Influence of reminder therapy for controlling bacterial plaque in patients undergoing orthodontic treatment:
A systematic review and meta-analysis

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ABSTRACT

Objective: To assess the scientific evidence regarding the influence of reminder therapy on plaque index, gingival index, and white spots in patients subjected to orthodontic treatment.

Materials and Methods: Randomized clinical trials were searched in the electronic databases LILACS, PubMed, SciELO, Scopus, Web of Science, Embase, LIVIVO, and Cochrane Library. The databases OpenThesis and OpenGrey were used to capture the "gray literature," preventing selection and publication biases. The risk of bias was assessed by the Joanna Briggs Institute Critical Appraisal Checklist for Randomized Controlled Trials tool. The software Review Manager was used for the meta-analysis. The heterogeneity among studies was assessed through the I^2 statistic. A summary of the overall strength of evidence available was assessed using the Grades of Recommendations Assessment, Development, and Evaluation tool.

Results: A total of 332 records were found, from which only 7 articles met the inclusion criteria and were subjected to analysis. Reminder therapy showed improved scores for the plaque index (standardized mean difference $= -1.22$; 95% confidence interval $= -2.03$ to -0.42; $P = .003$) and the gingival index (standardized mean difference $= 1.49$; 95% confidence interval $= -2.61$ to 0.37; $P = .009$). Moreover, there was lower occurrence of white spots (relative risk $= 0.53$; 95% confidence interval $= 0.38$ to 0.74; $P < .001$) when reminder therapy was implemented.

Conclusions: According to the existing high-quality evidence, reminder therapy is a valuable strategy and may contribute to the reduction of plaque and gingival indices as well as to the lower occurrence of white spots in patients subjected to orthodontic treatment. (*Angle Orthod.* 2018;88:483–493.)

KEY WORDS: Dental plaque; Gingival index; Orthodontics; Reminder systems; Smartphone; Text messaging; White Spots

INTRODUCTION

The harmonious alignment of teeth makes it easier to perform proper hygiene and has been claimed to decrease the incidence of caries and periodontal diseases.[1] In developing efficient strategies to correct tooth position, the specialist should not take for granted the importance of an effective oral hygiene protocol.[2] When facing hygiene challenges, many orthodontic

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patients tend to exhibit poor oral health and plaque accumulation.[2]

Plaque increase is a troubling side-effect of fixed orthodontic therapy and deserves special attention.[3] A performance drop in hygiene has been reported after the start of treatment, and a slight improvement is only seen after the 20th week, which causes the patient to present worse oral health indices at the end of treatment.[2] Moreover, it has been reported that during the middle part of orthodontic treatment, patient enthusiasm and motivation tend to decrease progressively, often leading to worsening oral hygiene.[1]

Aiming to decrease the incidence of bacterial plaque during orthodontic treatment, various measures have been suggested such as reminder therapy.[4–7] Mobile phone (smartphone) technology, with its numerous resources and applications for short message service (SMS), is widely available.[8] Many patients, especially adolescents and preadolescents, are avid users of smartphone technology and prefer receiving text messages for communication or reminders.[5] It is known that around 75% of users in the age group between 12 and 17 years often send and receive text messages.[9] Communication via text message has the potential to connect patients with information transmitted by health professionals, but the role of these applications is little known.[10]

Scientific evidence has shown that reminder therapy has been an effective ally for improving the results of proposed treatment in different health fields.[11–13] However, the scientific literature is controversial and there is not a consensus yet about the actual effect of this intervention regarding the oral hygiene of patients being treated orthodontically. Therefore, this systematic review aimed to assess the scientific evidence regarding the influence of reminder therapy on plaque index, gingival index, and white spot lesion development in patients undergoing orthodontic treatment.

MATERIALS AND METHODS

Protocol and Registration

This systematic review was performed following the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement[14] and the Cochrane guidelines.[15] The systematic review protocol was registered at PROSPERO database, CRD42017077671.

Eligibility Criteria

Clinical trials assessing the influence of reminder therapy on the bacterial plaque index in patients undergoing orthodontic treatment were included without restrictions of year, language, or publication status. The following were excluded: studies not related to the topic and review studies, case reports, letters to the editor or editorials, congress abstracts, personal opinions, and books and/or book chapters.

Sources of Information and Search

Two reviewers performed the search independently (IFPL and WAV). Table 1 shows the electronic databases accessed with the gray literature included. The descriptors were searched in the databases DeCS (Health Sciences Descriptors), MeSH (Medical Subject Headings), and Emtree (Embase Subject Headings). The Boolean operators "AND" and "OR" were used to enhance the research strategy through several combinations. The bibliographic research was developed in August 2017. The results obtained were exported to the software EndNote Basic/Online (Thomson Reuters, Toronto, Canada), desktop version, and the duplicates were removed.

Study Selection

The selection of studies was performed in three phases. In phase 1, two reviewers (IFPL and WAV) systematically analyzed the titles independently. The articles in which titles met the objectives of the study were selected for phase 2. In the second phase, the same reviewers systematically analyzed the abstracts. At this point, the eligibility criteria were applied. The articles in which titles met the objectives of the study but did not have abstracts available were fully analyzed in phase 3.

