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Research Article

Assessment of the Association between Mouthwash Use and Plaque Accumulation in a Cross-Sectional Study

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Abstract

Introduction: Plaque accumulation is a major risk factor for gingival inflammation and periodontal disease. While tooth brushing is the cornerstone of oral hygiene, mouthwash is often used as an adjunct to reduce plaque and improve oral health. Objective: To evaluate the association between mouthwash use and plaque accumulation among adults.

Methodology: A cross-sectional study was conducted at Mardan Medical Complex, Pakistan, from January to December 2023, enrolling 252 participants (mean age: 28.7 ± 8.4 years). Plaque scores were recorded using WHO Oral Health Survey (5th edition) criteria. Mouthwash use, brushing frequency, and demographic data were collected via structured questionnaires. Statistical analysis included chi-square, ANOVA, and multiple linear regression, with $p < 0.05$ considered significant.

Results: Regular mouthwash use was reported by 41.3% of participants, occasional use by 28.6%, and no use by 30.2%. Mean plaque scores were significantly lower among regular users (1.43 ± 0.35) compared to occasional (1.77 ± 0.41) and non-users (2.18 ± 0.47) ($p < 0.001$). Chlorhexidine users showed the lowest mean plaque scores (1.38 ± 0.29). Gender differences were significant on univariate analysis ($p = 0.04$) but not after adjustment in regression. Multiple regression identified regular mouthwash use ($\beta = -0.63$, $p < 0.001$) and higher brushing frequency ($\beta = -0.52$, $p < 0.001$) as independent predictors of lower plaque scores.

Conclusion: Regular mouthwash use, particularly chlorhexidine, and frequent tooth brushing significantly reduce plaque accumulation and should be encouraged as part of routine oral hygiene.

Introduction

Dental plaque is a major contributing factor to the development of gingivitis, periodontitis, and dental caries, making oral health an essential aspect of overall health and wellbeing [1]. Dental plaque is a biofilm that accumulates on tooth surfaces, consisting of a complex community of microorganisms embedded in an extracellular

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matrix [2]. If not adequately removed, plaque can lead to inflammation of the gingiva and progression to periodontal disease, which represents one of the most common oral health problems globally [3]. According to the World Health Organization, oral diseases affect nearly 3.5 billion people worldwide, with dental caries and periodontal disease being the most prevalent conditions [4]. Therefore, preserving long-term dental stability and preventing these oral health issues depend on effective plaque control [5].

Oral hygiene procedures still rely heavily on mechanical plaque management techniques, including interdental cleaning and toothbrushing [6]. However, despite regular mechanical cleaning, complete plaque removal is often difficult due to anatomical challenges, poor technique, or lack of compliance [7]. Consequently, adjunctive chemical plaque control agents, particularly antimicrobial mouthwashes, have gained importance in enhancing plaque reduction and maintaining oral hygiene [8]. Because of their substantivity and broad-spectrum antibacterial activity, chlorhexidine-based mouthwashes are regarded as the gold standard among them; yet, they are frequently linked to adverse effects like mucosal irritation, tooth discoloration, and altered taste perception [9]. Although their efficacy varies, other mouthwashes with fluoride, cetylpyridinium chloride, or essential oils are also commonly accessible and used in daily life [10].

Several studies have reported that regular use of mouthwash, in addition to toothbrushing, can significantly reduce plaque accumulation and gingival inflammation [11]. Nonetheless, the extent of benefit appears to depend on factors such as frequency of use, duration of rinsing, type of mouthwash, and patient compliance [12]. Furthermore, cultural practices, socioeconomic status, and individual awareness of oral hygiene also play a role in determining the overall effectiveness of mouthwash use in controlling plaque [13]. Despite its common use in both community and clinical settings, there is still debate over the long-term effectiveness and necessity of mouthwash as a preventive oral health strategy, especially in populations where mechanical plaque control is already practiced regularly [14].

In Pakistan and other developing countries, where the burden of periodontal disease remains high and preventive oral health practices are often inadequate, evaluating the role of adjunctive methods such as mouthwash becomes particularly relevant [15]. While international literature provides valuable insights, there is limited local evidence assessing the relationship between mouthwash use and plaque accumulation within our population [16].

