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Effectiveness of motivational interviewing at improving oral health: a systematic review

Efetividade da entrevista motivacional na melhoria da saúde bucal: revisão sistemática

ABSTRACT

OBJECTIVE: To analyze the effectiveness of motivational interviewing (MI) at improving oral health behaviors (oral hygiene habits, sugar consumption, dental services utilization or use of fluoride) and dental clinical outcomes (dental plaque, dental caries and periodontal status).

METHODS: A systematic search of PubMed, LILACS, SciELO, PsyINFO, Cochrane and Google Scholar bibliographic databases was conducted looking for intervention studies that investigated MI as the main approach to improving the oral health outcomes investigated.

RESULTS: Of the 78 articles found, ten met the inclusion criteria, all based on randomized controlled trials. Most studies (n = 8) assessed multiple outcomes. Five interventions assessed the impact of MI on oral health behaviors and nine on clinical outcomes (three on dental caries, six on dental plaque, four on gingivitis and three on periodontal pockets). Better quality of evidence was provided by studies that investigated dental caries, which also had the largest population samples. The evidence of the effect of MI on improving oral health outcomes is conflicting. Four studies reported positive effects of MI on oral health outcomes whereas another four showed null effect. In two interventions, the actual difference between groups was not reported or able to be recalculated.

CONCLUSIONS: We found inconclusive effectiveness for most oral health outcomes. We need more and better designed and reported interventions to fully assess the impact of MI on oral health and understand the appropriate dosage for the counseling interventions.

DESCRIPTORS: Motivational Interviewing, utilization. Health Behavior. Patient Acceptance of Health Care. Health Promotion, methods. Oral Health; Review.

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RESUMO

OBJETIVO: Analisar a efetividade da entrevista motivacional na melhoria dos comportamentos em saúde bucal (higiene bucal, consumo de açúcar, uso de serviços odontológicos e uso de fluoretos) e dos desfechos clínicos (placa dentária, cárie e condições periodontais).

MÉTODOS: Revisão sistemática da literatura com busca nas bases de dados PubMed, Web of Science, Lilacs, SciELO, PsyINFO, Cochrane e Google Scholar. Foram incluídos estudos que investigaram a entrevista motivacional como a principal abordagem para melhorar os desfechos em saúde bucal investigados.

RESULTADOS: De 78 estudos localizados, dez foram incluídos, todos randomizados e controlados; a maioria (n = 8) avaliou múltiplos desfechos. Cinco intervenções acessaram o impacto da entrevista motivacional nos comportamentos em saúde bucal e nove em desfechos clínicos (três em cárie, seis em placa dentária, quatro em gengivite e três em bolsas periodontais). A melhor qualidade de evidência foi encontrada nos estudos que investigaram cárie, os quais também possuíam as maiores amostras populacionais. A evidência do efeito da entrevista motivacional na melhoria da saúde bucal foi conflituosa. Quatro estudos reportaram efeitos positivos, enquanto outros quatro mostraram efeito nulo. A real diferença entre os grupos não foi apresentada ou possível de recalcular em duas intervenções.

CONCLUSÕES: Encontramos resultados inconclusivos para a maioria dos desfechos. São necessárias mais intervenções com metodologias mais apropriadas que avaliem amplamente o impacto da entrevista motivacional na saúde bucal, além de conhecer a dosagem adequada para as intervenções.

DESCRITORES: Entrevista Motivacional, utilização. Comportamentos Saudáveis. Aceitação pelo Paciente de Cuidados de Saúde. Promoção da Saúde, métodos. Saúde Bucal. Revisão.

INTRODUCTION

Most chronic dental problems are preventable by adopting effective preventive behaviors, such as regular oral hygiene (brushing teeth with fluoride toothpaste),[2,11] reduction of consumption of sugar[36] and cessation of tobacco smoking.[34] While some population groups are free or have low rates of dental diseases, others, especially the poor, suffer from a higher incidence, which indicates the need for preventive interventions.[29]

Meta-analyses and systematic reviews of oral health interventions point to the absence or ineffectiveness of educational interventions for the prevention of dental disease.[7,21,39,41,42] Most are traditional interventions, with a curative-restorative approach through lectures and the distribution of pamphlets. Other strategies for mass communication do not sufficiently consider the sociocultural context or behavioral determinants.[42]

