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REVIEW

The effect of periodontal treatment on *Helicobacter pylori*-infection: a systematic review

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Abstract

Helicobacter pylori (*H. pylori*), a bacterium widely distributed in the world's population, represents the most common cause of chronic gastritis and the main risk factor for stomach cancer. The main obstacle to the eradication of *H. pylori* is antibiotic resistance, therefore new therapeutic strategies are necessary. Recently, periodontitis has been correlated with several systemic diseases, including *H. pylori*-associated gastritis. The common pathogenetic link between these two diseases is the chronic inflammation induced by bacteria in the oral cavity and stomach. This systematic review aims to evaluate the benefits of non-surgical periodontal treatment (NSPT) on *Helicobacter pylori* eradication. PubMed, Scopus, Web of Science, and Cochrane were searched using the MESH terms "Helicobacter pylori" and "periodontal treatment", "Helicobacter pylori" and "periodontal", "Helicobacter pylori" and "scaling root planning" from January 2015 to January 2025, leading to 11 records included in the final analysis. The periodontal treatments evaluated in the studies are scaling and root planing and mouthwashing, in addition to antibiotic protocols for *H. pylori* eradication (HPE). A quality assessment and risk-of-bias of the studies were also performed. There is evidence that patients with *H. pylori* infection benefit from NSPT. The limitations of the studies examined are the small samples, the short follow-up, and the few numbers of randomized controlled trials. According to our data, NSPT might be included in HPE guidelines.

Keywords Helicobacter pylori · Inflammation · Microbioma · Periodontal treatment · Scaling and root planning

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Abbreviations

AGS	Gastric adenocarcinoma cells
CAL	Clinical attachment loss
FMBS	Full mouth bleeding score
FMD	Full mouth disinfection
FMPS	Full mouth plaque score
GB	Gastric biopsy
GI	Gingival index
H357	Oral epithelial cells
HPE	H. pylori eradication
H. pylori	Helicobacter pylori
HPI	H. pylori infection
HPS	H. pylori saliva antigen test
HPT	H. pylori systemic treatment
IL-1	Interleukin-1β
IL-6	Interleukin-6
IL-17	Interleukin-17
MALT	Mucosa-associated lymphoid tissue
NSPT	Non-surgical periodontal treatment
NEW	Rinsing with NEW
NEW-PT	Rinse with NEW and periodontal treatment
NS	Saline rinse
NS-PT	Saline rinse and periodontal treatment
PCR	Polymerase chain reaction
PD	Probing depth
PDL	Periodontal ligament cells
PI	Plaque index
RAL	Relative attachment level
RCT	Randomized controlled trial
SS	Supragingival scaling
TNF-α	Tumor necrosis factor-α
UBT	Urea breath test
WHO	World Health Organization

Introduction

Helicobacter pylori (*H. pylori*) is a Gram-negative, spiral-shaped bacterium that colonizes the gastric mucosa, being one of the most widespread bacterial infections worldwide [1–4]. It is highly adapted to survive in the stomach's harsh acidic environment through mechanisms such as urease production, which neutralizes stomach acid [5–8]. *H.pylori* infection (HPI) is usually acquired in childhood and can persist for life if left untreated [9–12]. While many individuals infected with *H. pylori* remain asymptomatic, others develop various gastrointestinal and systemic diseases. It is the leading cause of chronic gastritis and peptic ulcers, affecting both the stomach and duodenum [13, 14]. The infection triggers immune responses and

inflammation that damage the stomach lining, leading to significant discomfort and health risks [15]. *H. pylori* is also the major risk factor for gastric cancer [16]. The World Health Organization (WHO) classifies *H. pylori* as a Class I carcinogen, given its strong association with gastric adenocarcinoma [17]. This makes it one of the most dominant infectious carcinogens globally, contributing to a considerable number of cancer cases each year. Additionally, it plays a crucial role in the development of mucosa-associated lymphoid tissue (MALT) lymphoma, a rare but severe stomach cancer [18]. Nevertheless, *H. pylori's* virulence has no elective tropism on the gastrointestinal system: increasing evidence suggests its involvement in various extragastric diseases, including neurological (multiple sclerosis, Parkinson's disease, Guillain-Barré syndrome) cardiovascular (coronary atherosclerotic disease, myocardial infarction), dermatological (rosacea, psoriasis, chronic urticaria, alopecia areata), metabolic (diabetes mellitus, insulin resistance syndrome and metabolic syndrome), and immune disorders (rhinitis,asthma and eosinophilic esophagitis) [19–21]. Intriguingly, several studies have proposed links between HPI and conditions such as Alzheimer's disease, stroke, and certain autoimmune disorders (autoimmune bullous diseases and autoimmune neutropenia), although more research is needed to establish definitive connections [22, 23]. Despite its well-documented role in disease, treating HPI presents significant challenges due to rising antibiotic resistance [24]. Standard *H.pylori* eradication (HPE) regimens typically include triple or quadruple therapy combining antibiotics with proton pump inhibitors, but their effectiveness is declining due to bacterial resistance [25, 26]. This growing issue has prompted researchers to explore alternative strategies, including the development of vaccines, probiotics like Lactobacillus and Bifidobacterium, and novel antimicrobial agents [27–29].

Periodontitis is a chronic inflammatory disease that affects the supporting structures of the teeth, including the gums, periodontal ligament, and alveolar bone. It is primarily caused by bacterial infections that lead to progressive tissue destruction and, if left untreated, can result in tooth loss [30, 31]. The development of periodontitis follows a complex interaction between bacterial plaque, the host immune response, and environmental or genetic factors [32, 33]. The disease progresses through recurrent acute episodes, where bursts of destruction occur at specific sites, followed by remission [34]. Periodontal disease is characterized by the formation of deep periodontal pockets, gingival inflammation, attachment loss, and alveolar bone resorption [35, 36]. The inflammatory process involves the release of cytokines such as tumor necrosis factor-α (TNF-α), interkeuline-1β (IL-1β), interleukine-6 (IL-6), and interleukine-17 (IL-17), which contribute to connective tissue breakdown and alveolar bone resorption [37, 38]. Without intervention, the disease progresses from mild gingivitis to advanced periodontitis, leading to irreversible damage and potential tooth loss [39]. Key bacterial pathogens involved in the pathogenesis of periodontitis are *Porphyromonas gingivalis, Tannerella forsythia*, and *Treponema denticola*, collectively known as the "red complex" bacteria [40–42]. These bacteria play a crucial role in initiating and propagating the inflammatory response [38, 40, 43]. Beyond its impact on oral health, periodontitis has significant systemic consequences, as increasing evidence links it to a variety of chronic diseases, namely cardiovascular Disease (CVD), such as myocardial infarction, stroke,

and atherosclerosis [35, 44, 45], diabetes Mellitus and insulin resistance [46, 47]; various cancers, including gastrointestinal, pancreatic, and colorectal cancers [32, 48]; obesity and metabolic syndrome [32]; thyroid disease [49]; neurological disorders such as Alzheimer's disease [50]; respiratory diseases, such as pneumonia and chronic obstructive pulmonary disease (COPD) [51], and, finally, adverse pregnancy outcomes (preterm birth, low birth weight, and preeclampsia) [51–53]. Therefore, periodontitis is more than just an oral health issue, contributing to the development and maintenance of systemic diseases and overall health decline [36, 54]. Given its high prevalence and potential to exacerbate other chronic conditions, early diagnosis, effective treatment, and prevention strategies such as the administration of oral probiotics are crucial to maintaining both oral and general health [54–57].

The connection between H. pylori and periodontitis is becoming increasingly evident, with numerous studies revealing how the oral cavity serves as a potential reservoir for this bacterium [58–60]. The presence of H. pylori in periodontal pockets, dental plaque, and saliva indicates that it can persist in the mouth and potentially contribute to the progression of periodontal disease, in addition to the "red complex" bacteria [61–63].Individuals with chronic periodontitis tend to harbor *H. pylori* in their oral cavities more frequently than those with healthy gums [64, 65].