Despite the widespread use of mouthwashes globally, limited data exist on their association with plaque accumulation in the Pakistani population. This study aimed to assess the relationship between mouthwash use and plaque accumulation through a cross-sectional analysis

Materials and Methods

Study Design and Setting: This cross-sectional study was conducted at the Department of Dentistry, Mardan Medical Complex, Peshawar, over a duration of 12 months, from January 2023 to December 2023. The study aimed to evaluate the association between mouthwash use and plaque accumulation among participants attending the dental outpatient department.

Study Population: Adult participants who visited the outpatient dental clinic during the study period and were at least eighteen years old made up the study group. Participants with systemic conditions known to affect oral health (such as diabetes mellitus, immunocompromised states, or long-term antibiotic use), those who were unwilling to participate and those who had received periodontal therapy within the previous six months were not included.

Sample Size Calculation: A sample size of 252 participants was calculated using the World Health Organization (WHO) sample size calculator. The calculation was based on an anticipated prevalence of mouthwash use of 31.4% among Pakistani adults, as reported in a previous study among medical and dental students in Peshawar [17]. The estimated prevalence of 31.4% was derived from prior findings in that study, which reflected the local population's oral hygiene practices. A 95% confidence level and a

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6% margin of error were applied. To account for incomplete data or non-responses, 10% was added, resulting in the final sample size of 252 participants.

Sampling Technique: Participants meeting the inclusion criteria were recruited using a consecutive sampling technique during the study period.

Data Collection: A structured questionnaire was used to gather data on mouthwash usage frequency, oral hygiene habits, and demographic traits. Information regarding the type of mouthwash (chlorhexidine, essential oil-based, fluoride-containing, or others) and frequency of use (daily, occasional, or none) was also documented.

Clinical Examination: Dental professionals who had received training and calibration conducted the clinical evaluation in standardized settings. Examiners underwent inter- and intra-examiner calibration to ensure reliability in plaque score assessment. The World Health Organization Oral Health Surveys: Basic Methods, Fifth Edition [18] criteria were used to evaluate plaque buildup. After examining each participant's index teeth, the mean plaque score was determined.

Statistical Analysis: Version 26 of the SPSS was used to enter and analyze the data. Plaque scores, dental hygiene habits, and demographic traits were obtained using descriptive statistics. The independent t-test/ANOVA for continuous variables and the chi-square test for categorical variables were used, respectively, to assess the relationship between mouthwash use and plaque accumulation. Multivariate linear and logistic regression models were used to account for potential confounding variables such age, gender, and dental hygiene practices. Statistical significance was defined as a p-value of less than 0.05.

Ethical Considerations: The Mardan Medical Complex's Institutional Review Board granted ethical approval. Before any data was collected, each participant gave their written informed consent. All information was used only for research, and participant confidentiality was upheld

Results

The study comprised 252 participants, ages 18 to 55, with a mean age of 28.7 ± 8.4 years, as indicated in Table 1. The majority of participants were between the ages of 26 and 35 (112, 44.4%), followed by those between the ages of 18 and 25 (94, 37.3%), 36 and 45 (34, 13.5%), and over 45 (12, 4.8%). Females represented 54.8% (138) of the sample, while males accounted for 45.2% (114). Regarding oral hygiene practices, 162 (64.3%) participants reported brushing twice daily, 76 (30.2%) once daily, and 14 (5.6%) reported irregular brushing. Daily flossing was reported by only 48 (19.0%), and 92 (36.5%) participants reported visiting a dentist within the past 12 months. A thorough summary of the research population's demographic and oral hygiene traits is given in this table.

Table 1: Demographic and Oral Hygiene Characteristics of Participants (n = 252)

Variable	Category	n	%
Age (years)	18–25	94	37.3
	26–35	112	44.4
	36–45	34	13.5
	>45	12	4.8
Gender	Male	114	45.2
	Female	138	54.8
Brushing Frequency	Once daily	76	30.2
	Twice daily	162	64.3
	Irregular	14	5.6
Daily Floss Use	Yes	48	19.0
	No	204	81.0
Dental Visit in Past 12 Months	Yes	92	36.5
	No	160	63.5

Legend: *Distribution of participants by age, gender, oral hygiene habits, and dental visit history.*

As shown in Table 2, regular mouthwash use was reported by 104 participants (41.3%), occasional use by 72 (28.6%), and 76 (30.2%) participants did not use mouthwash. Among regular users, the most common type of mouthwash was chlorhexidine (62, 59.6%), followed by essential oils (28, 26.9%) and fluoride-based products (14, 13.5%). Regular mouthwash use was higher among females (64, 46.4%) than males (40, 35.1%), while non-use was more frequent in males (46, 40.4%) compared to females (30, 21.7%). These findings indicate that nearly half of the study population used mouthwash

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regularly, with chlorhexidine being the preferred type.

