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Do air polishing devices efficaciously control local inflammation in supportive periodontal therapy? A systematic review

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Do air polishing devices efficaciously control local inflammation in supportive periodontal therapy? A systematic review

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ABSTRACT

Objectives: The aim of this review was to compare air polishing devices with conventional periodontal therapy (hand instrumentation and/or ultrasonic debridement), in terms of their clinical, microbiological and patient related outcomes in patients undergoing periodontal maintenance therapy.

Methods: An online database search was performed to identify studies published between January 1987 and March 2021. All steps from selection, data extraction and assessment risk of individual bias of the studies were done by two independent reviewers. The PICO method was employed to formulate the question: “In patients undergoing periodontal maintenance therapy/supportive periodontal therapy, do air flow systems result in better clinical, microbiological and patient related outcomes than ultrasonic instrumentation or manual scaling?”. The systematic review protocol was registered in PROSPERO (CRD42021253735).

Results: Electronic search yielded 501 references of which 14 were included in this review. A great heterogeneity exists among the studies, therefore a meta-analysis was not performed. Regarding the primary outcome and the secondary outcomes, most studies showed that the two groups under evaluation presented similar results. Regarding the microbiological results, despite most studies presented inter-groups similar results, it seems that air polishing devices presented better microbiological behaviour. Air polishing devices shown better patient related outcomes.

Conclusions: Both air polishing devices and conventional techniques shown similar clinical efficacy, however air polishing devices shown a not yet consensual trend towards better microbiological behaviour and is also a safe, faster, and more comfortable option for the patients undergoing supportive periodontal therapy.

KEY-WORDS: Periodontal diseases; Supportive Periodontal Therapy; Dental Air Abrasion; Instrumentation.

RESUMO

Objetivos: O objetivo desta revisão foi comparar os sistemas de jato ar-água com as terapias periodontais convencionais (instrumentação manual e/ou desbridamento ultrassónico), quanto aos seus resultados clínicos, microbiológicos e de conforto, em pacientes submetidos a terapia periodontal de manutenção.

Métodos: Foi realizada uma pesquisa eletrónica em bases de dados para identificar os estudos publicados entre janeiro de 1987 e março de 2021. Todas as etapas foram executadas por dois autores independentes, desde a seleção, extração de dados à avaliação do risco individual de viés de cada. O método PICO foi utilizado para formular a pergunta: "Em pacientes submetidos a terapia periodontal de manutenção, os sistemas de jato ar-água resultam em melhores resultados clínicos, microbiológicos e de conforto que a instrumentação manual ou ultrassónica?". O protocolo da revisão sistemática foi registado na base de dados da PROSPERO (CRD42021253735).

Resultados: Da pesquisa eletrónica resultaram 501 referências, das quais 14 foram incluídas nesta revisão. Devido à grande heterogeneidade existente entre os estudos, não foi realizada uma meta-análise. Relativamente ao indicador primário e aos indicadores secundários, a maioria dos estudos revelou que os dois grupos em avaliação apresentaram resultados semelhantes. Os resultados microbiológicos revelaram que na maioria dos estudos os dois grupos apresentavam resultados semelhantes e os sistemas de jato ar-água parecem demonstrar melhores resultados microbiológicos. Os sistemas de jato ar-água apresentaram melhor resultados relativamente ao conforto do paciente.

Conclusões: Tanto os sistemas de jato ar-água como as terapias periodontais convencionais demonstraram uma eficácia clínica semelhante, contudo os sistemas de jato ar-água mostraram uma tendência, ainda não consensual, para um melhor comportamento microbiológico sendo também uma opção segura, mais rápida e confortável para os pacientes submetidos a terapia periodontal de suporte.

PALAVRAS-CHAVE: Doenças periodontais; Terapia periodontal de Suporte; Abrasão dentária por ar; Instrumentação.

INTRODUCTION

Periodontitis, a destructive inflammatory disease[1] affecting the supporting tissues of teeth, is the most prevalent bacteria-driven chronic disease in humans.[2] As one of the main causes of tooth loss within adult population[3–6] periodontitis may negatively affect both masticatory function and aesthetic with consequent repercussions on health and quality of life.[7]

Considering the etiology of periodontal inflammation[3,8,9], the elimination of pathogens contained in the biofilm, through the removal of plaque from dental surfaces, is essential to prevent and stop the progression of the disease.[4,5,8,10] Periodontal treatment aims to reduce the microbial load to levels compatible with periodontal tissue stability and health and consequently restore homeostasis of the immune system.[6,11,12]

According to the recent published guidelines on periodontal treatment [13], the first step of therapy is aimed at giving the periodontitis patient with adequate preventive and health promotion tools to facilitate their compliance with the prescribed therapy and to ensure adequate outcomes. The second step, also known as cause-related therapy, is aimed at controlling (reducing/eliminating) the subgingival biofilm and calculus and may be associated with removal of cementum root surface. The individual response to this second step of therapy should be assessed after an adequate healing period. If the endpoints of therapy (no periodontal pockets >4 mm with Bleeding on Probing (BoP) or no deep pockets [≥6 mm]) have not been attained, the third step of therapy should be employed. So, following completion of active periodontal therapy, successfully treated periodontitis patients may join in one of two diagnostic categories: periodontitis patients with a reduced but healthy periodontium or periodontitis patients with gingival inflammation.[14,15] The latter subjects remain at high risk for periodontitis progression/recurrence and necessitate specifically designed supportive periodontal therapy (SPT), which consist on a combination of preventive and therapeutic interventions rendered at different intervals which should containing: appraisal and on monitoring of both periodontal and systemic health[16], reinforcement of oral hygiene instructions, patient motivation towards continuous risk factor control, professional mechanical plaque removal and localized subgingival instrumentation at residual pockets.[12,13,17–20] Noteworthy, while it would appear intuitive that shallow pockets are consistent with health and deep pockets compatible with disease, there is ample evidence to indicate this may not necessarily be true. For example, deep pockets may continue stable and uninflamed, namely if careful supportive periodontal care is provided, over very long periods of time. Consequently, deep pockets may exist as so-called healthy pockets. This has been understood to indicate that mean values of clinical parameters such as attachment levels, probing depth, and bone height are not adequate predictors for sites that may become reinfected and undergo recurrent disease.[14] Furthermore, there is evidence that increased mean BoP in patients on SPT was

related to disease severity and periodontal instability.[21]

Periodontal debridement procedures are traditionally performed using energy-driven instruments such as sonic or ultrasonic devices or manual instruments such as Gracey curettes or a combination of both approaches.[6,9,18,19,22–24] Periodic instrumentation of the root surface can cause damage to both hard and soft tissues [3,9,25] with undesirable effects cumulative over time, like loss of tooth substance and gingival recession.[6,8,12,19,22,24,26] This may culminate in dentin hypersensitivity due to exposure of dentinal tubules.[6,10,12,18,27] As these procedures are repeated many times during SPT, it is extremely important that, more than be effective, they should cause minimal side effects.[6,8,26]

Air polishing devices have increasingly shown to be a promising alternative for the removal of bacterial deposits during SPT.[3,4,6,10] The effectiveness of air polishing application is conditioned by the properties of the particles used, namely their geometric shape, size and hardness.[6,28–30] Similarly, water and air pressure interfere with efficacy.[6,30] Over time, the use of these devices has expanded from the supragingival to the subgingival area.[6] This shift was allowed through the development of new powders with less abrasive properties, combined with subgingival application devices that allowed access and cleaning of deeper pockets.[18] Using a low abrasive powder, along with a tip that can be inserted into a periodontal pocket, it is possible to remove subgingival biofilm from the root surface in residual pockets.[27] Despite the powders low abrasiveness precludes calculus removal [6,10,18], subgingival bacterial deposits may not mineralize between two maintenance visits and may not form rigid and firmly attached calculus[6,27] and that justifies the pertinence of its use in SPT.

Although previous systematic reviews [4,11,18] explored the efficiency of air polishing devices on clinical outcomes such as probing depths and clinical attachment loss during supportive care, there is a notorious lack of clarification among existing literature regarding truly inflammatory outcomes, such as bleeding on probing and gingival indexes. So, we aimed to summarize the evidence regarding the effect of air polishing systems during periodontal maintenance therapy on outcomes of local inflammation, comparing to ultrasonic instrumentation or manual scaling.

METHODS

Protocol and registration

This systematic review was executed according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) criteria [31,32] and the Cochrane guidelines[33]. The systematic review protocol was registered in the PROSPERO database with the number CRD42021253735.

Focused PICO question

The PICO (Problem / Population, Intervention, Comparison, Outcomes) method was employed to formulate the following research question: "In patients undergoing periodontal maintenance therapy/supportive periodontal therapy, do air flow systems result in better clinical, microbiological and/or patient related outcomes than ultrasonic instrumentation or manual scaling?" (**Table 1**)

Population	Patients undergoing periodontal maintenance therapy / supportive periodontal therapy
Intervention	Air flow systems
Comparison	Ultrasonic instrumentation or manual scaling
Outcomes	Primary outcomes: bleeding on probing (BoP), gingival index (GI) and/or bleeding index (BI); Secondary outcomes: probing depth (PD), clinical attachment level (CAL) plaque index (PI), microbiological counts and/or patient tolerance

Table 1- Schematic representation of PICO question

Study design and eligibility criteria

For this systematic review, only clinical studies which met the following inclusion criteria, were selected:

- Randomized controlled trials (RCT) that compared the use of an air-polishing device to hand instruments and/or ultrasonic devices during periodontal maintenance therapy/ supportive periodontal therapy;
- Studies reporting results regarding primary and/or secondary outcomes;
- Human studies;
- Publications in English, Spanish, or Portuguese.