In the third phase, full texts were obtained for the preliminarily eligible studies, and these were evaluated to verify whether they fulfilled the eligibility criteria. When the two reviewers disagreed, a third reviewer (LRP) was consulted to make a final decision. The studies that were rejected were registered separately, clarifying the reasons for exclusion.

Process of Data Collection and Extraction

Two authors (APBL and WAV) extracted the following data with spreadsheets especially designed for data extraction: article identification (author, publication year, country of the study), sample characteristics (number of patients in each study, mean age, gender distribution), type of intervention (type of reminder, format, periodicity of intervention, recipient of the reminder), methods for obtaining the results (form of biofilm assessment, location or teeth assessed, periodicity of assessment), and duration of the study. As a calibration exercise, the reviewers discussed the eligibility criteria and applied them to a sample of 20% of the studies retrieved to determine interexaminer agreement. After achieving a proper

Table 1. Strategies for Database Search

Database	Search Strategy (August 2017)	Results
PubMed, http://www.ncbi. nlm.nih.gov/pubmed	("Orthodontics"[MeSH Terms] OR "Orthodontics"[All Fields] OR "Orthodontic"[All Fields] OR "Orthodontic Brackets"[MeSH Terms] OR "Orthodontic Brackets"[All Fields] OR "Dental Brace"[All Fields] OR "Orthodontic Braces"[All Fields]) AND ("Text Messaging"[MeSH Terms] OR "Text Messaging"[All Fields] OR "Text Messages"[All Fields] OR "SMS"[All Fields] OR "Texting"[All Fields] OR "Reminder Systems"[MeSH Terms] OR "Reminder Systems"[All Fields] OR "Reminder Therapy"[All Fields] OR "telemedicine"[MeSH Terms] OR "telemedicine"[All Fields] OR "mobile" [All Fields] or "Mobile Applications"[MeSH Terms] or "Mobile Applications"[All Fields] or "Cell Phones"[MeSH Terms] OR "Cell Phones"[All Fields] OR "App"[All Fields] OR "communication"[All Fields]) AND ("oral hygiene"[All Fields] OR "oral hygiene"[MeSH Terms] OR "Dental hygiene"[All Fields] OR "Biofilms"[MeSH Terms] or "Biofilms"[All Fields])	34
Embase, http://www. embase.com/	('orthodontics'/exp OR 'orthodontics' OR 'orthodontic'/exp OR 'orthodontic' OR 'orthodontic brackets'/exp OR 'orthodontic brackets') AND ('text messaging'/exp OR 'text messaging' OR 'sms' OR 'texting'/exp OR 'texting' OR 'reminder systems'/exp OR 'reminder systems' OR 'telemedicine'/exp OR 'telemedicine' OR 'mobile' OR 'cell phones'/exp OR 'cell phones' OR 'app' OR 'communication'/exp OR 'communication') AND ('oral hygiene'/exp OR 'oral hygiene' OR 'dental hygiene'/exp OR 'dental hygiene' OR 'biofilms'/exp OR 'biofilms')	68
Cochrane Library, http:// www.cochranelibrary. com/	*("Orthodontics" OR "Orthodontic" OR "Orthodontic Brackets") AND ("Text Messaging" OR "SMS" OR "Texting" OR "Reminder Systems" OR "telemedicine" OR "mobile" OR "Cell Phones" OR "App" OR "communication") AND ("oral hygiene" OR "Dental hygiene" OR "Biofilms")*	8
Scopus, http://www. scopus.com/	("Orthodontics" OR "Orthodontic" OR "Orthodontic Brackets") AND ("Text Messaging" OR "SMS" OR "Reminder Systems" OR "telemedicine" OR "mobile" OR "Cell Phones" OR "App" OR "communication") AND ("oral hygiene" OR "Dental hygiene" OR "Biofilms")	34
LILACS, http://lilacs. bvsalud.org/	(Orthodontics AND text messaging) AND (instance:"regional") AND (db:("LILACS"))	0
	(Orthodontics AND Biofilms) AND (instance:"regional") AND (db:("LILACS"))	6
	(Orthodontics AND Mobile) AND (instance:"regional") AND (db:("LILACS"))	4
	(Mobile AND Oral Hygiene) AND (instance:"regional") AND (db:("LILACS"))	9
	(Orthodontics AND App) AND (instance:"regional") AND (db:("LILACS"))	4
	(Orthodontics AND Reminder) AND (instance:"regional") AND (db:("LILACS"))	0
	(Ortodontia AND Biofilme) AND (instance:"regional") AND (db:("LILACS"))	40
SciELO, http://www.scielo. org/	Orthodontics AND Text Messaging	0
	Orthodontics AND Biofilms	3
	Orthodontics AND Mobile	1
	Mobile AND Oral Hygiene	2
	Orthodontics AND App	0
	Orthodontics AND Reminder	0
	Ortodontia AND Biofilme	3
LIVIVO, https://www.livivo. de	("Orthodontics" OR "Orthodontic" OR "Orthodontic Brackets") AND ("Text Messaging" OR "SMS" OR "Texting" OR "Reminder Systems" OR "telemedicine" OR "mobile" OR "Cell Phones" OR "App" OR "communication") AND ("oral hygiene" OR "Dental hygiene" OR "Biofilms")	103
Web of Science, http:// apps.webofknowledge. com/	(("Orthodontics" OR "Orthodontic" OR "Orthodontic Brackets") AND ("Text Messaging" OR "SMS" OR "Texting" OR "Reminder Systems" OR "telemedicine" OR "mobile" OR "Cell Phones" OR "App" OR "communication") AND ("oral hygiene" OR "Dental hygiene" OR "Biofilms"))	13
OpenGrey, http://www. opengrey.eu/	("Orthodontics" OR "Orthodontic") AND ("Text Messaging" or "Texting" or "Reminder Systems" OR "mobile" OR "Cell Phones" OR "App" OR "communication")	3
OpenThesis, http://www. openthesis.org/	("Orthodontics" OR "Orthodontic") AND ("Text Messaging" or "app") and ("oral hygiene")	6
Total		341