Table 2: Mouthwash Use According to Type and Frequency (n = 252)

Mouthwash Use	Total (n, %)	Type of Mouthwash	Chlorhexidine (n, %)	Essential oils (n, %)	Fluoride (n, %)	Male (n, %)	Female (n, %)
Regular (≥1/day)	104 (41.3)	Chlorhexidine, Essential oils, Fluoride	62 (59.6)	28 (26.9)	14 (13.5)	40 (35.1)	64 (46.4)
Occasional (<1/day)	72 (28.6)	Chlorhexidine, Essential oils, Fluoride	42 (58.3)	20 (27.8)	10 (13.9)	28 (24.6)	44 (31.9)
None	76 (30.2)	N/A				46 (40.4)	30 (21.7)

Legend: *Distribution of participants by mouthwash usage, type, and gender. N/A: Not applicable.*

The Mean plaque score was 1.82 ± 0.56, as indicated in Table 3. There was a significant difference between the groups (F = 42.7, p < 0.001), with regular mouthwash users having the lowest mean plaque score (1.43 ± 0.42), followed by occasional users (1.77 ± 0.51) and non-users (2.18 ± 0.49). Females had slightly lower plaque scores than males (1.75 ± 0.53 vs 1.90 ± 0.58, p = 0.04), and brushing twice daily was associated with significantly lower plaque (1.63 ± 0.49) compared to brushing once daily (2.01 ± 0.53, p < 0.001). Participants with irregular brushing had the highest mean plaque score (2.35 ± 0.44). These results suggest that both mouthwash use and proper brushing frequency are strongly associated with lower plaque accumulation.
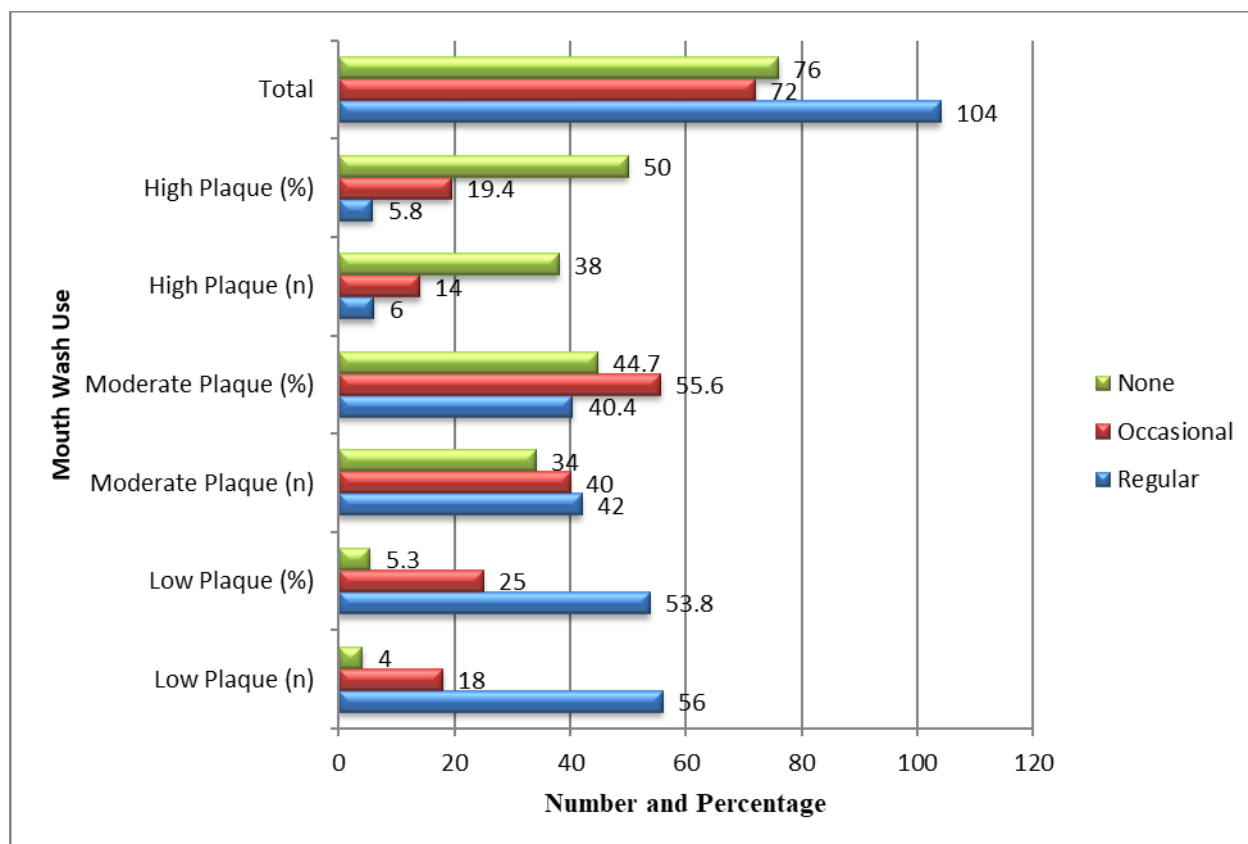
Table 3: Mean Plaque Scores by Mouthwash Use, Gender, and Brushing Frequency (n = 252)