Exclusion criteria were as follows:

- Studies not using an air-polishing device during PMT/SPT;

- Studies on patients with a systemic commitment (pregnancy, diabetes) or using any medications (eg, antibiotics, anti-inflammatory drugs) within 1 month before the trial;
- Studies on patients with dental implants;
- Review articles, cohort studies, case-control studies, case reports, books/book chapters, letters to the editor/editorials and abstracts.
-

Sources of information and search strategy

An online search was accomplished, and relevant articles published since 1 January 1987 were selected from MEDLINE (accessed through PubMed), Cochrane Library, Web of Science (all databases), Clinical Trials and Embase databases. A manual search was also performed through a systematized analysis of the reference list of the included articles.

The search strategy included the following terms: "Air Abrasion, Dental", "Air-Powder", "Air Polishing", "Air-Polishing", "Abrasive Powder", "Tooth Polishing", "Dental Polishing", "Periodontal Diseases", "Periodontal", "Periodontitis", "Periodontal Diseases", "Supportive Periodontal Therapy", "Supportive Periodontal Treatment" and "Periodontal Maintenance". The MeSH (Medical Subject Headings) and Emtree (Embase Subject Headings) resources were employed to select appropriate search descriptors. Additionally, boolean operators "AND" and "OR" were used to improve the search strategy through several combinations (**Table 2**). The bibliographic search ended in March 2021.

Study selection

The titles and abstracts of studies retrieved from the databases search were screened by two independent authors (AC and DS) to identify the studies that met the inclusion criteria. The full text of these potentially eligible studies was obtained and independently assessed for eligibility by two review authors (AC and DS). In addition to the electronic search, a hand search was performed in the reference list of all included studies by the same reviewers. Any disagreement between them, over the eligibility of specific studies, was resolved through discussion with a third reviewer (OM) and a decision arrived by consensus.

Data extraction

After study selection, the data was extracted to a standardized form, including author and year of publication, study design, follow-up, eligibility criteria, sample data (number, gender distribution and mean age of patients, characteristics of interventions (powder type, equipment, nozzle, and other specifications) and sources of funding, information presented in **table 3**.

Primary and secondary outcomes, professional time and adverse effects were also extracted, and presented in **table 4**.

If there was lack of data, the study authors were contacted by e-mail to provide the information or clarify potential doubts regarding the study methodology or results. The extraction of the information was done by two independent authors (AC and DS). A consensus meeting was always held to confirm the agreement and to resolve any disagreement between the reviewers.

MEDLINE	("Air Abrasion, Dental"[Mesh] OR "Air-Powder" OR "Air Polishing" OR "Air-Polishing" OR "Air Abrasion, Dental" OR "Abrasive Powder" OR "Tooth Polishing" OR "Dental Polishing") AND ("Periodontal Diseases"[Mesh] OR "Periodontal" OR "Periodontitis" OR "Periodontal Diseases" OR “Supportive Periodontal Therapy” OR “Supportive Periodontal Treatment” OR “Periodontal Maintenance”)
Cochrane Library	("Air Abrasion, Dental"[Mesh] OR "Air-Powder" OR "Air Polishing" OR "Air-Polishing" OR "Air Abrasion, Dental" OR "Abrasive Powder" OR "Tooth Polishing" OR "Dental Polishing") AND ("Periodontal Diseases"[Mesh] OR "Periodontal" OR "Periodontitis" OR "Periodontal Diseases" OR “Supportive Periodontal Therapy” OR “Supportive Periodontal Treatment” OR “Periodontal Maintenance”)
Web of Science	("Air Abrasion, Dental"[Mesh] OR "Air-Powder" OR "Air Polishing" OR "Air-Polishing" OR "Air Abrasion, Dental" OR "Abrasive Powder" OR "Tooth Polishing" OR "Dental Polishing") AND ("Periodontal Diseases"[Mesh] OR "Periodontal" OR "Periodontitis" OR "Periodontal Diseases" OR “Supportive Periodontal Therapy” OR “Supportive Periodontal Treatment” OR “Periodontal Maintenance”)
Clinical Trials	Interventional Studies | Periodontal Diseases | Air Flow Systems
Embase	(('abrasion dental':ti,ab,kw OR 'air powder':ti,ab,kw OR 'air polishing':ti,ab,kw OR 'air abrasion':ti,ab,kw OR 'abrasive powder':ti,ab,kw OR 'tooth polishing':ti,ab,kw OR 'dental polishing':ti,ab,kw) AND ('periodontal diseases':ti,ab,kw OR periodontal:ti,ab,kw OR periodontitis:ti,ab,kw OR 'periodontal disease':ti,ab,kw OR 'supportive periodontal therapy':ti,ab,kw OR 'supportive periodontal treatment':ti,ab,kw OR 'periodontal maintenance':ti,ab,kw)) OR (('dental polishing device'/exp OR 'dental polishing'/exp) AND 'periodontal disease'/exp)

Table 2- Search strategies for all databases

Risk of bias of individual studies

The evaluation of the methodological quality of the included studies is essential for understanding the results. Each RCT included was assessed using the evaluation method recommended in the Cochrane Handbook for Systematic Reviews of Interventions (version 6.2.0) and using Review Manager (RevMan) [Computer program]. Version 5.4. The Cochrane Collaboration, 2020. The tool focus seven domains of bias, including (a) random sequence generation to select the participants (selection bias); (b) allocation concealment (selection bias); (c) blinding intervention of participants and personnel (performance bias); (d) blinding of outcome assessment (detection bias); (e) incomplete outcome data (attrition bias); (f) selective reporting (reporting bias); and (g) other bias, specifically lack of sample size calculation and reduced follow-up time. Two reviewers (AC and DS) independently classified each study as having a low, high, or with some concerns of overall risk of bias. Any disagreements will be settled by discussion, with a third review author's (OM) involvement where necessary. For ease of interpretation, each trial was also tentatively assigned an “overall risk of bias”: low risk (low for all key domains); high risk (high for ≥1 key domains); and unclear risk (unclear for ≥1 key domains).

Evidence synthesis

A descriptive analysis of all articles included in this systematic review was carried out.

RESULTS

Study selection

During the first phase of study selection, a total of 501 references were found using the search strategies among the electronic databases. After removing duplicates, 299 articles were screened by two independent reviewers (AC and DS) for analysis of titles and abstracts. In addition, 278 studies were initially excluded because did not met the inclusion criteria. 21 studies were considered eligible for full-text analysis. At the full-text reading phase, 7 studies met the exclusion criteria and were, therefore, excluded. Ultimately, 14 studies were included in the systematic review.

The PRISMA flow diagram of study selection is shown in **Figure 1**.

Study characteristics

The studies were published between the years of 2003 and 2021. Regarding the study design, 11 studies [3,8–10,22,23,25–27,34,35] had split-mouth and three[19,24,36] had parallel group design. All studies occurred during periodontal maintenance therapy or supportive periodontal therapy although each had different eligibility criteria, notably as regards the Probing Depths.

The follow-up time of all the studies were substantially different, ranging from 1 week [8] to 1 year [9,27]. Also, in the sample size there was a great heterogeneity, ranging from 10 [22,34] to 50 [9,36] patients with great diversity in age and gender distribution. While 6 studies [3,10,22,26,27,34] compared with sonic/ultrasonic scalers, 5 studies[8,19,24,25,35] compared the use of air polishing with hand scaling (only). In addition, 3 studies [9,23,36] had combined instruments (US + hand instruments) or had more than one control group. Glycine powder was used in 8 studies [3,8,22,23,25,26,35,36], 4 studies[9,19,24,27] used erythritol powder, while trehalose powder was used in two[10,34] and sodium bicarbonate in one[22]. Twelve of the 14 studies used nozzles designed especially for subgingival application. However, supragingival air-polishing devices were also used in two studies.[3,22] All studies published reported that they followed ethical criteria and applied terms of consent to all patients. Of the 14 studies, only 3 [9,22,23] were not funded by the industry. The two studies of Petersilka et al. 2003 (a and b)[25,35] had no information regarding funding.

More details are found in **Table 3**.