SMS - Short Message Service

level of agreement ($\kappa = 0.81–0.85$), the reviewers read all of the studies independently. Disagreements were resolved by consensus and supervision of the gold standard (LRP). An e-mail was sent to the authors whose studies presented insufficient data or information that would prevent summarizing and making comparisons to data from the other eligible articles so that additional information could be provided.

Risk of Individual Bias of the Studies

The risk of bias of the studies selected was assessed by the Joanna Briggs Institute Critical Appraisal Checklist for Randomized Controlled Trials

tool.[16] Two authors (WAV and IFPL) independently assessed each domain regarding the potential risk of bias.

Summary Measures and Synthesis of Results

The software Review Manager, version 5.3 (Rev-Man; Cochrane Collaboration, London, United Kingdom) was used for the meta-analysis. Heterogeneity among the studies was assessed with the I^2 statistic and classified as follows: low ($I^2 < 25\%$), moderate ($I^2 = 50\%$), and high ($I^2 > 75\%$).[17] The outcomes assessed were plaque index (continuous variable), gingival index (continuous variable), and white spots (dichotomous variable).

Forest plots were constructed for each meta-analysis using random effects.[15,18] The differences in continuous outcomes were reported through the standardized mean difference, 95% confidence interval (CI), and P value. The difference in dichotomous outcomes was reported through the relative risk estimate, 95% CI, and P value. All statistical tests were two-tailed, and significance was fixed at $P < .05$. Funnel plots to assess the probability of bias were not produced because fewer than 10 studies were included in the models. A summary of the overall strength of evidence available was assessed using the Grades of Recommendations Assessment, Development, and Evaluation tool.[19]

RESULTS

Study Selection

Figure 1 depicts the search process, identification, inclusion, and exclusion of articles. During the first phase of study selection, 332 results were found, distributed in eight electronic databases and 9 records on gray literature. After analyzing the abstracts, only six articles were eligible for the analysis of full texts. The references of the six initially eligible articles were carefully assessed to determine if there was an article that was possibly skipped in the main search strategy. One additional study was located and added. Therefore, seven articles went on to the qualitative analysis of the results.

Study Characteristics

Table 2 shows a summary of the main characteristics of the studies. The analysis resulted in a total sample of 574 participants. The mean age of the groups ranged from 12.8 to 18.7 years. The female gender was a majority in all studies, except for one[8] that did not clarify the gender ratio in each group.

In all studies,[1,4–7,20,21] all patients received hygiene instructions through videos or lectures during the first visit. The method of reminder was exclusively text messaging in three studies.[4,5,20] In one study,[6] the groups were created in which one group received text messages and the other received phone calls. In another study,[21] the reminders were sent via notification through an application. Two other studies[1,7] associated text messaging with videos, voice messages, and scientific articles. Two studies[4,20] sent reminders only to the parents/guardians, whereas four studies[1,5,6,21] sent reminders only to the patients. One study[7] sent reminders only to patients aged older than 18 years or to the guardians of patients aged younger than 18 years.

Risk of Bias Within Studies

Six studies[1,4–7,21] presented low risk of bias and one study[20] presented moderate risk of bias assessed by the JBI Critical Appraisal Checklist for Randomized Controlled Trials tool. Table 3 shows detailed information on the risk of bias of the studies included. Item 4 was considered as "yes" only for the studies in which the participants were unaware that the text messages were part of the research. Item 5 of Table 3 was considered not applicable for all studies, considering that it was impossible to blind the individual who was applying the treatment (sending the reminder). The items marked as "uncertain" with regard to the randomization of the studies signify that the method of allocation in each group was not clearly presented. The studies[1,4,6,21] that were considered as "yes" in item 6 were those affirming that the evaluators of the control and interference groups were blind to the allocation of participants.

Individual Results of the Studies

Three studies[1,6,21] assessed the plaque index using the modified Silness and Loe Index. Two studies[5,21] used the modified Turesky plaque index, one study[5] used computed planimetry, and one study[7] did not indicate the assessment method. Three studies assessed the gingival health indices also by the Silness and Loe[1,21] and the modified Silness and Loe[4] indices. One study[7] did not indicate the method used. Three studies[1,4,20] also verified the incidence of white spots during the clinical examination. All studies performed plaque disclosure, gingival examination, and white spot inspection before the start of the study, and all of them showed similar indices for the control and experimental groups.