Transforming knowledge into actions which are beneficial to the population and affordable and creating opportunities and conditions that enable individuals and communities to enjoy good oral health is the great challenge.[30,42] There has been a rising number of interventions that aim to change behaviors using approaches from Psychology.[3] One popular approach in recent years that is proving to be a promising prospect in creating lasting change and improvement in health interventions is a technique called motivational interviewing (MI).[8] MI was defined by Miller & Rollnick[25] (2002) as a technique based on evidence, centered on the individual, and individually-tailored. The focus of the approach is to prepare the individual for change by promoting and facilitating resolution of the ambivalence of individual decisions about how to change and proceed.[25] MI can contribute to constructing new knowledge and to reducing the individual's resistance to change, thus, helping to overcome difficult situations.[31]

It is considered to be a refined form of the guideline and involves three styles of communication: direct, guide, and monitor; plus three skills: ask, inform, and listen.[31] MI is described as collaborative, evocative and with respect for individual autonomy. It is not a technique to get people to do what they do not want, but rather to evoke their motivations to make changes in behaviors for their health.[26]

The effectiveness of the MI approach for more lasting behavior change with consequent improvements in health outcomes has been documented in several systematic reviews related to alcohol use,[5,30] smoking,[11,12] eating disorders,[23] as well as the promotion of physical activity and healthy eating habits.[24]

There has been little investigation in the area of oral health and the evidence is not clear. This theory-based approach to health behavior modification, already successfully applied in other fields of medicine, might be a good alternative to conventional oral health promotion. However, no systematic review with recent studies involving rigorous evaluation of oral health on this subject is available. A review from 2009 on the effectiveness of MI in health promotion[24] just touched the issue of oral health by revising four articles with oral health outcomes. The authors concluded that the approach seems promising for improving oral health. These studies bring limited evidence given they were derived from two different empirical studies with considerably distinct populations. The publications suggest that MI might reduce dental care avoidance in adolescents (a pilot scale study);[37] and dental caries in young children, by targeting their mothers, in a 2-year intervention.[15,43,44] The evidence on effectiveness of MI at improving oral health is scarce, which invites further work.

This study aimed to analyze the effectiveness of motivational interviewing in changing oral health behaviors and preventing dental clinical problems.

METHODS

Systematic review of the literature conducted in PubMed, LILACS, SciELO, PsycINFO, Cochrane Database of Systematic Reviews and Google Scholar in April 2013 and without date limits or language restrictions. The references of all reviewed articles were also scanned for potential, additional articles.

The search used the expression: *(((Motivational interviewing or motivational interview))) AND (((((((((Oral health or dental health)) OR (Oral health behaviors or oral health behavioral change)) OR (Dental hygiene or oral hygiene)) OR ((Sweet foods or sweet drinks or sweet beverages) and (consumption or intake))) OR (Dental caries or tooth decay or early childhood dental caries)) OR Dental plaque) OR (Gingival bleeding or bleeding on probing)) OR (Periodontal disease or periodontal pocket or periodontal probing depth or clinical attachment loss))*.

The inclusion criteria were intervention studies that: utilized MI as the main approach to improve oral health in at least one intervention group; included a control group; evaluated as outcome changes in one of the four oral health behaviors: oral hygiene habits, sugar consumption, dental service utilization or use of fluoride; or clinical oral health outcomes: dental plaque, dental caries or periodontal conditions (gingival bleeding or periodontal disease).

All types of studies that aimed to teach the MI approach to professionals or students or included preventive components in one or more intervention groups other than MI or traditional education (e.g., professional treatment, professional application of topical fluoride gel, varnish or mouthwash or supervised tooth-brushing) were excluded.

A database with the search results was generated using the EndNote 3.1 tool, excluding duplicate references, totaling 78 articles. The selection of articles to be included was performed independently by two of the authors. The decision was based on a third reviewer in case of disagreement. Each reviewer selected the titles and abstracts for articles of interest. Then, we proceeded to search the full text.

The evaluation of the quality of evidence was also performed independently by two authors. The disagreements were discussed between these two authors and the consensus technique was applied to the final decision. The quality of studies was assessed with the instrument proposed by Downs & Black[12] (1998) that originally consists of 27 questions on reporting, external validity, internal validity (bias and confounding), and statistical power, yielding a score varying from zero to 28. We excluded the question about the attempt to blind subjects to exposure as it does not apply to the kind of intervention studied here. The maximum score was 27 in our case. The quality of evidence of the studies were categorized as being excellent (24 to 27), good (20 to 23), fair (15 to 19), poor or limited (14 or less). We did not exclude any study on the basis of quality of evidence, given that we wanted to assess all studies on MI and oral health.

