Concise Review

Motivational Interviewing on Periodontal Treatment Outcomes: A Meta-Analysis

Chaoning Zhan [a], Wanting Qu [a], Melissa Rachel Fok [b], Lijian Jin [b], Yifan Lin [a]*

[a] *Division of Paediatric Dentistry and Orthodontics, Faculty of Dentistry, the University of Hong Kong, Hong Kong SAR, China*
[b] *Division of Periodontology & Implant Dentistry, Faculty of Dentistry, The University of Hong Kong, Hong Kong SAR, China*

ABSTRACT

Objectives: This systematic review investigated the clinical efficacy of motivational interviewing (MI) in improving oral hygiene and periodontal health in patients with periodontal diseases.

Methods: A comprehensive literature search was conducted across various databases up to May 2023. Randomised controlled trials (RCTs) evaluating the effects of MI on periodontal conditions in patients with gingivitis, periodontitis, and peri-implantitis were included. After data screening, a risk-of-bias assessment was performed using the Cochrane risk of bias (RoB) tool. The meta-analysis was performed using random-effects models.

Results: Out of 2108 records screened, 7 RCTs involving 474 patients were included in the qualitative synthesis, with 6 of these studies included in the meta-analysis. Amongst these, 5 studies had a high RoB and 2 had some concerns about bias. Although individual studies reported varied results regarding the effects of MI on different periodontal indices and parameters at different time points, the pooled results revealed no significant difference in the overall effect on plaque level, bleeding on probing, and gingival inflammation between the MI and control groups. In addition, there is insufficient evidence to suggest any significant effect on attachment loss or probing depth.

Conclusions: The current evidence is insufficient to support the effectiveness of MI as an adjunctive intervention for improving oral hygiene and periodontal outcomes. However, these results should be interpreted with caution. Additional high-quality studies with standardised MI interventions are required to derive definite conclusions.

Introduction

Periodontal diseases are microbiota dysbiosis−associated, host-mediated, inflammatory conditions characterised by the inflammation and gradual destruction of tooth-supporting structures.[1] Gingivitis and periodontitis are the most prevalent forms of periodontal diseases, and periodontitis is a significant contributor to tooth loss globally. With 1.1 billion cases reported worldwide in 2019,[2] severe periodontitis is a public health challenge. Periodontal diseases are associated with stress, poor sleep quality, obesity, and diabetes mellitus.[3-5] Despite the complex aetiology of periodontal diseases, effective treatment consistently involves controlling periodontal plaque and infection.[6] Moreover, the effect of oral hygiene on periodontitis is superior to that of risk factors such as smoking, obesity, and diabetes mellitus.[7] In addition, peri-implantitis, a bacterium-induced inflammatory condition around dental implants, poses a considerable challenge in prevention. People with poor hygiene had a higher risk of peri-implantitis than those with good oral hygiene.[8] Thus, maintaining good oral hygiene is crucial.[9] However, many patients with periodontal diseases encounter difficulty in consistently maintaining high oral hygiene standards over time.[10]

Health education strategies in oral hygiene, such as the conventional "tell-show-do" method, typically rely on one-way knowledge dissemination or use fear-based tactics. Although these approaches are commonly used by oral health care providers to enhance patient motivation for maintaining oral hygiene, several studies have indicated that these methods may not effectively motivate patients. In some cases, they might even lead to decreased motivation.[11,12]

Motivational interviewing (MI) is a nonconfrontational, client-centred, and directive therapeutic approach that aims to enhance readiness for change.[13,14] This method operates on the assumption that knowledge is insufficient to elicit behaviour change and sustained behaviour change must align with an individual's values. MI focusses on evoking intrinsic motivation by addressing and resolving ambivalence.[15] This collaborative counselling approach is guided by 5 core principles: expressing empathy, identifying discrepancies between individuals' current behaviour and their goals/values, respecting autonomy, supporting self-efficacy, and avoiding argumentative or confrontational interactions.[16] Originally developed for addiction therapy,[17] MI has shown effectiveness in modifying behaviours related to smoking, substance abuse, and dietary habits in diabetes management.[18-20] Its positive outcomes are attributed to the "therapeutic alliance" and a strong bond between the patient and counsellor.[21] Multiple clinical studies have indicated the effectiveness of MI in improving periodontal health behaviours, leading to reductions in plaque buildup and gingival bleeding.[22-24] MI might enhance patient motivation and lead to better therapeutic outcome through behavioural changes. However, some studies did not support this perspective,[25,26] with one study even reporting a higher plaque score in the MI group than in the control group.[23]

The successful application of MI necessitates additional training for oral health professionals to develop effective counselling skills. Furthermore, it requires prolonged contact time with patients in the form of extended or additional sessions with an oral health specialist.[27,28] Thus, it is crucial to evaluate whether MI outperforms conventional health education in driving behaviour change and enhancing periodontal health, as recognised by periodontal indices.

Two systematic reviews focussing on behavioural interventions have revealed the ongoing debate regarding whether MI outperforms conventional methods in improving periodontal and oral hygiene outcomes, and the effectiveness of MI independent of other behavioural interventions remains uncertain.[29,30] However, these reviews have only included relevant studies on MI published up to 2022, suggesting that the research is still evolving. In addition, recent randomised controlled trials (RCTs) have provided new insights into the effects of MI on patients with periodontitis.[22,23] For instance, Arnett et al[23] conducted a 12-month RCT and found a significant improvement in the gingival index (GI) in the MI group compared with the control group. Furthermore, another recent trial revealed the positive effect of MI on patients with periodontitis, as evidenced by improvements in the plaque and bleeding indices (PI and BI, respectively).[22] Therefore, given these developments, an updated comprehensive review of the latest MI-related literature in periodontal diseases is necessary.