Synthesis of Results and Meta-Analysis

Only four studies[1,4,5,20] presented sufficient data to be included in the quantitative analysis. Figures 2 to 4
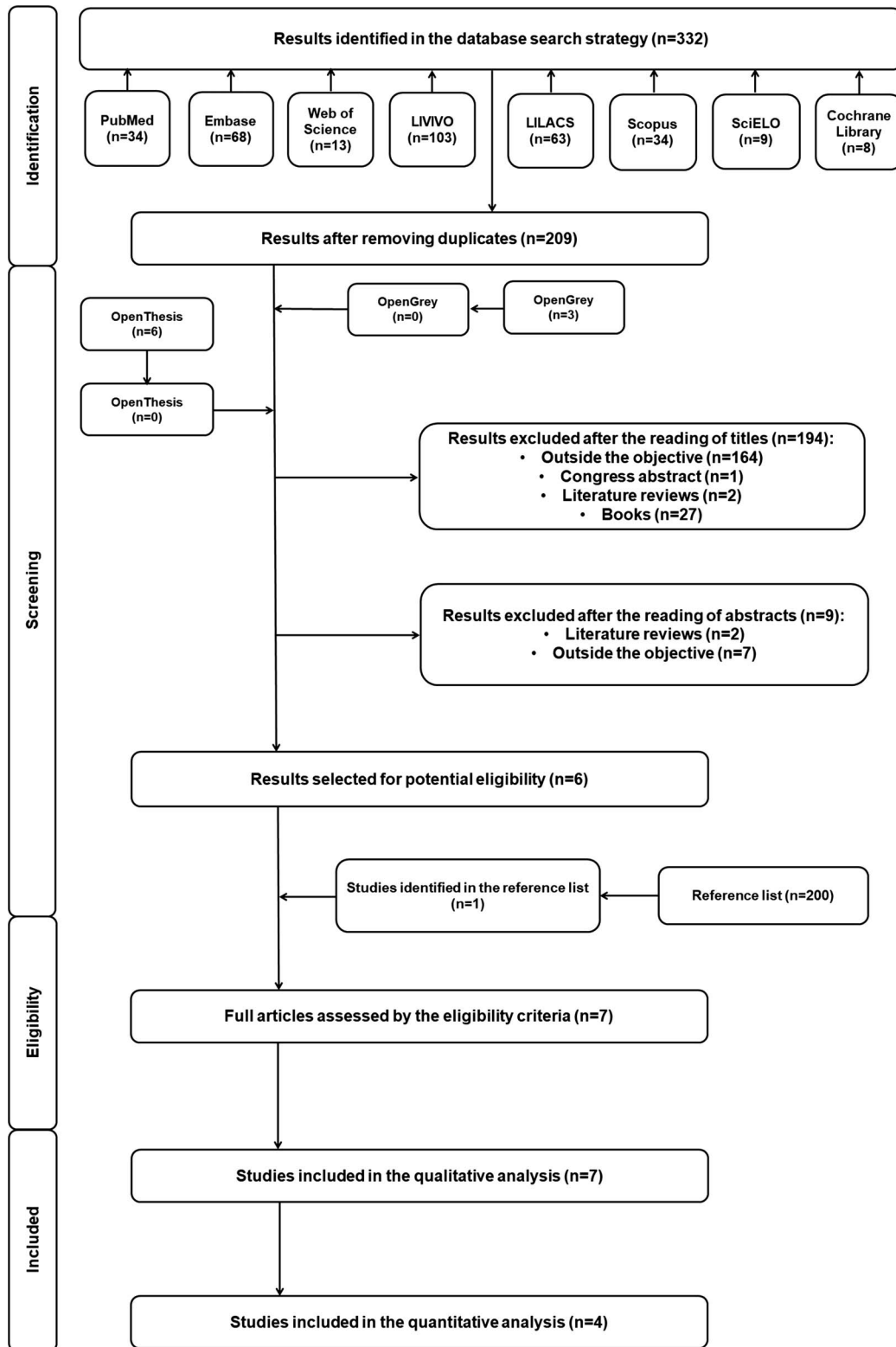
Figure 1. Flowchart of the process of literature search and selection, adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.

Table 2. Summary of the Main Characteristics of the Studies Eligible for Qualitative Analysis