Variable	Category	Mean Plaque Score ± SD	F/t	p-value
Mouthwash Use	Regular	1.43 ± 0.42	42.7	<0.001
	Occasional	1.77 ± 0.51		
	None	2.18 ± 0.49		
Gender	Male	1.90 ± 0.58	t = 2.05	0.04
	Female	1.75 ± 0.53		
Brushing Frequency	Once daily	2.01 ± 0.53	F = 21.4	<0.001
	Twice daily	1.63 ± 0.49		
	Irregular	2.35 ± 0.44		

Legend: *Mean plaque scores stratified by mouthwash use, gender, and brushing frequency. Differences among three or more groups (mouthwash use and brushing frequency) were assessed using ANOVA (F), whereas an independent samples t-test (t) was used to evaluate the differences between two groups (gender). Where p < 0.05 statistically significant differences are indicated.*

As shown in Table 4, plaque scores categorized as low, moderate, or high were significantly associated with mouthwash use (χ^2 = 61.4, p < 0.001). Among regular users, 56 (53.8%) had low plaque scores, whereas 38 (50.0%) non-users had high plaque scores. Occasional users mainly had moderate plaque (40, 55.6%). These findings indicate a strong inverse association between mouthwash use and plaque accumulation.

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Table 4: Plaque Category by Mouthwash Use (n = 252)
Legend: *Distribution of plaque category according to mouthwash usage.*

As shown in Table 5, among regular mouthwash users, mean plaque scores varied by the type of mouthwash. Chlorhexidine users had the lowest mean plaque score (1.38 ± 0.41), followed by essential oil users (1.52 ± 0.43) and fluoride-based users (1.61 ± 0.45). This difference was statistically significant (p = 0.02), indicating that mouthwash type influences plaque reduction. Chlorhexidine was the most effective, while essential oils showed moderate effectiveness and fluoride the least. These findings highlight the importance of selecting an appropriate mouthwash for optimal oral hygiene.

As shown in Table 6, multivariate linear regression analysis revealed that regular mouthwash use was independently associated with lower plaque scores (β = -0.63, 95% CI: -0.79 to -0.47, p < 0.001). Similarly, brushing twice daily significantly predicted lower plaque levels (β = -0.41, 95% CI: -0.59 to -0.23, p < 0.001). In contrast, age (β = 0.05, 95% CI: -0.01 to 0.11, p = 0.11) and gender (β = -0.03, 95% CI: -0.17 to 0.11, p = 0.65) were not significant predictors of plaque accumulation. These findings confirm that consistent mouthwash use and proper brushing frequency are key determinants of dental plaque.