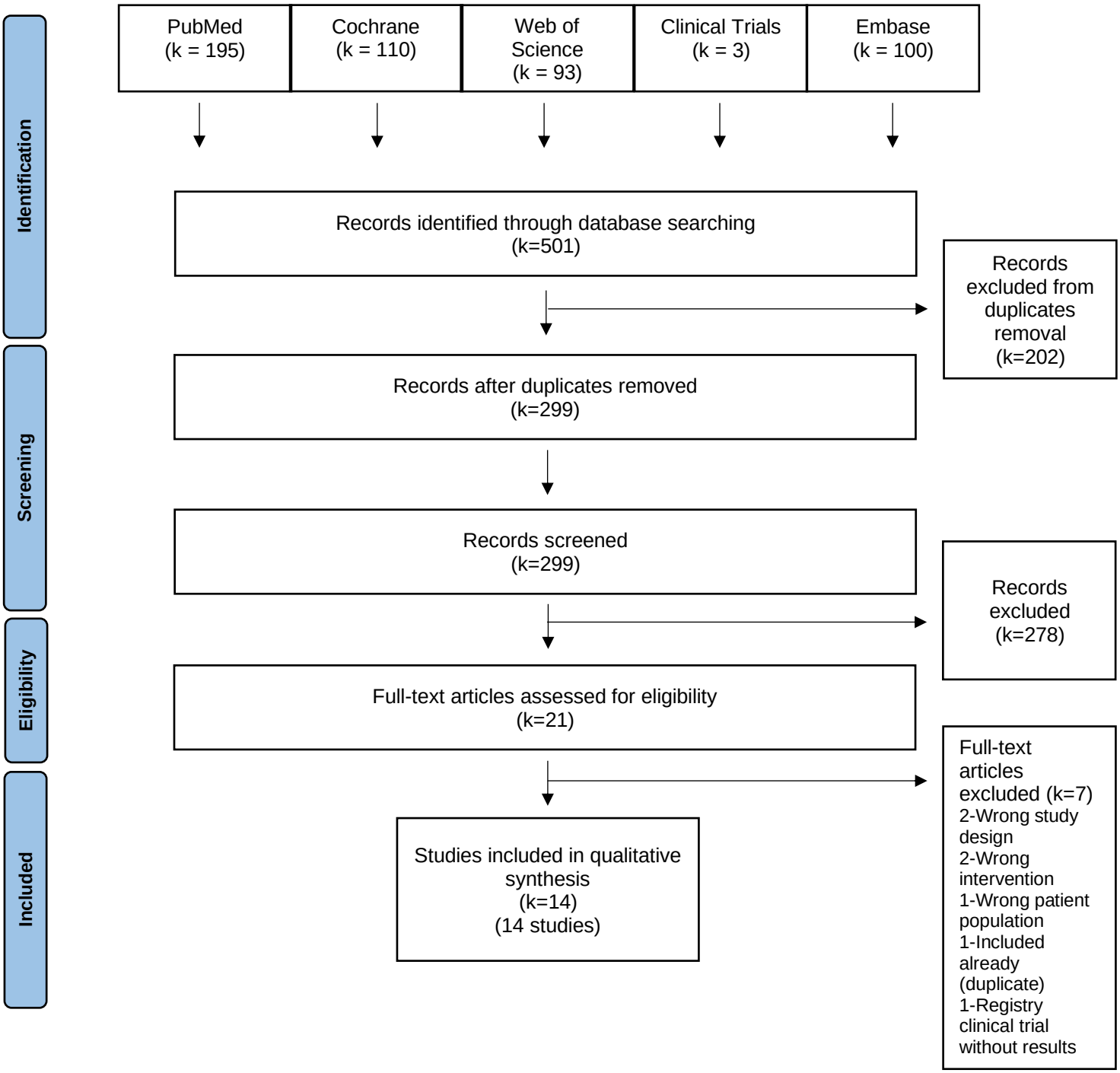

Figure 1: PRISMA flow diagram of the study selection

Risk of Bias of individual studies

The measures of risk of bias were assessed as described above (Cochrane Handbook for Systematic Reviews of Interventions (version 6.2.0), Review Manager (RevMan) [Computer program]. Version 5.4. The Cochrane Collaboration, 2020), and graphic representations of

potential bias were computed (**Figure 2**). All studies were at high risk for at least one of the above-mentioned domains. Six studies [10,19,24,27,34,36] adequately generated their randomisation sequence; nine [3,9,10,22–24,26,27,34] adequately concealed allocation; and none of the studies blinded participants/personnel, while with regard to blinding outcome assessors only did not occur in one study [23]. All studies had low risk of missing outcome data and presented low risk for reporting bias. Regarding other biases, four studies [8,19,22,34] presented high risk of bias. All studies presented an overall high risk of bias.

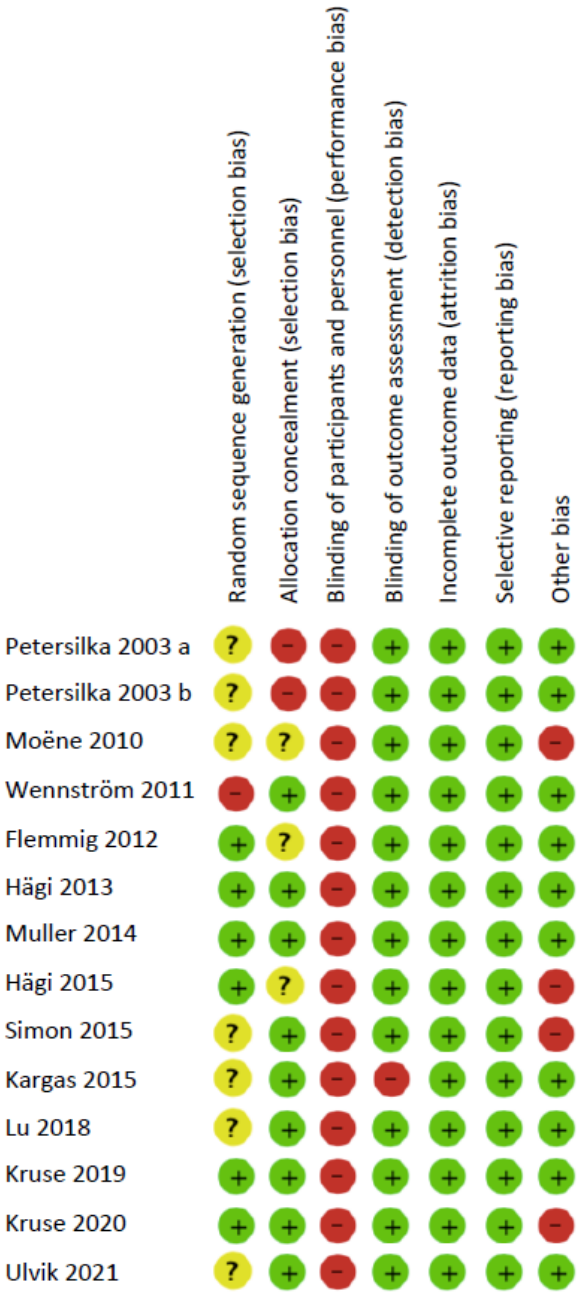

Figure 2: Review authors' judgments about each risk of bias item for each included study

Evidence synthesis

A great heterogeneity in setting parameters, spraying protocols and data analysis exists among the studies included in the review. Therefore, a meta-analysis was not appropriate and was not performed. **Table 4** presents the outcomes domains of interest of every study included in this review. Eleven studies evaluated gingival inflammation through BoP [3,8–10,19,24,26,27,36], GI [22,23] or BI [26]. Nine studies presented information about PD [3,9,10,19,23,24,26,27,36] and six studies presented about CAL [9,10,19,23,24,26]. In addition, bacterial plaque was measured in all studies, through PI [3,9,10,22–24,26] or Bacterial Counts [3,8,9,19,23,25–27,34–36]. Finally, data about patient comfort was presented in almost all studies, not present in only 5 studies[3,19,22,34,35]. Information on professional time and adverse reactions was also presented in 3 [8,24,27] and 14 studies, respectively.

Primary outcome

Bleeding on probing (BoP)

Nine studies made reference to BoP used different powders. Four used glycine [3,26,27,36], 4 used erythritol [8,9,19,24] and 1 used trehalose powder [10]. Four compared the air polishing devices with US scalers [3,10,26,27], 3 with hand instruments [8,19,24] and 2 with hand instruments combined with US scalers [9,36].

All studies, with the exception of Moëne et al. 2010 [8], demonstrated that there were no statistically significant differences regarding this parameter between the groups in comparison. Moëne et al. 2010 [8] noted that there were statistically significant differences in favour of hand instruments. Ulvik et al. 2021[9] only reported intra-group results, with no inter-group comparison.

Gingival index (GI)

Two studies [22,23] evaluated GI. Both used glycine powder and both used quadrant-split design, although in the study of Simon et al. 2015 [22] it was also used sodium bicarbonate power. Simon et al. 2015 [22] compared two different powders, glycine and sodium bicarbonate with ultrasonic scaling, while Kargas et al. 2015 [23] compared glycine with ultrasonic scaling and hand instruments. Simon et al. 2015[22] revealed that there were only statistically significant differences between the sodium bicarbonate air polishing and ultrasonic scaling groups, favouring the latter. Revealing further, that between glycine powder air polishing and ultrasonic scaling there were no statistically significant differences. Kargas et al. 2015[23] declared that no differences were observed among groups for GI at any time point.

