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Review Article

Periodontal Care in Orthodontic Patients with Fixed Appliances: An Umbrella Review of Self-Care Protocols and Evidence-Based Guidelines

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ABSTRACT

This umbrella review investigated the methods and tools used for periodontal self-care in patients with healthy periodontium undergoing orthodontic treatment with fixed appliances. It aimed to summarize self-care recommendations, evaluate their effects on periodontal outcomes, and provide evidence-based guidance. The study followed a pre-registered protocol on PROSPERO (CRD42022367204) and adhered to PRISMA guidelines. English-language systematic reviews without date limits were searched up to 21 November 2022 in PROSPERO, Cochrane Library, Web of Science, Scopus, and MEDLINE/PubMed. Quality assessment was performed using AMSTAR 2. Seventeen systematic reviews were included. Results indicated that powered and manual toothbrushes perform similarly in controlling dental biofilm, although powered brushes may provide short-term improvements in gingival inflammation, bleeding, and probing depth. Chlorhexidine mouthwashes were effective as adjuncts to brushing for biofilm and inflammation control, whereas gels, varnishes, and pastes showed limited benefit. Herbal and natural agents, including aloe vera and chamomile, demonstrated antimicrobial activity comparable to chlorhexidine but with fewer side effects. Behavioral interventions and motivational techniques were also beneficial for maintaining oral hygiene, while current evidence does not support the use of probiotics in this context.

Keywords: Orthodontic treatment, Periodontal health, Fixed appliances, Biofilm management, Self-care, Gingival inflammation

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Introduction

Periodontal health is defined as the absence of inflammation detectable at microscopic or clinical levels, ensuring normal periodontal function [1, 2]. Since dental biofilm accumulation is a key factor in the development of gingivitis and periodontitis [3, 4], effective oral hygiene and self-care practices, reinforced by routine professional evaluations, are essential for maintaining periodontal stability [1, 4-6].

Fixed orthodontic treatment, involving appliances such as bands, brackets, archwires, ligatures, and auxiliary components, aims to correct dental malocclusions [7, 8]. However, these appliances can complicate oral hygiene procedures and promote biofilm accumulation on both teeth and appliance surfaces [9-14]. Consequently, patients with fixed orthodontic appliances often present with higher biofilm levels and worse periodontal inflammation compared to those with removable appliances or no orthodontic treatment [14-18]. Uncontrolled periodontal inflammation during treatment may accelerate tissue damage and contribute to periodontitis progression [19-22], highlighting the importance of comprehensive assessment and achieving periodontal stability prior to initiating orthodontic therapy [23-25].

When biofilm and inflammation are properly managed, no long-term detrimental effects on clinical or microbial periodontal parameters are expected in otherwise healthy patients after appliance removal [26-30]. Maintaining periodontal health relies heavily on patient engagement in self-care. Accordingly, a variety of strategies have been proposed to optimize mechanical and chemical biofilm control during fixed orthodontic treatment [31-34].

Daily manual toothbrushing remains the cornerstone of preventive care [35-37]. Orthodontic-specific toothbrushes, designed to improve bristle contact with brackets and wires, may further enhance plaque control [38, 39]. Chemical agents, such as chlorhexidine, continue to serve as the reference standard for biofilm management [40, 41], while natural products like aloe vera and herbal-based mouthwashes demonstrate antimicrobial properties with fewer side effects [41-45]. Probiotics, live microorganisms that confer health benefits, may modulate biofilm composition and host immune response, contributing to reduced inflammation and improved biofilm control [46-50].

Behavioral interventions, including motivation and education, are also widely applied to encourage patient adherence to self-care routines [51]. Despite these advances, an integrated, evidence-based approach for managing periodontal health in patients undergoing fixed orthodontic treatment remains undefined. Given the critical role of lifelong patient education and motivation in periodontal maintenance [52], this review aims to: (i) summarize current periodontal self-care instructions and recommendations; (ii) evaluate their effects on periodontal outcomes; and (iii) provide integrated, evidence-based guidance for maintaining periodontal health in periodontally healthy patients with fixed orthodontic appliances.

Materials and Methods

Study protocol

This umbrella review followed a pre-registered protocol in the PROSPERO database (CRD42022367204) and adhered to the PRISMA guidelines [53]. The protocol outlined strategies for literature search, data extraction, and analysis, with a primary focus on periodontal self-care instructions, recommendations, and motivational strategies [54].

Research questions, inclusion criteria, and search strategies were defined according to the PICO framework [55]. The central question was: "What are the current evidence-based standards for home care instructions, prescriptions, and motivational strategies in periodontally healthy patients undergoing fixed orthodontic treatment?" with the following specifications:

- **Population (P):** Periodontally healthy orthodontic patients of any age or sex using fixed appliances (vestibular or lingual).
- **Intervention (I):** Periodontal self-care instructions, product prescriptions, and motivational methods.
- **Comparison (C):** No intervention, placebo, or comparison between different interventions.
- **Outcomes (O):** Objective measures of periodontal health assessed using validated clinical indices (excluding self-reported outcomes).

Search strategy

A systematic search was performed by two independent reviewers (F.D.S. and M.P.D.P.) to identify English-language systematic reviews, with or without meta-analyses, addressing periodontal self-care guidance, product recommendations, and motivational approaches. No publication date limits were applied. The search covered the PROSPERO Registry, Cochrane Library, Web of Science (Core Collection), Scopus, and MEDLINE/PubMed up to 21 November 2022. Keywords **(Figure 1)** were combined using Boolean operators. Database-specific filters included: Web of Science – "Review (English)" and "refine: systematic review"; Scopus – "Review (English)"; MEDLINE/PubMed – "Systematic Review (English)"; Cochrane Library – "Keywords" and "Review"; PROSPERO – "Systematic review," "Meta-analysis," and "Completely published."

1. toothbrush OR toothpaste OR mouthwash OR mouth rinse OR chlorhexidine OR gel OR probiotics
AND
2. orthodontic treatment OR fixed OR appliance OR appliances OR vestibular OR lingual
AND
3. periodontal OR gingival OR biofilm OR plaque AND indices OR parameters OR values OR scores.

Figure 1. Keywords applied in the electronic database cross-search.

Study selection and eligibility

All retrieved citations were imported into EndNoteTM (Clarivate) to remove duplicates. Titles were then screened independently by two reviewers (F.D.S. and M.P.D.P.), followed by a detailed assessment of abstracts for potentially relevant systematic reviews, with or without meta-analyses. Full-text articles were retrieved for all records meeting the eligibility criteria or for which the title and abstract were ambiguous. Direct contact with study authors was not required as all full texts were accessible. Full-text evaluation was performed independently by three reviewers (F.D.S., M.P.D.P., and D.C.), and disagreements were resolved

by discussion. If consensus could not be reached, a fourth author (F.D.A.) provided adjudication.

Inclusion criteria encompassed systematic reviews published in English, regardless of date, addressing any type of periodontal self-care instructions, prescriptions, or motivational strategies in periodontally healthy orthodontic patients undergoing fixed appliance therapy. Exclusion criteria included duplicate publications, commentaries, editorials, in vitro and preclinical studies, studies involving patients with periodontitis or other oral/dental infections, and investigations involving removable orthodontic appliances. Self-reported periodontal outcomes were also excluded.

Data extraction

Data were independently extracted by three authors (F.D.S., M.P.D.P., and D.C.) using a predesigned standardized form based on guidance for intervention reviews of both RCTs and non-RCTs. Discrepancies were resolved through consultation with a fourth reviewer (F.D.A.). Extracted information included:

- First author, year of publication, journal, funding, and methodological quality;
- Design and number of primary studies included in each review;
- Sample characteristics (size, gender distribution, mean age) of participants in the included reviews;
- Type and duration of fixed orthodontic treatment;
- Details of periodontal self-care instructions, prescribed interventions, and motivational methods, including comparisons if available;
- Evaluated clinical periodontal outcomes;
- Statistically significant findings and study conclusions.