RESULTS

Of the 104 references initially identified, 26 were excluded due to duplication. From 78 references, 17 papers selected from the titles or abstracts, seven were excluded after reading the full text: two articles were excluded because the behavioral intervention used was not MI;[28,35] one was just a commentary,[45] one did not measure any outcome studied in this review;[37] and three had been superseded by more comprehensive analyses published later[15,19-20] (Figure 1).

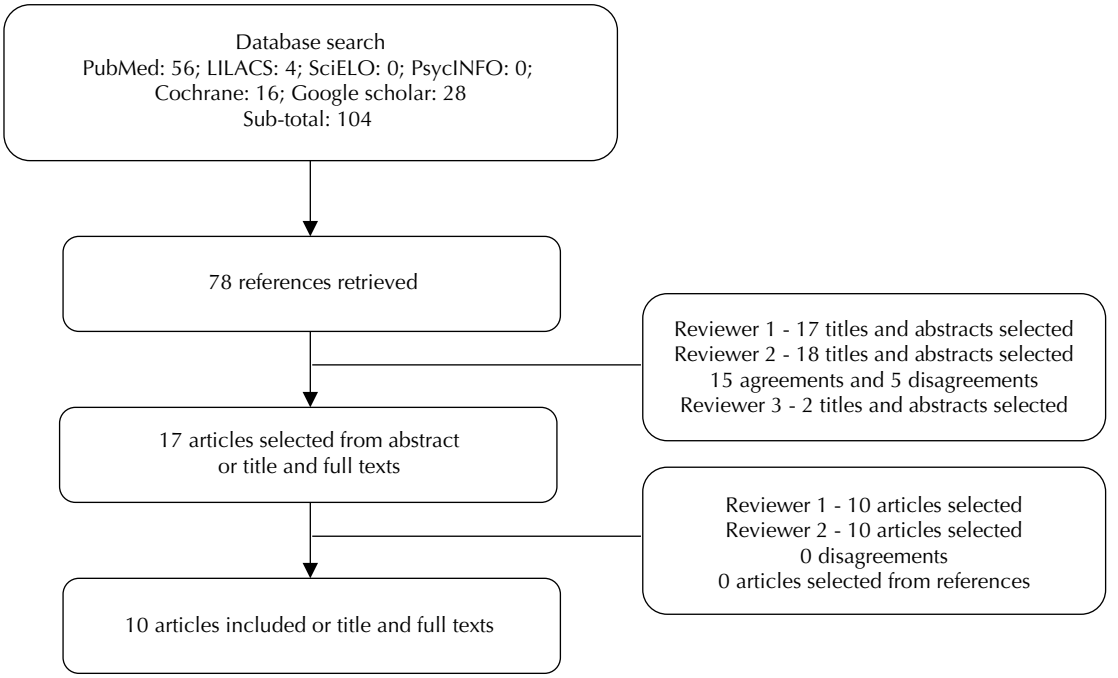

Figure 1. Flow diagram of study selection.

Description of studies

All 10 papers reviewed were based on randomized controlled trials and were performed in high income countries in North America and Europe. The majority of studies investigated adults with a mean age of 50 years (n = 6), mostly subjects attending university programs or dental clinics.[1,6,14,22,40] The other four interventions were performed with parents of young children up to five years old in their communities, of immigrants,[15] indigenous[16] and low-income populations[13,18] (Table 1).

Several limitations in the randomization process were identified. Some studies needed to attempt to control for confounding variables not sufficiently dealt with by the randomization process. These problems, allied with a variety of outcomes, both clinical and non-clinical, and different ways of measuring them, make the drawing of a clear conclusion difficult. The pooling of the results was deemed impossible given the circumstances.

The MI interventions varied in duration (15 to 90 minutes) and number of sessions (one to seven), as well as by the addition or not of the traditional approach, as available, to the control group (Table 1). Almost all studies included a control group that received traditional educational intervention, citing ethical concerns as the reason. Most often they involved presenting oral hygiene guidelines, video programs or delivering leaflets. One study did not provide any oral health education to the control group because the district health department provides a fluoride varnish program in the public school system twice a year.[13] Pamphlets were available for the control mothers to take home if desired and questions were answered, if posed, during children's regular dental visits.[13]