Table 3: Main characteristics of included studies

Author Year	**Study design**	**Follow-up**	**Eligibility criteria**	**Sample** (n)	**Age** Mean ± SD (year range)	**Interventions**					**Sources of funding**
						Test			**Control**		
						Powder	**Equipment/ Noozle**	**Specifications**	**Equipment**	**Specifications**	
Petersilka et al. 2003 a	**RCT** Split mouth design	12 W	**SPT** PD: 3-5 mm (buccal or lingual sites)	**27** 40,7% F 59,3% M	46.4 ± 10	**Gly**[1]	**AirPU**[1] EMS Air Flow S1 **SubNoz**	5 s/site	**HandInst** Cur[1]	**Endpoint of instrumentation:** no visible plaque on instrument	NR
Petersilka et al. 2003 b	**RCT** Split mouth design	12 W	**SPT** PD: 3-5 mm (interdental sites)	**23** 43,5% F 56,5% M	47.3 ± 11.6	**Gly**[1]	**AirPU**[1] EMS Air Flow S1 **SubNoz**	5 s/site	**HandInst** Cur[1]	**Endpoint of instrumentation:** no visible plaque on instrument	NR
Moëne et al. 2010	**RCT** Split mouth design	1 W	**SPT** PD ≥5 mm	**50** % F/M NR	(18 to 70)	**Gly**[2] 20 µms	**AirPU**[2] AIR-FLOW Master **SubNoz**	4-5 s/site	**HandInst** Cur	>5 min/site	EMS Electro Medical System, Nyon, Switzerland GABA International, Therwil, Switzerland
Wennström et al. 2011	**RCT** Split mouth design	2 W 8 W	**SPT** PD: 5-8 mm and BoP+	20 70% F 30% M	60 (40 to 71)	**Gly**[2]	**AirPU**[2] AIR-FLOW Master **SubNoz**	Each periodontal pocket was debrided for 2x5 s	**USInst**[1]	Debrided for 30 s	EMS Electro Medical System, Nyon, Switzerland
Flemmig et al. 2012	**RCT** Parallel group design	2,5 W 22,5 W	**SPT** PD: 4-9 mm	**30** 50% F 50% M	Test: 63.9 ± 8.3 Control: 63.8 ± 7.8 (41 to 78)	**Gly**[2] ¶	**AirPU**[2] AIR-FLOW Master **SubNoz**	5 s/site	**HandInst** Cur + **USInst**	No time limit	EMS Electro Medical System, Nyon, Switzerland Institute of Translational Health Sciences

Hägi et al. 2013	**RCT** Parallel group design	12 W	**SPT** PD ≥4 mm and BoP+ but no detectable calculus	**40** 37,5% F 62,5% M	Test: 55.2 ± 7.97 Control: 53.7 ± 10.09	**Ery[NR]**	**AirPU[2]** AIR-FLOW Master **SubNoz**	5 s/site	**HandInst** Cur[2]	**Endpoint of instrumentation:** no visible plaque on instrument **(lasted 85 s on average)**	EMS Electro Medical System, Nyon, Switzerland
Muller et al. 2014	**RCT** Split mouth design	52 W	**SPT** PD: 5-9 mm	**50** 58% F 42% M	58.5	**Ery[1] (14 µm)** with 0.3% CHX	**AirPU[2]** AIR-FLOW Master **SubNoz**	5 s/site	**USInst[2]**	20 s/site	EMS Electro Medical System, Nyon, Switzerland
Hägi et al. 2015	**RCT** Parallel group design	24 W	**SPT** PD ≥4 mm and BoP+ but no detectable calculus	**40** 47,5% F 62,5% M	54.5	**Ery[NR]**	**AirPU[2]** AIR-FLOW Master **SubNoz**	5 s/site	**HandInst** Cur[2]	**Endpoint of instrumentation:** no visible plaque on instrument	EMS Electro Medical System, Nyon, Switzerland Walter Bürgin, Biomed Ing
Simon et al. 2015	**RCT** Split mouth quadrant design	3 W	**SPT** PD: 5 mm	**10** 40% F 60% M	(30 to 40)	**1. Gly [2]** **2. SodBic**	**AirPU[3]** Dentsply Prophy-Jet **SupNoz**	Distance of 5 mm Angle of 60–70° to the root surface for 5 s/site	**USInst[3]**	**Endpoint of instrumentation:** no visible plaque when checked with a probe	None
Kargas et al. 2015	**RCT** Split mouth quadrant design	4 W 12 W 24 W	**SPT** PD > 4 mm and BoP-	**25** 40% F 60% M	52.50 ± 9.54	**Gly[NR]**	**AirPU[NR]** **SubNoz**	5 s/site	**1. HandInst** Cur[3] **2. USInst[4]**	**NR**	None

Lu et al. 2018	**RCT** Split mouth design	12 W	**SPT**	**22** 63,6% F 36,4% M	(28 to 72)	**Gly**[3] (65µm)	**AirPU**[2] AIR-FLOW Master **SupNoz**	NR	**USInst**[5]	NR	National Science and Technology Pillar Program of the 11th Five-Year Plan of China (2007BAll8802) Project of the Key Clinical Disciplines of Ministry of Health of China (2010)
Kruse et al. 2019	**RCT** Split mouth design	12 W 24 W	**SPT** PD: 5 mm and BoP+ or PD> 5 mm	**44** 40,9% F 59,1% M	59.68 ±11.18	**Treh**[1]	**AirPU**[NR] **SubNoz**	5 s/site	**USInst**[6]	20 s/ teeth	Orochemie, part of The Dürr Dental Group (Bietigheim-Bissingen, Germany)
Kruse et al. 2020	**RCT** Split mouth design	12 W 24 W	**SPT** PD: 5 mm and BoP+ Or PD> 5 mm	**10** 20% F 80% M	61.4 ± 10.6	**Treh**[1]	**AirPU**[NR] **SubNoz**	5 s/site	**USInst**[5]	20 s/ teeth	Dürr Dental SE (Bietigheim-Bissingen, Germany)
Ulvik et al. 2021	**RCT** Split mouth design	52 W	**SPT** Mandibular furcations (grade II)	**20** 30% F 70% M	61	**Ery**[1]	**AirPU**[2] AIR-FLOW Master **SubNoz**	Striking movements over the furcation area for **5 s**	**HandInst** Cur[3] + **USInst**[1]	NR	Self-funded by the authors and their institutions.

Abbreviations: **NR**-Not reported; **RCT**- Randomized clinical trial; **SPT**- Supportive periodontal treatment; **PD**- Probing depth; **BoP**- Bleeding on probing; **F**-Female; **M**-Male; **SD**-Standard deviation; **Gly**- Glycine; **Ery**- Erythritol; **Treh**- Trehalose; **SodBic**- Sodium Bicarbonate; **USInst**- Ultrasonic instrumentation; **HandInst**- Hand Instruments; **Cur**- Curettes; **AirPu**- Air polishing unit; **SubNo**z- Subgingival noozle**; SupNoz**- Supragingival noozle; **CHX**- Chlorhexidine; **S**- Seconds; **Min**-Minutes; **W**-Weeks

Informations:

Glycine 1: Clinpro Prophypowders, 3M ESPE, Seefeld, Germany

Glycine 2: AIR-FLOW Powder PERIO, EMS Electro Medical Systems, Nyon, Switzerland

Glycine 3: Air-Flow Polishing Soft; EMS, Nyon, Switzerland

Erythritol 1: Air Flow Powder PLUS, mean grain size of 14 µm

Trehalose 1: Lunos® Prophylaxis Powder Perio Combi, Orochemi

Air polishing unit 1: EMS Air Flow S1, EMS, Nyon, Switzerland

Air polishing unit 2: AIR-FLOW Master, EMS Electro Medical Systems.

Air polishing unit 3: Dentsply Prophy-Jet, Dentsply, York, PA, USA

¶: Particle size distribution of Dv10 (5 µm), Dv50 (19 µm), and Dv90 (52 µm)

Curettes1: Stoma, Tuttlingen, Germany

Curettes2: Gracey curettes Hu-Friedy+ universal curette GX4 (Deppeler)+ the Goldman- Fox curette GX2 (Deppeler)

Curettes 3: Gracey curettes Hu-Friedy, Chicago, IL, USA

Ultrasonic instrumentation1: EMS Piezon Masters 400, PerioSlim tip, EMS

Ultrasonic instrumentation 2: Piezon LED, tip PS, EMS Electro Medical System S.A., Nyon, Switzerland

Ultrasonic instrumentation 3: EMS, Mini Piezon Ultrasonic Scaler

Ultrasonic instrumentation 4: Piezon, Instrument PS, EMS, Nyon, Switzerland

Ultrasonic instrumentation 5: Satelec,Merignac, France

Ultrasonic intrumentation 6: Sonic Flex, KaVo, Biberach/Riß, Germany

Table 4- Summary of main outcomes of included studies

Author, Year	**Outcomes domains of interest**									
	Primary outcome			**Secondary outcomes**					**Professional time**	**Adverse effects**
	Gingival Inflammation			***PD***	***CAL***	**Bacterial Plaque**		***Patient Confort***		
	BoP	***GI***	***BI***			***PI***	***Bacterial counts***			
Petersilka et al. 2003 a	NA	NA	NA	NA	NA	NA	**SS** **CFU reduction (mean)**: Test vs Control (**Favour Test**, p<0.05)	**SS** Test vs Control (**Favour Test**, p<0.05)	NA	**None**
Petersilka et al. 2003 b	NA	NA	NA	NA	NA	NA	**SS** **CFU reduction (mean)**: Test vs Control (**Favour Test**, p<0.05)	NA	NA	**Nor were there any major adverse effects during the study period**.
Moëne et al. 2010	**SS** **Bleeding tendency reduction:** Test vs Control (**Favour Control**, p=0.045)	NA	NA	NA	NA	NA	**NSS** **Total bacteria/6 PP:** Test vs Control (p>0.05)	**SS** Test vs Control (**Favour Test**, p<0.001)	**SS** Test vs Control (**Favour Test**, p<0.001)	**None**
Wennström et al. 2011	**NSS**	NA	**MGB** decreased in both treatment groups	**NSS**	**NSS**	NA	**NSS**	**SS** Test vs Control (**Favour Test**, p<0.05)	NA	**None**
Flemmig et al. 2012	**NSS**	NA	NA	**NSS**	NA	NA	**SS** **GPAP resulted in significantly lower total viable bacterial counts immediately after, at day**	**NSS**	NA	**None**