Clinical periodontal outcomes included measures such as clinical attachment loss (CAL), periodontal probing depth (PPD), bleeding on probing (BoP), gingival bleeding index (GBI), bleeding index (BI), gingival index (GI), modified gingival index (MGI), plaque index (PI), alongside radiographic, crevicular, or other reported parameters.

Data synthesis

A narrative synthesis was performed focusing on study populations, interventions, and measured outcomes. Extracted data were qualitatively summarized using descriptive statistics in Microsoft Excel 2019 (Microsoft Corporation, Redmond, WA, USA) to:

- Describe the periodontal self-care instructions, prescriptions, and motivational approaches reported, including any comparative analyses;
- Evaluate clinical periodontal outcomes associated with these interventions;
- Compare outcomes following the interventions versus no intervention, placebo, or alternative strategies.

Quality assessment

The methodological quality of the included systematic reviews was evaluated using the AMSTAR 2 (A MeaSurement Tool to Assess systematic Reviews) tool, accessed online on 22 November 2022 (https://amstar.ca), which assesses reviews of randomized and non-randomized studies for quality and reliability.

Results and Discussion

Study selection

The database search initially retrieved a total of 380 records: 94 from MEDLINE/PubMed, 79 from Scopus, 17 from the Cochrane Library, 176 from Web of Science (Core Collection), and 14 from the PROSPERO Registry. After removing 99 duplicate entries, the remaining citations were screened for relevance.

Seventeen systematic reviews [42-44, 51, 56-68] fulfilled the inclusion criteria. Collectively, these reviews incorporated 145 randomized controlled trials (RCTs) [42-44, 51, 56–68], 7 non-randomized studies [42, 59, 66], 3 controlled clinical trials (CCTs) [51, 58, 67], 3 quasi-experimental studies [63], 1 quasi-randomized trial [34], and 1 before–after study [67].

Table 1. summarizes key details extracted from these reviews. This includes general information such as first author, publication year, journal, reference number, meta-analysis status, funding sources, and methodological quality. Study characteristics are also reported, including design, number of included studies, participant demographics (sample size, mean age, gender distribution, baseline periodontal health, comorbidities potentially affecting oral hygiene), and specifics of fixed orthodontic treatment. Interventions are described in terms of type, duration, and follow-up, along with any comparison groups. Finally, the table reports observed clinical periodontal outcomes, radiographic findings, inflammatory markers in gingival crevicular fluid, and the conclusions drawn by the review authors.

Authors, Year	Journal	Meta-analysis	Funding	Quality	Studies (design and number)	Population	Intervention	Comparison	Periodontal Outcomes (Statistically Significant, $p < 0.05$)	Conclusion(s)
ElShehaby M., 2020 [56]	*Am J Orthod Dentofacial Orthop.*	Yes	None	**Low**	7 RCTs	**n = 423** Age: 10–20 y.o. M/F: 172/251 Periodontal: NDF Comorbidities: None Fixed Tx: ≥1 mo	**Manual toothbrush** Mean duration: **8.86 w** (4–20 w)	**Powered toothbrush**	**Clinical** At **4 & 8 w**: • GI: **NSS** • PI: **NSS** • OPI: **NSS**	Slight improvements in **GI, PI, OPI** favoring **powered brushing**, but **not statistically significant**.
Fatima F., 2020 [63]	*Int Orthod.*	Yes	None	**Critically low**	4 RCTs + 3 quasi-experimental	**n = 477** Age: 10.4–20 y.o. M/F: 125/127/225 NDF Periodontal: NDF Comorbidities: NDF	**Manual toothbrush + antimicrobial gels** (CHX, stannous fluoride, triclosan, etc.) Duration: 1 application–23 mo	**Manual only, placebo, or different concentrations**	**Clinical** At **2 & 4 w**: • PPD: **NSS**	**No significant PPD reduction** in antimicrobial groups vs. controls at **2 or 4 weeks**.
Pithon M.M., 2017 [57]	*Biosci J*	Yes	None	**Critically low**	23 RCTs	**n = 1022** Age: 10–53 y.o. M/F: 295/408/319 NDF Periodontal: Healthy/gingivitis Comorbidities: None	**Various mechanical methods** (manual, orthodontic, Siwak, electric, interdental, ultrasonic, etc.)	**Other mechanical methods**	**Clinical • Manual brush** at **1 mo**: PI: **MD −1.01** (95% CI: −1.23 to −0.79), **p < 0.001**	**Conventional manual brushing** was **effective** for **plaque control** in orthodontic patients.
Marçal F.F., 2022 [59]	*Int J Dent Hyg.*	Yes	None	**Critically low**	3 RCTs + 3 non-RCTs	**n = 243** Age: 8–40 y.o. M/F: 98/125/20 NDF Periodontal: NDF Comorbidities: NDF	**Orthodontic toothbrush** Duration: 15 d–6 mo	**Conventional toothbrush**	**Clinical** • GBI: **NSS** • PI: **MD −1.72** (95% CI: −2.61 to −0.83), **p = 0.0001**	**Orthodontic toothbrush** significantly **reduced PI**, but **no effect on GBI**.

Al Makhmari S.A., 2017 [68]	*Am J Orthod Dentofacial Orthop.*	Yes	None	**Low**	9 RCTs	**n = 434** Age: 11.4–19.25 y.o. M/F: 145/168/121 NDF Periodontal: Healthy/mild-moderate gingivitis Comorbidities: None	**Powered toothbrush** (rotation-oscillation, sonic, etc.) Mean: **4 mo** (3–12 mo)	**Manual toothbrush**	**Clinical (Short-term)**: • PPD: **WMD −0.760**, **p = 0.000** • GI: **WMD −0.079**, **p = 0.021** • GBI: **SMD −0.637**, **p = 0.06** (borderline) **Long-term**: • GBI: **WMD −1.630**, **p = 0.043** • GI: **WMD −0.220**, **p = 0.035** • PPD: **NSS**	**Short-term**: Powered brushes **reduced PPD, GI, GBI**. **Long-term**: Benefit in **GI & GBI**, but **not PPD**.
Kaklamanos E.G., 2008 [60]	*Am J Orthod Dentofacial Orthop.*	Yes	None	**Critically low**	5 RCTs	**n = 304** Age: >11 y.o. M/F: 77/94/133 NDF Periodontal: NDF Comorbidities: NDF	**Powered toothbrush** (rotation-oscillation, side-to-side, ionic) Duration: **60 d**	**Manual toothbrush**	**Clinical** • BoP: **NSS** • GI: **NSS**	**No significant difference** in **GI or BoP** between powered and manual brushing.
Hussain U., 2022 [61]	*Eur J Orthod.*	Yes	None	**Low**	20 RCTs	**n = 1001** Age: 14.9–15.4 y.o. M/F: 103/279/619 NDF Periodontal: NDF Comorbidities: NDF	**CHX mouthwash/gel/toothpaste/varnish** (0.06%–2%) Duration: 1–6 mo	**Placebo, no intervention, sodium fluoride**	**Clinical (CHX mouthwash vs. placebo)**: • **1 mo**: GI (**MD −0.67**, **p < 0.001**), PI (**MD −0.71**, **p < 0.001**) • **3 mo**: PPD (**MD −0.60**, **p < 0.01**), BI (**MD −1.61**, **p < 0.02**), GI (**MD −0.68**, **p < 0.001**), PI (**MD −0.65**, **p < 0.001**) • **6 mo**: BI (**MD −0.90**, **p < 0.001**), GI (**MD −0.44**, **p < 0.04**), PI: **NSS** **Gel/varnish/toothpaste**: Mostly **NSS**	**CHX mouthwash** showed **clinically relevant benefits** in **PPD, GI, PI, BI** at **0–3 mo**, but **not beyond 3–6 mo**. **No benefits** from CHX gel, varnish, or toothpaste.
Karamani I., 2022 [62]	*Oral Health Prev Dent.*	Yes	None	**Low**	14 RCTs	**n = 602** Age: 11–35 y.o. M/F: 200/357/45 NDF Periodontal: Healthy/mild-moderate gingivitis Comorbidities: None	**CHX mouthwash** (0.06%–0.2%) Duration: 1 d–3 mo	**Placebo, herbal, propolis, probiotics**, etc.	**Clinical**: • **GBI, GI, PI, PBI, BBI, HI, PPD**: **Significant** vs. controls, **especially in first week** • vs. **herbal/propolis/probiotics** at **3–4 w**: GI **NSS**	**CHX reduced plaque and inflammation** more effectively than placebo, **especially early**. **Comparable to some alternatives** at later time points.