This systematic review evaluated the effectiveness of MI in driving behaviour changes, as reflected by periodontal indices and parameters, in patients with periodontal diseases, such as gingivitis, periodontitis, and peri-implantitis. This review aimed to answer the following question: What is the effect of MI on improving clinical periodontal conditions in individuals with periodontal issues when compared with standard oral health instruction?

Methods

Protocol development and registration

This systematic review investigated the effectiveness of MI in improving periodontal health in patients with periodontal diseases. This study adhered to the PRISMA statement[31] and followed the guidelines outlined in the *Cochrane Handbook for Systematic Reviews of Interventions*.[32] The systematic review protocol was registered in PROSPERO (CRD42023458021).

Eligibility criteria

In this review, studies were selected based on the PICOT (population, intervention, comparison, outcome, and time) framework:

1. *Participants*

We recruited noninstitutionalised adolescent and adult patients (aged ≥12 years and independent of others) with gingivitis, periodontitis, and/or peri-implantitis. Patients with comorbidities (eg, diabetes and hypertension) and those undergoing orthodontic treatment were excluded. No restrictions were imposed on the definition, extent, and severity of periodontal diseases.

2. *Intervention or exposure*

Studies that employed MI without any other psychological interventions were included. MI could either be used as an adjunct to or independent of standard periodontal treatments, such as scaling and root planing, to improve periodontal health. All formats, durations, follow-up lengths, delivery settings, and delivery modes were considered eligible.

3. *Comparison*

The comparison group in these studies received standard oral health instruction from oral health specialists.

4. *Outcome measures*

Clinical indicators, including the PI, BI, GI, probing depth, and other validated indices or parameters used for assessing oral hygiene and periodontal condition before and after the intervention.

5. *Time and study design*

RCTs with no restriction on the duration of follow-up.

Information sources and search

An electronic literature search was performed in May 2023 to identify relevant studies for this systematic review. This search was performed in the following online databases: Medline (via PubMed), Embase, Cochrane Library, Web of Science, and Scopus databases. In addition, a search of the gray literature was conducted using OpenGrey and ProQuest Dissertations & Theses databases. We also searched Clinical-Trials.gov and the WHO International Clinical Trials Registry Platform to identify ongoing or completed but unpublished trials. The search employed a combination of the following MeSH terms and key words: "motivational interview(ing)," "motivational intervention," "motivational counselling," "stages of change," "readiness to/for change," "transtheoretical model" AND "gingivitis," "periodontitis," "peri-implantitis," "periodontal diseases," "periodontal," "oral," "dental," "dental plaque". Additionally, the reference lists of all included studies and relevant systematic reviews were cross-checked to identify additional pertinent reports.

Study selection and data extraction

The titles and abstracts of the retrieved articles were independently reviewed by 2 authors (CZ and WQ) using Rayyan software.[33] The selection of papers was based on 2 criteria: (1) the presence of a combination of the specified key words anywhere in the paper and (2) the paper being written in English. The title and abstract of each record were screened. In instances of disagreement between the 2 reviewers, a consensus was reached or a third author was consulted (YL). Interobserver agreement was assessed using the kappa score. After the preselection of articles, both reviewers examined the full text of the articles, involving a thorough reading of the articles to evaluate their eligibility based on PICOS (population, intervention, comparison, outcome, and study design) criteria. This process was performed independently by the 2 reviewers to ensure complete agreement on the final selection of studies. In the full-text analysis, we collected the study characteristics and main findings in Microsoft Excel spreadsheets and summarised them in tables for qualitative and quantitative analyses.

Risk of bias

The risk of bias (RoB) was independently assessed by the 2 reviewers using the revised Cochrane RoB tool (RoB 2) for general bias.[34]

Summary measures and synthesis of results

A quantitative synthesis (meta-analysis) was performed when feasible. The outcome measures of clinical indicators were extracted as mean values and standard deviations (SDs) for both the experimental group (ie, patients with periodontal diseases receiving MI without any other psychological interventions) and the control group (ie, patients with periodontal disease receiving standard oral health instruction). The standardised mean difference (SMD) and 95% confidence interval were calculated for each study to quantify the size of the intervention's efficacy, wherever necessary and possible. Random-effect models were used in this meta-analysis to account for potential interstudy heterogeneity and adopt a more conservative approach. The Tau^2 and I^2 indices were used to assess the statistical absolute and relative between-trial heterogeneity, respectively. The I^2 index is defined as the percentage of variation in the global estimate that is attributed to heterogeneity (I^2 = 25%: low; I^2 = 50%: moderate; I^2 = 75%: high heterogeneity).[35] Funnel plots were used to demonstrate the publication bias. Forest plots were used to illustrate the effects in the meta-analysis, including the overall effect and various subanalyses. Statistical significance was set at $P \le .05$. Review Manager (version 5.4, by Cochrane Collaboration, Copenhagen, Denmark) was used to conduct the meta-analysis.
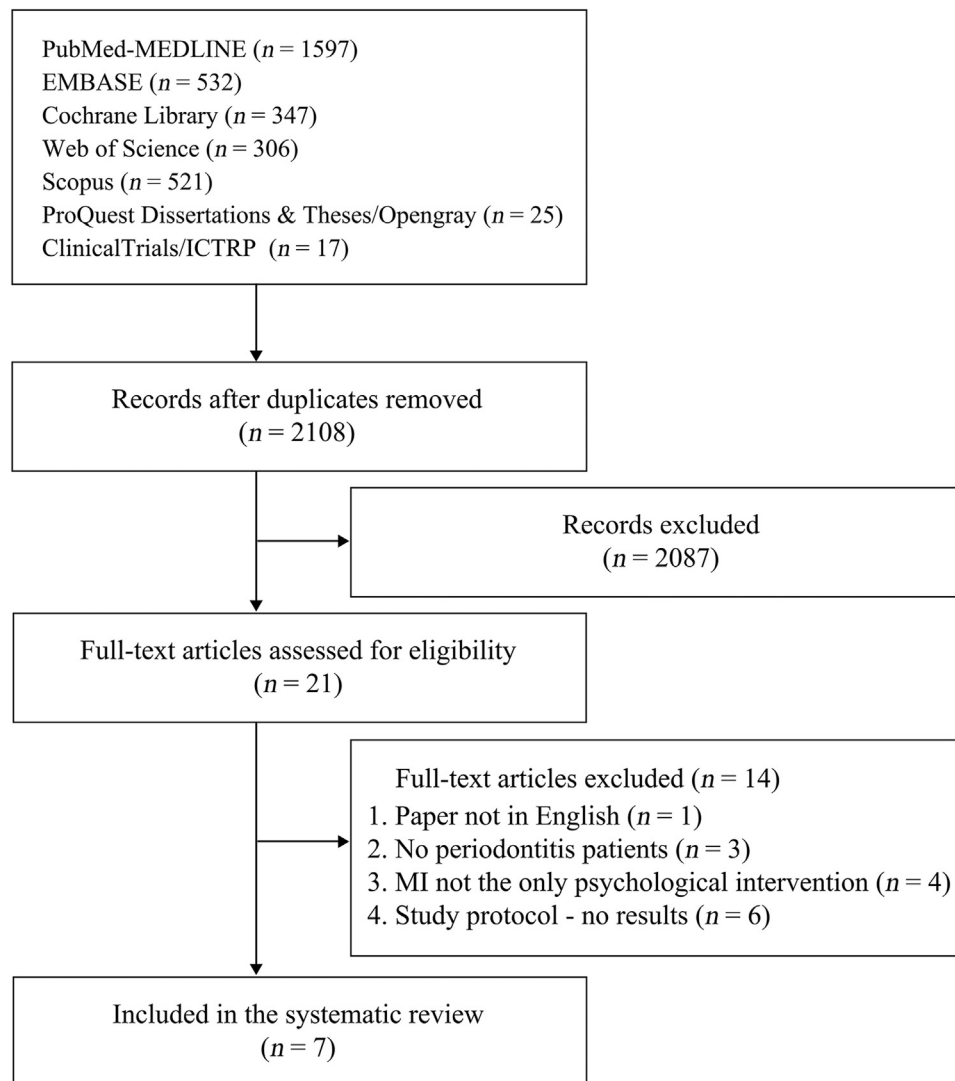
Results