							10 (P <0.05) **and day 90** (P <0.05)			
Hägi et al. 2013	**NSS**	NA	NA	**NSS**	**NSS**	**NSS**	NA	**SS** Test vs Control (**Favour Test,** p=0.0006)	**Treatment of test sites:** 5s per site **Treatment of control sites:** 85s (BL) 63s (FT)	**None**
Muller et al. 2014	**NSS**	NA	NA	**NSS**	NA	NA	**Counts of Aa:** **Test sites were less frequently** positive than controls (12m)	**SS** Test vs Control (**Favour Test,** p = 0.004)	**Treatment of test sites:** 1.5 ± 1.4 min **Treatment of control sites:** 1.7 ±1.5 min	**Nor were there any major adverse effects during the study period**.
Hägi et al. 2015	**NSS**	NA	NA	**NSS**	**NSS**	**NSS**	NA	NA	NA	**None**
Simon et al. 2015	NA	**SS** **Reduction:** SBAP vs Control (**Favour control,** p=0.017) **NSS** **Reduction** GPAP vs Control p>0,05	NA	NA	NA	**SS** **Reduction:** SBAP vs Control (**Favour control**, p<0.001) **NSS** **Reduction** GPAP vs Control p>0,05	NA	NA	NA	**None**

Kargas et al. 2015	NA	**NSS**	NA	**SS** **1,3,6 months:** Test vs Control (both groups) (**Favour Control**, p<0.05)	**SS** **1†,3†§,6†§ months:** Test vs Control †§ (**Favour Control** †§, p<0.05)	**NSS**	**NSS**	NA	NA	**None**
Lu et al. 2018	**NS**	NA	NA	**NS**	NA	**NS**	**NS**	NA	NA	**None**
Kruse et al. 2019	**NSS**	NA	NA	**NSS**	**NSS**	**NSS**	NA	**SS** Test vs Control (**Favour Test**, p< 0.001)	NA	**None**
Kruse et al. 2020	NA	NA	NA	NA	NA	NA	**NSS**	NA	NA	**None**
Ulvik et al. 2021	NA	NA	NA	**NSS**	**SS** Test vs Control: 6m- **Favour Control**, p=0.032 12 m**- Favour Control,** p = 0.0097	NA	**NSS**	**SS** Test vs Control (**Favour Test**, p = 0.001)	NA	**None**

Abbreviations:

NA- Not applicable; **NSS**- Not statistically significant; **SS**- Statistically significant; **†**-Hand instruments; **§**-Ultrasonic instrumentation

BoP- Bleeding on probing; **GI**- Gingival index; **BI**- Bleeding index; **PD**- Probing depth; **CAL**- Clinical attachment level; **PI**- Plaque index; **SBAP**- Sodium bicarbonate air polishing; **GPAP**- Glycine powder air polishing; **PP**- Periodontal pathogens; **CFU**- Colony-forming unit; **Aa**- *Aggregatibacter actinomycetemcomitans*; **M**-Months; **S**- Seconds; **Min**- minutes; **BL**- Baseline; **FT**- Follow-up time

Bleeding index (BI)

Only Wennström et al. 2011 [26] evaluated. The author compared glycine powder air-polishing with ultrasonic scaling, revealing that marginal gingival bleeding scores decreased in both treatment groups from approximately 40% at baseline to 10% at the final examination.

Secondary outcomes

Probing depth (PD)

Probing depth was evaluated in 9 studies. Four used glycine [3,23,26,36], 4 used erythritol [9,19,24,27] and 1 trehalose powder [10]. From these 9, 4 compared the air polishing devices with US scalers [3,10,26,27], 2 with hand instruments [19,24], 2 with hand instruments combined with US scalers [9,36] and 1 [23] with hand instruments in a group apart from the group of US scalers.

All studies, with the exception of Kargas et al. 2015 [23], revealed that there were no statistically significant differences regarding this parameter between the groups. Kargas et al. 2015 [23] reported that air polishing using glycine powder group displayed statistically significant higher PD compared to hand instruments and US scalers groups, at 1, 3 and 6 months.

Clinical attachment level (CAL)

Six studies presented results regarding CAL with 3 using erythritol [9,19,24], 2 glycine [23,26], and 1 trehalose powder [10]. Two compared the air polishing devices with US scalers [10,27], 2 with hand instruments [19,24], 1 with hand instruments combined with US scalers [9] and 1 [23] with hand instruments in a group apart from the group of US scalers.

Four studies[10,19,24,26] demonstrated that there were no statistically significant differences in CAL between the groups in comparison. On the contrary, Ulvik et al. 2021 [9] reported that, at 6 and 12 months, a significant difference between-treatment was observed in favour of hand instruments combined with US scalers group. Kargas et al. 2015 [23] reported that air polishing using glycine group displayed statistically significant differences with hand instruments group in all periods of time (1,3 and 6 months) and also with ultrasonic debridement group (3 and 6 months), always in favour of control group.

Plaque index (PI)

This parameter was evaluated in 7 studies, 3 erythritol [9,19,24], 2 using only glycine [3,23], 1 used trehalose [10] and 1 used glycine and sodium bicarbonate powders[22]. Air polishing devices were compared with US scalers in 3 studies[3,10,22], with hand instruments in 2 [19,24], with hand

instruments combined with US scalers in 1 [9] and with hand instruments in a group apart from the group of US scalers also in 1 [23].

Five [3,10,19,23,24] of the 7 studies revealed that there were no statistically significant differences between the studied groups. Of the remaining two, Simon et al. 2015 [22] reported that there were only statistically significant differences between the sodium bicarbonate air polishing and ultrasonic scaling groups, favouring the latter. Ulvik et al. 2021[9] only reported intra-group results, with no inter-group comparison.

Bacterial Counts

Eleven of the 14 with results assessed this parameter. Of the 11 studies, 7 used glycine [3,8,23,25,26,35,36], 3 used erythritol [9,19,27] and 1 used trehalose powder [34]. Four compared the air polishing devices with US scalers [3,26,27,34], 4 with hand instruments [8,19,25,35], 2 with hand instruments combined with US scalers [9,36] and 1 [23] with hand instruments in a group apart from the group of US scalers.

Six [3,8–10,23,26] of the 11 studies revealed that there were no statistically significant differences between the groups in comparison. Although, 3 studies [25,35,36] stated that were statistically significant differences between the groups, in favour of test group. Additionally, Muller et al. 2014 [27] reported that, at month 12, test sites were less frequently positive for *Aggregatibacter actinomycetemcomitans* at >1000 cells/ml than controls. Hägi et al. 2015[19] only reported intra-group results, with no inter-group comparison.

Patient comfort

Eight studies reported patient comfort. Four used glycine [8,25,26,36], 3 used erythritol [9,24,27] and 1 used trehalose powder [10]. Three compared the air polishing devices with US scalers [10,26,27], 3 with hand instruments [24,25] and 2 with hand instruments combined with US scalers [9,36]. From the 8 studies, 7 reported that were statistically significant differences between the groups, in favour of air polishing group. Solely, Flemmig et al. 2012 [36] stated that did not exist statistically significant differences between the study groups.

Professional time

Only three authors addressed this parameter in their studies. [8,24,27] Two used erythritol [24,27] and 1 used glycerine[8] powder. Two compared the air polishing devices with hand instruments [8,24] and 1 with US scalers [27]. Moëne et al. 2010 [8] announced that the mean time needed by the operator to treat one site was significantly shorter with the air-polishing device than with the

curets (0.5 minutes/site versus 1.4 minutes/site; p <0.001). Muller et al. 2014 [27] only mentioned that the average time required by the operator on the test side, from picking-up the handpiece from the instrument holder, air-polishing all sites >4 mm, to putting the handpiece back, was 1.5 ± 1.4 min per person. The respective time on the control side was, 1.7 ±1.5 min. Hägi et al. 2013 [24] revealed that the treatment of test sites was set to 5 seconds per site and the treatment of control sites, on the other hand, lasted 85 seconds on average at baseline and 63 seconds at follow-up, respectively.

Adverse effects

All studies reported no adverse reactions. Although Petersilka et al. 2003 [35] mentioned that a few hours after instrumentation, one patient reported slight but painless bleeding at the mesiobuccal aspect of an upper right canine which had been treated with the low abrasive powder.

DISCUSSION

This systematic review was developed to evaluate the clinical, microbiological and patient related outcomes resulting from the application of air flow systems in periodontal supportive treatment compared with ultrasonic instrumentation or manual scaling. It is not possible to perform meta-analysis due to the high heterogeneity of the studies included.

Periodontitis is a chronic disease that persists through the patient life. In order to assess its stability, it is necessary to regularly re-evaluate the periodontal status according to various parameters, including those related to gingival inflammation (BoP, BI and GI), PD, CAL and bacterial plaque.[14] The assessment of BoP, as well as other indexes of local inflammation, such as BI and GI, is an important diagnostic criteria for evaluation in each stage of periodontal treatment.[37] In this systematic review we highlighted the outcome of local inflammation, since BoP has been used in clinical practice as a diagnostic tool to evaluate both gingival inflammation and periodontal stability in patients undergoing SPT.[21,38,39] BoP works as an indicator of the host's periodontal inflammatory response to the dental biofilm.[21,38] Thus, BoP is a presumptive indicator of sites with recurrent "active" periodontitis.[38] Due to this reason, it is important to consider these inflammatory predictive parameters, since they indicate the presence of an undergoing inflammatory process that may result in soft tissue destruction and, in more severe cases, alveolar bone loss.