Table 5: Mean Plaque Scores by Mouthwash Type among Regular Users (n = 104)

Mouthwash Type	n	Mean Plaque Score ± SD	p-value (ANOVA)
Chlorhexidine	62	1.38 ± 0.41	0.02
Essential oils	28	1.52 ± 0.43	
Fluoride	14	1.61 ± 0.45	

Legend: *Comparison of mean plaque scores by type of mouthwash among regular users (n = 104). Differences were significant statistically (p = 0.02).*

Table 6: Multivariate Linear Regression for Predictors of Plaque Score

Predictor	β Coefficient	95% CI	p-value
Mouthwash Use (Regular vs None)	-0.63	-0.79 to -0.47	<0.001
Brushing Frequency (Twice vs Once)	-0.41	-0.59 to -0.23	<0.001
Age	0.05	-0.01	0.11

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		to 0.11	
Gender (Female vs Male)	-0.03	-0.17 to 0.11	0.65

Legend: *Multivariate analysis showing independent predictors of plaque score. Regular mouthwash use and brushing twice daily were statistically significant predictors (p < 0.001).*

Discussion

This study assessed the association between mouthwash use and plaque accumulation in a cross-sectional population of adults attending a dental outpatient clinic. The results demonstrated a clear inverse relationship between regular mouthwash use and plaque scores. Participants using mouthwash daily had significantly lower mean plaque scores compared to occasional users and non-users. Regular mouthwash use, particularly chlorhexidine-based formulations, is associated with lower plaque accumulation. Additionally, brushing frequency independently influenced plaque levels, highlighting the combined importance of mechanical and chemical oral hygiene measures. These associations remained after adjusting for potential confounders like age and gender, according to multivariate analysis.

The findings of this study are consistent with existing literature, which indicates that chemical adjuncts, particularly antimicrobial mouthwashes, significantly reduce plaque accumulation and improve oral hygiene outcomes [19]. Regular use of mouthwash is associated with lower plaque scores and a decreased risk of gingival inflammation, whereas irregular or non-use correlates with higher plaque accumulation [20]. Chlorhexidine-based formulations are widely recognized as the most effective in reducing plaque due to their potent antimicrobial properties, followed by essential oil-based and fluoride-containing mouthwashes, which show moderate benefits [21]. Furthermore, frequent tooth brushing remains a critical determinant of oral health, and combined use of mouthwash and proper brushing provides optimal plaque control [20]. The present study also reinforces the observation that gender and age, while often considered potential confounders, may have minimal impact on plaque

scores when proper oral hygiene practices are employed [22].

These results are in agreement with global evidence, where chlorhexidine consistently emerges as the gold standard for short-term plaque control [23]. Other studies have highlighted the role of essential oil-based rinses as a well-tolerated option for long-term maintenance, particularly in individuals where prolonged chlorhexidine use is not recommended [24]. Furthermore, multicenter trials have confirmed that combining chemical adjuncts with mechanical brushing provides superior plaque reduction compared to brushing alone, supporting the integrated approach promoted by international guidelines [25].

Limitations and Future Suggestions

In spite of these advantages, the study contains a number of drawbacks. First, the inability to establish causality between mouthwash use and plaque accumulation is an inherent limitation of the cross-sectional design. Second, self-reporting bias may have influenced the findings, as information regarding mouthwash use and brushing frequency was based solely on participants' self-reported data. Third, the study was only carried out in one tertiary care facility, which might have limited how broadly the results can be applied. Multi-center samples should be used in future research to increase external validity, and longitudinal designs should be taken into account to determine causal linkages. Furthermore, a more thorough understanding of oral hygiene practices and their effects on plaque accumulation may be obtained by assessing additional variables like nutrition, smoking, and socioeconomic status.

Conclusion

Regular mouthwash use, particularly chlorhexidine-based formulations, is significantly associated with lower plaque accumulation, and its effect is enhanced when combined with proper tooth brushing. The findings highlight the importance of incorporating chemical adjuncts alongside routine mechanical oral hygiene for optimal plaque control. Promoting consistent mouthwash use and effective brushing practices may contribute to improved oral health outcomes in adult populations.

Authors' contributions

Dr. Ali Baqar: Conceived the study, designed methodology, and supervised overall research.

Dr. Abdullah Shafiq: Collected data and contributed to statistical analysis.

Dr. Raheem Haider: Assisted in literature review and manuscript drafting.