Study selection

The flowchart of study identification and inclusion is shown in Figure 1. Initially, 3345 articles were identified through the initial search. After the removal of duplicates, 2108 articles remained for screening. The titles and abstracts of these articles were screened, leading to the selection of 21 articles for full-text assessment. Finally, 7 studies were included in this systematic review. The excluded studies, along with reasons for their exclusion, are listed in Table S1. The interexaminer agreement during the study selection process was high, with a Cohen's kappa score of 0.92 for the title and abstract screening and 1.00 for the full-text evaluation.

Study characteristics

Seven studies were included in this analysis, and their publication dates spanned from 2012 to 2022.[22,23,25,26,36-38] All of these studies were RCTs conducted in various countries: the US (n = 2), Sweden (n = 2), Germany (n = 1), Brazil (n = 1), and Turkey (n = 1). The sample sizes ranged from 26 to 172 participants, and the follow-up period ranged from 2 weeks to 3 years. These studies collectively included 474 patients with periodontal diseases, including varying degrees of gingivitis and periodontitis. Specifically, one study included only patients with gingivitis,[22] and 5 studies only included patients with periodontitis.[22,23,25,26,36,38] One study included all patients with periodontal problems without differentiating between gingivitis and periodontitis.[37] None of the studies included patients with peri-implantitis. The majority of these patients were older than 50 years, except for one study targeting patients aged between 22 and 35 years.[22] In most of the studies, the control group received standard oral health care and information booklets without additional input. Conversely, the MI group received more personalised evaluations and suggestions than the control group. Psychological interventions were administered by experienced periodontists or psychologists in the majority of included studies. In one study, MI was delivered by dental students in their final last clinical periodontal course.[38] In another study, MI was administered by a trained dental hygienist.[23] In the work of

PubMed-MEDLINE (*n* = 1597)
EMBASE (*n* = 532)
Cochrane Library (*n* = 347)
Web of Science (*n* = 306)
Scopus (*n* = 521)
ProQuest Dissertations & Theses/Opengray (*n* = 25)
ClinicalTrials/ICTRP (*n* = 17)

Records after duplicates removed
(*n* = 2108)

Records excluded
(*n* = 2087)

Full-text articles assessed for eligibility
(*n* = 21)

Full-text articles excluded (*n* = 14)
1. Paper not in English (*n* = 1)
2. No periodontitis patients (*n* = 3)
3. MI not the only psychological intervention (*n* = 4)
4. Study protocol - no results (*n* = 6)

Included in the systematic review
(*n* = 7)

Fig. 1 – Flowchart of study identification and inclusion.

Stenman et al, short- and long-term outcomes of the same research are published consecutively in 6 months and 3 years.[25,36] Six out of 7 studies reported information on MI-related training. Amongst them, 5 studies assessed MI fidelity by rating the intervention delivery in recorded sessions using the MI treatment integrity coding manual. Detailed characteristics of the studies are displayed in the Table.