Pithon M.M., 2015 [58]	*J Dent.*	No	None	**Critically low**	14 RCTs + 1 CCT	**n = 638** Age: 11–33 y.o. M/F: 158/266/214 NDF Periodontal: NDF Comorbidities: NDF	**Mouthwashes** (CHX, CPC, essential oils, NaF, etc.) Duration: 2 w–8 mo	**Placebo, no intervention**	**Clinical**: • PI: **Reduced** with CHX, octenidine, essential oils, CPC, NaF, amine/stannous fluoride	**Mouthwashes** (esp. **CHX-based**) were **effective in reducing PI**.
Papadopoulou, 2021 2021 [43]	*Clin Exp Dent Res.*	No	None	**Critically low**	3 RCTs	**n = 135** Age: 12–40 y.o. M/F: 44/91 Periodontal: Healthy/gingivitis Comorbidities: NDF	**Organic products** (MTC, aloe vera, honey, chlorine dioxide) Duration: 30 min–15 d	**Placebo, CHX, sorbitol**	**Clinical**: • **MTC**: ↓GBI **−29.9%**, ↓VPI **−25.6%** • **CHX**: ↓GBI **−32.0%**, ↓VPI **−39.9%** • **Chlorine dioxide**: ↓PI **−30.29%**, ↓GI **−12.22%** • **Honey**: ↓bacterial counts, ↓pH change	**MTC** and **chlorine dioxide** effective alternatives to **CHX**. **Honey** reduced **bacterial growth** and **modified pH**.
Kommuri K., 2022 [44]	*Int J Dent Hyg.*	Yes	None	**Critically low**	8 RCTs	**n = 425** Age: 13–26 y.o. M/F: 132/171/122 NDF Periodontal: NDF Comorbidities: NDF	**Herbal mouthwash** Duration: 3 d–8 w	**CHX mouthwash**	**Clinical & Microbial**: • **CHX superior** in ↓**S. mutans** (2 studies) • **CHX improved PI/PPD** (1 study) • **4 studies**: Herbal = CHX	**CHX** often **superior** in microbial reduction; **herbal mouthwashes comparable** in clinical outcomes.
Panagiotou A., 2021 [42]	*Int J Environ Res Public Health*	No	None	**Critically low**	3 RCTs + 3 non-RCTs	**n = 255** Age: 10–64 y.o. M/F: 66/110/79 NDF Periodontal: NDF Comorbidities: NDF	**Essential oil mouthwash** (Listerine®, Fructus mume, MTC, Zingiber) Duration: 1 w–6 mo	**Non-essential oil** (CHX, povidone-iodine, placebo)	**Clinical**: • **Listerine®**: ↓PI, ↓GBI • **Fructus mume**: ↓GBI • **MTC, Zingiber**: ↓GBI, ↓biofilm	**Listerine®**, **MTC**, **Zingiber** effective in reducing **GBI and plaque**. **MTC ≈ CHX** in anti-inflammatory effect.
Pietri F.K., 2020 [64]	*Probiotics and Antimicrobial Proteins*	No	None	**Critically low**	9 RCTs	**n = 391** Age: 8–35 y.o. M/F: 88/166/137 NDF Periodontal: NDF Comorbidities: NDF	**Probiotics** (S. salivarius, L. reuteri, etc.) Form: lozenges, yogurt, toothpaste Duration: 2 w–17 mo	**Placebo, CHX, fluoride**	**Clinical & Microbial**: • **7 studies**: ↓pathogenic bacteria • **1 study**: ↓halitosis • **1 study**: ↓PI & GI • **1 study**: No effect on PI/GI	**Probiotics** reduced **pathogens** and **halitosis**; **variable effect** on **PI/GI**.
Hadj-Hamou R., 2020 [65]	*BMC Oral Health*	No	None	**Low**	4 RCTs	**n = 237** Age: 10–30 y.o. M/F: 77/130/30 NDF Periodontal: Healthy/mild-moderate gingivitis Comorbidities: NDF	**Probiotics** (S. salivarius, L. reuteri, etc.) Duration: 2 w–23.8 mo	**Placebo, no intervention**	**Clinical**: • GI: **NSS**	**No significant benefit** in **gingival inflammation**.

Huang J., 2018 [51]	*Medicine (Baltimore)*	Yes	None	**Critically low**	10 RCTs + 1 quasi + 1 CCT	**n = 830** Age: 10–31 y.o. M/F: NDF Periodontal: NDF Comorbidities: NDF	**Motivational methods** (SMS, WhatsApp, video, OHI reinforcement) Duration: 6 w–12 mo	**No OHI, baseline OHI only, written OHI**	**Clinical**: • **1 mo**: GI (**MD −0.17**, **p < 0.05**), PI: **NSS** • **3 mo**: GI (**MD −0.20**, **p < 0.05**), PI (**MD −0.23**, **p < 0.05**) • **6 mo**: GI (**MD −0.30**, **p < 0.05**), PI (**MD −0.19**, **p < 0.05**)	**Motivational interventions** significantly improved **GI** (all time points) and **PI** (3–6 mo).
Sharif M.O., 2019 [66]	*Br Dent J*	No	Royal College of Surgeons	**Critically low**	1 RCT + 1 non-RCT	**n = 130** Age: 14.5 y.o. M/F: 55/75 Periodontal: NDF Comorbidities: NDF	**Mobile phone interventions** (SMS, app, video tutorials) Duration: 3–12 mo	**Non-mobile OHI** (AV, standard instructions)	**Clinical**: • **App + video group**: At **6, 9, 12 mo**: ↓GBI (**p < 0.01–0.05**), ↓PI (**p < 0.01**) At **3 mo**: **NSS**	**Mobile apps + video** significantly reduced **GBI & PI** from **6 mo onward**.
Migliorati M., 2015 [67]	*Eur J Orthod.*	No	None	**Critically low**	8 RCTs + 1 CCT + 1 before/after	**n = NDF** Age: NDF M/F: NDF Periodontal: NDF Comorbidities: NDF Fixed Tx: ≥12 mo	**Motivational + professional prophylaxis** (hygienist sessions, communication techniques)	**Usual care, no intervention**	**Clinical**: • GI: **Reduced** • PI: **Reduced**	**Regular motivational sessions + professional cleaning** helped **maintain good oral hygiene** during fixed orthodontics.

Abbreviations: randomized clinical trial, “RCT”; controlled clinical trial, “CCT”; male, “M”; female, “F”; years old, “y.o.”; number, “n”; month(s), “mo.”; week(s), “w”; day(s), “d”; minute(s), “min”; parts per million, “ppm”; not defined, “N/D”; no data found, “NDF”; not statistically significant, “NNS”; Chlorhexidine, “CHX”; Matricaria chamomilla L, “MTC”; oral hygiene instruction, “OHI”; clinical attachment loss, “CAL”; periodontal probing depth, “PPD”; bleeding on probing, “BoP”; gingival bleeding index, “GBI”; bleeding index, “BI”; gingival index, “GI”; modified gingival index, “MGI”; plaque index, “PI”; visible plaque index, “VPI”; modified plaque index, “MPI”; orthodontic plaque index, “OPI”; community periodontal index, “CPI”; papilla bleeding index, “PBI”; bonded bracket index, “BBI”; hyperplastic index, “HI”; colony forming units, “CFU”; mean difference, “MD”; standardized mean difference, “SMD”; weighted mean difference, “WMD”; prediction interval, “Pi”; confidence interval, “CI”; *p*-value, “*p*”.