Five studies used a trained counselor with extensive experience in MI,[1,6,13,18] two interventions were delivered by community members that received MI training,[15,16] one was performed by two dentists and another two studies did not report who delivered the intervention sessions.[19,22] Participants in most studies received individualized MI intervention, during dental visits or wellness child visits.[1,6,13,14,16,22] In one publication, it was not clear if the video sessions were performed in groups or individualized.[18] Six of the seven MI sessions were conducted by telephone in Harisson et al[15] (2007) intervention and Freudenthal & Bowden[13] (2010) performed follow-up sessions by telephone. Five studies audio recorded the sessions to assess the counselor's fidelity in providing MI.[6,15,18,40]

Quality of evidence

The total mean score was 19.3 points (SD = 2.6), according to Downs & Black[12] (1998). The minimum score, 14, was assigned to the Freudenthal & Bowden[13] study (2010) and the maximum, 22, to the studies of Harisson et al[15] (2007), Ismail et al[18] (2011) and Brand et al[6] (2012) (Table 2).

Five publications scored between 20 and 23, classified as being good evidence.[6,14,15,18,40] Four articles scored < 20, considered fair quality of evidence,[16,19,22] and one showed limited quality of evidence.[13]

Table 1. Characteristic of the studies. (N = 10)

Author, year and country	Sample characteristics	Control group	Intervention group	Number of MI sessions	Duration of MI session (minutes)	Oral health clinical outcomes and measures	Oral health behaviors outcomes and measures	Follow-up (months)	Response rate (%)
Almomani et al[1] (2009) United States	N = 60 Adults between 22 and 62 years old with mental illness from a community program (program not described)	N = 30; TOHE	N = 30; MI + TE	One	15-20	1. Dental plaque[a]	–	Two	93.0
Brand et al[6] (2012) United States	N = 56 Adults with mean age of 61.9, from a university dental school graduate periodontics maintenance program	N = 27; TOHE	N = 29; MI	One	15-20	1. Dental plaque[a] 2. Bleeding on probing[b] 3. Periodontal probing depth (PPD 4-6 mm and > 7 mm)[b]	–	Three	95.0
Freudenthal et al[13] (2010) United States	N = 72 Parents of children between the ages of 6 to 24 months, enrolled in the Supplemental Nutritional Program for Women, Infants and Children (WIC)	N = 32; Nothing	N = 40; MI	Three	20-30	–	1. Reported frequency of child mouth cleaning or tooth-brushing (mean of a Likert scale)	One	94.4
Godard et al[14] (2011) France	N = 51 Adults with mean age of 50 from the Department of Periodontology of a university hospital	N = 27; TOHE	N = 24; MI + TOHE	Two	15-20	1. Dental plaque[c]	–	One	100.0
Harisson et al[15] (2007) Canada	N = 240 Mothers of South Asian immigrants children between 6 to18 months of age	N = 122; TOHE	N = 118; MI+ TOHE	Seven	45	1. Dental caries[d]	1. Reported number of child fluoride applications received per year (mean)	24	85.4
Harisson et al[16] (2012) Canada	N = 272 Mothers of indigenous children who had recently given birth or were between 12th and 34th weeks of pregnancy from Cree indigenous communities	N = 141; TOHE	N = 131; MI	Seven	Not informed	Dental caries[e]	Reported child visits to dentist for tooth ache (%)	24	88.6

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Ismail, et al[18] (2011) United States	N = 1,021 Caregivers of low-income African-American children aged 0 to 5 from a population-based sample	N = 515; TOHE	N = 506; MI+ TOHE	Two	40	1. Dental caries[f]	Reported frequency of tooth-brushing per day and times a week (%) Reported tooth-brushing before bedtime (%)	24	64.0
Lopez-Jornet et al[22] (2012) Spain	N = 60 Adults with mean age of 56.7, with hyposalivation and attending the Department of Oral Medicine clinic	N = 30; TOHE	N = 30; MI	Four	Not informed	Dental plaque[g] Bleeding on probing[h] Periodontal probing depth (PPD 4-5 mm and ≥6 mm)[h]	Reported frequency of tooth-brushing per day Reported duration of tooth-brushing in minutes (%) Reported frequency of interdental cleaning (%)	Two	100.0
Jonsson et al[19] (2010) Sweden	N = 113 Adults with mean age of 51.2 referred to a specialized dental clinic for periodontics	N = 56; TOHE + non-surgical periodontal treatment	N = 57; MI + non-surgical periodontal treatment	Seven	Not informed	1. Dental plaque[i] 2. Bleeding on probing[b] 3. Periodontal probing depth[b]	–	12	95.6
Stemann et al[40] (2013) Sweden	N = 44 Adults with mean age of 50.4, with moderate chronic periodontitis from a dental clinic specialized in periodontology	N = 22; TOHE	N = 22; MI	One	20-90	Dental plaque[b] Bleeding on probing[b]	–	Six	100.0