This association is likely due to the inflammatory environment and deep periodontal pockets, which create a niche for bacterial colonization [66, 67]. The inflammation caused by periodontitis leads to the destruction of the supporting structures of the teeth, and the presence of *H. pylori* could exacerbate this damage by increasing inflammation and modifying the oral microbiota [68, 69]. Specifically, Soto C. et al., demonstrated for the fost time a direct interaction between *H.pylori* and *Porphyromonas gingivalis*: the incubation with *H.pylori* increases *Porphyromonas gingivalis* virulence, enhancing *Porphyromonas gingivalis* biofilm formation, bacterial internalization into oral keratinocytes and hemagglutination [70]. Furthermore, the persistence of *H. pylori* in the mouth may play a crucial role in the reinfection of the stomach [21, 71]. Recent evidence suggests that the gastric eradication of H. pylori can be compromised if the oral cavity remains untreated, as the bacteria may recolonize the gut through repeated swallowing of contaminated saliva [72, 73]. This raises an important clinical implication: treating *H. pylori* only with antibiotics targeting the stomach might not be sufficient, especially in individuals with periodontal disease [74, 75]. If H. pylori contributes to periodontitis, it could indirectly increase the risk of periodontitis-related systemic diseases [76, 77]. Moreover, the presence of *H. pylori* in the oral cavity may affect the effectiveness of eradication therapies, potentially requiring more aggressive or combined treatment approaches [78–80]. Standard HPE therapy remains the first line of treatment for gastric infections [81–83]. However, addressing the oral reservoir of *H. pylori* through periodontal therapy might significantly enhance eradication success and reduce the risk of reinfection [84–86]. In this regard, scaling and root planing (SRP), professional cleanings, and the use of antiseptic mouthwashes like chlorhexidine have shown promise in reducing oral *H. pylori* levels [87, 88]. This systematic review aims to assess if non-surgical periodontal treatment (NSPT) can HPE and reduce gastric reinfection risk, laying the basis for a further integrated approach between dentists and gastroenterologists (Fig. 1).

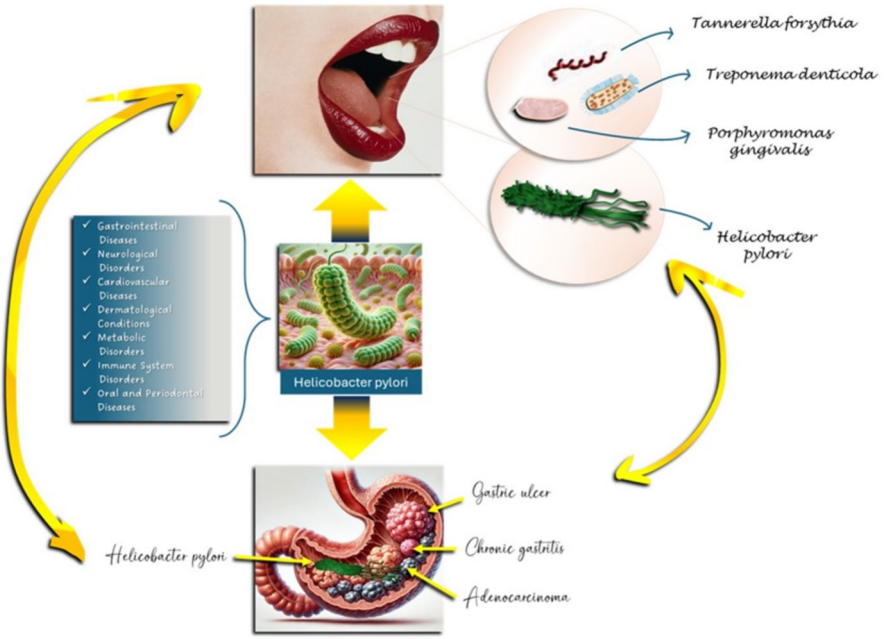

Fig. 1 Relationship between H. pylori and systemic diseases: the role of the oral cavity: the image illustrates the link between oral colonisation of H. pylori and its impact on systemic health. Oral pathogenic bacteria, including *Porphyromonas gingivalis*, *Treponema denticola,* and *Tannerella forsythia*, can facilitate the persistence of H. pylori in the oral cavity, leading to frequent reinfection of gastric mucosa. This bacterium, if ingested or transmigrated, can colony the stomach and contribute to serious diseases such as chronic gastritis, gastric ulcers, and gastric adenocarcinoma. In addition, H. pylori is associated with various systemic diseases, including neurological, cardiovascular, metabolic and immune system disorders

Materials and methods

PICO question

For RCT the question is: "Do patients with *Helicobacter pylori* infection (P) benefit (O) from periodontal treatment (I) than the control group (C)?" (Population: adult patients with *Helicobacter pylori* infection and periodontitis; Intervention: periodontal treatment; Comparison: control group, patients who have not received periodontal treatment but only Helicobacter pylori antibiotic protocol; Outcome: improvement of Helicobacter-associated gastritis in terms of clinical and/or laboratoristic and/or functional parameters).

For observational studies the question is the PIO: "Do patients with Helicobacter pylori infection (P) benefit (O) from periodontal treatment (I)?)?" (Population: adult patients with Helicobacter pylori infection and periodontitis; Intervention: periodontal treatment; Outcome: improvement of Helicobacter-associated gastritis in terms of clinical and/or laboratoristic and/or functional parameters).

Protocol and registration

Our search was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and registered in the International Prospective Register of Systematic Review Registry Guidelines (PROSPERO) CRD42025644571.

Search processing

The electronic databases consulted were PubMed, Scopus, Web of Science, and Cochrane, to find papers that answer the PICO question dating from 1 January 2015 to 20 January 2025. The following Medical Subject Headings (MESH) terms were used: "Helicobacter pylori" AND "periodontitis"; C: "Helicobacter pylori"; D: "periodontal"; E: "Helicobacter pylori"; F: "scaling root planning" (Table 1).

Inclusion and exclusion criteria

The inclusion criteria were the followings: (1) human subjects; (2) English language; (3) randomized controlled trials (RCT), clinical trials, cohort studies, and observational studies; (4) adult patients affected by both HPI and periodontitis; (5) patients receiving periodontal treatment; (6) timespan from 2015 to 2025.

Conversely, the exclusion criteria were the followings: (1) mice models; (2) other languages except English; (3) qualitative studies, reviews, meta-analysis, case reports, case series, editorials, and consensus reports; (4) off-topic articles; (5) in vitro studies; (6) inappropriate outcomes; (7) clinical trials in progress.

Data processing

A reviewer (M.C.F.) screened the records according to the inclusion and exclusion criteria. Any doubt was resolved through the consultation of a senior reviewer (F.I.). The selected articles were schematized in an Excel table and downloaded into reference manager software, in this case, Zotero (version 6.0.15).

Table 1 Article screening strategy

Articles screening strategy	KEYWORDS: A: "Helicobacter pylori"; B: "periodontitis" C: "Helicobacter pylori"; D: "periodontal" E: "Helicobacter pylori"; F: "scaling root planning"
	Boolean Indicators: "A" AND "B"
	Timespan: from January 1, 2015, to January 20, 2025
	Electronic Databases: Pubmed, Scopus, Web of Science and Cochrane

Quality assessment

The quality of the papers included was assessed by a reviewer, A.P., using the ROBINS, which is a tool developed to assess the risk of bias in the results of non-randomized studies that compare the health effects of two or more interventions. Seven points were evaluated, and each was assigned a degree of bias. A senior reviewer (F.I.) was consulted to clear up any doubts.

Results

Search results

A total of 170 records were collected using the MESH terms "Helicobacter pylori" and "periodontitis". A total of 107 records were collected using the MESH terms "Helicobacter pylori" and "periodontal". A total of 5 records were collected using the MESH terms "Helicobacter pylori" and "scaling root planning". In total, the records collected were 282. The automatic filters applied were only human, only in English, only clinical studies, and only articles. The consulted databases were PubMed (12), Scopus (102), Web of Science (133), and Cochrane (35). Duplicates (15) were manually removed, leading to 267 articles.

The screening phase consisted of the application of inclusion and exclusion criteria based on the analysis of the title and abstract. Only studies that focus on the effect of periodontal treatment on *Helicobacter pylori*-associated gastritis were selected. Studies about the effects of periodontal treatment on oral health or other systemic diseases and studies about the association between HPI and periodontitis but focusing on other fields, such as epidemiology, genetic, pathogenetic mechanisms, oral microbioma, or therapies other than periodontal treatments, were excluded because of the off-topic. After screening, 239 articles were excluded by the reviewer, leading to 19 reports sought for retrieval. resulting in 11 selected records.

The phase of eligibility was based on the complete reading of the articles, resulting in 11 studies for the final analysis (Fig. 2).