The remaining 281 records were assessed for relevance, resulting in the exclusion of 214 studies that did not fulfill the eligibility criteria. The full texts of the remaining 67 articles were then retrieved and examined. No additional information or author contact was necessary to access the full texts.

Following this review, 54 articles were further excluded for not meeting the inclusion and exclusion criteria of the present study. Specifically, 28 studies included participants who had not undergone fixed orthodontic treatment, 6 did not report periodontal outcomes, 1 was not published in English, 1 lacked an evaluable intervention, 1 included mixed orthodontic treatments with indistinguishable periodontal results, 1 systematic review contained no studies meeting the eligibility requirements, and 13 were narrative reviews. Consequently, 15 studies [42–44, 56–67] identified through electronic database searching were included in the umbrella review. Additionally, 2 studies [51, 68] meeting the inclusion criteria were retrieved through manual screening of reference lists from the selected articles.

The flow of study selection, including database searches, registry screening, and manual identification of relevant studies, is illustrated in **Figure 2**.

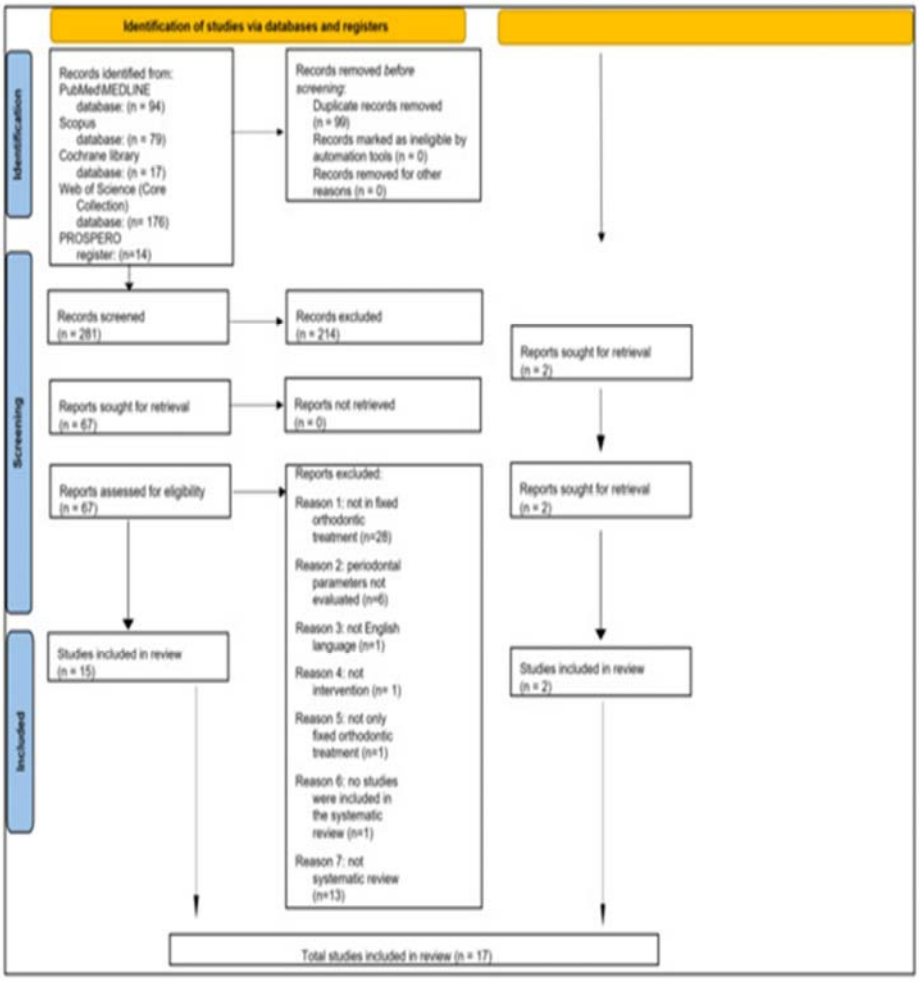

Figure 2. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers, and via other methods.

Ultimately, 17 studies [42–44, 51, 56–68] were included in this umbrella review.

Study characteristics

Among the 17 included systematic reviews [42–44, 51, 56–68], 9 incorporated a meta-analysis [51, 56, 57, 59–63, 68], and only one study [66] reported receiving external funding. Based on the AMSTAR 2 assessment, twelve reviews [42–44, 51, 57–60, 63, 64, 66, 67] were classified as critically low quality, while five [56, 61, 62, 65, 68] were rated as low quality.

The total participant count across the studies was 7,547, although one study [67] did not provide the sample size. Gender distribution included 1,835 males and 2,818 females (M:F ratio = 1:1.5), with ages ranging from 8 to 64 years. Gender information was missing for 2,894 participants, and mean age was rarely reported.

Gingival or periodontal health status was described in only five studies [43, 57, 62, 65, 68], including participants who were periodontally healthy or presented with mild to moderate gingivitis [43, 57, 62, 65, 68]. Four studies [56, 57, 62, 68] explicitly reported the absence of systemic or oral comorbidities that could influence periodontal health or oral hygiene practices, while no study reported the presence of comorbidities. Only one study [56] provided a minimum duration of fixed orthodontic treatment (1 month); the remaining studies did not report treatment duration.

All included reviews assessed clinical periodontal parameters. Gingival index (GI) was evaluated in 12 studies [43, 44, 51, 56, 60–62, 64–68]; plaque index (PI) in 13 studies [42-44, 51, 56–59, 61, 62, 64, 66, 67]; gingival bleeding index (GBI) in 6 studies [42, 43, 59, 62, 66, 68]; probing pocket depth (PPD) in 4 studies [44, 61, 63, 68]; bleeding on probing (BoP) in 2 studies [44, 60]; bleeding index (BI) in 2 studies [42, 61]; visible plaque index (VPI) in 2 studies [42, 43]; other indices such as OPI [56], HI [44, 62], CPI [44], PBI [62], MPI [42], and BBI [62] were recorded in single studies. Clinical attachment loss (CAL) was not reported because the populations were periodontally

healthy according to the inclusion criteria. Radiographic parameters were not reported in any study; gingival crevicular fluid parameters were reported in 2 studies [43, 64]; other miscellaneous parameters in 3 studies [43, 44, 64].

Evidence on periodontal outcomes in relation to self-care instructions, prescriptions, and motivational methods

Manual and powered toothbrushes

Six studies [56, 57, 59, 60, 63, 68] evaluated periodontal outcomes in relation to manual [56, 57, 63], orthodontic [59], or powered toothbrushes [60, 68], used alone or in combination and with or without antimicrobial gels. All included at least one control group for comparison. Three studies [57, 60, 68] detailed the type of manual, orthodontic, or powered toothbrush used, while one study [63] specified the type of antimicrobial gel associated with manual brushing. Intervention durations were reported in 4 studies [56, 59, 60, 63], ranging from 15 days [59] to 23 months [63], with follow-ups in 4 studies [59, 60, 63, 68] from 15 days [59] to 12 months [68].

Manual toothbrush use did not produce significant improvements in GI [56], PI [56], OPI [56], or PPD [63] in two studies [56, 63], though one study [57] reported improved PI at 1 month. Orthodontic toothbrushes showed significant PI reduction in one study [59], without affecting GBI [59]. Powered toothbrushes improved PPD [68] in the short term, as well as GI and GBI [68] in both short- and long-term evaluations, but no significant changes were observed for BoP [60], GI [60], or PPD [68] over the long term.