All studies were randomized controlled trials.
TOHE: Traditional oral health education; MI: Motivational Interviewing; PPD: Periodontal Pocket
[a] Modified Quigley-Hein Plaque Index (two sites of each Ramfjord's teeth examined; mean score range 0-5).
[b] Six sites of each tooth; mean prevalence of site, range 0-100%.
[c] O'Leary Plaque Index (four sites of each tooth examined; mean prevalence of sites, range 0-100%).
[d] Modified Radike criteria (incidence of surfaces decayed, missing due to caries or filled, and noncavitated lesions; dmfs mean index, range 0-88)
[e] Diagnostic criteria not described (incidence of teeth with enamel caries, dentinal caries, pulpal caries and restorations; incidence rate, range 0-100%)
[f] International Caries Detection and Assessment System (incidence of untreated noncavitated and cavitated lesions; mean number of surfaces, range 0-88)
[g] Modified Quigley-Hein Plaque Index (two sites of each tooth; mean score, range 0-5).
[h] Community Periodontal Index of Treatment Needs (six sites per teeth; 12 teeth examined; worst condition of CPITN was registered per sextant; mean prevalence of sites, range 0-100%).
[i] Silness & Loe Plaque Index (four sites in six teeth examined; mean prevalence of sites, range 0-100%).

Table 2. Evaluation criteria adapted from Downs & Black (1998).

Studies	Reporting [0 to 10]	External validity [0 to 3]	Bias[a] [0 to 6]	Confounding [0 to 6]	Power [0 to 1]	Overall score [0 to 26]
Brand et al[6] (2012)	10	0	6	5	1	22
Harisson et al[15] (2007)	10	2	6	4	0	22
Ismail et al[18] (2011)	9	2	5	5	1	22
Godard et al[14] (2011)	10	1	6	4	0	21
Stemman et al[40] (2012)	8	1	5	6	0	20
Jonsson et al[19] (2010)	9	1	5	4	0	19
Almomani et al[1] (2009)	8	1	4	4	1	18
Lopez-Jornet et al[22] (2013)	7	1	5	5	0	18
Harisson et al[16] (2012)	5	0	6	5	1	17
Freudenthal et al[13] (2010)	5	2	4	3	0	14
Mean (SD) Total (N = 10)	8.1 (1.9)	1.1 (0.7)	5.2 (0.8)	4.5 (0.8)	0.4 (0.5)	19.3 (2.6)

[a] Question 14 was excluded

Overall score of outcomes investigated varied from worse to better evidence: 18.6 (SD 3.4; min 14, max 22), 19.7 (SD 1.6; min 18, max 22), 19.7 (SD 2.1; min 18, max 22), 19.8 (SD 1.7; min 18, max 22) and 20.3 (SD 2.9, min 17, max 22) for oral health behaviors, dental plaque, periodontal pocket, gingival bleeding and dental caries, respectively. The main problems identified were: lack of representative samples (n = 7); inadequate analysis due to the absence of comparison between groups, not reporting actual p-value and intervention efficacy measures (n = 7); lack of adjustment for confounding (n = 6), not accounting for losses in the analysis (n = 4); no *a priori* sample size calculation, resulting in convenience samples and studies with low power to detect differences (n = 4); the lack of blinding of outcomes (n = 3); the lack of blinding and detailing aspects of randomization (n = 3).

Effectiveness of MI

We analyzed the effectiveness of MI in the ten different interventions. Five studies assessed the impact of MI on oral health behaviors outcomes and nine on dental clinical outcomes (three on dental caries, six on dental plaque, four on gingivitis and three on periodontal pockets). We were able to calculate and present the actual p-value of some studies that did not compare differences between control and intervention groups. Other publications did not provide enough information to calculate actual p-values not presented in the articles (Table 3).