Quality assessment and risk of bias of included articles

The Risk of Bias (RoB) assessment across the eleven selected studies highlights a range of methodological approaches and levels of scientific rigor. The study by Song and Li (2013), along with Tongtawee et al. [89] and Yadollahzad et al. [98] all conducted as randomized controlled trials (RCTs) and evaluated using the RoB 2.0 tool—showed a moderate risk of bias, mainly due to potential deviations from the intended interventions and selective reporting of results, despite an overall adequate randomization process. Similarly, Figliuzzi et al. [93] and Chen et al. (2022), both prospective randomized studies analyzed with the ROBINS-I tool, exhibited a moderate risk of bias. They demonstrated reliable handling of missing data but some uncertainty in

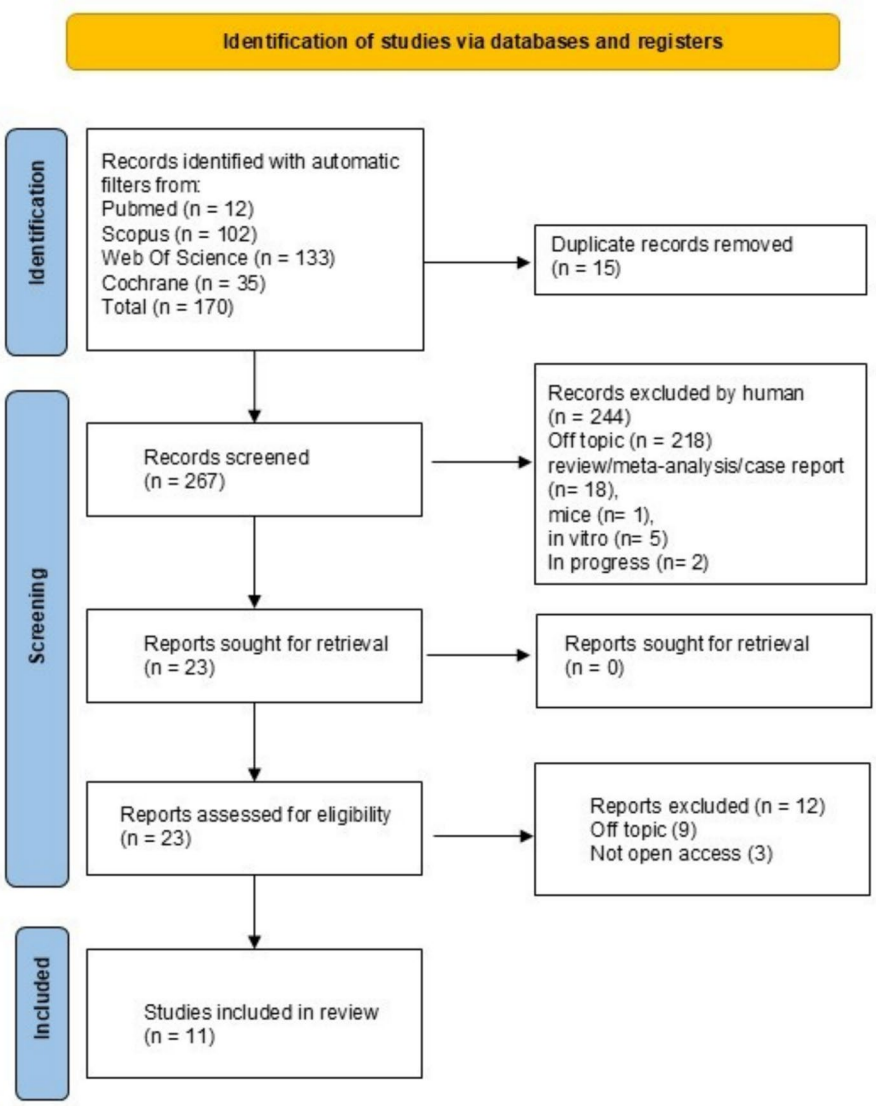

Fig. 2 Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 flow-chart

the selection of reported outcomes and adherence to the planned interventions. In contrast, observational studies such as Tsimpiris et al. (2021), Venkata et al. [92] and Zaric et al. [53] showed a high risk of bias, largely due to the absence of randomization and the presence of confounding variables, which weaken the reliability of their conclusions. Urrutia-Baca et al. [97] and Jia et al. (2009), also prospective randomized studies assessed using ROBINS-I, maintained a moderate risk of bias, particularly regarding the selection of reported results and some deviations from the intended interventions,

Table 2 Risk of bias assessment

Authors	Study Design	Bias Domain	Randomization Process	Deviations from Interventions	Missing Outcome Data	Measurement of Outcomes	Selection of Reported Results	Overall Bias
Song HY, Li Y (2013)	RCT	RoB 2.0	○	○	◍	◍	○	○
Tongtawee T. (2019)	RCT	RoB 2.0	○	○	◍	◍	○	○
Figliuzzi M.M. (2020)	Prospective Randomized	ROBINS-I	○	○	◍	○	○	○
Tsimpiris A. (2021)	Observational	ROBINS-I	●	○	◍	◍	○	●
Urrutia-Baca V.U. (2024)	Prospective Randomized	ROBINS-I	○	○	◍	◍	○	○
Venkata T. (2021)	Prospective Observational	ROBINS-I	●	○	◍	○	○	●
Chen K. (2022)	Prospective Randomized	ROBINS-I	○	○	◍	○	○	○
Yadollahzad A. (2022)	RCT	RoB 2.0	◍	◍	○	◍	○	○
Wongsuwanlert M. (2023)	Observational	NOS	○	○	◍	◍	○	○
Zaric et al. (2009)	Prospective	ROBINS-I	●	○	◍	○	○	●
Jia et al. (2009)	Prospective Comparative	ROBINS-I	○	○	◍	○	○	○

Legend:

- ◍ Low Risk
- ○ Moderate Risk
- ● High Risk

though they displayed accurate outcome measurement. Finally, Wongsuwanlert et al. (2023), an observational study evaluated using the Newcastle–Ottawa Scale (NOS), also demonstrated a moderate risk of bias, with strengths in outcome measurement but weaknesses related to data selection and transparency in reporting results. Overall, the RCTs emerge as the most robust source of evidence, despite the presence of moderate bias, while the observational and prospective studies, though offering valuable insights, appear more prone to methodological biases that limit their reliability (Table 2).

Discussion

The articles selected (Table 3) have been discussed by dividing them according to the type of periodontal treatment. For the exception of two studies concerning mouth-washes, a NSPT was applied, consisting into supra and subgingival scaling with or

Table 3 Studies concerning the effect of periodontal treatment on *Helicobacter pylori* infection (HPI)

Authors	Study design	Study sample (N.patients)	Follow-up	Parameters evaluated	Outcomes
Tongtawee T 2019 [89]	RCT	HPT (347) HPT + NSPT(342)	4 we. ForHPT; 3 mo. for SRP; 1 yrs. for reinfection	HP in saliva and GB by PCR; genes cagA and vacA; PI, GI, PD and RAL	No significant difference after initial eradication; In HPT + NSPT lower recurrence of HPI
Figliuzzi M.M., 2020 [93]	Prospective randomized	HPT (22) HPT + NSPT (22)	1,3,6 mo	UBT, PI, GI, PD, RAL, FMPS, FMBS	In HPT + NSPT group HPE and PI, GI, PD reduction; 100% HPT group had reinfection
Tsimpiris A, 2021 [94]	Observational	NSPT (33), HV (32)	3 mo	CAL,PD,PI, BOP; UBT, and PCR from saliva samples	Both HP (+) and HP (−) P improved periodontal markers post-treatment Greater clinical benefit in HP (+) with additional HPT 100% HPE after HPT Higher prevalence of gastric HP in patients with advanced periodontitis (stages 3 and 4) compared to less severe cases
Urrutia-Baca V.U, 2024 [97]	Prospective randomized	HPT + NS (25) HPT + NS + PT (25) HPT + NEW (25) HPT + NEW-PT (25)	4–16 we	PCR, gastric symptoms, GI, PD, CAL, and BOP	After 4 we. NEW-PT showed 96% of HPE; NEW reduced reinfection of 81,2%; Absence of gastric infection and symptoms in NEW group *vs.* the others without NEW

Table 3 (continued)

Authors	Study design	Study sample (N.patients)	Follow-up	Parameters evaluated	Outcomes
Venkata T., 2021 [92]	Prospective observational	NSPT group: periodontitis (30); control group: healthy patients (15)	Baseline,1 mo, 2 mo., 3 mo	GI, PI, PB, and CAL; PCR analysis	Significant reduction in the percentage of H. pylori in subgingival plaque in NSPT group
Chen K.., 2022 [91]	Prospective randomized	HPT-SS (65) HPT-NSPT (95)	2 mo. and 1 yrs	PD, CAL, and BOP	In HPT- NSPT group higher eradication rate at 2 mo; No differences between the two groups at 1 yrs
Yadollahzad A, 2022 [98]	RCT	40 P; HPT (20) Group B: anti-HPT + FMD (20)	1 mo., 6 mo	UBT; PI, GI,PD, and CAL	No significant difference at 1 mo.; Reinfection in 33,3% with HPT-FMD group *vs.* 53,3% HPT group at 6 mo
Wongsuwanlert M,2023 [100]	Observational	cagA- positive HP strains (10) cagA negative HP-strains (9)	5–15-60–120-360 min and 24 h. for eradication biofilm; 24 h for cell vitality and inflammatory CK	HP in the saliva and plaque; cagA mRNA; IL-1β, IL-6, IL-8 e TNF-α; (H357,AGS,PDL	83% biofilm eliminated after 24 h Reduction of H. pylori adhesion on H357 by 47.8% and on AGS by 62.9% Significant decrease in cagA gene expression after mouthwash treatment Decrease in inflammatory CK