Chlorhexidine-containing products

Three studies [58, 61, 62] investigated periodontal outcomes with chlorhexidine products, administered as mouthwash in all three [58, 61, 62] and as gels, toothpaste, or varnishes in one [61]. The concentration of chlorhexidine was reported in all studies, along with duration and follow-up, ranging from 1 day [62] to 8 months [58]. Chlorhexidine gel did not significantly affect PPD [61], varnish did not improve GI or PI [61], and toothpaste had no significant impact on GI or BI [61], although positive effects on OPI were observed [61].

Other organic products

Three studies [42–44] assessed the use of organic products for periodontal health in fixed orthodontic patients. The type or concentration of the products was consistently reported. Treatment duration was indicated in 2 studies [42, 43], ranging from 30 minutes [43] to 6 months [42].

The timing of follow-up was documented in two studies [43, 44], ranging from 30 minutes [43] to 8 weeks [44].

Two studies [42, 44] assessed clinical periodontal parameters, including PPD [44], BoP [44], GI [44], CPI [44], PI [42, 44], HI [44], GBI [42], BI [42], MGI [42], VPI [42], and MPI [42]; however, no quantitative measurements were provided. One study [43] reported significant improvements in GBI and VPI for participants using *Matricaria chamomilla L.*, and improvements in PI and GI for those using aloe vera.

Probiotics

Periodontal outcomes in participants taking probiotics during fixed orthodontic treatment were evaluated in two studies [64, 65]. Both studies clearly specified the type and dosage of probiotics, with intervention durations ranging from 2 weeks [64, 65] to 23.8 months [65]. Follow-up timing was reported in only one study [64]. One study [64] measured PI and GI without reporting quantifiable data, while the other study [65] found no statistically significant effect on GI.

Motivational methods

Three studies [51, 66, 67] investigated the effects of motivational strategies—such as computer-assisted programs or other behavioral interventions—on periodontal outcomes in patients with fixed appliances. Intervention methods were described in all studies. Two studies [51, 66] reported intervention durations from 6 weeks [51] to 12 months [51, 66], with follow-up ranging from 1 month [66] to 12 months [51, 66].

Significant improvements were observed in GI and PI at the 3-month follow-up in one study [51], although PI did not improve at the 1-month follow-up [51]. In two other studies [66, 67], GI and PI were evaluated but no numerical data were provided. The use of smartphone apps was associated with significant improvements in GBI and PI after 6 months, but not at the 3-month mark [66].

Table 2 provides a summary of the main findings from the included studies, detailing periodontal outcomes in relation to self-care instructions, prescriptions, and motivational strategies.

Table 2. Synthesis of periodontal outcomes reported in the currently included systematic reviews related to the self-care intervention(s) investigated in periodontally healthy patients undergoing fixed orthodontic treatment. Evidence concerning manual and powered toothbrushes are in blue, chlorhexidine-containing products in

yellow, other organic products in green, probiotics in fuchsia, and motivational methods in violet.

Authors, Year, Title	Methods and Comparison	Periodontal Outcomes (Statistically Significant)	Conclusions
ElShehaby, 2020 [56] *Powered vs. manual tooth brushing in patients with fixed orthodontic appliances: A systematic review and meta-analysis*	Manual toothbrush vs. Powered toothbrush	At 4 & 8 w: • GI: NSS • PI: NSS • OPI: NSS	No significant differences in plaque or gingival indices between manual and powered toothbrushes at 4- and 8-week follow-ups.
Fatima, 2020 [63] *Effectiveness of antimicrobial gels on gingivitis during fixed orthodontic treatment: A systematic review and meta-analysis*	Manual toothbrush + antimicrobial gels vs. Manual toothbrush alone	At 2 w: • PPD: NSS At 4 w: • PPD: NSS	No significant PPD reduction with antimicrobial gels vs. control at 2 or 4 weeks. Potential benefit in gingivitis management.
Pithon, 2017 [57] *Effectiveness of different mechanical bacterial plaque removal methods in patients with the fixed orthodontic appliance: a systematic review and meta-analysis*	Mechanical oral hygiene vs. Other mechanical methods	Manual brush at 1 mo: • PI: MD −1.01 (95% CI: −1.23 to −0.79), $p < 0.001$	Conventional manual toothbrushes were effective in reducing PI in orthodontic patients.
Marçal, 2022 [59] *Effectiveness of orthodontic toothbrush versus conventional toothbrush on plaque and gingival index reduction: A systematic review and meta-analysis*	Orthodontic toothbrush vs. Conventional toothbrush	• GBI: NSS • PI: MD −1.72 (95% CI: −2.61 to −0.83), $p = 0.0001$	Orthodontic toothbrushes significantly reduce PI but do not affect GBI. Recommended for biofilm control.
Al Makhmari, 2017 [68] *Short-term and long-term effectiveness of powered toothbrushes in promoting periodontal health during orthodontic treatment: A systematic review and meta-analysis*	Powered toothbrush vs. Manual toothbrush	Short-term: • PPD: WMD −0.760, $p = 0.000$ • GI: WMD −0.079, $p = 0.021$ • GBI: SMD −0.637, $p = 0.06$ (borderline) Long-term: • GBI: WMD −1.630, $p = 0.043$ • GI: WMD −0.220, $p = 0.035$ • PPD: NSS	Powered toothbrushes offer short-term benefits in PPD, GI, GBI. Long-term: Benefit in GI & GBI, no PPD improvement. No clear superiority.
Kaklamanos, 2008 [60] *Meta-analysis on the effectiveness of powered toothbrushes for orthodontic patients*	Powered toothbrush vs. Manual toothbrush	• BoP: NSS • GI: NSS	No significant difference in GI or BoP between powered and manual brushing.
Hussain, 2022 [61] *Effects of CHX use on periodontal health during fixed appliance orthodontic treatment: a systematic review and meta-analysis*	CHX products (mouthwash, gel, toothpaste, varnish) vs. Placebo / no intervention / sodium fluoride	CHX mouthwash vs. placebo: • 1 mo: GI (MD −0.67, $p < 0.001$), PI (MD −0.71, $p < 0.001$) • 3 mo: PPD (MD −0.60, $p < 0.01$), BI (MD −1.61, $p < 0.02$), GI (MD −0.68, $p < 0.001$), PI (MD −0.65, $p < 0.001$) • 6 mo: BI (MD −0.90, $p < 0.001$), GI (MD −0.44, $p < 0.04$), PI: NSS Gel/varnish/toothpaste: Mostly NSS	CHX mouthwash reduces GI, PI, BI, PPD in short term (≤3 mo). No long-term benefit. No benefit from gel, varnish, or toothpaste.