Author, Year, Reference Number	Country	Sample, n	Mean Age, y	Type of Reminder
Jejurikar et al. 2014[20]	India	Group intervention: 15 ♀ 10 ♂ Group control: 15 ♀ 10 ♂	13–19 years[b]	Text message
Eppright et al. 2014[4]	USA	Group intervention: 21[a] Group control: 21[a]	Group intervention: 13.67 ± 1.59 Group control: 14.67 ± 1.20	Text message
Bowen et al. 2015[5]	USA	Group intervention: 15 ♀ 10 ♂ Group control: 14 ♀ 11 ♂	Group intervention: 15.5 Group control: 14.6	Text message
Li et al. 2016[7]	China	Group intervention: 79 ♀ 33 ♂ Group control: 77 ♀ 35 ♂	Group intervention: 17.6 ± 0.8 Group control: 18.7 ± 1.0	Text, video, and voice message
Zotti et al. 2016[1]	Italy	Group intervention: 17 ♀ 23 ♂ Group control: 23 ♀ 17 ♂	Group intervention: 14.1 Group control: 13.6	Text message, photos, and videos about hygiene, via chat
Cozzani et al. 2016[6]	Italy	Group intervention: 16 ♀ 12 ♂ Group intervention II: 10 ♀ 16 ♂ Group control: 15 ♀ 15 ♂	Group intervention I: 12.8 Group intervention II: 13.6 Group control: 13.5	Text message (group intervention I) and phone call (group intervention II)
Alkadhi et al. 2017[21]	Saudi Arabia	Group intervention: 11 ♀ 11 ♂ Group control: 14 ♀ 8 ♂	Group intervention: 16.6 ± 3.2 Group control: 17.2 ± 5.20	Notifications via app

[a] There was no division between men and women.
[b] Not informed by the author.

show the forest plots produced from the meta-analysis. There were major differences regarding oral hygiene and oral clinical condition in the control and experimental groups. Considering the overall estimates, it was found that the experimental group showed lower scores for the plaque index (standardized mean difference = −1.22; 95% CI = −2.03 to −0.42; P = .003) and the gingival index (standardized mean difference = 1.49; 95% CI = −2.61 to 0.37; P = .009). Moreover, there was a lower occurrence of white spots (relative risk = 0.53; 95% CI = 0.38 to 0.74; P < .001) in the experimental group. The overall evidence rated by the Grades of Recommendations Assessment, Devel-

opment, and Evaluation approach was considered high quality (Table 4).

DISCUSSION

The hygiene challenges that the users of fixed orthodontic appliances face is a problem in dentistry, considering that poor hygiene may lead to caries or white spots, which are common when wearing orthodontic appliances.[2] Hence, this systematic review sought to assess whether reminder therapy had a positive influence on the reduction of plaque index,

Table 2. Extended

Periodicity of Reminder	Recipient of Reminder	Teeth Assessed	Time of Assessment
Weekly	Parents/guardians	16, 21, 36, 41, 44	4 months
Weekly	Parents/guardians	16, 21, 36, 41, 44	5 months
2 to 3 times a week (T1) Weekly (T2)	Patients	12, 16, 22, 26, 33, 34, 43, 44 (plaque index) 12, 14, 22, 24 (white spot index)	3 months
Weekly	Patient <18 years old: Parents/guardians Patient >18 years old: patients	[b]	From start to end of the orthodontic treatment
Weekly	Patients	16, 12, 24, 32, 36, 44	12 months
Monthly	Patients	All the teeth with brackets	1 month
Daily	Patients	16, 21, 24, 36, 41, 44	1 month

gingival index, and white spots in patients undergoing orthodontic therapy.

Bacterial plaque accumulation occurs because of poor oral hygiene, and it is common during orthodontic treatment because the orthodontic accessories make oral hygiene more difficult to maintain.[2] Scientific evidence has shown that optimal oral health maintenance during orthodontic treatment should be a gold standard in practice today.[3] Attempting to work toward this achievement, studies[1,4,5,20,21] have been performed recently to determine the effects of sending reminders of oral hygiene reinforcement via text, video, or voice messages.

The use of mobile phones (smartphones), with their various resources and applications for text messaging (SMS), has revolutionized the means of interpersonal interaction and communication. Their use is increasingly present in the daily lives of people, surpassing geographical, social, and cultural barriers.[8] A recent survey found that more than 5 billion people (67% of the world population) use some type of mobile device in the world, and 4 billion of them use smartphones specifically.[22] Because it is an instant-messaging and low-cost technology, the text message has been extensively used by smartphone users.[8,9] Sending reminders via text, video, or voice messages became

Table 3. Risk of Bias Assessed by the Joanna Briggs Institute Critical Appraisal Checklist for Randomized Controlled Trials Tools[a]

Authors	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10	Q.11	Q.12	Q.13	% Yes/Risk
Jejurikar et al. 2014[20]	U	U	√	–	NA	–	√	√	√	√	√	√	√	66.6% moderate
Eppright et al. 2014[4]	√	√	√	–	NA	√	√	√	√	√	√	√	√	91.6% low
Bowen et al. 2015[5]	√	√	√	√	NA	–	√	√	√	√	√	√	√	91.6% low
Li et al. 2016[7]	√	√	√	–	NA	–	√	√	√	√	√	√	√	83.3% low
Zotti et al. 2016[1]	√	√	√	–	NA	√	√	√	√	√	√	√	√	75% low
Cozzani et al. 2016[6]	√	√	√	√	NA	√	√	√	√	√	√	√	√	83.3% low
Alkadhi et al. 2017[21]	√	√	√	–	NA	√	√	√	√	√	√	√	√	91.6% low