Table 3 (continued)

Authors	Study design	Study sample (N.patients)	Follow-up	Parameters evaluated	Outcomes
Zaric et al., 2009 [90]	Prospective	Group A:triple therapy + NSPT(22) Group B:triple therapy (44): 21P HP + in gastric and oral samples; 23P HP + in gastric samples	3 mo	PCR, PI, GI, and CAL	Eradication of gastric HP:87,4% in group A vs 47,6% in group B; Eradication of oral HP:73% group A vs 33,3% group B
Jia et al., 2009 [3]	Prospective comparative	NSPT(56) no NSPT(51)	6 mo	UBT; GI, PI, CAL	Significantly lower H. pylori reinfection rate in patients undergoing plaque control
Song HY, 2019 [99]	Controlled Trials	431p	4 we	saliva H. pylori antigen test (HPS), UBT, gastroscopy, and gastric mucosal histopathological features	The use of mouthrinse treatment, either independently or in conjunction with periodontal therapy, can somewhat diminish the prevalence of oral H. pylori and enhance the eradication rate of stomach H. pylori

AGS gastric adenocarcinoma cells, *HPT* H. Pylori therapy, *CAL* clinical attachment loss, *CK* cytokines, *FMBS* full mouth bleeding score, *FMD* full mouth disinfection, *FMPS* full mouth plaque score, *GB* gastric biopsy, *GI*gingival index, *HPE* h.pylori eradication, *HPIH.pylori* infection, *HPS* saliva H. pylori antigen test,*HPT* H. pylori systemic treatment, *H357* oral epithelial cells, *HV* healthy volounteers, *NEW* rinsing with new, *NEW-PT* rinse with new and periodontal treatment, *NS* saline rinse, *NS-PT* saline rinse and periodontal treatment, *PCR* polymerase chain reaction, *PD* probing depth, *PDL* periodontal ligament cells, *PI* plaque index, *RAL* relative attachment level, *SRP* scaling and rootplanning, *SS* supragingival scaling, *UBT* urea breath test

without root planning. No study has taken into consideration surgical periodontal treatment.

The role of non-surgical periodontal treatment (NSPT) in helicobacter pylori-associated gastritis management

The randomized clinical trial by Tongtawee et al. involved 698 patients with gastric HPI, divided into two groups: one receiving standard antibiotic therapy—consisting in esomeprazole 20 mg twice a day plus clarithromycin 500 mg twice a day or metronidazole 400 mg three times a day (if resistant to clarithromycin) and amoxicillin 1000 mg twice a day—and the other receiving the same antibiotics combined with NSPT, consisting in SRP. Although no significant differences were observed in gastric eradication rates between the groups, the recurrence of HPI was significantly lower in patients who also received NSPT (OR 0.67; 95% CI 0.45–0.99). These findings suggest that the oral cavity may act as a reservoir for the bacterium and that periodontitis might play a role in the recurrence of *H.pylori*-associated gastritis, emphasizing the importance of periodontal status for definitive eradication of the bacterium [89].

These results are consistent with the prospective clinical study by Zaric et al., which evaluated the efficacy of combining periodontal therapy with triple antibiotic HPE-therapy compared with triple antibiotic HPE-therapy alone in for *H. pylori* associated gastritis. The triple therapy consisted of amoxicillin 2 g/day (g/d), clarithromycin 1 g/d, and Pantoprazole 80 mg/d, for 7 days. Basic periodontal therapy consisted of oral hygiene orientation, plaque and calculus removal with an ultrasonic device, SRP, as well as irrigation of periodontal pockets with 0.12% chlorhexidine-gluconate, performed during triple therapy, in one sitting. The results showed that 77.3% of patients undergoing combination therapy achieved eradication of gastric infection, compared with 47.6% of those treated with triple therapy alone. In addition, the eradication of oral H. pylori was more effective in the group with periodontal treatment (73%) than antibiotic treatment alone (33.3%). NSPT could improve the efficacy of systemic treatment as adjuvant and reduce the risk of recurrence [90].

In a prospective study, Chen et al. compared two different periodontal therapeutic protocols for patients with gastric HPI and periodontitis: one group received standard bismuth-containing quadruple antibiotic therapy plus supragingival scaling (SS), while another received the same antibiotic regimen combined with SRP. Periodontal parameters improved in both groups at 2 months. The SRP group showed a higher eradication rate (87.37% vs. 75.38%) detected by 13C-urea breath test (UBT)at 2 months, suggesting that deeper removal of the oral biofilm facilitates *H. pylori* elimination. However, no significant difference was found at 12 months. This implies the need to carry out frequently SRP throughout the year in patients affected both by HPI and periodontitis [91].

Some authors evaluated the effect of NSPT on oral HPI rather than gastric HPI. In a prospective observational study, Venkata et al. examined the effect of NSPT on *H. pylori* presence in subgingival plaques and saliva of patients with chronic periodontitis *vs.* healthy subjects. At three months, a significant reduction in H. pylori

levels in dental plaque was observed in the study group, reinforcing the role of the oral cavity in infection persistence [92].

In a prospective study Figliuzzi et al. evaluated 44 patients with biopsy-confirmed H. pylori-associated gastritis. After six months, the group received both the classical therapy with proton pump inhibitor plus antibiotics (tetracycline 250 mg, metronidazole 250 mg, and bismuth subcitrate 120 mg), and SRP achieved complete oral eradication of the bacterium, whereas in the group treated only with antibiotics, *H. pylori* remained present in the oral cavity in 100% of patients. This demonstrates that antibiotic therapy alone is effective for gastric eradication but not for oral eradication, leaving room for potential reinfections [93].

The prospective study by Jia et al. investigated the relationship between dental plaque control and HPI in the gastric mucosa. The researchers conducted a 13C urea breath test (13C-UBT) on 56 subjects who received professional dental plaque control and 51 subjects who did not. The results showed that *H. pylori* prevalence was significantly lower (19.64%) in the plaque control group compared to the control group (84.31%) after six months. The findings suggest that long-term dental plaque control may reduce gastric reinfection by *H. pylori*, highlighting the importance of oral hygiene in preventing H. pylori-associated gastritis [3].

In an observational study, Tsimpiris et al. analyzed the relationship between H. pylori and periodontitis in 33 patients with advanced periodontal disease and 32 healthy individuals. Even if H. pylori was not detected in the saliva of both groups, it was found in the stomachs of six patients with periodontitis and seven healthy subjects, a result contrasting with the above mentioned studies suggesting the prevalence of HP in saliva. HPI in stomach was found to be associated with increased severity of periodontitis (stages 3 and 4) and a faster rate of progression (grade C). However, no direct correlation emerged between the presence of *H.pylori*-associated gastritis and periodontal conditions. Furthermore, after treatment, all patients showed improvements in periodontal parameters, but the benefits were greatest in HP-positive patients who had also received antibiotic therapy. Specifically, probing pocket depth (PPD) was reduced by 1.3 mm in HP-positive patients compared with 0.9 mm in HP-negative patients.

The results therefore suggest that gastric HPI could influence the severity of periodontitis, although a direct link between HP and oral infection has not been demonstrated. Combined treatment of periodontitis and HP appears to significantly improve clinical outcomes, probably through a reduction in systemic inflammation [94].

The role of coadiuvant therapies in addition to NSPR in the management of Helicobacter pylori-associated gastritis

The use of specific mouthwashes and oral disinfection strategies represents an additional approach to improving HPI management. The prospective study by Urrutia-Baca et al. evaluated the efficacy of oral hygiene with neutral electrolyzed water (NEW) in combination with systemic therapy for gastric *H.pylori* eradication and reduction of recurrence. In a prospective, randomized, four-arm clinical trial, 100

patients with PCR-confirmed oral and gastric infection were divided into four groups: i) systemic therapy + saline rinse (NS); ii) systemic therapy + saline rinse and periodontal treatment (NS-PT); iii) systemic therapy + rinsing with NEW; iv) systemic therapy + rinse with NEW and periodontal treatment (NEW-PT). After four weeks, the NEW-PT group showed a significantly higher gastric eradication rate (96%) than the NS and NS-PT groups. In addition, the use of NEW reduced recurrence by 81.2% and improved symptomatic remission. After 16 weeks, therapeutic success (absence of gastric infection and symptoms) was 88.9% in patients treated with NEW, compared with 47.4% in patients without NEW [95, 96].