Dr. Balaj Rehman: Contributed to data interpretation and critical revision of the manuscript.

Dr. Amna Noreen: Assisted in proofreading, formatting, and final approval of the manuscript.

Conflict of interest

The authors declared no conflict of interest.

References

1. Abdulkareem AA, Al-Taweel FB, Al-Sharqi AJ, Gul SS, Sha A, Chapple IL. Current concepts in the pathogenesis of periodontitis: from symbiosis to dysbiosis. Journal of Oral Microbiology. 2023 Dec 31;15(1):2197779.https://doi.org/10.1080/20002297.2023.2197779

2. Jakubovics NS, Goodman SD, Mashburn-Warren L, Stafford GP, Cieplik F. The dental plaque biofilm matrix. Periodontology 2000. 2021 Jun;86(1):32-56.https://doi.org/10.1111/prd.12361

3. Li W, Li L, Xu W, Guo Y, Xu M, Huang S, Dai D, Lu C, Li S, Lin J. Identification of Gingival Inflammation Surface Image Features Using Intraoral Scanning and Deep Learning. International Dental Journal. 2025 Jan 27.https://doi.org/10.1016/j.identj.2025.01.002

4. World Health Organization. Oral health [Internet]. Geneva: WHO; 2022 [cited 2025 Sep 11]. Available from: https://www.who.int/news-room/fact-sheets/detail/oral-health

5. Xiao C, Zhang L, Li Z, Xu Q, Lin S, Zheng S, Shi H. Periodontal health intervention for oral health-related outcomes in older type 2 diabetes patients: a randomized controlled trial in a Chinese tertiary hospital. Scientific Reports. 2025 Jul 31;15(1):28014.https://doi.org/10.1038/s41598-025-13434-0

6. Chan AK, Tsang YC, Chu S, Chu CH. Comprehensive Strategies for Preventive Periodontal Care in Older Adults. Geriatrics. 2025 May 25;10(3):72.https://doi.org/10.3390/geriatrics10030072

7. Ng E, Lim LP. An overview of different interdental cleaning aids and their effectiveness. Dentistry journal. 2019 Jun 1;7(2):56.https://doi.org/10.3390/dj7020056

8. Mohammed SA, Akram HM. Evaluating the Efficacy of Resveratrol-Containing Mouthwash as an Adjunct Treatment for Periodontitis: A Randomized Clinical Trial. European Journal of Dentistry. 2025 May;19(02):354-65.DOI: 10.1055/s-0044-1788686

9. Ozmeric N, Enver A, Isler SC, Gökmenoğlu C, Topaloğlu M, Selamet H, Altun G, Aykol Sayar S. Evaluating the effects of chlorhexidine and vitamin c mouthwash on oral health in non-surgical periodontal therapy: a randomized controlled clinical trial. Scientific reports. 2025 Jan 29;15(1):3703.https://doi.org/10.1038/s41598-025-88100-6

10. McGrath C, Clarkson J, Glenny AM, Walsh LJ, Hua F. Effectiveness of mouthwashes in managing oral diseases and conditions: do they have a role?. International dental journal. 2023 Nov 1;73:S69-73.https://doi.org/10.1016/j.identj.2023.08.014

11. Oo MM, Oo PH, Saddki N. Efficacy of 0.05% cetylpyridinium chloride mouthwash as an adjunct to toothbrushing compared with 0.12% chlorhexidine gluconate mouthwash in reducing dental plaque and gingival

inflammation: A randomized control trial. International Journal of Dental Hygiene. 2023 Feb;21(1):195-202.https://doi.org/10.1111/idh.12614

12. Hoseyni S, Rostamzadeh M, Salimizand H, Azadnia A, Rahimi F, Khalifehzadeh S. Efficacy of preprocedural mouth rinses (Chlorhexidine, essential oil, and hydrogen peroxide) in reducing bacterial aerosols during dental scaling. BMC Oral Health. 2025 Jul 2;25:1004.https://doi.org/10.1186/s12903-025-06308-4

13. Oberoi SS, Sharma G, Oberoi A. A cross-sectional survey to assess the effect of socioeconomic status on the oral hygiene habits. Journal of Indian Society of Periodontology. 2016 Sep 1;20(5):531-42.DOI: 10.4103/0972-124X.201629