Synthesis of results

MI was used in all the studies to improve periodontal health by reinforcing oral hygiene practices. Out of the 7 studies, 3 showed that MI was more effective than conventional health instructions in significantly improving at least one clinical indicator (PI, BI, GI, or probing depth).[22,23,38] However, the other 4 studies found no significant differences between the experimental and control groups in terms of periodontal outcomes.[25,26,36,37] Of these 7 studies, 2 had a follow-up period of 1 year or more.[23,25] The study by Arnett et al,[23] with a 1-year duration and 58 patients, reported that 4 sessions of

MI failed to outperform conventional health education in improving PI. Similarly, another long-term RCT involving 26 patients showed no significant effect on PI and BI after 3 years.[25] Amongst the 4 studies, 1 reported that the MI group exhibited a higher level of knowledge concerning oral health.[22] Furthermore, 1 of 2 studies reported higher self-efficacy regarding oral health in the MI group.[37] However, 1 study did not observe an increase in general self-efficacy but noted increased self-efficacy regarding interdental cleaning in the MI group.[38] Two studies assessed motivation, but only 1 study conducted by Gunpinar et al[22] found a higher motivation level in the MI group.[26]

Quantitative analyses of results

Two studies were excluded from quantitative analysis due to incomplete information regarding SD or the specific study duration.[22,37] The MI group exhibited a higher PI than the control group at the 6-month follow-up (P < .001; Figure 2). Arnett et al reported a significantly higher PI but a lower GI at the 12-

Table – Characteristic of the included studies.

First author, year, and country	Study design, study setting and source of funding	Sample size calculation	Age range, y, mean (SD)	Sample size, n and gender	Experimental group, n	Control group, n	Control MI duration	MI duration	MI sessions	Study duration	MI operators	Definition of periodontal disease	Outcome measures	Impact on Plaque Index, mean (SD)	Impact on Bleeding Index, mean (SD)	Impact on Gingival Index, mean (SD)	Impact on pocket depth, mean (SD)	Impact on clinical attachment loss, mean (SD)	Additional findings
Stenman et al (2012) Sweden	RCT; setting: specialist clinic in periodontics; funding: TUA-research funding, and the foundation Swedish Patent Revenue Fund for Research in Preventive Odontology	Yes	50.4 (10.6)	44 (31 M, 13 F)	22	22	20–90 min	20–90 min	1	6 mo	1 experienced clinical psychologist	Moderate chronic periodontitis	PI (O'Leary); MBI	NS-D; Exp: BL: 50.2% (21.5); at 2 wk: 46.2% (19.5); at 4 wk: 28.4% (16.5); at 12 wk: 27.1% (15.2); at 26 wk: 25.2% (15.4); Con: BL: 43.1% (19.2); at 2 wk: 40.2% (21.3); at 4 wk: 26.2% (17.7); at 12 wk: 19.0% (13.3); at 26 wk: 18.6% (13.2)	NS-D; Exp: BL: 36.6% (17.1); at 2 wk: 33.9% (16.9); at 4 wk: 26.0% (17.1); at 12 wk: 21.0% (12.5); at 26 wk: 18.8% (10.9); Con: BL: 33.0% (12.4); at 2 wk: 34.9% (15.9); at 4 wk: 24.0% (14.2); at 12 wk: 16.2% (13.4); at 26 wk: 18.4% (14.1)	NP	NP	NP	MI cannot be served as a predictor of achieving a plaque index or bleeding index ≤20%
Brand et al (2013) USA	RCT; setting: university; funding: grant from the Procter & Gamble Company	Yes	61.9 (11.0)	56 (27 M, 29 F)	29	27	15–20 min	15–20 min	1	12 wk	1 trained counsellor who was not a dental professional	In periodontal maintenance for at least 1 year and with a BOP score of ≥40% or at least 2 teeth with interproximal PD ≥5 mm	PI (Quigley-Hein); BOP; percentage of pockets (PD 4–6 mm and PD >7 mm)	NS-D; Exp: BL: 2.4 (0.6); at 6 wk: 1.9 (0.6); at 12 wk: 2.1 (0.7); Con: BL: 2.6 (0.5); at 6 wk: 2.2 (0.4); at 12 wk: 2.3 (0.7)	NS-D; Exp: BL: 50% (18); at 6 wk: 31% (14); at 12 wk: 33% (15); Con: BL: 55% (18); at 6 wk: 40% (19); at 12 wk: 36% (20)	NP	NS-D: 4–6 mm: Exp: BL: 23.8 (15.8); at 6 wk: 23.5 (19.0); at 12 wk: 20.3 (15); Con: BL: 23.3 (23.1); at 6 wk: 18.9 (19.9); at 12 wk: 16.1 (21.4); >7 mm: Exp: BL: 2.0 (4.1); at 12 wk: 1.7 (3.0); at 12 wk: 1.7 (3.9); Con: BL: 1.8 (6.9); at 6 wk: 2.7 (11.8); at 12 wk: 1.4 (5.7)	NP	The intervention did not produce differential increases in knowledge, motivation, or self-regulation
Neves et al (2015) Brazil	RCT; setting: primary health unit—family health; funding: not reported	No	NP	68 (NP)	35	33	3–15 min	3–15 min	4–6	Period of dental treatment	1 trained periodontist	PI expressed in percentage ≥40% and BOP >10%	PI (Silness and Loe); BOP	NS-D: Exp: BL: 72.62% (16.58); after treatment: 39.69%; Con: BL: 69.82% (16.70); after treatment: 47.61% (23.34)	NS-D: Exp: BL: 29.91% (20.37); after treatment: 10.80% (22.18); Con: BL: 21.35% (10.84); after treatment: 13.03% (7.98)	NP	NP	NP	Individuals in the experimental group showed higher improvement percentage in psychocognitive categories than control group
Woelber et al (2016) Germany	RCT; setting: university; funding: institutional funding and a grant of the Neue Arbeitsgruppe Parodontologie e. V.	No	59.3 (11.4)	172 (88 M, 84 F)	73	99	NP	NP	NP	6 mo	56 trained students taking part in the last clinical periodontal course	Periodontal disease with a Community Periodontal Index for Treatment Needs of at least 2 sextants with Code 3 or above	PI (Silness and Loe); GI; PPD; CAL; BOP	NS-D; Exp: BL: 0.56 (0.30); at 6 mo: 0.72 (0.32); Con: BL: 0.43 (0.30); at 6 mo: 0.54 (0.32)	NS-D; Exp: BL: 51.87% (23.18); at 6 mo: 46.65% (25.07); Con: BL: 53.65% (23.86); at 6 mo: 51.82% (27.32)	↓significantly in the Exp: Exp: BL: 1.10 (0.15); at 6 mo: 1.03 (0.29); Con: BL: 0.91 (0.27); at 6 mo: 1.05 (0.15)	NS-D: >6 mm: Exp: BL: 10.12% (18.93); at 6 mo: 7.32% (11.02); (5.67); at 6 mo: 4.94% (8.46); NS-D: 4–6 mm: Exp: BL: 89.88% (18.93); at 6 mo: 47.81% (19.46); Con: BL: 95.59% (11.23); at 6 mo: 46.69% (23.81); ↓ in the Exp: ≥4 mm: Exp: BL: 4.66 (0.59); at 6 mo: 3.90 (0.73); Con: BL: 4.45 (0.34); at 6 mo: 3.91 (0.69)	NS-D; Exp: BL: 3.42 (2.53); 6 mo: 3.17 (2.36); Con: BL: 5.23 (0.96); 6 mo: 4.81 (1.19)	Individuals in the experimental group showed higher self-efficacy regarding interdental cleaning
Stenman et al (2018) Sweden	RCT; setting: specialist clinic in periodontics; funding: TUA-research funding, and the foundation Swedish Patent Revenue Fund for Research in Preventive Odontology	No	56.3 (10.4)	26 (7 M, 19 F)	13	13	NP	NP	1	3 y	1 experienced clinical psychologist	Moderate chronic periodontitis	PI; MBI	NS-D: Exp: BL: 49.6% (23.7); at 3 y: 42.1% (30.6); Con: BL: 38.4% (15.3); at 3 y: 41.9% (30.3)	NS-D: Exp: BL: 37.8% (19.7); at 6 mo: 17.1% (8.6); at 3 y: 14.7% (9.2); Con: BL: 32.1% (12.3); at 6 mo: 16.3% (8.9); at 3 y: 15.4% (17.6)	NP	NP	NP	NP
Gunpinar et al (2021) Turkey	RCT; setting: university; funding: self-funded by the authors	Yes	27.2 (2.3)	50 (24 M, 26 F)	25	25	NP	NP	1	6 mo	1 experienced periodontist	Gingivitis (to clinical attachment loss), with a visible plaque level >50%	PI (Rustogi); PBI	↓ in the Exp: Exp: BL: 0.68; at 1 mo: 0.15; at 3 mo: 0.17; at 6 mo: 0.18; Con: BL: 0.67; at 1 mo: 0.24; at 3 mo: 0.25; at 6 mo: 0.25	↓ in the Exp at 3 mo and 6 mo; Exp: BL: 2.27; at 1 mo: 0.44; at 3 mo: 0.22; at 6 mo: 0.24; Con: BL: 2.25; at 1 mo: 0.53; at 3 mo: 0.46; at 6 mo: 0.48	NP	NP	NP	Individuals in the experimental group showed higher knowledge level and motivation scores following the educational MI session
Arnett et al (2022) USA	RCT; setting: school of dentistry; funding: National Institutes of Health's National Center for Advancing Translational Science	Yes	62.9 (10.3)	58 (34 M, 24 F)	27	31	NP	NP	4	12 mo	1 licensed dental hygienist and dental hygiene educator	Periodontal maintenance phase (at least 1 year), plaque score ≥30% (O'Leary plaque score); minimum of 2 sites with BOP	PI (O'Leary); BOP; GI	↓ in the Con at 8 mo and 12 mo; Exp: BL: 53.2 (15.1); at 4 mo: 47.0 (14.2); at 8 mo: 40.9 (14.0); at 12 mo: 41.4 (14.0); Con: BL: 50.4; at 4 mo: 40.5; at 8 mo: 33.1; at 12 mo: 32.9	NS-D; Exp: BL: 0.134 (0.081); at 4 mo: 0.089 (0.081); at 8 mo: 0.081 (0.081); at 12 mo: 0.073 (0.080); Con: BL: 0.135 (0.085); at 4 mo: 0.069 (0.085); at 8 mo: 0.057 (0.085)	↓ in the Exp at 12 mo; Exp: BL: 1.027 (0.321); at 4 mo: 0.847 (0.321); at 8 mo: 0.719 (0.161); at 12 mo: 0.553 (0.321); Con: BL: 0.990 (0.335); at 4 mo: 0.848 (0.334); at 8 mo: 0.819 (0.204); at 12 mo: 0.714 (0.121)	NP	NP