Regarding the primary outcome, most studies show that air flow systems compared to hand or US instruments present similar results. However, Moëne et al. 2010 [8] reveal that hand instruments' group present superiority regarding BoP parameter. Nevertheless, Moëne et al. 2010 [8] reveals that the main purpose of his study is evaluate the safety of a new method for subgingival air polishing in deep pockets. In addition, only presents a 1-week follow-up and for that reason, periodontal parameters should be interpreted with caution. Simon et al. 2015 [22] also show, regarding GI parameter, that ultrasonic debridement has superiority over sodium bicarbonate air-polishing, but not with glycine powder air polishing. Simon et al. 2015 [22] is the only study included that uses sodium bicarbonate powder. Therefore, the discrepancy of the results obtained in this outcome may be due to the type of powder used and this argument is strengthened because this is no longer the case when compared with glycine powder.

From the analysis of the secondary outcomes, namely at the level of PD and CAL, we find that in most studies there are no differences between the air polishing devices and the control groups. However, in Kargas et al. 2015 [23], there is a superior behaviour of both control groups, hand instruments and US, with regard to PD and CAL. Despite this, in this study there is no blinding of outcome assessment and therefore, the results are subject to high risk of bias. Additionally, Ulvik et al. 2021 [9], with regard to CAL, also demonstrate that the use of hand

instruments alone shows superiority. However, in this author's study we are facing a different context from the other studies, the presence of furcation defects. The subgingival nozzle tip used is not specially designed to access subgingival furcation's complex horizontal/ vertical anatomy and inherent concavities, a possible explanation for the results presented.

Still within the secondary outcomes, the microbiological results also revealed that in most studies the two groups had similar results. Only Simon et al. 2015 [22] demonstrated that ultrasonic group had superiority over sodium bicarbonate air-polishing, superiority not demonstrated when compared with glycine powder air polishing. As mentioned above, Simon et al. 2015 [22] is the only study included that uses sodium bicarbonate powder and consequently the discrepancy of the results may be due to the type of powder used, once more this argument is strengthened because this is no longer the case when compared with glycine powder. Furthermore, it also uses a supragingival nozzle, which may not be effective reaching the pocket, with repercussions on the microbiological results and consequently on the clinical parameters. However, the other exceptions in the bacterial counts are in favour of the superiority of air polishing devices, mentioned by the 2 studies of Petersilka et al. 2003 [25,35] and by Flemmig et al. 2012 [36]. In both Petersilka et al. 2003 [25,35] studies, we are considering maximum probing depth of 5mm. On the other hand, in Flemmig et al. 2012 [36] study, probing depths vary between 4 and 9 mm and for that reason, it shows that the air-polishing devices are also effective in moderate-to-deep periodontal pockets. Regarding the microbiological analysis, there is no agreement between the authors about behaviour of periodontal pathogens after SPT. There are two theories: the first advocates that the levels of periodontal pathogens return to the values presented at baseline, defended by Wennström et al. 2011 [26], who claims that this occur after 2 weeks, while Flemmig et al. 2012 [36] and Lu et al. 2018 [3] demonstrate that the same happens after 12 weeks. Other authors believe that the levels of periodontal pathogens remain lower than the initial assessment, even after 6 months[34] or even 1 year[9]. These considerations are demonstrated independently of the type of therapy used. Another aspect to be considered is the prescription of chlorhexidine digluconate rinse after SPT. Chlorhexidine is widely used as a short-term adjunct to mechanic plaque control, offering some clinical benefits in controlling plaque and gingival inflammation.[40] Of the studies included, only five[19,24,26,27,36] make reference to chlorhexidine, two[19,24] of them stating that no prescription was made. In the remaining 3 studies, in Müller et al. 2014[27] there is no true prescription of the chlorhexidine, since chlorhexidine (0.3%) is present in the powder composition together with erythritol, which according to the manufacturer, it is only added with the purpose of conserving the powder, not with the intention to have a therapeutic effect. Only in the studies of Wennström et al. 2011[26] and Flemmig et al. 2012[36] there is chlorhexidine rinse prescription after SPT, for 2 weeks, 2 times a day. In Wennström et al. 2011[26], the author states that there are no significant differences between the groups. In Flemmig et al. 2012[36], the results shows that air

polishing group always presents significantly lower total viable bacterial counts, whether immediately after or at day 10 or day 90. Moreover, there is a lack of consensus regarding the effect of a range of antimicrobials therapies as adjuncts to debridement in patients undergoing SPT.[20,41] Locally-delivered antimicrobials, such as chlorhexidine mouthwashes may aid during SPT by eradicating any residual microbes, preventing the recolonisation of debrided tooth surfaces.[42]

Overall, air polishing devices also prove to be more comfortable to the patient, only Flemmig et al. 2012 [36] shows no differences. Conventional instrumentation using curettes and ultrasonic devices may cause pain.[12,43] The results from the study of Flemmig et al. 2012 [36] may be explained by the fact that anaesthesia was used during the intervention of the control group, and it is not possible to effectively evaluate the discomfort caused by this procedure. Müller et al. 2014 [27] reports that the most frequent comment made by the patients was a cold sensation during air-polishing and a bad power taste.

Of the few studies that evaluated professional time, all shows the superiority of air polishing devices in this parameter.

In addition to the clinical, microbiological and the other patient-centred aspects, Simon et al. 2015 [22] also demonstrated that air polishing with glycine powder results in considerably less soft tissue damage compared to ultrasonic scaling or air polishing with sodium bicarbonate, thus demonstrating that glycine air polishing is safe and a less invasive option. The particles of glycine are approximately four times smaller than particles of sodium bicarbonate powder, it consequently results in about 80% lower abrasiveness of polishing with glycine powder on the roots of humans' teeth. Also, the chiselled shape of the particles of sodium bicarbonate may cause more abrasion to the soft and hard tissues as compared to glycine powder.[22] Spraying with glycine powder seems to result in less gingival trauma and less surface modifications even compared with conventional therapy (curettes and ultrasonic devices).[44–46] Since in general no adverse effects were reported or, if any [27,35], they were minor and never involved emphysema, we conclude that air polishing devices are a safe treatment option to be used as part of SPT.

Our review supports the findings of previous systematic reviews, revealing that the use of air polishing devices in patients undergoing SPT showed similar efficacy in reducing periodontal inflammation and controlling biofilm compared to conventional therapy.[11,18] However, it should be noted that direct comparison with Nascimento et al. 2021 [11] systematic review should not be done, since the author included studies where the use of air polishing devices was adjuvant for conventional therapies. Moreover and contrasting our findings, Zhang et al.'s 2019 systematic review [4] adds that neither air polishing devices nor US debridement showed superior clinical effect. Bühler et al. 2016's [12] systematic review supports the evidence found

in our systematic review, highlighting the superiority of air polishing devices on patient perception of periodontal treatment.

From our observations, both air polishing devices and other conventional techniques are clinically effective treatment options for SPT but based on the above data of the studies included in this systematic review, it was found that air polishing devices present comparable clinical outcomes with a not yet consensual trend towards better microbiological behaviour, and with less time and greater satisfaction when compared to conventional treatment.

Nevertheless, when two treatment options present comparable clinical results, the one that proves to be more comfortable, faster and less invasive is preferable, especially when we are discussing a treatment that will have a regular and lifelong character.[14]The association between the patient's perception of the therapy used and compliance appears to be plausible. Although this association is not yet clearly defined in Periodontitis, several chronic diseases show this tendency.[47]

Besides the fact that air polishing devices seem to be at least an effective intervention for periodontal maintenance, we must not forget that these are not capable of removing calculus, due to the low abrasive capacity of their powders, and therefore, in these cases, it is necessary to resort to means capable of doing so, such as hand instruments or US. However, between SPT visits, due to their regular nature, there may be no need for calculus removal, as there has not been time for mineralisation of the bacterial deposits.[8,25,35]

Limitations

This systematic review has, however, several limitations. First, all included studies present an overall high risk of bias, mainly because of non-blinded participants/personnel (blinding intervention of participants and personnel in clinical procedures was impossible, it is easy to distinguish between the various forms of treatment). Also, in relation to the process of randomisation and allocation of treatment, some studies present some flaws in their explanation, which consequently may question their validity. Additionally, in our review, one of the studies had not blinded evaluators, which may also call into question the results present by this study[23]. One aspect that is highlighted is the industry's involvement for the most part of the studies. This fact ought to cause the reader to be cautious as the results of the studies may be subject to large bias.

We are aware that more studies have data related to the outcomes of interest of this systematic review, namely Zhao et al. 2015[48], however this study is published in Chinese and we only included RCTs in English, Portuguese, and Spanish.

The year of publication of the studies ranged from 2003 to 2021, thus there was an 18-year interval between the oldest and the most recent study. This implies that in this interval, there have been developments in the air-polishing devices, in the powders used, and as well as in their application protocol. Moreover, in the included studies there was a great variety of air polishing devices, with different powder emission rates, air pressures, angulations, directions and work distances and time of applications, as well as powders with different properties. In addition, some of the brands of powders [19,23,24] used , as well as air polishing units [10,23,34] were not mentioned by the authors, an aspect that is important and that limits this review because different powders and air polishing units have different effects. [28]

Also, in certain studies, the control group consisted of a combination of hand scaling and ultrasonic instrumentation, which should be avoided in future studies, since in these studies there is no control group to allow us to evaluate the effect of each therapy, so it is not possible to determine how much combined treatment may affect the results.

