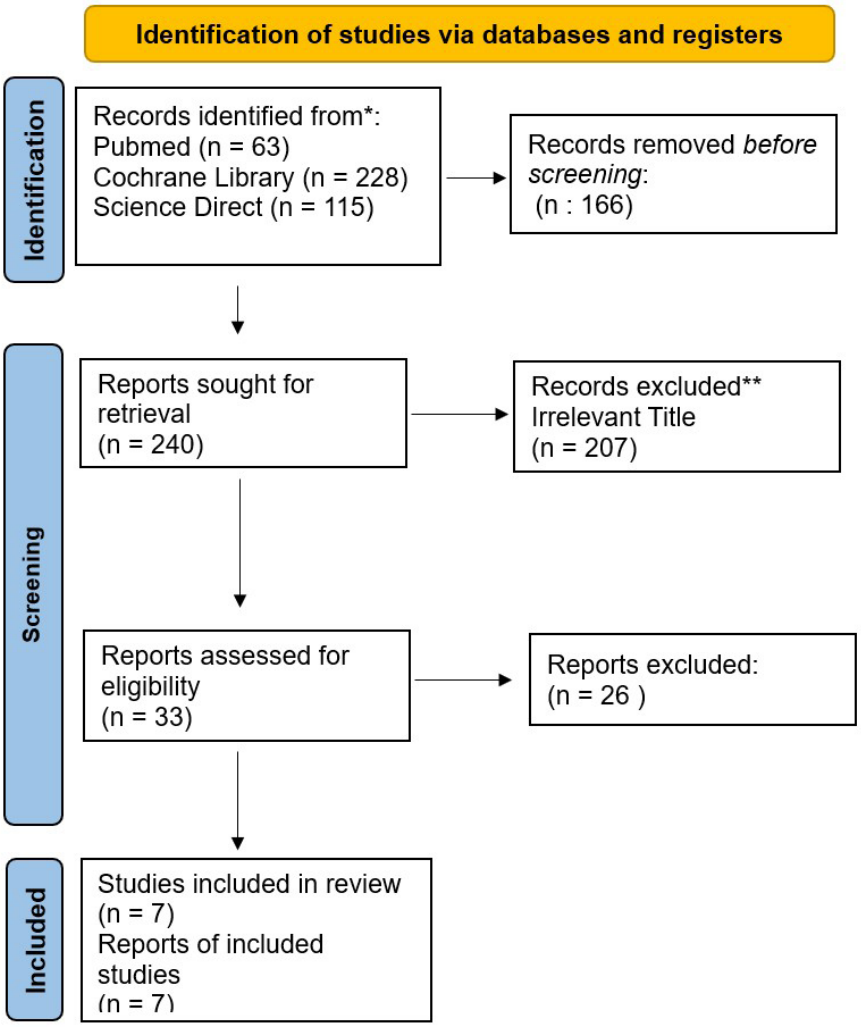

Figure 1 - PRISMA Guideline for Article selection process.

Table I - Demographic characteristics of the studies

No	Author	Country	Patient	Sex		Age (years)
				Female	Male	
1	Aravinth et al. [11]	India	30	unspecific	unspecific	12–15
2	Hoover et al. [12]	Canada	30	17	13	20-26
3	Calvo-Guirado et al. [13]	Spain	93	54	39	19-42
4	Collins et al. [3]	Dominican Republic	37	unspecific	unspecific	30-68
5	Ballini et al. [14]	Italy	20	9	11	14-17
6	Sharma et al. [15]	India	40	unspecific	unspecific	unspecific
7	Rana et al. [16]	Bangladesh	84	54	30	22–64