BL, baseline; BOP, bleeding on probing; Con, control group; Exp, experimental group; GI, gingival index; MBI, marginal bleeding index; MI, motivational interviewing; NP, not reported; NS-D, non-significant difference between groups; PBI, papillary bleeding index; PD, pocket depth; PI, plaque index; PPD, probing pocket depth; RCT, randomised controlled trial; TUA, Torrens University Australia.
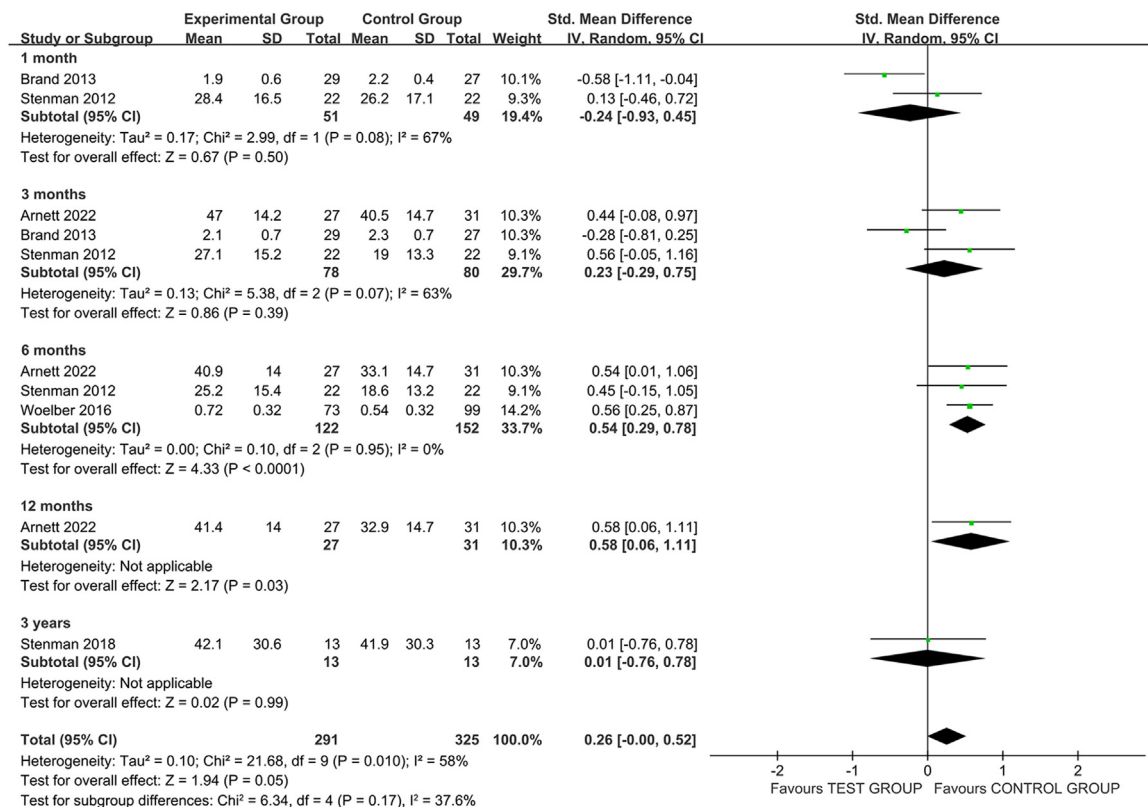
Fig. 2 – Forest plot showing the impact of motivational interviewing on the plaque index.