These results indicate that the use of NEW as a mouthwash, especially when combined with NSPT, enhances the efficacy of systemic therapy for HPE and prevents recurrence. This supports the integration of oral hygiene into treatment protocols for the management of HPI [97].

In a RCT, Yadollahzad et al. investigated the effect of full-mouth disinfection (FMD) on *H. pylori* recurrence. Specifically, the study aimed to determine if FMD, in conjunction with conventional antibiotic therapy, may lower H. pylori recurrence. Forty patients with HPI and chronic periodontitis participated in the study. They were split up as follows: group A (20 patients) received typical quadruple therapy (proton pump inhibitor, amoxicillin, clarithromycin, and bismuth) and quadruple therapy plus FMD for Group B (20 patients). At one- and six-months following treatment, the existence of H. pylori was confirmed by the urea breath test (14C-UBT). The findings demonstrated that 90% of patients with FMD and 75% of those without FMD tested negative for *H.pylori* after 1 month, according to the data, whereas 33.3% of patients with FMD and 53.3% of those without FMD exhibited recurrence after 6 months.

Therefore, it appears that adding FMD to antibiotic therapy reduces recurrence; nonetheless, there is no statistically significant difference between the groups [98].

Wongsuwanlert et al. studied a mouthwash containing polylysine and glycerol monolaurate, demonstrating that it reduced bacterial biofilm formation (− 83% in 24 h), inhibited H. pylori adhesion to oral epithelial (− 47.8%) and gastric cells (− 62.9%), decreased expression of the cagA gene (linked to bacterial virulence), and reduced pro-inflammatory cytokines, namely IL-8, IL-6, TNF-α. These findings suggest that regular use of specialized mouthwashes may improve HPE and lower recurrence rates.

Finally, the controlled trials by Song Y. et al. included 391 patients with dyspepsia and 40 healthy volunteers as controls who were tested for H. pylori infection in both the gastric and oral regions, with oral H. pylori being diagnosed using a salivary antigen (HPS) test, while gastric *H. pylori* was identified using the gold-standard 13C-urea breath test (13C-UBT). Based on these results, patients were divided into different treatment groups:

Group O–G + t: patients who showed positivity for gastric *H. pylori* while negative for oral H. pylori, who underwent the conventional triple therapy including a proton pump inhibitor (esomeprazole) and two antibiotics (amoxicillin and levofloxacin).

Group O + G + t: patients who tested positive for oral and gastric *H. pylori* and received only triple conventional therapy.

Group O + G + tm: patients tested positive for both oral and gastric *H. pylori* who used an antibacterial mouthwash consisting of chlorhexidine and tinidazole with triple therapy.

Group O + G + tmp: patients with positivity for both oral and gastric *H. pylori* who completed triple therapy, used a mouthwash and received expert periodontal treatment for removal of dental plaque and tartar.

Patients were re-evaluated for four weeks after treatment to assess gastric H. pylori eradication rates.

The study indicated that the presence of *H. pylori* in the oral cavity greatly influenced the efficacy of stomach eradication; in fact, in patients who were negative for oral *H. pylori* (O–G + t group), the eradication rate of gastric *H. pylori* was 93.3 percent, while in those who tested positive for both oral and gastric infection but were given only triple therapy (O + G + t group), the eradication rate dropped to 78.4 percent.

Notably, the introduction of additional oral therapies significantly increased the success rate: the cohort who used mouthwash (O + G + tm) showed an eradication rate of 90.0%, while participants who received both mouthwash and professional periodontal treatment (O + G + tmp) achieved the highest eradication rate of 94.7%.

These results further validated that treatment of oral H. pylori significantly decreased its presence in the oral cavity, thus improving gastric eradication results [99].

The limitations of the studies examined are their observational nature, the small sample size, the heterogeneity of the parameters evaluated, and the frequent absence of a control group. Herein, RCT with larger numbers of patients are mandatory for NSPT to be included in treatment guidelines for *H.pylori*-eradication [100].

Conclusions

The articles reviewed suggest clinical implications and implication for research.

NSPT is an effective adjuvant therapy for gastric HPI, primarily by reducing recurrence rather than aiding initial eradication. Supra- and subgingival scaling is the most effective periodontal treatment, as it lowers *H. pylori* levels in saliva and minimizes the oral reservoir, a key factor in reinfection. Additional oral treatments, such as chlorhexidine rinses, NEW, and mouthwashes with polylysine and glycerol monolaurate, help reduce biofilm formation, inhibit *H. pylori* adhesion, and downregulate virulence factors and inflammatory responses. These cost-effective interventions can lower healthcare burdens associated with HPI.

Further research is needed, including large-scale RCTs to confirm the role of NSPT in *H. pylori* management and etiopathogenetic studies to explore the interaction between “red complex” bacteria and *H. pylori*. For istance, the presence of *H. Pylori* in dental plaque could ehnance the virulence of periodontitis-associated bacteria. Understanding the link between oral and gut microbiota imbalances could lead to novel systemic treatment strategies, reinforcing the idea that

periodontitis and *H. pylori*-associated gastritis may be interconnected inflammatory conditions requiring an integrated therapeutic approach.

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Declarations

Conflict of Interest The authors declare no competing interests.

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References

1. Hoffman PS (2020) Amixicile: a concept therapeutic for treatment of chronic anaerobic infections. Br J Gastroenterol 2:138–142. https://doi.org/10.31488/bjg.1000108
2. Teoman I, Ozmeriç N, Ozcan G, Alaaddinoğlu E, Dumlu S, Akyön Y, Baloş K (2007) Comparison of different methods to detect helicobacter pylori in the dental plaque of dyspeptic patients. Clin Oral Investig 11:201–205. https://doi.org/10.1007/s00784-007-0104-5
3. Jia C-L, Jiang G-S, Li C-H, Li C-R (2012) Effect of dental plaque control on infection of helicobacter pylori in Gastric Mucosa. Tex Dent J 129:1069–1073
4. Hooi JKY, Lai WY, Ng WK, Suen MMY, Underwood FE, Tanyingoh D, Malfertheiner P, Graham DY, Wong VWS, Wu JCY et al (2017) Global prevalence of helicobacter pylori infection: systematic review and meta-analysis. Gastroenterology 153:420–429. https://doi.org/10.1053/j.gastro.2017.04.022
5. Botelho J, Mascarenhas P, Viana J, Proença L, Orlandi M, Leira Y, Chambrone L, Mendes JJ, Machado V (2022) An umbrella review of the evidence linking oral health and systemic noncommunicable diseases. Nat Commun 13:7614. https://doi.org/10.1038/s41467-022-35337-8
6. Shirataki Y, Kawase M, Sakagami H, Nakashima H, Tani S, Tanaka T, Sohara Y, Schelz Z, Molnar J, Motohashi N (2005) Bioactivities of Anastasia black (Russian sweet pepper). Anticancer Res 25:1991–1999
7. Nowack R (1946) Cranberry juice—a well-characterized folk-remedy against bacterial urinary tract infection. Wien Med Wochenschr 2007(157):325–330. https://doi.org/10.1007/s10354-007-0432-8