Table II - Clinical characteristics of the studies

Author	Design	Number of Subjects	Parameters	Treatment	Intervention	Comparator	Result
Aravinth et al. [11]	School-based, double-blind, randomized controlled clinical trial (RCT) + in vitro MIC analysis	30	PI	For five days, use 10 ml of the designated mouthwash (study and control group) for 30 s every morning between 9:00 and 9:30 am while being watched by the co-investigator.	0.8 M Salt water	0.2% Chlorhexidine	Effective
Hoover et al. [12]	Single-blind, randomized controlled clinical trial (pilot)	30	PI,BOP	The control group was instructed to use the modified Bass approach to brush their teeth twice a day for two minutes each time, and to use the spool method to floss once a day. Participants in the test group were also asked to brush and floss as previously mentioned, and after a 30-day trial period, they were to rinse their mouths for 30 s in the morning and before bed with a table spoonful of the supplied sea salt mouth rinse (per the manufacturer's instructions) without diluting it.	mouth rinse containing sea salt, xylitol, and lysozyme.	brush teeth and floss only.	No Effective
Calvo-Guirado et al. [13]	Double-blind, randomized, crossover, controlled clinical trial (RCT, pilot)	93	PI,GI	Rinsed three times daily for one minute following meals, using ten milliliters of solution that were dispensed at random from bottle A, bottle B, or bottle C. Initial and final clinical measurements were taken following the conclusion of each ten-day mouth rinse phase.	Sea 4® Encias (seawater)	Chlorhexidine 0.20% and saline solution	Effective
Collins et al. [3]	Randomized, prospective, blind clinical trial (RCT)	37	GI	Following surgery, mouthwashes were given out in accordance with the prior randomization. Patients in the test group were instructed to rinse their mouths twice a day, 30 min after brushing their teeth, with 15 mL of saline mouthwash for one minute and then spitting it out, while patients in the control group were instructed to rinse their mouths with 15 mL of 0.12% CHX mouthwash (Clorhexidina Lacer®) for one minute. All participants were asked to rinse their mouths both in the morning and at night before bed.	a sodium chloride (salt) water-based mouth rinse	0.12% chlorhexidine mouth rinse	Effective
Ballini et al. [14]	Randomized, double-blind, placebo-controlled clinical trial	20	PI	All subjects were instructed to rinse twice a day, after tooth brushing, in the morning and at night, for 60 s with 20 ml of solution.	mouth rinse containing purified water, sea salt, xylitol, lysozyme, and menthol (H2Ocean Sea Salt Mouthwash, USA)	placebo (mint-flavored and colored water)	Effective
Sharma et al. [15]	Invivo, randomized, controlled comparative clinicaltrial (quasi-RCT; random assignment mentioned)	40	PI	For five days, the participants were instructed to rinse the designated mouthwash. Salivary bacteria analysis and plaque examination were performed before and after the rinsing.	salt water rinse	chlorhexidine rinse.	Effective
Rana et al. [16]	Descriptive comparative observational study (cross-sectional comparative; sometimes considered quasi-experimental due to assigned interventions, but not randomized)	84	PI	They were adviced to brush their teeth twice daily and use mouthwash. Prior to bracket assembly, oral hygiene measurements were taken, and four weeks after the observation period using the Loe-Silness plaque indices.	salt water mouthwash,	chlorhexidine mouthwash, and essential oil mouthwash.	Effective

Study description

Aravinth et al. [11] (India)

The results showed that rinsing with a salt water solution significantly reduced dental plaque and certain microbial counts, with effectiveness comparable to that of chlorhexidine (CHX) mouthwash.

Hoover et al. [12] (Canada)

A study with 30 adult participants examined the outcomes of rinsing twice daily. According to the data, there was no discernible improvement in plaque and gum bleeding when compared to brushing and flossing alone. However, before any decisions are made regarding its role as a therapeutic agent in the management of chronic gingivitis, more clinical studies involving a larger sample size, subjects from a diverse population, and a longer trial period must be attempted. This is because of some of the limitations of this pilot study, as well as empirical data and the traditional use of salt water rinses.

Calvo-Guirado et al. [13] (Spain)

Sea4® mouthwash (based on sea salt) significantly reduced plaque and gingival inflammation, although CHX demonstrated superior results. Sea4® is considered a potential long-term alternative due to its fewer side effects.