[a] The risk of bias was ranked as high when the study reached up to 49% of "yes" scores, moderate when the study reached from 50% to 69% of "yes" scores, and low when the study reached more than 70% of "yes" scores. U indicates unclear; √, yes; –, no; NA, not applicable. Q.1: Was true randomization used for assigning participants to treatment groups? Q.2: Was allocation to treatment groups concealed? Q.3: Were treatment groups similar at baseline? Q.4: Were participants blind to the treatment assignment? Q.5: Were those delivering the treatment blind to the treatment assignment? Q.6: Were the outcome assessors blind to the treatment assignment? Q.7: Were the treatment groups treated identically other than the intervention of interest? Q.8: Was follow-up completed and, if not, were the differences between groups in terms of their follow up adequately described and analyzed? Q.9: Were the participants analyzed in the groups in which they were randomized? Q.10: Were the outcomes measured in the same way for the treatment groups? Q.11: Were the outcomes measured in a reliable way? Q.12: Was appropriate statistical analysis used? Q.13: Was the trial design appropriate and were any deviations from the standard randomized control trial design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?
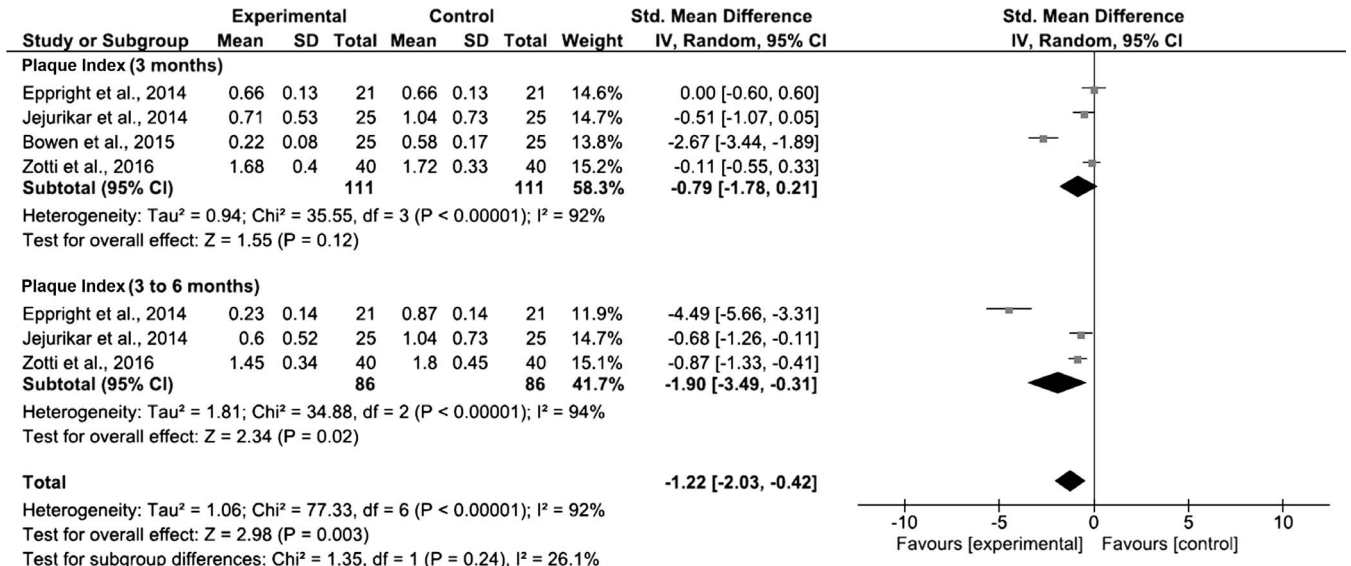

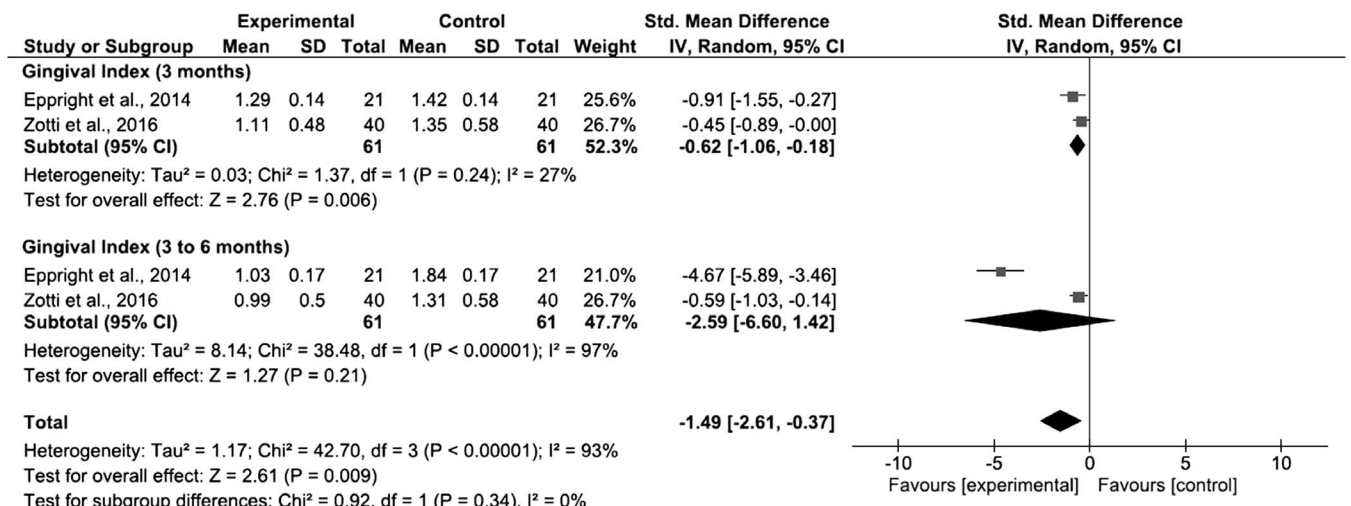**Figure 2.** Differences between the experimental and control groups according to the plaque index.