8. FitzGerald R, Smith SM (2021) An overview of helicobacter pylori infection. Methods Mol Biol Clifton NJ 2283:1–14. https://doi.org/10.1007/978-1-0716-1302-3_1
9. Hoshi K, Yamano Y, Mitsunaga A, Shimizu S, Kagawa J, Ogiuchi H (2002) Gastrointestinal diseases and halitosis: association of gastric helicobacter pylori infection. Int Dent J 52(Suppl 3):207–211. https://doi.org/10.1002/j.1875-595x.2002.tb00926.x
10. Sessa R, Pietro MD, Filardo S, Turriziani O (2014) Infectious burden and atherosclerosis: a clinical issue. World J Clin Cases 2:240–249. https://doi.org/10.12998/wjcc.v2.i7.240
11. Conde-Agudelo A, Villar J, Lindheimer M (2008) Maternal infection and risk of preeclampsia: systematic review and metaanalysis. Am J Obstet Gynecol 198:7–22. https://doi.org/10.1016/j.ajog.2007.07.040
12. Sabbagh H, Khazaei Y, Baumert U, Hoffmann L, Wichelhaus A, Janjic Rankovic M (2022) Bracket transfer accuracy with the indirect bonding technique-a systematic review and meta-analysis. J Clin Med 11:2568. https://doi.org/10.3390/jcm11092568
13. Camilo V, Sugiyama T, Touati E (2017) Pathogenesis of *Helicobacter Pylori* Infection. Helicobacter 22:e12405. https://doi.org/10.1111/hel.12405
14. Salazar CR, Francois F, Li Y, Corby P, Hays R, Leung C, Bedi S, Segers S, Queiroz E, Sun J et al (2012) Association between oral health and gastric precancerous lesions. Carcinogenesis 33:399–403. https://doi.org/10.1093/carcin/bgr284
15. de Brito BB, da Silva FAF, Soares AS, Pereira VA, Santos MLC, Sampaio MM, Neves PHM, de Melo FF (2019) Pathogenesis and clinical management of helicobacter pylori gastric infection. World J Gastroenterol 25:5578–5589. https://doi.org/10.3748/wjg.v25.i37.5578
16 Ford AC, Yuan Y, Forman D, Hunt R, Moayyedi P (2020) Helicobacter pylori eradication for the prevention of gastric neoplasia. Cochrane Database Syst Rev 7:CD005583. https://doi.org/10.1002/14651858.CD005583.pub3
17. Shirani M, Pakzad R, Haddadi MH, Akrami S, Asadi A, Kazemian H, Moradi M, Kaviar VH, Zomorodi AR, Khoshnood S et al (2023) The global prevalence of gastric cancer in helicobacter pylori-infected individuals: a systematic review and meta-analysis. BMC Infect Dis 23:543. https://doi.org/10.1186/s12879-023-08504-5
18. Chen Y-C, Malfertheiner P, Yu H-T, Kuo C-L, Chang Y-Y, Meng F-T, Wu Y-X, Hsiao J-L, Chen M-J, Lin K-P et al (2024) Global prevalence of helicobacter pylori infection and incidence of gastric cancer between 1980 and 2022. Gastroenterology 166:605–619. https://doi.org/10.1053/j.gastro.2023.12.022
19. Amieva M, Peek RM (2016) Pathobiology of helicobacter pylori-induced gastric cancer. Gastroenterology 150:64–78. https://doi.org/10.1053/j.gastro.2015.09.004
20. Yong W, Upala S, Sanguankeo A (2018) Association between psoriasis and *Helicobacter Pylori* Infection: a systematic review and meta-analysis. Indian J Dermatol 63:193. https://doi.org/10.4103/ijd.IJD_531_17
21. Heydari K, Yousefi M, Alizadeh-Navaei R, Lotfi P, Sheydaee F, Raei M, Vahdatinia A, Hessami A, Rafati S, Moosazadeh M et al (2022) Helicobacter pylori infection and non-alcoholic fatty liver disease: a systematic review and meta-analysis. Turk J Gastroenterol Off J Turk Soc Gastroenterol 33:171–181. https://doi.org/10.5152/tjg.2022.21467
22. Gravina AG, Zagari RM, De Musis C, Romano L, Loguercio C, Romano M (2018) Helicobacter pylori and extragastric diseases: a review. World J Gastroenterol 24:3204–3221. https://doi.org/10.3748/wjg.v24.i29.3204
23. Fu P, Gao M, Yung KKL (2020) Association of intestinal disorders with parkinson's disease and alzheimer's disease: a systematic review and meta-analysis. ACS Chem Neurosci 11:395–405. https://doi.org/10.1021/acschemneuro.9b00607
24. Savoldi A, Carrara E, Graham DY, Conti M, Tacconelli E (2018) Prevalence of antibiotic resistance in helicobacter pylori: a systematic review and meta-analysis in world health organization regions. Gastroenterology 155:1372-1382.e17. https://doi.org/10.1053/j.gastro.2018.07.007
25. Shahbazi S, Vahdat Shariatpanahi Z (2018) Comparison between daily single-dose triple therapy and conventional triple therapy on patient compliance and helicobacter pylori eradication: a randomized controlled trial. Off J Indian Soc Gastroenterol 37(6):550–554. https://doi.org/10.1007/s12664-018-0916-z
26 Dowsett SA, Kowolik MJ (2003) Oral helicobacter pylori: can we stomach it? Crit Rev Oral Biol Med Off Publ Am Assoc Oral Biol 14:226–233. https://doi.org/10.1177/154411130301400307

27. Tshibangu-Kabamba E, Yamaoka Y (2021) Helicobacter pylori infection and antibiotic resistance—from biology to clinical implications. Nat Rev Gastroenterol Hepatol 18:613–629. https://doi.org/10.1038/s41575-021-00449-x
28. Huang R, Xing H-Y, Liu H-J, Chen Z-F, Tang B-B (2021) Efficacy of probiotics in the treatment of acute diarrhea in children: a systematic review and meta-analysis of clinical trials. Transl Pediatr 10:3248–3260. https://doi.org/10.21037/tp-21-511
29. Inchingolo F, Inchingolo AM, Malcangi G, De Leonardis N, Sardano R, Pezzolla C, de Ruvo E, Di Venere D, Palermo A, Inchingolo AD et al (2023) The benefits of probiotics on oral health: systematic review of the literature. Pharm Basel Switz 16:1313. https://doi.org/10.3390/ph16091313
30. Slots J (2000) Periodontitis: facts fallacies and the future. Periodontol 2017(75):7–23. https://doi.org/10.1111/prd.12221
31. Preshaw PM (2000) Host modulation therapy with anti-inflammatory agents. Periodontol 2018(76):131–149. https://doi.org/10.1111/prd.12148
32. Kwon T, Lamster IB, Levin L (2021) Current concepts in the management of periodontitis. Int Dent J 71:462–476. https://doi.org/10.1111/idj.12630
33. Mombelli A (2000) Microbial colonization of the periodontal pocket and its significance for periodontal therapy. Periodontol 2018(76):85–96. https://doi.org/10.1111/prd.12147
34. Cerkezi S, Nakova M, Gorgoski I, Ferati K, Bexheti-Ferati A, Palermo A, Inchingolo AD, Ferrante L, Inchingolo AM, Inchingolo F et al (2024) The role of sulfhydryl (Thiols) groups in oral and periodontal diseases. Biomedicines 12:882. https://doi.org/10.3390/biomedicines12040882
35. Sanz M, Marco Del Castillo A, Jepsen S, Gonzalez-Juanatey JR, D'Aiuto F, Bouchard P, Chapple I, Dietrich T, Gotsman I, Graziani F et al (2020) Periodontitis and cardiovascular diseases: consensus report. J Clin Periodontol 47:268–288. https://doi.org/10.1111/jcpe.13189
36. Rapone B, Ferrara E, Qorri E, Dipalma G, Mancini A, Corsalini M, Fabbro MD, Scarano A, Tartaglia GM, Inchingolo F (2022) The impact of periodontal inflammation on endothelial function assessed by circulating levels of asymmetric dimethylarginine: a single-blinded randomized clinical trial. J Clin Med 11:4173. https://doi.org/10.3390/jcm11144173
37. Trindade D, Carvalho R, Machado V, Chambrone L, Mendes JJ, Botelho J (2023) Prevalence of periodontitis in dentate people between 2011 and 2020: a systematic review and meta-analysis of epidemiological studies. J Clin Periodontol 50:604–626. https://doi.org/10.1111/jcpe.13769
38. Ballini A, Cantore S, Farronato D, Cirulli N, Inchingolo F, Papa F, Malcangi G, Inchingolo AD, Dipalma G, Sardaro N et al (2015) Periodontal disease and bone pathogenesis: the crosstalk between cytokines and porphyromonas gingivalis. J Biol Regul Homeost Agents 29:273–281
39. Pihlstrom BL, Ammons WF (1997) Treatment of gingivitis and periodontitis. research, science and therapy committee of the american academy of periodontology. J Periodontol 68:1246–1253
40. Isacco CG, Ballini A, De Vito D, Nguyen KCD, Cantore S, Bottalico L, Quagliuolo L, Boccellino M, Di Domenico M, Santacroce L et al (2021) Rebalancing the oral microbiota as an efficient tool in endocrine, metabolic and immune disorders. Endocr Metab Immune Disord Drug Targets 21:777–784. https://doi.org/10.2174/1871530320666200729142504
41. Hajishengallis G, Lamont RJ (2012) Beyond the red complex and into more complexity: the polymicrobial synergy and dysbiosis (PSD) model of periodontal disease etiology. Mol Oral Microbiol 27:409–419. https://doi.org/10.1111/j.2041-1014.2012.00663.x
42. Jiang Y, Song B, Brandt BW, Cheng L, Zhou X, Exterkate RAM, Crielaard W, Deng DM (2021) Comparison of red-complex bacteria between saliva and subgingival plaque of periodontitis patients: a systematic review and meta-analysis. Front Cell Infect Microbiol 11:727732. https://doi.org/10.3389/fcimb.2021.727732
43. Ballini A, Dipalma G, Isacco CG, Boccellino M, Di Domenico M, Santacroce L, Nguyễn KCD, Scacco S, Calvani M, Boddi A et al (2020) Oral microbiota and immune system crosstalk: a translational research. Biology 9:131. https://doi.org/10.3390/biology9060131
44. Rapone B, Inchingolo F, Tartaglia GM, De Francesco M, Ferrara E (2024) Asymmetric dimethylarginine as a potential mediator in the association between periodontitis and cardiovascular disease: a systematic review of current evidence. Dent J 12:297. https://doi.org/10.3390/dj12090297
45. Ozmeric N, Elgun S, Kalfaoglu D, Pervane B, Sungur Ç, Ergüder İ, Yavuz Y (2024) Interaction between hypertension and periodontitis. Oral Dis 30:1622–1631. https://doi.org/10.1111/odi.14543
46. Baima G, Minoli M, Michaud DS, Aimetti M, Sanz M, Loos BG, Romandini M (2000) Periodontitis and risk of cancer: mechanistic evidence. Periodontol 2024(96):83–94. https://doi.org/10.1111/prd.12540