Some studies included smokers in their sample, which may have influenced both the primary and the remaining secondary outcomes (clinical and microbiological). According to Ramseier et al. 2015 [21], smokers demonstrate lower mean BoP concomitantly with an increased prevalence of residual PD, which shows the importance of of discriminating the sample with regard to smokers.

None of the studies presented a follow-up higher than one year. The results found in studies with follow-up of only one week should be interpreted with caution because as we know a longer interval of time is required to allow healing of periodontal tissues.

Although data about bacterial plaque, namely bacterial counts or identification, belongs to secondary outcomes, it is important to note the sources of heterogeneity resulting from sampling and processing methods of microbiologic samples, which precludes an accurate comparison between studies.

Directions for further research

Considering the prominence displayed by local inflammation parameters in assessing the risk of periodontal disease progression, further studies should not be limited to the most frequently assessed clinical parameters and should also explore the assessment of the gingival crevicular fluid, as an inflammatory fluid of excellence.[49]

To allow for a better comparison of results, authors of future RCTs should consider to properly apply eligibility criteria concerning smoking habits and periodontal disease classification. The clarification of the classification of periodontal disease of patients in each study is of extreme importance, so that we do not compare patients who are both on SPT, but with great disparities

regarding the loss of attachment evidenced. They also should use a very detailed protocol that allows standardising the duration of the various forms of treatment, the assessment of clinical parameters/patient comfort (with validated tolls like Visual Analogue Scale (VAS)), and methods for subgingival plaque sampling and microbiologic analysis. We also advise to carry out studies with large sample sizes and longer follow-up times.

CONCLUSION

Through the results of this systematic review, it can be concluded that both air polishing devices and other conventional techniques show similar clinical efficacy, however air polishing devices show a not yet consensual trend towards better biological behaviour and is also a safe, faster, and more comfortable option for the patients undergoing SPT. Despite the limitation of air polishing devices on calculus removal, may not be important because patients on a frequent periodontal maintenance therapy are less likely to accumulate subgingival calculus.

However, even the possible impact of industry funding, the interpretation of the results of this systematic review, should be cautious. In order to offer definitive and better recommendations, high quality studies with greater homogeneity and a longer follow-up time would be necessary.

CLINICAL RELEVANCE

Scientific rationale for study

In recent times, air polishing devices are gaining increasing prominence as an alternative therapy for patients undergoing SPT.

Principal findings

Air polishing devices show similar clinical efficacy and better biological outcomes than conventional techniques. Their safety, comfort for the patient and shorter working time were supported by the evidence of this review.

Practical implications

Air polishing devices may be considered an effective, low invasive and comfortable approach. It can be used exclusively in patients without calculus, but if there are any, the remaining methods (hand instruments and/or US debridement) can be used.

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APPENDIX I- Author Guidelines

Author Guidelines

Sections

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New submissions should be made via the Research Exchange submission portal **https://wiley.atyponrex.com/journal/IDH**. Should your manuscript proceed to the revision stage, you will be directed to make your revisions via the same submission portal. You may check the status of your submission at any time by logging on to submission.wiley.com and clicking the "My Submissions" button. For technical help with the submission system, please review our FAQs or contact **submissionhelp@wiley.com**.

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3. Acknowledgments;
4. Abstract structured (intro/methods/results/conclusion) or unstructured
5. Up to seven keywords;
6. Main body;
7. Clinical relevance;
8. References;
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Acknowledgments

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Abstract

The abstract should not exceed 250 words and should be arranged in a structured fashion (to include objectives, methods, results and conclusions.) It should state the purpose of the study, basic procedures (study subject/patients and methods), main findings (specific data and statistical significance), and principal conclusions.

Keywords

Please provide 3-6 keywords. Whenever possible, keywords should be taken from those recommended by the US National Library of Medicine's Medical Subject Headings (MeSH) browser list at **www.nlm.nih.gov/mesh**.

Main Text of Original Articles

Should include introduction, study population and methodology, results and discussions.

Introduction: Present the background briefly, but do not review the subject extensively. Give only pertinent references. State the specific questions you want to answer.

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Discussion: Do not repeat in detail data given in the Results section. Emphasize the new and important aspects of the study. Relate the observations to other relevant studies. On the basis of your findings (and others) discuss possible implications/conclusions.

Clinical Relevance (Original Articles and Review Articles)

This section is aimed at giving clinicians a reading light to put the present research in perspective. It should be no more than 100 words and should not be a repetition of the abstract. It should provide a clear and concise explanation of the rationale for the study, of what was known before and of how the present results advance knowledge of this field. If appropriate, it may also contain suggestions for clinical practice. It should be structured with the following headings: scientific rationale for study, principal findings, and practical implications. Authors should pay particular attention to this text as it will be published in a highlighted box within their manuscript; ideally, reading this section should leave clinicians wishing to learn more about the topic and encourage them to read the full article.

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If a method or tool is introduced in the study, including software, questionnaires, and scales, the author should state the license this is available under and any requirement for permission for use. If an existing method or tool is used in the research, the authors are responsible for checking the license and obtaining the permission. If permission was required, a statement confirming permission should be included in the Methods and Materials section.

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1. King VM, Armstrong DM, Apps R, Trott JR. Numerical aspects of pontine, lateral reticular, and inferior olivary projections to two paravermal cortical zones of the cat cerebellum. J Comp Neurol 1998;390:537-551.

Book

2. Voet D, Voet JG. Biochemistry. New York: John Wiley & Sons; 1990. 1223 p.

Internet document

3. American Cancer Society. Cancer Facts & Figures 2003. http://www.cancer.org/downloads/STT/CAFF2003PWSecured.pdf Accessed March 3, 2003

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Tables should be self-contained and complement, not duplicate, information contained in the text. They should be supplied as editable files, not pasted as images. Legends should be concise but comprehensive – the table, legend, and footnotes must be understandable without reference to the text. All abbreviations must be defined in footnotes. Footnote symbols: †, ‡, §, ¶, should be used (in that order) and *, **, *** should be reserved for P-values. Statistical measures such as SD or SEM should be identified in the headings.

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Legends should be concise but comprehensive – the figure and its legend must be understandable without reference to the text. Include definitions of any symbols used and define/explain all abbreviations and units of measurement. If micrographs are used, information about staining methods and magnification should be given.

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Author Guidelines Updated 08 February 2021

Consulted on 5 July 2021

APPENDIX II-PROSPERO Record

Systematic review

To edit the record click *Start an update* below. This will create a new version of the record - the existing version will remain unchanged.

1. * Review title.

Give the title of the review in English

Do air polishing devices efficaciously control local inflammation in supportive periodontal therapy? A systematic review

2. Original language title.

For reviews in languages other than English, give the title in the original language. This will be displayed with the English language title.

3. * Anticipated or actual start date.

Give the date the systematic review started or is expected to start.

01/12/2020

4. * Anticipated completion date.

Give the date by which the review is expected to be completed.

01/07/2021

5. * Stage of review at time of this submission.

Tick the boxes to show which review tasks have been started and which have been completed.
Update this field each time any amendments are made to a published record.

Reviews that have started data extraction (at the time of initial submission) are not eligible for inclusion in PROSPERO.
If there is later evidence that incorrect status and/or completion date has been supplied, the published PROSPERO record will be marked as retracted.

This field uses answers to initial screening questions. It cannot be edited until after registration.

The review has not yet started: No

Review stage	Started	Completed
Preliminary searches	Yes	No
Piloting of the study selection process	Yes	No
Formal screening of search results against eligibility criteria	Yes	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

Provide any other relevant information about the stage of the review here.

8. * Named contact.

The named contact is the guarantor for the accuracy of the information in the register record. This may be any member of the review team.

Dr. Orlando Martins

Email salutation (e.g. "Dr Smith" or "Joanna") for correspondence:
Dr. Orlando Martins

7. * Named contact email.

Give the electronic email address of the named contact.

ortmm@yahoo.com

8. Named contact address

PLEASE NOTE this information will be published in the PROSPERO record so please do not enter private information, i.e. personal home address

Give the full institutional/organisational postal address for the named contact.

Institute of Periodontology, Faculty of Medicine, University of Coimbra

9. Named contact phone number.

Give the telephone number for the named contact, including international dialling code.

10. * Organisational affiliation of the review.

Full title of the organisational affiliations for this review and website address if available. This field may be completed as 'None' if the review is not affiliated to any organisation.

Institute of Periodontology, Faculty of Medicine, University of Coimbra

Organisation web address:

11. * Review team members and their organisational affiliations.

Give the personal details and the organisational affiliations of each member of the review team. Affiliation refers to groups or organisations to which review team members belong. NOTE: email and country now MUST be entered for each person, unless you are amending a published record.

Miss Ana Rita Carvalho Costa. Faculdade de Medicina da Universidade de Coimbra
Dr Daniela Silva. Institute of Periodontology, Faculty of Medicine, University of Coimbra
Dr Orlando Martins. Institute of Periodontology, Faculty of Medicine, University of Coimbra

12. * Funding source(s)/sponsors.

Details of the individuals, organizations, groups, companies or other legal entities who have funded or sponsored the review.