Oral health behaviors

The evidence for the effectiveness of motivational interviewing on improving oral health behaviors was conflicting and could not be established with confidence. The use of MI significantly improved the number of fluoride varnish applications in the parents who were recommended to take their child to the dentist to apply fluoride.[15] The most investigated behavior was oral hygiene, presented in three studies[13,18,22] and one found improvements of reported oral hygiene in the intervention group compared to control.[22] No study assessed the impact of MI on changing sugar consumption and no effect was found that investigated improvements for dental service utilization.[16]

Dental caries

Two interventions reported no significant effect on reducing dental caries[16,18] and one has found a positive effect, with an estimated relative risk (RR) of 0.44, i.e., the intervention was able to prevent 56.0% of dental caries.[15] Although the study of Harisson et al (2012) did not find a significant difference between groups (p = 0.17), relative risk showed preventive direction (RR = 0.86 95%CI 0.66;1.07).

Dental plaque

Evidence on dental plaque reduction was also unable to be established. Two studies with good evidence quality assessment showed no significant effect. Another two with good[14] and fair[19] quality of evidence showed relevant magnitude of protection in MI groups compared to controls: 39.0%[14] and 77.0%[19] of reduction in the percentage of affected sites. Actual p-value was not present or able to be recalculated in another two interventions.[1,22] However, Almomani et al[1] (2009) presented a reduction of 47.0% of plaque in the intervention group compared to 24.0% in the control.

Table 3. Main results about the effectiveness of motivational interviewing according to the outcomes.

Outcomes	Reference	Summary findings		p-value[a]
		Control group	Intervention group	
Oral health behaviors				
Dental utilization	Harisson et al[16] (2012)	B: 35.5% (N = 39) F: 15.4% (N = 17)	B: 50.0% (N = 65) F: 24.4% (N = 32)	0.085[a]
Sugar consumption	–	–	–	–
Oral hygiene	Freudenthal et al[13] (2010)	B: mean 3.2 (SD NI) F: mean 3.3 (SD NI)	B: mean 2.8 (SD NI) F: mean 3.7 (SD NI)	NI
	Ismail et al[18] (2011)	Brushing 2x per day: B: 47.3% (N = 142) F: NI Brushing 7 days per week: B: 77.3% (N = 232) F: NI Brushing 7 days a week at bedtime: B: 25.3% (N = 76) F: NI	Brushing 2x per day: B: 56.1% (N = 168) F: NI Brushing 7 days per week: B: 76.2% (N = 228) F: NI Brushing 7 days a week at bedtime: B: 34.4% (N = 103) F: NI	0.700[b] 0.860[b] 0.830[b]
	Lopez-Jornet et al[22] (2012)	Brushing 2x or more per day: B: 53.3% (N = 16) F: 90.0% (N = 27) Brushing duration ≥ 2 min: B: 30.0% (N = 9) F: 70.0% (N = 21) Interproximal tooth brushing 1x day: B: 36.6% (N = 11) F: 59.9% (N = 18)	Brushing 2x or more per day: B: 86.6% (N = 26) F: 100.0% (N = 30) Brushing duration ≥ 2 min: B: 13.3% (N = 4) F: 80.0% (N = 24) Interproximal tooth brushing 1x day: B: 19.7% (N = 6) F: 56.6% (N = 17)	0.037[a] 0.038[a] 0.260[a]
Fluoride application[c]	Harisson et al[15] (2007)	B: mean 0.0 F: mean 0.25 (SD 0.5)	B: mean 0.0 F: mean 3.81 (SD 1.2)	0.001[b]
Oral health clinical outcomes				
Dental caries	Harisson et al[15] (2007)	dmfs: B: mean almost 0.0 (2 children) F: mean 7.59 (SD 14.2) dmfs plus noncavitated lesions: B: mean almost 0.0 (2 children) F: mean 7.91 (SD 14.2)	dmfs: B: mean dmfs almost 0.0 (4 children) F: mean dmfs 3.35 (SD 7.8) dmfs plus noncavitated lesions: B: mean dmfs almost 0.0 (4 children) F: mean 3.52 (SD 8.0)	0.001[b] 0.01[b]
	Harisson et al[16] (2012)	Total incidence: B: NI F: 76.4% (N=100)	Total incidence: B: NI F: 65.4% (N = 72)	0.17[b]
	Ismail et al[18] (2011)	Cavitated and noncavitated caries: B: mean of 5.59 F: incidence of 6.4	Cavitated and noncavitated caries: B: 5.65 F: incidence of 6.5	0.990[b]
Dental plaque	Almomani et al[1] (2009)	B: mean 3.3 (SD 0.8) F: mean 2.5 (SD 0.9)	B: mean 3.6 (SD 0.6) F: mean 1.9 (SD 0.7)	NI
	Brand et al[6] (2012)	B: mean 2.6 (SD 0.5) F: mean 2.3 (SD 0.7)	B: mean 2.4 (SD 0.6) F: mean 2.1 (SD 2.1)	0.390[b]
	Godard et al[14] (2011)	B: mean 58.0% of sites (SD 12) F: mean 54.0% of sites (SD 12)	B: mean 55.0% of sites (SD 15) F: mean 34.0% of sites (SD 20)	0.01[b]