Collins et al. [3] (Dominican Republic)

Saline rinsing produced anti-inflammatory and clinical effects similar to CHX in the early stages of wound healing, suggesting its potential for routine use during the early recovery period.

Ballini et al. [14] (Italy-Albania)

Results showed a significant increase in plaque control and a decrease in the number of oral pathogenic bacteria compared to conventional dental hygiene alone.

Sharma et al. [15] (India)

Results showed that rinsing with salt solution can significantly reduce plaque and microbial load, making it an effective adjunct to oral hygiene.

Rana et al. [16] (Bangladesh)

Mouthwash helps control dental plaque during orthodontic treatment. The study found that chlorhexidine was more effective in reducing plaque compared to essential oil and salt water mouthwashes. However, all three types of mouthwash contribute to plaque management in orthodontic patients, highlighting the value of regular use as an adjunct to mechanical oral hygiene for optimal plaque control.

Risk of bias

Risk of bias was assessed for the seven included studies using the JBI assessment tool, revealing diverse methodological quality with final assessment scores 83.31% (low risk) for RCT design and 75% (low risk) for Cross-sectional design . The assessment was based on study design for interpreting the results.The risk of bias assessment of all studies can be found in Table III.

Using the GRADE approach, the overall certainty of evidence was assessed as moderate.

Table III - The risk of bias included studies based on the Joanna Briggs Institute (JBI) assessment

JBI Assessment Tools	Questions													Score % (Category of Bias)
RCT	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q 10	Q11	Q 12	Q 13	
Aravinth et al. [11]	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	84.6
Hoover et al. [12]	✓	?	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	76.9
Calvo-Guirado et al. [13]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Collins et al. [3]	✓	?	✓	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓	76.9
Ballini et al. [14]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
Sharma et al. [15]	✓	?	✓	✗	✗	✓	?	✓	?	✓	✓	✓	✓	61.5
Average Score														**83.31 (Low Risk)**
Cross Sectional	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**						
Rana et al. [16]	✓	✓	✓	✓	?	?	✓	✓						**75 (Low Risk)**

Abbreviations: ✓Yes (Low risk); ✗No (High risk); ?Unclear.

Although most evidence was derived from randomized controlled trials with low risk of bias based on JBI appraisal, the certainty was downgraded due to inconsistency of findings and imprecision related to small sample sizes and short follow-up durations. Evidence for plaque index and gingival index outcomes was rated as moderate certainty, while evidence for bleeding on probing and probing depth was assessed as low to moderate.

DISCUSSION

This systematic review reveals that saline and salt-based mouthrinses demonstrate clinically meaningful efficacy in improving key indicators of periodontal health, particularly plaque reduction, gingival inflammation, and oral microbial control.

Data from a number of studies that show how different patient groups and clinical situations respond differently to saline and salt water rinses in terms of improving periodontal health markers. As demonstrated by the studies by Aravinth et al. [11], Calvo-Guirado et al. [13], Ballini et al. [14], Kim and Nam [17], and Sharma et al. [15], which all reported significant decreases in PI from pre- to post-rinse, the majority of research suggests that using saline or saltwater mouth rinses can significantly lower the Plaque Index (PI) [11,13]. In many instances, this decline is accompanied by drops in the Gingival Index (GI) and other inflammatory metrics in addition to the plaque index. Saline, saltwater, or salt-based solution rinses successfully decreased the plaque index, bleeding on probing (BOP), and probing depth (PD) after scaling and root planing in the Hassan et al. [2] study. This finding supports the idea that saline is a more palatable and side-effect-minimizing option than chlorhexidine for some patient groups. Collins et al. [3] study from 2021 also showed that saline had anti-inflammatory effects similar to those of chlorhexidine after periodontal surgery. This suggests that saline could be used in the early stages of wound healing without the potential for staining or taste problems that are frequently associated with chlorhexidine.