Karamani, 2022 [62] *CHX Mouthwash for Gingivitis Control in Orthodontic Patients: A Systematic Review and Meta-Analysis*	CHX mouthwash vs. Other mouthwashes (including placebo)	• GBI, GI, PI, PBI, BBI, HI, PPD: Significant vs. controls, especially first week • vs. propolis/probiotics/herbs at 3–4 w: GI: NSS	CHX mouthwash effectively controls gingival inflammation & bleeding vs. placebo. Equally effective as alternatives at later stages.
Pithon, 2015 [58] *Assessment of the effectiveness of mouthwashes in reducing cariogenic biofilm in orthodontic patients: a systematic review*	Mouthwashes (CHX, octenidine, essential oils, CPC, NaF, amine/stannous fluoride) vs. Placebo or no intervention	• PI: Reduced with CHX, octenidine, essential oils, CPC, NaF, amine/stannous fluoride	Oral antiseptics (esp. CHX-based) are effective adjuncts in PI reduction.
Papadopoulou, 2021 [43] *A systematic review on the effectiveness of organic unprocessed products in controlling gingivitis in patients undergoing orthodontic treatment with fixed appliances*	Organic products (MTC, aloe vera, honey, chlorine dioxide) vs. Placebo / CHX / sorbitol	• MTC vs. placebo: Placebo: ↑GBI +23.1%, ↑VPI +10.2% MTC: ↓GBI −29.9%, ↓VPI −25.6% • CHX: ↓GBI −32.0%, ↓VPI −39.9% • Chlorine dioxide: ↓PI −30.29%, ↓GI −12.22% • Honey: ↓bacterial counts, ↓pH change	Non-pharmacological agents reduce biofilm & gingival indices via antimicrobial & anti-inflammatory effects. No CHX-like side effects.
Kommuri, 2022 [44] *Efficacy of herbal- versus CHX-based mouthwashes towards oral hygiene maintenance in patients undergoing fixed orthodontic therapy: A systematic review and meta-analysis*	Herbal mouthwash vs. CHX mouthwash	• CHX superior in ↓S. mutans (2 studies) • CHX improved PI/PPD (1 study) • 4 studies: Herbal = CHX in clinical outcomes	CHX often better in microbial control; herbal mouthwashes comparable in clinical outcomes.
Panagiotou, 2021 [42] *Role of Essential Oil-Based Mouthwashes in Controlling Gingivitis in Patients Undergoing Fixed Orthodontic Treatment: A Review of Clinical Trials*	Essential oil mouthwash (Listerine®, Fructus mume, MTC, Zingiber) vs. Non-essential oil (CHX, povidone-iodine, placebo)	• Listerine®: ↓PI, ↓GBI • Fructus mume: ↓GBI • MTC, Zingiber: ↓GBI, ↓biofilm	Essential oil mouthwashes are effective in gingivitis management during fixed orthodontics.
Pietri, 2020 [64] *Role of Probiotics in Oral Health Maintenance Among Patients Undergoing Fixed Orthodontic Therapy: a Systematic Review of Randomized Controlled Clinical Trials*	Probiotics vs. No probiotics	• 7 studies: ↓pathogenic bacteria (S. mutans, Lactobacillus) • 1 study: ↓halitosis • 1 study: ↓PI & GI • 1 study: No effect on PI/GI	Probiotics reduce oral pathogens and halitosis; variable effect on PI/GI.
Hadj-Hamou, 2020 [65] *Do probiotics promote oral health during orthodontic treatment with fixed appliances? A systematic review*	Probiotics vs. Placebo / no intervention	• GI: NSS	No significant effect on gingival inflammation.
Huang, 2018 [51] *Effects of motivational methods on oral hygiene of orthodontic patients: A systematic review and meta-analysis*	Motivational methods vs. No or different motivation	• 1 mo: GI (MD −0.17, $p < 0.05$), PI: NSS • 3 mo: GI (MD −0.20, $p < 0.05$), PI (MD −0.23, $p < 0.05$) • 6 mo: GI (MD −0.30, $p < 0.05$), PI (MD −0.19, $p < 0.05$)	Motivational methods significantly improve GI (all time points) and PI (3–6 mo). Reinforcement is beneficial.

Sharif, 2019 [66] *A systematic review to assess interventions delivered by mobile phones in improving adherence to oral hygiene advice for children and adolescents*	Mobile phone interventions (SMS, app, video) vs. Non-mobile OHI	App + video group: • 3 mo: GBI/PI: NSS • 6, 9, 12 mo: ↓GBI ($p < 0.01$–0.05), ↓PI ($p < 0.01$)	Mobile apps + video tutorials significantly reduce GBI & PI from 6 months onward.
Migliorati, 2015 [67] *Efficacy of professional hygiene and prophylaxis on preventing plaque increase in orthodontic patients with multibracket appliances: a systematic review*	Motivational + professional prophylaxis vs. Usual care / no intervention	• GI: Reduced • PI: Reduced	Regular motivation + professional cleaning helps maintain good oral hygiene during fixed orthodontics.

Abbreviations: month(s), “mo.”; week(s), “w”; not defined, “N/D”; not statistically significant, “NNS”; Chlorhexidine, “CHX”; Matricaria chamomilla L, “MTC”; periodontal probing depth, “PPD”; bleeding on probing, “BoP”; gingival bleeding index, “GBI”; bleeding index, “BI”; gingival index, “GI”; modified gingival index, “MGI”; plaque index, “PI”; visible plaque index, “VPI”; modified plaque index, “MPI”; orthodontic plaque index, “OPI”; community periodontal index, “CPI”; papilla bleeding index, “PBI”; bonded bracket index, “BBI”; hyperplastic index, “HI”; colony forming units, “CFU”; mean difference, “MD”; standardized mean difference, “SMD”; weighted mean difference, “WMD”; prediction interval, “Pi”; confidence interval, “CI”; *p*-value, “*p*”.

Since lifelong education, motivation, and guidance in periodontal self-care are essential for maintaining periodontal health [52], and considering that biofilm control can be particularly difficult for orthodontic patients with fixed appliances [12-14], this review aimed to (1) identify the types of periodontal self-care instructions, prescriptions, and motivational approaches used; (2) assess and compare the corresponding periodontal outcomes; and (3) develop evidence-based recommendations for self-care among periodontally healthy individuals undergoing fixed orthodontic treatment.

Seventeen studies [42-44, 51, 56–68] were included, encompassing a total of 7,547 periodontally healthy patients aged 8–64 years who were undergoing fixed orthodontic treatment. This demographic distribution reflects that of the contemporary orthodontic population [69]. While adult orthodontic patients were rare in the 1960s, their numbers increased markedly by the early 2000s. By 2006, patients aged ≥40 years constituted approximately 4.2% of the orthodontic population, with 20% being over 60 years old. Given that the prevalence of periodontitis increases with age [70], this review focused exclusively on periodontally healthy adults. Consistent with previous reports, the sample showed a female predominance (M:F ratio of 1:1.5), which aligns with the higher rate of female orthodontic patients in all age groups [69]. None of the included studies reported the presence of health impairments or comorbidities that could influence periodontal health, although some confirmed their absence. It is recognized that physical (e.g., osteoarthritis, rheumatoid arthritis, and other musculoskeletal disorders [71]) and mental conditions [72, 73] can limit effective oral hygiene practices.

Additionally, certain systemic diseases (e.g., neoplastic disorders) can affect periodontal tissues independent of plaque-induced inflammation [74]. Therefore, the presence or absence of such conditions should be considered potential confounding factors in similar studies and clearly reported.

Most reviewed studies did not specify the duration of orthodontic treatment, but this omission is not critical since enamel demineralization and soft tissue inflammation can develop rapidly in the first few months, depending more on individual susceptibility than treatment length [75].

Periodontal health management in orthodontic patients with fixed appliances: self-care, prescriptions, and motivation

Manual vs. powered toothbrushes

Toothbrushing remains the cornerstone of oral and periodontal self-care [26]. However, its effectiveness depends on factors such as brushing frequency, duration [75], motivation, knowledge, and manual dexterity [76]. Individuals without dental training typically remove only 30–40% of plaque at the cervical areas of teeth [77, 78], whereas dental professionals achieve more than 90% plaque removal at gingival margins [79].

Powered toothbrushes, introduced in the 1960s as an alternative to manual brushing [76], vary in their mechanisms (rotational, oscillating, ultrasonic, ionic, etc.) and are often marketed as providing superior plaque control [80]. Supporting this claim, a systematic review by Yaacob *et al*. [81] demonstrated a slight but statistically significant advantage of certain electric toothbrush designs over manual brushes in reducing biofilm and gingivitis; however, that study did not focus specifically on orthodontic patients.

In the current umbrella review, no consistent evidence demonstrated significant differences between manual and powered toothbrushes in managing bacterial plaque among fixed orthodontic patients. ElShehaby *et al*. [56] reported minor, non-significant differences in

GI, PI, and OPI scores between the two methods after 4 and 8 weeks. Similarly, Kaklamanos *et al*. [60] found no difference in gingival inflammation indices (GI and BoP). Conversely, Al Makhmari *et al*. [68] observed a statistically significant benefit of powered toothbrushes for GI, GBI, and PD but emphasized the need for further high-quality studies with longer follow-ups and larger samples to confirm these findings.