Figure 3. Differences between the experimental and control groups according to the gingival index.

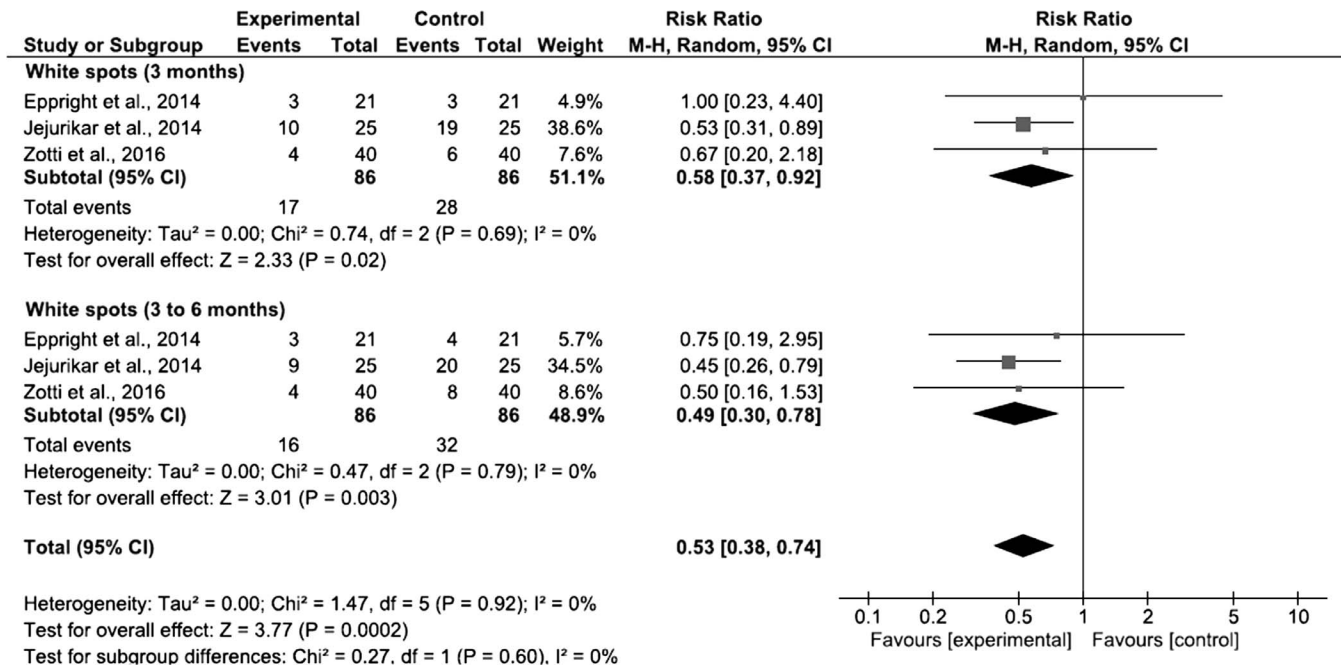| Study or Subgroup	Experimental Events	Total	Control Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
White spots (3 months)						
Eppright et al., 2014	3	21	3	21	4.9%	1.00 [0.23, 4.40]
Jejurikar et al., 2014	10	25	19	25	38.6%	0.53 [0.31, 0.89]
Zotti et al., 2016	4	40	6	40	7.6%	0.67 [0.20, 2.18]
Subtotal (95% CI)		86		86	51.1%	0.58 [0.37, 0.92]
Total events	17		28			
Heterogeneity: Tau² = 0.00; Chi² = 0.74, df = 2 (P = 0.69); I² = 0%						
Test for overall effect: Z = 2.33 (P = 0.02)						
White spots (3 to 6 months)						
Eppright et al., 2014	3	21	4	21	5.7%	0.75 [0.19, 2.95]
Jejurikar et al., 2014	9	25	20	25	34.5%	0.45 [0.26, 0.79]
Zotti et al., 2016	4	40	8	40	8.6%	0.50 [0.16, 1.53]
Subtotal (95% CI)		86		86	48.9%	0.49 [0.30, 0.78]
Total events	16		32			
Heterogeneity: Tau² = 0.00; Chi² = 0.47, df = 2 (P = 0.79); I² = 0%						
Test for overall effect: Z = 3.01 (P = 0.003)						
Total (95% CI)						0.53 [0.38, 0.74]
Heterogeneity: Tau² = 0.00; Chi² = 1.47, df = 5 (P = 0.92); I² = 0%						
Test for overall effect: Z = 3.77 (P = 0.0002)						
Test for subgroup differences: Chi² = 0.27, df = 1 (P = 0.60), I² = 0%						