Across the included trials, saline rinses consistently yielded reductions in Plaque Index (PI) ranging from approximately 38% to 57%, with notable comparability to standard antiseptic agents such as chlorhexidine (CHX). This is of particular clinical importance given the accessibility and biocompatibility of salt-based rinses, which lack the side effects associated with long-term CHX use, such as tooth staining and taste alteration [18-20].

Multiple studies reinforced the antimicrobial effectiveness of saline, showing reductions in colony-forming units (CFUs) from baseline by 30–70%, depending on concentration and exposure duration [2,17,21,22]. Kamdem et al. [22] demonstrated that a 5.8% saline solution had prolonged bactericidal effects up to five hours post-rinse, suggesting that concentration plays a significant role in clinical effectiveness. This finding is echoed by Abraham et al. [21], who reported that saline reduced bacterial loads nearly as effectively as CHX and herbal-based rinses, underscoring its viability as an adjunctive antiseptic.

Moreover, short-term use of saline in gingivitis management proved effective across varied populations, including children and institutional settings. Aravinth et al. [11] and Sharma et al. [15] showed that school-aged children experienced substantial improvements in plaque scores and bacterial count using saltwater rinses, supporting its potential for community-level oral health interventions. These benefits were particularly relevant in settings where commercial mouthrinses are unavailable or unaffordable, and where compliance and tolerability are critical.

While CHX generally demonstrated slightly greater efficacy, this was often not statistically significant, and its advantages were offset by higher rates of adverse effects and reduced user acceptability [18]. In contrast, saline rinses were reported as well tolerated and easy to integrate into routine hygiene, making them a suitable first-line or maintenance option in both clinical and home-care scenarios. Additionally, Naik et al. [23] demonstrated that warm saline was as effective as 0.12% CHX in preventing alveolar osteitis following third molar extractions, suggesting that its mechanical flushing action may also contribute to wound healing and bacterial clearance. The findings from Sinha et al. [24] added nuance, showing that while saline did not outperform CHX or herbal alternatives in microbial control, it preserved salivary pH and was better accepted by patients, highlighting its potential for long-term use.

The interpretation of these findings should consider the methodological quality of the included studies. Using the JBI critical appraisal tools, most randomized controlled trials demonstrated low to moderate risk of bias, whereas the cross-sectional study was assessed as having low risk of bias. These limitations, together with heterogeneity in saline concentration, intervention duration, and outcome assessment, may influence the strength of the observed effects.

Despite promising outcomes, heterogeneity among studies—including variability in concentration, rinse duration, population health status, and follow-up period—limits direct comparability and precludes meta-analysis. Notably, most studies had short intervention durations (7-15 days), and long-term effects remain underexplored. Nonetheless, although the certainty of evidence is limited, the available findings support a potential role for salt-based rinses as a safe and economical adjunct in periodontal care [2,17].

CONCLUSION

Saline and salt-based mouthrinses may provide beneficial effects on plaque accumulation and gingival inflammation and can be considered a safe, low-cost adjunct to conventional periodontal care. The evidence, derived mainly from randomized controlled trials with low risk of bias, was rated as moderate certainty using the GRADE approach, with downgrading due to inconsistency and imprecision. While these rinses cannot replace established antiseptics such as chlorhexidine, they may be useful in patients with intolerance to chemical agents or in resource-limited settings. Further well designed randomized trials with longer follow-up are needed to strengthen the evidence base.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author's Contributions

CJC: Conceptualization, Methodology, Writing – Original Draft Preparation. SO: Conceptualization, Supervision, Funding Acquisition, Writing – Review & Editing. HT: Formal Analysis, Validation, Writing – Review & Editing. DS: Resources, Software, Data Curation. SRJR: Project Administration, Investigation. ANIG: Data Curation, Investigation, Visualization.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Regulatory Statement

This systematic review was conducted through a search strategy in electronic databases. The approval for ethics committee for the reviewed studies were obtained in their original work.

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