Pithon *et al*. [57] presented mixed results but concluded that twice-daily manual toothbrushing for 1–3 minutes effectively reduced plaque index in orthodontic patients. Another study examined orthodontic toothbrushes, designed with a V-shaped groove and shorter central bristles to enhance cleaning around brackets [39]. While these brushes achieved greater plaque removal, they showed no significant differences in gingival bleeding. Further clinical trials are therefore needed before issuing definitive clinical recommendations [39].

Chlorhexidine-containing products

Chlorhexidine (CHX) is a positively charged antimicrobial agent that interacts with the negatively charged bacterial cell envelope, disrupting the cytoplasmic membrane and leading to bacterial cell death [82]. It demonstrates activity against a broad range of microorganisms, including Gram-positive and Gram-negative species, as well as both aerobes and anaerobes [83]. Owing to its wide antimicrobial coverage and strong ability to remain active in the oral cavity, CHX is regarded as the benchmark for chemical plaque control [41]. Consequently, it is often prescribed for short-term use alongside mechanical periodontal therapy [84, 85].

Evidence gathered in this umbrella review supports the role of CHX in minimizing plaque formation and gingival inflammation among orthodontic patients with fixed appliances. Karamani *et al*. [62] reported significantly lower plaque and gingival indices in CHX mouthwash users compared with controls. Similarly, Hussain *et al*. [61] compared CHX-based products (including mouth rinses, gels, toothpastes, and varnishes) with placebo or sodium fluoride formulations and noted significant improvements in gingival inflammation (GI, BI) and plaque accumulation (PI) when CHX mouth rinses were used. They also observed a concentration-dependent response, where 0.20% CHX solutions were approximately twice as effective as 0.12% formulations in reducing gingival inflammation. Moreover, probing pocket depth (PPD) was significantly decreased in patients using CHX mouth rinses [61].

A comparison between CHX and fluoride mouth rinses showed greater reductions in GI and BI values with CHX use. This is expected since fluoride primarily functions by reducing tooth demineralization through inhibition of bacterial carbohydrate metabolism [86, 87], but it does not substantially modify the microbial ecosystem [88]. Any limited anti-plaque properties of fluoride—especially in the form of stannous fluoride—are likely due to the presence of tin ions [89].

Consistent findings were reported by Pithon *et al*. [58], who compared CHX with other active compounds (octenidine, essential oils, cetylpyridinium chloride, sodium fluoride, and amine fluoride/stannous fluoride). CHX-based mouth rinses produced a marked reduction in plaque scores among orthodontic patients. Fatima *et al*. [63] also confirmed that antimicrobial gels containing CHX led to a significant improvement in gingival inflammation, though no significant change was observed in probing depth.

In contrast, CHX toothpastes, gels, and varnishes offered no meaningful clinical advantage [61]. This may be attributed to the higher convenience and patient compliance associated with mouth rinses, particularly for individuals with fixed orthodontic appliances. Thus, rinses remain the preferred CHX formulation for maintaining gingival health [61, 62].

Despite these benefits, the potential adverse effects of CHX—such as tooth staining, altered taste perception, dry mouth, and hypersensitivity—necessitate careful consideration of its risk-to-benefit ratio before prescription [90].

Other organic products

Beyond chlorhexidine, several other organic compounds have demonstrated antimicrobial activity against oral pathogens. These include other biguanides (e.g., octenidine, alexidine), quaternary ammonium salts (e.g., cetylpyridinium chloride, benzalkonium chloride), and pyrimidine derivatives such as hexidine [91]. Pithon *et al*. [58] evaluated these agents and reported positive periodontal outcomes, though their effects were generally comparable to or weaker than those of CHX.

In recent years, increasing interest has been directed toward natural agents with antimicrobial and anti-inflammatory potential in oral health care [92]. Herbal mouth rinses containing botanical extracts—such as *Matricaria chamomilla L.* [92], *Sanguinaria canadensis*, *Eucalyptus globulus*, *Salvadora persica*, *Azadirachta indica* [93], *Zingiber officinale* [94], *Prunus mume* [95], and *Aloe vera* [96]—have been

investigated for their ability to control dental biofilm. According to Panagiotou *et al*. [42], mouth rinses formulated with *M. chamomilla L.*, *Z. officinale*, or *P. mume* effectively reduced plaque accumulation and gingival inflammation in orthodontic patients. Similarly, Papadopoulou *et al*. [43] observed beneficial effects from *Aloe vera* and chamomile mouth rinses, as well as honey ingestion, in decreasing plaque buildup and gingival bleeding.

However, when herbal formulations were compared directly with CHX-based rinses, Kommuri *et al*. [44] found inconsistent outcomes, largely due to the limited number of available trials and high levels of methodological bias. Therefore, while herbal products show promise as adjunctive agents for biofilm control, further rigorous clinical studies are necessary to establish their comparative effectiveness and safety.

Probiotics

The World Health Organization and the Food and Agriculture Organization (WHO/FAO) define probiotics as live microorganisms that, when consumed in adequate quantities, confer health benefits to the host [47]. Some evidence suggests that probiotics can interfere with gingival biofilm formation and influence host immune modulation, although their precise mechanisms remain unclear [48, 49]. Because dental biofilm plays a central role in the development of caries and periodontal disease—both influenced by microbial and host factors—probiotics have been proposed as a preventive or adjunctive approach in their management [97, 98]. Nevertheless, current findings on their clinical efficacy for caries prevention and periodontal health remain inconsistent and inconclusive [50, 99, 100].

For patients undergoing fixed orthodontic treatment—who are at increased risk of caries and gingivitis due to plaque accumulation around brackets—probiotics have been explored as a potential supportive measure [101, 102]. However, the available systematic reviews report mixed outcomes. Hadj-Hamou *et al*. [65] found moderate evidence that probiotic use did not significantly influence gingival inflammation in these patients. Conversely, Pietri *et al*. [64] observed that probiotic administration reduced pathogenic bacterial counts in plaque and saliva, contributing to better oral health maintenance. They also noted a minor but favorable effect on plaque accumulation and gingival inflammation. Still, due to methodological heterogeneity, limited sample sizes, and moderate bias across the included studies, the reliability of these results remains uncertain [64].

Overall, the current evidence does not allow definitive conclusions regarding the benefits of probiotics in orthodontic populations. Clinically, further randomized controlled trials with larger sample sizes and extended follow-up durations are required to clarify their role in maintaining oral and periodontal health during fixed orthodontic treatment.

Motivational methods

The onset of caries, plaque buildup, and gingivitis primarily stems from inadequate oral hygiene practices. Although dental professionals often provide instructions on proper brushing and oral health care, traditional educational methods that focus only on information delivery rarely lead to sustained behavioral change [103]. Huang *et al*. [51] emphasized that enhancing patient motivation is a key factor in achieving and maintaining improved oral hygiene behaviors. Their study revealed significant improvements in plaque control (lower PI) and gingival inflammation (lower GI) among individuals who received motivational interventions compared with control groups.

Various strategies have been introduced to enhance patient engagement, with the most promising being digital tools such as mobile health applications [104–107] and SMS-based reminders [108–110]. In orthodontic settings, Sharif *et al*. [66] demonstrated that smartphone-based reminders and apps effectively improved adherence to oral hygiene recommendations during treatment. Similarly, Migliorati *et al*. [67] reported that personalized motivational sessions delivered directly by dental hygienists were beneficial in maintaining high oral hygiene standards in patients wearing fixed appliances.