Figure 4. Differences between the experimental and control groups according to the incidence of white spot lesions.

a major research tool within the health environment, improving the efficiency of service provision.[10]

Concerned about the clinical outcomes of patients, recent studies[12,13] have applied text messaging to verify patient improvement in several situations. The current study verified that the type of reminder that authors mostly used were text messages, and they were used in six eligible studies[1,4–7,20] (Table 2). This may be because the text message is a more discrete tool than video or voice messages, ensuring a structured communication without emotional influence.[6] However, studies should be conducted to verify the reach and

efficiency of each type of reminder. Although the studies did not discuss the influence of periodicity for sending the reminders, it is possible to believe that the shorter the period between reminders, the more positive the results.

The plaque index is an important tool to assess not only oral hygiene but also the motivation and self-care of the patient during treatment.[23] Orthodontic patients experience barriers to controlling plaque, considering that the orthodontic appliance extends the areas of bacterial plaque retention, which complicates hygiene.[2] Although the studies included in this systematic review

Table 4. Grading of Recommendations Assessment, Development, and Evaluation (GRADE) Summary of Findings Table for the Outcomes of the Systematic Review and Meta-Analysis

		GRADE Factors[a]								
		Quality Assessment					Summary of Results			
							Primary Outcome	Secondary Outcomes		
Authors	Study Design	Study Limitations	Inconsistency	Lack of Objectivity	Imprecision	Publication Biases	Plaque Index	Gingival Index	White Spots	General Quality[b]
Jejurikar et al. 2014[20]	Randomized controlled trials	√	√	√	√	√	√	NA	√	++++
Eppright et al. 2014[4]	Randomized controlled trials	√	√	√	√	√	√	√	√	++++
Bowen et al. 2015[5]	Randomized controlled trials	√	√	√	√	√	√	NA	NA	++++
Zotti et al. 2016[1]	Randomized controlled trials	√	√	√	√	√	√	√	√	++++

[a] GRADE factors: √, no serious limitations; X, serious limitation; NA indicates not applicable, since the authors focused on the primary outcome (plaque index).
[b] General quality of evidence: +, very low; ++, low; +++, moderate; ++++, high.

assessed the plaque index in periods prior to and after 3 months, it was decided in this review to assess the results after 3 months. This decision was based on social psychology because, according to this field of study, an average of 66 days are required to transform a behavior into an automatic habit.[24] Therefore, all of the studies included that assessed the plaque index[1,4,5,20] observed an improvement when comparing the experimental group to the control group.

The gingival index is a reliable tool for identifying the periodontal health condition.[25] Several indices have been used for this purpose, and the Silness and Loe and modified Silness and Loe, in which the scores are ranked according to degree of gingival inflammation, were chosen by the authors of the eligible studies.[1,4] It is known that orthodontic treatment may elevate the values of the gingival index and contribute to the development of periodontopathogenic bacteria.[4] A statistically significant reduction of the gingival index was found when the studies compared the experimental group with the control group. This finding reinforces that the motivation and education on oral hygiene are essential for the success of orthodontic treatment.[26]

White spot lesions are signals of demineralization from poor oral hygiene.[27] These decalcifications have been commonly observed in patients subjected to orthodontic treatment,[28] and several studies[28,29] have been developed to assess the prevalence of these lesions in this group of patients, thus demonstrating its clinical significance. It has been reported that white spots are clinically detected after 4 weeks of orthodontic treatment.[30] However, this information is still controversial because some authors[1] suggest that white spots become clinically visible after the first 6 months of treatment.

The eligible studies of this systematic review showed a significant difference between the incidence of white spots in the participants exposed to the reminder therapy in comparison to those who were not exposed to it, with assessments at the third month and between 3 and 6 months (Figure 2). In the period from 3 to 6 months, this difference became even more evident. This may be explained due to the higher amount of time available for the development of lesions so they could manifest clinically. Therefore, encouraging the education of patients and reinforcing the importance of oral hygiene using reminder therapy is a valuable tool to help reduce the development of white spots.

This study is not free from limitations. Despite the comprehensive nature of this review, there was a high heterogeneity among studies. The studies varied especially regarding the sample size and time of follow-up of the participants. When only two articles are considered for meta-analysis, the results should be interpreted with caution. Further studies are recom-mended to determine whether the effects of reminder therapy persist over time as well as to assess whether it contributes to a better quality of life regarding oral health.

This review was original and contributed to the development of scientific knowledge from two main perspectives. First, it is the first systematic review with meta-analysis that investigated the influence of reminder therapy on oral hygiene and the clinical oral condition of patients undergoing orthodontic treatment. Second, an extensive search strategy was applied without any restriction of language or publication date and including the "gray literature," seeking to avoid selection and publication biases.

CONCLUSIONS

Overall, based on the high-quality evidence found, we note the following:

- Reminder therapy is a valuable strategy for encouraging better oral hygiene in patients undergoing orthodontic treatment.
- Reminder therapy may contribute to improvements in the plaque and gingival indices as well as to a lower occurrence of development of white spot lesions.

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