47. Rapone B, Ferrara E, Qorri E, Inchingolo F, Isola G, Dongiovanni P, Tartaglia GM, Scarano A (2023) Research efficacy of gaseous ozone therapy as an adjuvant to periodontal treatment on oxidative stress mediators in patients with type 2 diabetes: a randomized clinical trial. BMC Oral Health 23:278. https://doi.org/10.1186/s12903-023-02985-1
48 Yusuf K, Sampath V, Umar S (2023) Bacterial infections and cancer: exploring this association and its implications for cancer patients. Int J Mol Sci. https://doi.org/10.3390/ijms24043110
49. Inchingolo F, Inchingolo AM, Inchingolo AD, Fatone MC, Ferrante L, Avantario P, Fiore A, Palermo A, Amenduni T, Galante F et al (2024) Bidirectional association between periodontitis and thyroid disease: a scoping review. Int J Environ Res Public Health 21:860. https://doi.org/10.3390/ijerph21070860
50. Gaur V, Singh N, Doshi AG, Chandrahas B (2021) Immediate rehabilitation of a rheumatoid arthritis patient with single-piece implants. Int J Surg Case Rep 82:105874. https://doi.org/10.1016/j.ijscr.2021.105874
51. Nasiri K, Amiri Moghaddam M, Etajuri EA, Badkoobeh A, Tavakol O, Rafinejad M, Forutan Mirhosseini A, Fathi A (2023) Periodontitis and progression of gastrointestinal cancer: current knowledge and future perspective. Clin Transl Oncol Off Publ Fed Span Oncol Soc Natl Cancer Inst Mex 25:2801–2811. https://doi.org/10.1007/s12094-023-03162-0
52. Ren Q, Yan X, Zhou Y, Li WX (2016) Periodontal therapy as adjunctive treatment for gastric helicobacter pylori infection. Cochrane Database Syst Rev 2:CD009477. https://doi.org/10.1002/14651858.CD009477.pub2
53. Zaric S, Bojic B, Jankovic L, Dapcevic B, Popovic B, Cakic S, Milasin J (2009) Periodontal therapy improves gastric helicobacter pylori eradication. J Dent Res 88:946–950. https://doi.org/10.1177/0022034509344559
54. Del Corso M, Vervelle A, Simonpieri A, Jimbo R, Inchingolo F, Sammartino G, Dohan Ehrenfest DM (2012) Current knowledge and perspectives for the use of platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) in oral and maxillofacial surgery part 1: periodontal and dentoalveolar surgery. Curr Pharm Biotechnol 13:1207–1230. https://doi.org/10.2174/138920112800624391
55. Bartold PM (2000) Lifestyle and periodontitis: the emergence of personalized periodontics. Periodontol 2018(78):7–11. https://doi.org/10.1111/prd.12237
56. Laforgia A, Inchingolo AD, Piras F, Colonna V, Giorgio RV, Carone C, Rapone B, Malcangi G, Inchingolo AM, Inchingolo F et al (2024) Therapeutic strategies and genetic implications for periodontal disease management: a systematic review. Int J Mol Sci 25:7217. https://doi.org/10.3390/ijms25137217
57. Inchingolo F, Martelli FS, Gargiulo Isacco C, Borsani E, Cantore S, Corcioli F, Boddi A, Nguyễn KCD, De Vito D, Aityan SK et al (2020) Chronic periodontitis and immunity, towards the implementation of a personalized medicine: a translational research on gene single nucleotide polymorphisms (SNPs) linked to chronic oral dysbiosis in 96 caucasian patients. Biomedicines 8:115. https://doi.org/10.3390/biomedicines8050115
58. Wei X, Zhao H-Q, Ma C, Zhang A-B, Feng H, Zhang D, Liu C (2019) The association between chronic periodontitis and oral helicobacter pylori: a meta-analysis. PLoS ONE 14:e0225247. https://doi.org/10.1371/journal.pone.0225247
59. Hoare A, Soto C, Rojas-Celis V, Bravo D (2019) Chronic inflammation as a link between periodontitis and carcinogenesis. Mediators Inflamm 2019:1–14. https://doi.org/10.1155/2019/1029857
60 López-Valverde N, Macedo De Sousa B, López-Valverde A, Suárez A, Rodríguez C, Aragoneses JM (2022) Possible association of periodontal diseases with helicobacter pylori gastric infection: a systematic review and meta-analysis. Front Med 9:822194. https://doi.org/10.3389/fmed.2022.822194
61. Moradi Y, Majidi L, Khateri S, Azh N, Gheshlagh RG, Saniee N, Zarei M, Moradpour F (2023) The association between periodontal diseases and helicobacter pylori: an updated meta-analysis of observational studies. BMC Oral Health 23:523. https://doi.org/10.1186/s12903-023-03232-3
62. Mao X, Jakubovics NS, Bächle M, Buchalla W, Hiller K-A, Maisch T, Hellwig E, Kirschneck C, Gessner A, Al-Ahmad A et al (2021) Colonization of *Helicobacter Pylori* in the oral cavity—an endless controversy? Crit Rev Microbiol 47:612–629. https://doi.org/10.1080/1040841X.2021.1907740
63. Kadota T, Hamada M, Nomura R, Ogaya Y, Okawa R, Uzawa N, Nakano K (2020) Distribution of helicobacter pylori and periodontopathic bacterial species in the oral cavity. Biomedicines 8:161. https://doi.org/10.3390/biomedicines8060161