month follow-up in the MI group than in the control group (P < .05) [23]. However, when considering the overall effect, no significant difference was found between the MI and control groups in terms of the PI, BI, or GI (Figures 2, 3 and 4). As shown in Figure S1 through S3, funnel plots did not show significant publication bias.

RoB in individual studies

The overall RoB was assessed by 2 reviewers (CZ and WQ) and is presented in Table S2. Specifically, 5 of the 7 studies were considered to have a high RoB,[22,23,25,37,38] whereas 2 studies were considered to have "some concerns."[26,36]

Discussion

Inadequate oral hygiene increases the risk of periodontitis by approximately 2 to 5 times when compared with good oral hygiene practices, and regular toothbrushing could reduce the incidence of periodontitis by 34%.[7] Oral hygiene practices are associated with overall health behaviours that are influenced by habits, lifestyles, medical knowledge, and attitudes towards relevant diseases. Thus, educating patients about self-care is a crucial first step in treatment, enabling them to effectively manage their periodontal health. Because fostering changes in oral hygiene behaviour and establishing new, healthier practices is a gradual process, behavioural or psychological interventions that boost a patient's motivation are

vital for achieving long-term successful outcomes of periodontal therapies.

To evaluate oral hygiene behavioural changes, this study used the PI, which effectively reflects patients' attitudes towards oral hygiene and their ability to maintain it through daily self-performed plaque removal. A significant between-group difference in the PI was reported in 2 clinical trials.[22,23] However, the other 5 trials included in this study did not definitively find any difference in the PI between the MI and control groups, despite noticeable improvements in both groups.[25,26,36-38] One study even reported a higher plaque score in the MI group than in the control group.[23] This meta-analysis showed that the control group exhibited a significant reduction in the plaque score at 6 months (P < .001) and a borderline significant decrease in overall changes compared with the MI group (P = .05). This finding can be attributed to one of the study's exclusion criteria related to adherence to instructions. Although this criterion was implemented to ensure data collection during research visits, participants in the control group might have interpreted it as a requirement to comply with conventional hygiene instructions, leading to a decreased plaque score.[23] This could have resulted in all participants in the control group demonstrating a high level of adherence. Therefore, the absence of significant additive effects of MI on the plaque score in the evaluated studies should be carefully interpreted.