Periodontal health management in orthodontic patients with fixed appliances: self-care outcomes and evidence-based recommendations

Biofilm control

Studies indicate no significant difference in plaque index (PI) values between manual and powered toothbrushes, suggesting that both are equally effective for mechanical plaque removal in orthodontic patients [56, 57]. Orthodontic toothbrushes, however, may offer improved plaque control due to their design adaptations [59].

Among chemical adjuncts, CHX mouth rinses—but not CHX-based gels, varnishes, or toothpastes—proved effective in controlling plaque when used alongside mechanical cleaning, though only for short durations to minimize side effects [58, 61, 62]. Herbal and other organic rinses also showed a notable reduction in PI scores [42, 43, 58], and their

performance was comparable to that of CHX rinses [44].

Probiotics did not demonstrate significant benefits in plaque reduction [64], while motivational strategies—such as regular reminders and personalized guidance—proved to be simple yet effective in maintaining plaque control and reinforcing oral hygiene compliance [51, 66, 67].

Gingival inflammation reversal

Evidence regarding toothbrush type and its influence on gingival health is mixed. Several studies reported no significant differences in inflammatory parameters—such as gingival bleeding index (GBI) [56, 59], gingival index (GI), bleeding on probing (BoP) [60], or probing pocket depth (PPD) [63]—between electric and manual brushes. Others, however, observed short-term improvements in GI, GBI, and PPD values with powered toothbrush use [68].

CHX-based [61, 62] and herbal mouth rinses [42–44] consistently showed reductions in GI, GBI, and PPD compared with controls, supporting their use as adjuncts to maintain gingival health in orthodontic patients.

In contrast, probiotics have not demonstrated measurable improvements in gingival parameters [64, 65]. Regular motivational interventions, including personalized hygiene instruction and digital reminders, remain effective strategies for reducing gingival inflammation and promoting sustained oral care behaviors during orthodontic treatment [51, 66, 67].

Evidence-based periodontal self-care recommendations for periodontally healthy orthodontic patients with fixed appliances

Orthodontic patients should be advised to brush their teeth at least twice daily for 1–3 minutes using either a manual or powered toothbrush, depending on personal preference and comfort [56, 57, 59, 60, 63]. In cases where standard toothbrushes do not provide adequate plaque removal, the use of orthodontic toothbrushes—specifically designed to improve cleaning efficiency around brackets and wires—should be recommended [59].

For patients who are unable to achieve satisfactory biofilm control through mechanical means alone, adjunctive chemical plaque control may be considered [42–44, 57, 61, 62]. However, the prescription of chlorhexidine (CHX) must always be preceded by a careful evaluation of the benefit–risk balance, since, although CHX remains the most effective and widely studied antiseptic agent [111], it can cause undesirable side effects such as mucosal irritation, tooth discoloration, and taste alterations [112].

When periodontal risk is high and no hypersensitivity reactions to CHX have been documented, mouth rinses containing CHX at concentrations between 0.12% and 0.20% should be used, as lower concentrations have uncertain efficacy while higher ones increase the likelihood of adverse events [113]. The appropriate CHX regimen has been detailed in a recent Cochrane systematic review [90].

For patients presenting low to moderate periodontal risk or a history of allergic reactions to CHX (type I or type IV), alternative formulations containing organic compounds such as octenidine, cetylpyridinium chloride, sodium fluoride, amine fluoride/tin fluoride, or essential oils should be considered instead [42–44, 57]. These products should be used in accordance with manufacturer recommendations.

Throughout orthodontic treatment, oral hygiene instructions should be periodically reviewed and reinforced through motivational strategies. The use of digital reminders—such as text messages and mobile health applications—has proven particularly effective in enhancing adherence to oral hygiene routines, especially among children and adolescents [51, 66, 67].

A schematic summary of these evidence-based recommendations for periodontal management in periodontally healthy orthodontic patients with fixed appliances is presented in **Figure 3**.

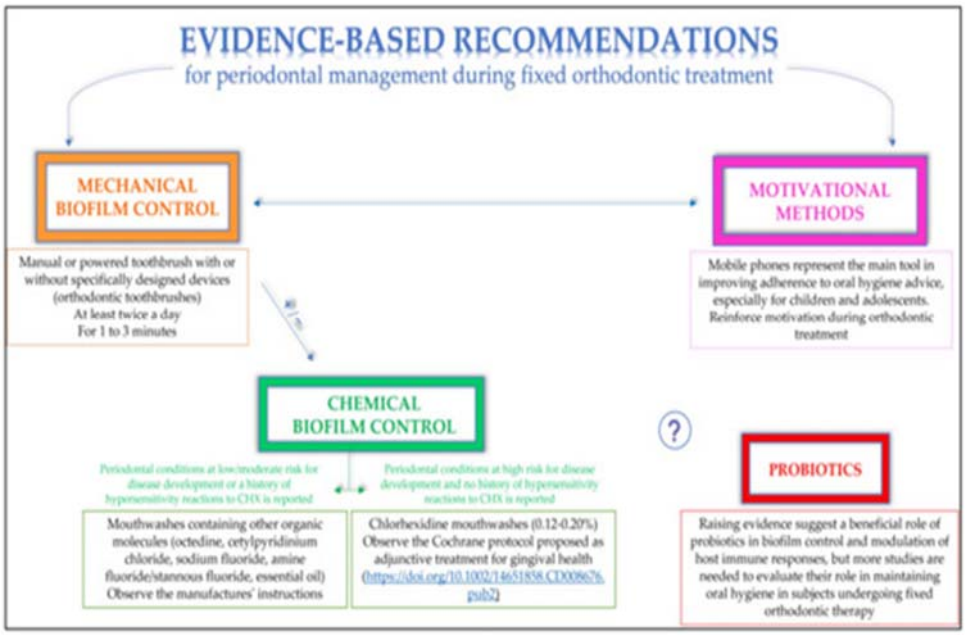

Figure 3. Evidence-based recommendations for periodontal management in periodontally healthy orthodontic patients with fixed appliances [90].

The heterogeneity of the extracted data—particularly regarding follow-up timing, administration regimens, and intervention duration—prevented the performance of a meta-analysis, representing the main limitation of this umbrella review. Despite this limitation, the present study may be the first to comprehensively describe periodontal self-care instructions, prescriptions, and motivational strategies, aiming to establish evidence-based recommendations for periodontal self-care in periodontally healthy orthodontic patients with fixed appliances. Future investigations should focus on identifying the most effective self-care measures, both individually and in combination, to develop standardized periodontal health management protocols for these patients.

Conclusion

This umbrella review included 17 systematic reviews that assessed periodontal parameters in periodontally healthy individuals undergoing fixed orthodontic treatment, focusing on different self-care modalities, including manual, orthodontic, or powered toothbrushes; chlorhexidine (CHX)-containing and other organic products; probiotics; and motivational approaches.

No significant differences were found between powered and manual toothbrushes regarding plaque index (PI) reduction; however, short-term improvements in gingival index (GI), gingival bleeding index (GBI), and probing pocket depth (PPD) were observed with powered brushing. CHX mouthwashes—but not other CHX-based formulations such as gels, varnishes, or pastes—appeared effective in controlling biofilm accumulation and gingival inflammation when used as an adjunct to toothbrushing for a limited duration.

Among alternative agents, organic products like aloe vera and chamomile exhibited antimicrobial efficacy comparable to CHX while avoiding its adverse effects, suggesting their potential for long-term use. Motivational methods demonstrated clear benefits in reducing biofilm accumulation and gingival inflammation, whereas the clinical evidence supporting probiotic use remains inconclusive.

Overall, the current evidence suggests that the optimal strategy for controlling biofilm and reducing gingival inflammation in patients with fixed orthodontic appliances involves a combined approach—integrating mechanical plaque removal through manual, orthodontic, or powered brushing, reinforcement through motivational techniques, and adjunctive use of organic products or short-term CHX mouthwash.

Future research should aim to establish standardized, evidence-based periodontal self-care protocols to optimize periodontal health management in orthodontic patients with fixed appliances.

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