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Dental plaque	Lopez-Jornet et al[22] (2012)	B: mean 0.4 (SD 0.2) F: mean 0.2 (SD 0.1)	B: mean 0.7 (SD 0.1) F: mean 0.3 (SD 0.2)	NI
	Jonsson et al[19] (2010)	B: mean 57.0% of sites (SD 17) F: mean 28.0% of sites (SD 13)	B: mean 59.0% of sites (SD 18) F: mean 14.0% of sites (SD 12)	< 0.001[b]
	Stemann et al[40] (2013)	B: mean 43.1% of sites (SD 19.2) F: mean 18.6% of sites (SD 13.2)	B: mean 50.2% of sites (SD 21.5) F: mean 25.2% of sites (SD 15.4)	> 0.05[b]
Bleeding on probing	Brand et al[6] (2012)	B: mean 55.0% of sites (SD 18) F: mean 36.0% of sites (SD 20)	B: mean 50.0% of sites (SD 18) F: mean 33.0% of sites (SD 15)	0.263[b]
	Lopez-Jornet et al[22] (2012)	B: mean 22.4% of sites (SD 34.7) F: mean 6.1% of sites (SD 13.4)	B: mean 29.7% of sites (SD 34.9) F: mean 18.4% of sites (SD 25.8)	NI
	Jonsson et al[19] (2010)	B: mean 75.0% of sites (SD 18) F: mean 29.0% of sites (SD 14)	B: mean 70.0% of sites (SD 20) F: mean 19.0% of sites(SD 13)	< 0.001[b]
	Stemann et al[40] (2013)	B: mean 33.0% of sites (SD 12.4) F: mean 18.4% of sites (SD 14.1)	B: mean 36.6% of sites (SD 17.1) F: mean 18.8% of sites (SD 10.9)	> 0.05[b]
Periodontal probing depth	Brand et al[6] (2012)	PPD 4-6 mm: B: mean 23.3% of sites (SD 23.1) F: mean 16.1% of sites (SD 21.4) PPD > 7 mm: B: mean 1.8% of sites (SD 6.9) F: mean 1.4% of sites (SD 5.7)	PPD 4-6 mm: B: mean 23.8% of sites (SD 15.8) F: mean 20.3% of sites (SD 15.0) PPD > 7 mm: B: mean 2.0% of sites (SD 4.1) F: mean 1.7% of sites (SD 3.9)	0.777[b] 0.844[b]
	Jonsson et al[19] (2010)	PPD 4-5 mm: B: mean 33.0% of sites (SD 14.0) F: mean 12.2% of sites (SD 10.8) PPD ≥ 6 mm: B: mean 9.3% of sites (SD 11.0) F: mean 1.5% of sites (SD 3.2)	PPD 4-5 mm: B: mean 31.0% of sites (SD 14.3) F: mean 10.4% of sites (SD 7.9) PPD ≥ 6 mm: B: mean 9.2% of sites (SD 9.3) F: mean 1.6% of sites (SD 2.9)	> 0.05[b] > 0.05[b]
	Lopez-Jornet et al[22] (2012)	PPD 4-5 mm: B: mean 1.7 (SD 7.5) F: mean 1.5 (SD 7.1) PPD ≥ 6 mm: B: mean 0.0 F: mean 0.0	PPD 4-5 mm: B: mean 3.5 (SD 9.5) F: mean 2.6 (SD 7.1) PPD ≥ 6 mm: B: mean 0.8 (SD 4.5) F: mean 1.0 (SD 5.6)	NI NI

NI: not informed or not possible to calculate. B: baseline. F: final follow-up. PPD: periodontal pocket.
[a] Estimated p-value.
[b] Informed by original authors.
[c] The application of fluoride varnishes provided was considered a proxy of oral health behavior on dental visits.

Periodontal conditions (gingival bleeding and periodontal pocket)

There was limited evidence about the effectiveness of MI on periodontal pocket and gingival bleeding reduction. One study found significant effect of MI intervention at reducing gingival bleeding, showing a reduction of 73.0% in the intervention group compared to 62.0% in the control. Similar results on periodontal pockets reduction were showed for intervention and control groups, and no significant effects were found.