The influence of MI on changes in the BI and GI was analysed in this study. Reductions in these scores can be regarded as the result of improved PI, reflecting the
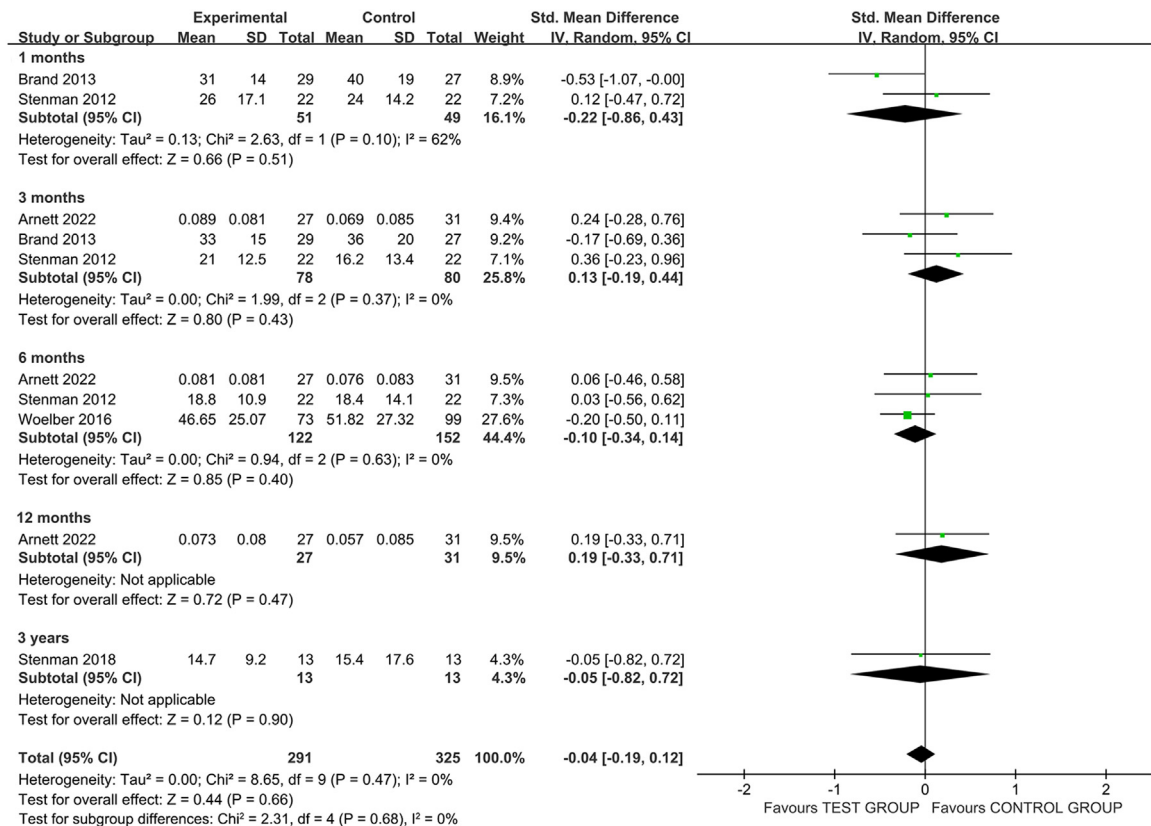
Fig. 3 – Forest plot showing the impact of motivational interviewing on the bleeding index.

amelioration of gingival inflammation. In particular, the BI is regarded as a key indicator of periodontal disease activity.[39] Unlike PI, which examines the regular implementation of plaque control measures, the BI and GI assess whether patients have maintained effective plaque control over a long period.[40,41] No significant difference in the BI was reported when there was no improvement in the PI.[25,26,36-38] However, a lower PI was not always accompanied by a lower BI.[23] Only 2 studies examined the effects of MI on the GI, revealing a

marginally significant decrease in the index for the MI group compared to the control group (SMD = −0.29, P = .07).[23,38] These findings suggest that MI promotes the recovery of gingival tissues, although this requires additional experimental confirmation. The outcomes for the bleeding score did not correspond to the GI in these 2 studies. Despite a lower gingival score in the MI group, corresponding changes in the BI were not observed. This discrepancy can be explained by the fact that bleeding can occur independently of gingival
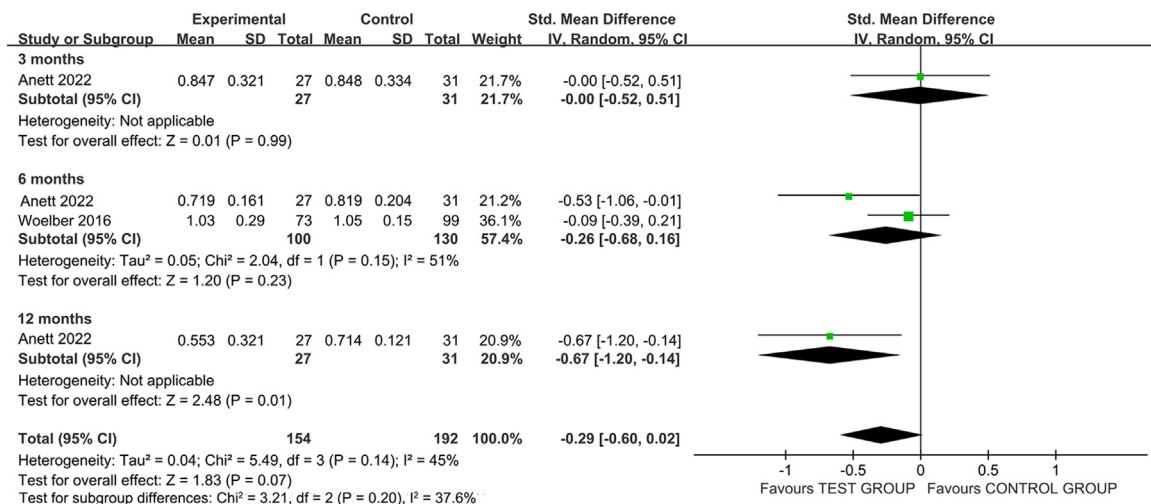
Fig. 4 – Forest plot showing the impact of motivational interviewing on the gingival index.

oedema.[42] This meta-analysis revealed no difference in the BI and GI between the MI and control groups at any time point. However, because of the relatively small sample size, caution is warranted whilst interpreting these outcomes.

Regardless of whether there was a reduction in plaque scores, pocket depth and clinical attachment loss did not exhibit significant improvement.[26,38] Two main reasons can explain this finding. First, pocket depth and clinical attachment loss are more significantly influenced by scaling and root planing during the follow-up period than by other factors, such as MI, which did not directly impact the subgingival biofilm.[43] Another plausible explanation is that the regeneration of gingival tissues and alveolar bone is a slow process. The observation periods in the existing studies may have been too short to detect significant clinical changes in these aspects. In addition, approximately half of these studies reported that MI effectively improved patients' motivation, self-efficacy in oral health, periodontal knowledge, or satisfaction with dental visits.[22,37,38] However, a meta-analysis of these aspects was not performed due to the heterogeneity of the studies and limited quantitative data.

The application of MI in these studies yielded varying results. Although MI demonstrated superiority over conventional education in some cases, pooled data analysis indicated that the adjunctive use of MI did not significantly improve the PI, BI, and GI in patients with periodontal diseases compared with conventional health education. Furthermore, data on the effect of MI on the surrogate outcomes of periodontal therapy, including pocket depth and clinical attachment loss reduction, were insufficient for performing a meaningful meta-analysis, and individual studies did not demonstrate a significant benefit of MI in improving for these outcomes.