14. Brookes ZL, McCullough M, Kumar P, McGrath C. Mouthwashes: implications for practice. international dental journal. 2023 Nov 1;73:S98-101.https://doi.org/10.1016/j.identj.2023.08.013

15. Waqar SM, Razi A, Qureshi SS, Saher F, Zaidi SJ, Kumar C. Comparative evaluation of propolis mouthwash with 0.2% chlorhexidine mouthwash as an adjunct to mechanical therapy in improving the periodontitis among perimenopausal women: a randomized controlled trial. BMC Oral Health. 2024 Jan 5;24(1):26.https://doi.org/10.1186/s12903-023-03768-4

16. Abid M, Baig MI, Khurshid A, Kumar A, Farooq S, Iqbal Z. Comparing the efficacy of Chlorhexidine Mouthwash and Natural Honey in Reducing Plaque and Improving Gingival Health. A Randomized Controlled Trial: Plaque Reduction and Gingival Health. Pakistan Journal of Health Sciences. 2024 May 31:95-9.https://doi.org/10.54393/pjhs.v5i05.1548

17. Jehan OH, Khan F, Jehan AM, Yousaf M. Assessment of oral health behavior, knowledge, and practice among medical and dental undergraduate students of Peshawar Medical and Dental College, Pakistan. Biomedica. 2024 Oct 3;40(1):26-31.DOI: 10.24911/BioMedica/5-1146

18. World Health Organization. Oral health surveys: basic methods. World Health Organization; 2013.https://books.google.com/books?hl=en&lr=&id=8rEXDAAAQBAJ&oi=fnd&pg=PP1&dq=Oral+health+surveys:+basic+methods+-+5th+edition&ots=fEIKW2Bx_v&sig=3fwKGCiT8KsRlpnYCdP7CpkDVDI

19. Montesani L, Montesani L, Mateo L, Daep C, Huber N, Isapour G, Zhang YP. Antibacterial and clinical effectiveness of a mouthwash with a novel active system of amine+ zinc lactate+ fluoride: a randomized controlled trial. Clinical Oral Investigations. 2024 Jan 13;28(1):90.https://doi.org/10.1007/s00784-023-05487-0

20. Min K, Bosma ML, John G, McGuire JA, DelSasso A, Milleman J, Milleman KR. Quantitative analysis of th e effects of brushing, flossing, and mouthrinsing on supragingival and subgingival plaque microbiota: 12-week clinical trial. BMC Oral Health. 2024 May 17;24(1):575.https://doi.org/10.1186/s12903-024-04362-y

21. Alroudhan IE, Gamal M, Ganji KK, Khan AM, Alsharari KN, Alruwaili MK, Al Waqdani NH. The effectiveness of mouthwashes with various ingredients in plaque control: a systematic review and meta-analysis. Health Med. 2021 Sep 1;27(5):52-7. http://www.alternative-therapies.com/oa/pdf/6823.pdf

22. Barbe AG, Al-Barwari A, Hamacher S, Deinzer R, Weik U, Noack MJ. Effectiveness of brushing teeth in patients with reduced

oral hygiene by laypeople: a randomized, controlled study. BMC Oral Health. 2021 Apr 30;21(1):225.https://doi.org/10.1186/s12903-021-01590-4

23. Thangavelu A, Kaspar SS, Kathirvelu RP, Srinivasan B, Srinivasan S, Sundram R. Chlorhexidine: an elixir for periodontics. Journal of Pharmacy and Bioallied Sciences. 2020 Aug 1;12(Suppl 1):S57-9.DOI: 10.4103/jpbs.JPBS_162_20

24. Lynch MC, Cortelli SC, McGuire JA, Zhang J, Ricci-Nittel D, Mordas CJ, Aquino DR, Cortelli JR. The effects of essential oil mouthrinses with or without alcohol on plaque and gingivitis: a randomized controlled clinical study. BMC oral health. 2018 Jan 10;18(1):6.https://doi.org/10.1186/s12903-017-0454-6

25. Bosma ML, McGuire JA, DelSasso A, Milleman J, Milleman K. Efficacy of flossing and mouth rinsing regimens on plaque and gingivitis: a randomized clinical trial. BMC Oral Health. 2024 Feb 3;24(1):178.https://doi.org/10.1186/s12903-024-03924-4