DISCUSSION

The overall quality of evidence of the studies was considered fair and the effect of the MI-based interventions on the outcomes assessed is not clear, since results were conflicting. Positive results were reported in four studies with lower quality of evidence[14,15,19,22] while null effects were reported in another four studies with better quality evidence assessment.[6,16,18,40]

The target populations in the interventions differed considerably, making it hard to make comparisons between the studies or to compile evidence. It is not possible to assess what intensity of MI intervention is effective. The strongest evidence was found for the prevention of dental caries, provided by interventions with population-based samples. The largest study[18] was the one that used the shortest schedule for the motivational interviews, two with each individual, compared to seven in the study where a significant positive effect was reported.[15]

The studies which assessed dental caries as an outcome reported its increment (number of new carious lesions, teeth or surfaces occurring in an individual within a stated period of time – DMFS index) by subtracting their caries experience score at baseline from their corresponding score at follow-up. Slade et al (1999) discussed several limitations of this analytical approach and presented a uniform alternative for enumerating caries events that permits DMFS increment to be applied both to cumulative and incidence density calculations.[38] This analytic method addresses multiple events of caries initiation, progression and reversal, which may occur at different intervals on a single tooth surface.

The lack of uniformity in case definitions of periodontitis and the use of different theories and models for periodontal disease progression limit the assessment of the disease in longitudinal studies.[5] The interventions included in this review used periodontal probing depth as a proxy of periodontal disease. However, the use of combinations of periodontal disease indicators are suggested under the rationale that they represent both cumulative tissue destruction (attachment loss) and current pathology (periodontal pocket depth).[5]

Evidence about reduction of dental plaque is unclear. However, where a significant effect was detected, the magnitude of reduction was large. Evidence on gingival bleeding and periodontal probing depth were also limited. We still need better studies with longer-term assessments to arrive at any firm conclusion.

Half of the studies presented an attempt to assess fidelity of the implementation to the original protocol,[1,6,15,18,40] but only Ismail et al[18] (2011) and Stemann et al[40] (2012) presented a clearly defined strategy to measure fidelity. Fidelity assessment should take into account all key elements considered essential intervention components, and also non-specific elements, such as therapeutic alliance or empathy. These assessments are essential to understanding the effects on the outcomes.[9,27]

This was the largest review to examine the effectiveness of MI on oral health outcomes. Two independent reviewers assessed all publications identified by an extensive search of the literature performed in many databases and with no language limitations to avoid bias selection. Agreement between the reviewers was high, and a third reviewer resolved all discrepancies. All included articles were assessed by two independent reviewers in order to summarize the quality of evidence both global and for each outcome.

We were unable to summarize quantitative assessments of the included articles due to heterogeneity of the studies. The low number of publications and diversity of outcome measurements further hampered interpretation of the available evidence.

Based on the assessment of quality of the 10 articles, we suggest a few key points that should be considered for new interventions. It is essential that a sequence of endpoints, relevant to the assessment of effect on oral health, be assessed. They should include measures of knowledge and behavior, as well as clinical indicators with enough follow-up to capture the changes. Oral disease progression is influenced by several prognostic factors, such as age, sex, surfaces and tooth types, severity/activity of disease at baseline, socioeconomic level, oral health behaviors, among others, that should be considered in determining appropriate time of follow-up in order to assess significant changes. Sample size, individual selection and randomization procedure need to be carefully considered. The selection of individuals and the randomization process need to assure comparability of the groups. Special attention should be given to blinding clinical raters to intervention status of individuals and also to including appropriate process evaluation, by assessing whether the implementation of the proposed intervention was done according to protocol (fidelity).

The studies that showed beneficial effects conducted the interventions in clinical settings, applying MI

individually. The only study performed with a larger sample in the community did not find any effect.[18] Individual models for health prevention alone may not be enough to achieve sustainable improvements in health at a population level.[4,32,42] As MI was developed to promote individual changes in a clinical setting, further research should answer whether effective interventions at the individual level are translatable to a public health scale.

MI appears to be a promising approach for changing individual behavior in many health outcomes,[10,17,24,33] and this is probably also true for oral health. The evidence we presented in this review is limited, but do allow us to be optimistic. The effectiveness of MI in changing oral health behavior and preventing dental diseases, such as caries and periodontal disease, is still unclear. We need more and better designed and reported interventions to fully assess its impact on oral health and longer term outcomes.

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