This systematic review is inconclusive regarding the effectiveness of MI alone in enhancing oral health and improving periodontal indices. The lack of significant additive effects of MI should be carefully interpreted by considering the professionals delivering the intervention. For instance, the trial by Woelber et al[38] showed that trained dental students successfully motivated patients to engage in interdental cleaning. Conversely, when MI was administered by clinical psychologists, there appeared to be no significant influence on clinical outcomes related to the PI and BI.[25,26,36] This difference might be due to the specific counsellor conducting the educational session. Dental students could have provided definitive answers to patients enquiries, potentially making MI more effective in such circumstances. Another crucial factor is the quality of MI delivered by the counsellor. Although studies mentioned MI training, it is challenging for MI-trained dental students or periodontists to achieve the same level of proficiency as professional psychologists. Mastering MI involves comprehensive training in attitudes, philosophy, and diverse practical skills, which is a time-consuming process.[44] In the future, this issue should be formally addressed by implementing more systematic training programmes. Given that the majority of studies included only a single MI practitioner, the results were susceptible to the individual characteristics of that counsellor.

To maximise the potential benefit of MI, combining it with other psychological principles could be feasible. A viable approach involves combining MI with the transtheoretical model. According to this model, health behaviour changes usually occur when individuals move through 5 stages of readiness: precontemplation, contemplation, preparation, action, and maintenance.[45] To tailor intervention strategies more precisely, it is necessary to determine the current stage of patients' oral hygiene behaviour before implementing MI.[46] Furthermore, oral health education programmes based on MI and cognitive behavioural principles have received support from 2 systematic reviews.[29,30] This combined approach has the potential to offer a more comprehensive and effective method to enhance oral health behaviours.

This systematic review has several strengths. Unlike in previous reviews,[29,30] we exclusively included RCTs to minimise confounding and limit bias. Previous reviews have focussed only on adult patients aged 18 years or older.[29,30] We included studies without considering patients' age. However, all participants in the included studies were adults. Some reviews have analysed the overall efficacy of various health-related behavioural interventions, including cognitive behavioural therapy, social cognitive theory, or digital technologies, in periodontal diseases.[29,30,47] However, their scope was often broad and complex, with overlaps in different interventions, such as MI guided by Leventhal's self-regulatory theory and educational programme integrating cognitive behavioural principles, including MI.[48-51] Assessing the specific effectiveness of the MI component within these complex interventions can be challenging. In this analysis, we determined whether MI independently serves as an effective intervention for improving periodontal outcomes amongst patients with periodontal diseases. By maintaining this clear focus, we aimed to contribute to a more precise understanding of MI's impact on periodontal health.

Despite its strength, this systematic review has some limitations. This study included publications only in English, leading to a selection bias. Subgroup analyses conducted at follow-up times resulted in multiple analyses involving a small number of studies. Furthermore, the included studies exhibited clinical heterogeneity due to variations in interventions duration, MI programme length, number of sessions, and delivery formats. In addition, the patients included in our review exhibited difference in the severity of their periodontal diseases. Although we identified the sources of heterogeneity, we were largely unable to explain the observed differences in outcomes. Moreover, the overall quality of evidence is low because 5 of the included studies were judged to have a high RoB. Nevertheless, removing these studies did not substantially affect our results. Therefore, despite including only RCTs, the impact of MI on periodontal diseases must be carefully interpreted.

Motivation and self-efficacy of patients are important factors and present an area of interest for future research. The absence of significant difference in periodontal indices may suggest a lack of changes in motivation.[22,26] However, the effectiveness of MI could be limited in participants who already exhibit good compliance and motivation to adhere to treatment, having moved beyond the stage of ambivalence.[36] This suggests the need for further RCTs with more stringent inclusion and exclusion criteria. Specifically, patients with lower motivation might be more suitable for inclusion in

future parallel-arm RCTs. Moreover, further studies should investigate the optimal duration and frequency of MI sessions. In addition, plaque control also plays an important role in preventing of peri-implantitis. However, whether MI affects oral hygiene behaviour after dental implant placement remains unclear.[52] Therefore, future clinical trials investigating the potential of MI implementation for improving peri-implant health are warranted. Periodontitis can be classified into different grades (Grade A, B, or C), which assess the risk of disease progression and responsiveness to treatment.[53] For high-risk patients with periodontitis (Grade B or C), implementing MI could prevent the progression of periodontitis, aligning with the principles of precision medicine. However, to date, no MI-related RCT has incorporated this new classification of periodontitis.

Conclusions

The existing evidence is insufficient to conclusively support the effectiveness of MI as an adjunctive intervention for improving oral hygiene or periodontal condition in patients with periodontal diseases. Due to the high RoB of the current studies, the findings should be interpreted with caution.

Future studies should be designed with more stringent inclusion criteria with reference to the staging and grading of periodontitis and standardised MI interventions to minimise bias. Additionally, it is important to include clear and detailed information on MI training like sham exposure and scoring, and add essential supplementary materials for facilitating comprehension of the results, improving the reproducibility and homogeneity of studies, and enhancing the overall quality of the work.

Author contributions

Chaoning Zhan: data collection, data analysis/interpretation, drafting article, critical revision of article, approval of article. Wanting Qu: data collection, critical revision of articles, approval of article. Melissa Rachel Fok: critical revision of articles, approval of article. Lijian Jin: critical revision of articles, approval of article. Yifan Lin: concept/design, data analysis/interpretation, critical revision of article, approval of article. Design and implementation of the systematic review: Chaoning Zhan, Wanting Qu, and Yifan Lin. Writing of the manuscript: Chaoning Zhan and Yifan Lin. All authors discussed the results and commented on the manuscript.

Conflict of interest

None disclosed.

Funding

Supplementary materials

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