64. Maurotto M, Costa LG, Manso MC, Mosley GA, Fernandes JCH, Fernandes GVO, Castro F (2024) Correlation between periodontitis and gastritis induced by helicobacter pylori: a comprehensive review. Microorganisms 12:1579. https://doi.org/10.3390/microorganisms12081579
65. Suzuki N, Yoneda M, Naito T, Iwamoto T, Masuo Y, Yamada K, Hisama K, Okada I, Hirofuji T (2008) Detection of helicobacter pylori DNA in the saliva of patients complaining of halitosis. J Med Microbiol 57:1553–1559. https://doi.org/10.1099/jmm.0.2008/003715-0
66. Payão SLM (2016) *Helicobacter Pylori* and its reservoirs: a correlation with the gastric infection. World J Gastrointest Pharmacol Ther 7:126. https://doi.org/10.4292/wjgpt.v7.i1.126
67. Anand PS (2014) Role of dental plaque, saliva and periodontal disease in *Helicobacter Pylori* infection. World J Gastroenterol 20:5639. https://doi.org/10.3748/wjg.v20.i19.5639
68. Zhang L, Chen X, Ren B, Zhou X, Cheng L (2022) Helicobacter pylori in the oral cavity: current evidence and potential survival strategies. Int J Mol Sci 23:13646. https://doi.org/10.3390/ijms232113646
69. Ray RR (2023) Periodontitis: an oral disease with severe consequences. Appl Biochem Biotechnol 195:17–32. https://doi.org/10.1007/s12010-022-04127-9
70. Soto C, Rojas V, Yáñez L, Hidalgo A, Olivera M, Pacheco M, Venegas D, Salinas D, Bravo D, Quest AFG (2022) *Porphyromonas Gingivalis-Helicobacter Pylori* Co-incubation enhances *Porphyromonas Gingivalis* virulence and increases migration of infected human oral keratinocytes. J Oral Microbiol 14:2107691. https://doi.org/10.1080/20002297.2022.2107691
71. Tsimpiris A, Tsolianos I, Grigoriadis A, Moschos I, Goulis DG, Kouklakis G (2023) Association of chronic periodontitis with helicobacter pylori infection in stomach or mouth: a systematic review and meta-analysis. Eur J Dent 17:270–282. https://doi.org/10.1055/s-0042-1756690
72. Liu Y, Li R, Xue X, Xu T, Luo Y, Dong Q, Liu J, Liu J, Pan Y, Zhang D (2020) Periodontal disease and helicobacter pylori infection in oral cavity: a meta-analysis of 2727 participants mainly based on asian studies. Clin Oral Investig 24:2175–2188. https://doi.org/10.1007/s00784-020-03330-4
73. Adler I (2014) *Helicobacter Pylori* and oral pathology: relationship with the gastric infection. World J Gastroenterol 20:9922. https://doi.org/10.3748/wjg.v20.i29.9922
74. Sulaiman Y, Pacauskienė IM, Šadzevičienė R, Anuzyte R (2024) Oral and gut microbiota dysbiosis due to periodontitis: systemic implications and links to gastrointestinal cancer: a narrative review. Med Kaunas Lith 60:1416. https://doi.org/10.3390/medicina60091416
75. Gao Y, Yu Q, Wang Y-B, Zhang Z, Chen Y, Kuang J, Hou M, Liu Z, Guan K, Li J et al (2024) Optimizing lifestyle behaviors to support healthy body-mind. Complement Ther Clin Pract 57:101912. https://doi.org/10.1016/j.ctcp.2024.101912
76. Inchingolo F, Inchingolo AM, Avantario P, Settanni V, Fatone MC, Piras F, Di Venere D, Inchingolo AD, Palermo A, Dipalma G (2023) The effects of periodontal treatment on rheumatoid arthritis and of anti-rheumatic drugs on periodontitis: a systematic review. Int J Mol Sci 24:17228. https://doi.org/10.3390/ijms242417228
77. Sung C, Lin F, Huang R, Fang W, Cheng W, Tsai YC, Chen W (2022) Periodontitis, *Helicobacter Pylori* Infection, and gastrointestinal tract cancer mortality. J Clin Periodontol 49:210–220. https://doi.org/10.1111/jcpe.13590
78. Anand PS, Nandakumar K, Shenoy KT (2006) Are dental plaque, poor oral hygiene, and periodontal disease associated with *Helicobacter Pylori* infection? J Periodontol 77:692–698. https://doi.org/10.1902/jop.2006.050163
79. Ren Q, Yan X, Zhou Y, Li WX (2016) Periodontal therapy as adjunctive treatment for gastric *Helicobacter Pylori* infection. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD009477.pub2
80. Bohatu S, Rozhkovskyi Y, Lyubchenko O (2023) Condition of periodontal tissues on the background of helicobacter invasion: the concept of pathogenesis. Wiad Lek 76:377–385. https://doi.org/10.36740/WLek202302119
81. Rokkas T, Gisbert JP, Malfertheiner P, Niv Y, Gasbarrini A, Leja M, Megraud F, O'Morain C, Graham DY (2021) Comparative effectiveness of multiple different first-line treatment regimens for helicobacter pylori infection: a network meta-analysis. Gastroenterology 161:495-507.e4. https://doi.org/10.1053/j.gastro.2021.04.012
82. Lai J, Angulmaduwa S, Kim M-A, Kim A, Tissera K, Cho Y-J, Cha J-H (2024) Influence of oipA phase variation on virulence phenotypes related to type iv secretion system in helicobacter pylori. Helicobacter 29:e13140. https://doi.org/10.1111/hel.13140

83. Lauritano D, Cura F, Candotto V, Gaudio RM, Mucchi D, Carinci F (2015) Periodontal pockets as a reservoir of helicobacter pylori causing relapse of gastric ulcer: a review of the literature. J Biol Regul Homeost Agents 29:123–126
84. Lauritano D, Bignozzi CA, Pazzi D, Cura F, Carinci F (2017) Efficacy of a new coating of implant-abutment connections in reducing bacterial loading: an in vitro study. ORAL Implantol 10:1–10. https://doi.org/10.11138/orl/2017.10.1.001
85. Romanova IG, Zolotukhina OL, Romanov GO, Shnaider SA, Tkachenko IM (1960) State of microcirculation and free-radical processes of periodontal tissues in smoking dependent patients with chronic generalized periodontitis associated with chronic hyperacid gastritis. Wiadomosci Lek Wars Pol 2022(75):156–163
86. Bouziane A, Ahid S, Abouqal R, Ennibi O (2012) Effect of periodontal therapy on prevention of gastric *H Elicobacter Pylori* recurrence: a systematic review and meta-analysis. J Clin Periodontol 39:1166–1173. https://doi.org/10.1111/jcpe.12015
87. Rahat M, Saqib M, Ahmed M, Suleman M, Ismail SM, Mumtaz H, Khalid H (2012) Use of eradication therapy in adjunction to periodontal therapy versus alone for treatment of helicobacter pylori infections: a mini review. Ann Med Surg 2023(85):2756–2760. https://doi.org/10.1097/MS9.0000000000000741
88. Adachi K, Notsu T, Mishiro T, Yoshikawa H, Kinoshita Y (2019) Influence of helicobacter pylori infection on periodontitis. J Gastroenterol Hepatol 34:120–123. https://doi.org/10.1111/jgh.14358
89. Tongtawee T, Wattanawongdon W, Simawaranon T (2019) Effects of periodontal therapy on eradication and recurrence of helicobacter pylori infection after successful treatment. J Int Med Res 47:875–883. https://doi.org/10.1177/0300060518816158
90. Zarić S, Bojić B, Janković Lj, Dapčević B, Popović B, Čakić S, Milašin J (2009) Periodontal therapy improves gastric helicobacter pylori eradication. J Dent Res 88:946–950. https://doi.org/10.1177/0022034509344559
91. Chen K, Chen G, Liu SG, Wei FZ, Lin SZ Influence of different periodontal therapies on eradication and recurrence of helicobacter pylori infection. | EBSCOhost Available online: https://openurl.ebsco.com/contentitem/gcd:164562616?sid=ebsco:plink:crawler&id=ebsco:gcd:164562616. Accessed 12 Feb 2025
92. Venkata T, Chickanna R, Prabhuji MLV (2021) Effectiveness of nonsurgical periodontal therapy on the levels of helicobacter pylori in dental plaque and saliva of patients with chronic periodontitis. Eur J Gen Dent 6:29–35
93. Figliuzzi MM, Iuliano E, Altilia M, Altilia S, Iuliano R, Fortunato L (2020) The benefits of non-surgical periodontal treatment in association with gastric eradication. Open J Stomatol 10:281–299. https://doi.org/10.4236/ojst.2020.1010027
94. Tsimpiris A, Grigoriadis A, Tsolianos I, Moschos I, Goulis DG, Kouklakis G (2022) Periodontitis and helicobacter pylori infection: eradication and periodontal therapy combination. Eur J Dent 16:145–152. https://doi.org/10.1055/s-0041-1731928
95. Walker JT, Bradshaw DJ, Bennett AM, Fulford MR, Martin MV, Marsh PD (2000) Microbial biofilm formation and contamination of dental-unit water systems in general dental practice. Appl Environ Microbiol 66:3363–3367. https://doi.org/10.1128/AEM.66.8.3363-3367.2000
96. Microbial contamination of dental unit waterlines and potential risk of infection: a narrative review available online: https://www.mdpi.com/2076-0817/9/8/651. Accessed 17 Feb 2025
97. Urrutia-Baca VH, Paz-Michel BA, Calderon-Porras AN, Valle JAJ-D, Alvarez-Fernández WJ, Mervitch-Sigal N, Rodríguez-León MA, De La Garza-Ramos MA (2024) Oral hygiene with neutral electrolyzed water and systemic therapy increases gastric helicobacter pylori eradication and reduces recurrence. Clin Exp Dent Res 10:e927. https://doi.org/10.1002/cre2.927
98. Yadollahzade A, Amiriani T, Fakhari E (2022) Effects of full-mouth disinfection on the recurrence of helicobacter pylori infection. Casp J Dent Res. https://doi.org/10.22088/cjdr.11.2.85
99. Can Eradication Rate of Gastric Helicobacter Pylori Be Improved by Killing Oral Helicobacter Pylori? Cochrane Library Available online: https://www-cochranelibrary-com.ezproxy.uniba.it/central/doi/https://doi.org/10.1002/central/CN00991675/full?highlightAbstract=helicobacter%7Cperiodont%7Cpylori%7Chelicobact%7Cperiodontal. Accessed 15 Mar 2025
100. Wongsuwanlert M, Teanpaisan R, Ruangsri P, Kaewdech A, Sunpaweravong S, Pahumunto N (2024) Effect of mouthwash containing poly L-lysine and glycerol monolaurate on oral *Helicobacter Pylori* relating to biofilm eradication, anti-adhesion, and pro-inflammatory cytokine suppression. J Dent Sci 19:1748–1757. https://doi.org/10.1016/j.jds.2023.10.010

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