Institute of Periodontology, Faculty of Medicine, University of Coimbra

(Grant number(s))
State the funder, grant or award number and the date of award

13. * Conflicts of interest.

List actual or perceived conflicts of interest (financial or academic).

None

14. Collaborators.

Give the name and affiliation of any individuals or organisations who are working on the review but who are not listed as review team members. NOTE: email and country must be completed for each person, unless you are amending a published record.

15. * Review question.

State the review question(s) clearly and precisely. It may be appropriate to break very broad questions down into a series of related more specific questions. Questions may be framed or refined using PI(E)COS or similar where relevant.

In patients undergoing periodontal maintenance therapy, do air flow systems result in better clinical outcomes than ultrasonic instrumentation or manual scaling?"

P: patients undergoing periodontal maintenance therapy / supportive periodontal therapy
I: air flow systems
C: ultrasonic instrumentation or manual scaling
O: clinical parameters (primary outcome: bleeding on probing (BoP); secondary outcomes: probing depth (PD)/ pocket probing depth (PPD); clinical attachment level (CAL); plaque index (PI); gingival recession (GR) and patient tolerance)

16. * Searches.

State the sources that will be searched (e.g. Medline). Give the search dates, and any restrictions (e.g. language or publication date). Do NOT enter the full search strategy (it may be provided as a link or attachment below.)

We will search the following electronic bibliographic databases: PubMed, Cochrane Library, Web of Science (all databases), Clinical Trials, MedRxive and Embase.
Filters: Articles published in English, Portuguese, and Spanish only.
Search dates (from and to): January/1987 to March/2021
The references of the included studies will be evaluated to identify potentially relevant articles.

17. URL to search strategy.

Upload a file with your search strategy, or an example of a search strategy for a specific database, (including the keywords) in pdf or word format. In doing so you are consenting to the file being made publicly accessible.

Or provide a URL or link to the strategy. Do NOT provide links to your search results.

Do not make this file publicly available until the review is complete

18. * Condition or domain being studied.

Give a short description of the disease, condition or healthcare domain being studied in your systematic review.

Periodontal disease is a condition associated with the inflammatory
destruction of the periodontium that lastly leads to tooth
loss. Periodontal disease is clinically characterized by clinical attachment
loss (CAL) and bleeding on probing (BoP) accompanied
by increased probing pocket depth (PPD) and/or gingival
recession.

19. * Participants/population.

Specify the participants or populations being studied in the review. The preferred format includes details of both inclusion and exclusion criteria.

Patients under undergoing periodontal maintenance therapy / supportive periodontal therapy
Exclusion criteria: patients with a systemic commitment (pregnancy, diabetes) or using any medications (eg, antibiotics, anti-inflammatory drugs) within 1 month before the trial and patients with dental implants

20. * Intervention(s), exposure(s).

Give full and clear descriptions or definitions of the interventions or the exposures to be reviewed. The preferred format includes details of both inclusion and exclusion criteria.

Use of air flow systems on supportive periodontal therapy

21. * Comparator(s)/control.

Where relevant, give details of the alternatives against which the intervention/exposure will be compared (e.g. another intervention or a non-exposed control group). The preferred format includes details of both inclusion and exclusion criteria.

Ultrasonic instrumentation or manual scaling

22. * Types of study to be included.

Give details of the study designs (e.g. RCT) that are eligible for inclusion in the review. The preferred format includes both inclusion and exclusion criteria. If there are no restrictions on the types of study, this should be stated.

Randomized clinical trials

23. Context.

Give summary details of the setting or other relevant characteristics, which help define the inclusion or exclusion criteria.

24. * Main outcome(s).

Give the pre-specified main (most important) outcomes of the review, including details of how the outcome is defined and measured and when these measurement are made, if these are part of the review inclusion criteria.

Gingival inflammation

Measures of effect
Bleeding on probing (BoP) or bleeding index (BI) or gingival index (GI)

25. * Additional outcome(s).

List the pre-specified additional outcomes of the review, with a similar level of detail to that required for main outcomes. Where there are no additional outcomes please state 'None' or 'Not applicable' as appropriate to the review

Probing depth (PD)/ pocket probing depth (PPD); clinical attachment level (CAL) and plaque index (PI), gingival recession (GR) and patient tolerance

Measures of effect

26. * Data extraction (selection and coding).

Describe how studies will be selected for inclusion. State what data will be extracted or obtained. State how this will be done and recorded.

The titles and abstracts of studies retrieved from the databases search will be independently screened by two independent authors (AC and DS) to identify studies that potentially meet the inclusion criteria. The full text of these potentially eligible studies will be obtained and independently assessed for eligibility by two review authors (AC and DS). Any disagreement between them over the eligibility of specific studies will be resolved through discussion with a third reviewer (OM).
The data will be extracted according to the PRISMA statement (PRISMA flow chart).
The data will be extracted to a standardized form, including authors and year of publication, sample data (number and mean age of patients), follow-up and study design, study groups, air polishing characteristics (power type, equipment, and nozzle), clinical and mode application of air flow systems, primary and secondary outcomes, adverse effects, and source of funding. It was also extracted information for the assessment of the risk of bias. If missing data exists, the study authors will be contacted to provide the information. Two review authors will extract data independently, and any discrepancies will be resolved through discussion with a third author.

27. * Risk of bias (quality) assessment.

State which characteristics of the studies will be assessed and/or any formal risk of bias/quality assessment tools that will be used.

The clinical trials' quality will be assessed using the bias risk assessment tool described in the Cochrane Handbook of Systematic Reviews of Interventions (Version 6.1.0).
Two review authors will independently assess the risk of bias in included studies by considering the tools, and any disagreements will be settled by discussion, with a third review author's involvement where necessary.

28. * Strategy for data synthesis.

Describe the methods you plan to use to synthesise data. This must not be generic text but should be specific to your review and describe how the proposed approach will be applied to your data.
If meta-analysis is planned, describe the models to be used, methods to explore statistical heterogeneity, and software package to be used.

The authors will provide a narrative synthesis of the included studies' findings.

29. * Analysis of subgroups or subsets.

State any planned investigation of 'subgroups'. Be clear and specific about which type of study or participant will be included in each group or covariate investigated. State the planned analytic approach.

Non appliable

30. * Type and method of review.

Select the type of review, review method and health area from the lists below.

Type of review

Cost effectiveness	No
Diagnostic	No
Epidemiologic	No
Individual patient data (IPD) meta-analysis	No
Intervention	Yes
Living systematic review	No
Meta-analysis	No
Methodology	No
Narrative synthesis	Yes
Network meta-analysis	No
Pre-clinical	No
Prevention	No

Prognostic	No
Prospective meta-analysis (PMA)	No
Review of reviews	No
Service delivery	No
Synthesis of qualitative studies	No
Systematic review	Yes
Other	No

Health area of the review

Alcohol/substance misuse/abuse	No
Blood and immune system	No
Cancer	No
Cardiovascular	No
Care of the elderly	No
Child health	No
Complementary therapies	No
COVID-19	No
Crime and justice	No
Dental	Yes
Digestive system	No
Ear, nose and throat	No
Education	No
Endocrine and metabolic disorders	No
Eye disorders	No
General interest	No
Genetics	No
Health inequalities/health equity	No
Infections and infestations	No
International development	No
Mental health and behavioural conditions	No
Musculoskeletal	No
Neurological	No
Nursing	No
Obstetrics and gynaecology	No
Oral health	No
Palliative care	No
Perioperative care	No
Physiotherapy	No
Pregnancy and childbirth	No
Public health (including social determinants of health)	No
Rehabilitation	No
Respiratory disorders	No
Service delivery	No
Skin disorders	No
Social care	No
Surgery	No

Tropical Medicine	No
Urological	No
Wounds, injuries and accidents	No
Violence and abuse	No

31. Language.

Select each language individually to add it to the list below, use the bin icon to remove any added in error.

English

There is an English language summary.

32. * Country.

Select the country in which the review is being carried out. For multi-national collaborations select all the countries involved.

Portugal

33. Other registration details.

Name any other organisation where the systematic review title or protocol is registered (e.g. Campbell, or The Joanna Briggs Institute) together with any unique identification number assigned by them.
If extracted data will be stored and made available through a repository such as the Systematic Review Data Repository (SRDR), details and a link should be included here. If none, leave blank.

34. Reference and/or URL for published protocol.

If the protocol for this review is published provide details (authors, title and journal details, preferably in Vancouver format)

No I do not make this file publicly available until the review is complete

35. Dissemination plans.

Do you intend to publish the review on completion?

Yes

36. Keywords.

Give words or phrases that best describe the review. Separate keywords with a semicolon or new line. Keywords help PROSPERO users find your review (keywords do not appear in the public record but are included in searches). Be as specific and precise as possible. Avoid acronyms and abbreviations unless these are in wide use.

37. Details of any existing review of the same topic by the same authors.

If you are registering an update of an existing review give details of the earlier versions and include a full bibliographic reference, if available.

38. * Current review status.

Update review status when the review is completed and when it is published.
New registrations must be ongoing so this field is not editable for initial submission.

Review_Ongoing

39. Any additional information.

Provide any other information relevant to the registration of this review.

40. Details of final report/publication(s) or preprints if available.

Leave empty until publication details are available OR you have a link to a preprint (NOTE: this field is not editable for initial submission).
List authors, title and journal details preferably in Vancouver format.