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Effects of Mechanical, Chemical and Combination Methods on Halitosis: A Systematic Review and Meta-analysis

Mekanik, Kimyasal ve Kombine Yöntemlerin Ağız Kokusuna Etkileri: Sistematik Bir İnceleme ve Meta-analiz

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Abstract

Objective: Halitosis or bad breath is one a problem that can have a profound effect on the quality of life associated with health. The purpose of this systematic review and meta-analysis was to investigate the treatments used to treat halitosis.

Materials and Methods: This study involved a systematic review and meta-analysis. It was used in conjunction with treatment, management, therapy, and therapeutics for the first-call combination of bad breath, bad breath, halitosis, pseudohalitosis, halitophobia. Finally, these articles were removed according to the text and 37 articles remained.

Results: The effect of chemical methods on the treatment of bad breath was significant; halitosis was reduced by 1.19 [95% confidence interval (CI), 1.57 to 0.78]. Additionally, there was heterogeneity between studies (Q=11.32). Mechanically, despite the presence of heterogeneity between studies (Q=5.41), the p-value was not statistically significant (p=0.15), with the effect of the combined methods, bad breath was reduced to 1.18 (with a 95% CI, 1.68 to -0.51). Additionally, there is heterogeneity (Q=12.14).

Conclusion: The results of this study show that chemical and compound methods are effective in reducing bad breath.

Keywords
Halitosis, bad breath, treatment, management

Anahtar Kelimeler
Halitozis, ağız kokusu, tedavi, yaklaşım

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Öz

Amaç: Halitozis veya ağız kokusu, sağlıkla ilişkili yaşam kalitesi üzerine önemli etkileri olabilecek sorunlardan biridir. Bu sistematik derleme ve meta-analizin amacı, halitozisin tedavisinde kullanılan yöntemleri incelemektir.

Gereç ve Yöntemler: Bu çalışma bir sistematik derleme ve meta analizdir. Veri tabanlarında ağız kokusu, halitozis, pseudohalitozis, halitofobi ile tedavi, yönetim, terapi ve terapötikler kelimelerinin kombinasyonları tarandı. Son olarak, bu makaleler metne göre değerlendirildi, 41 tanesi çıkarılarak 37 makale dahil edildi.

Bulgular: Kimyasal yöntemlerin ağız kokusunun tedavisi üzerindeki etkisi belirgindi; halitozis 1,19 düzeyinde azaltıldı [%95 güven aralığı (GA), 1,57 ila 0,78]. Ek olarak çalışmalar arasında heterojenite bulunmaktaydı (Q=11,32). Mekanik olarak, çalışmalar arasında heterojenite olmasına rağmen (Q=5,41), p değeri istatiksel olarak anlamlı değildi (p=0,15), kombine yöntemlerin etkisi ile ağız kokusu 1,18 düzeyine azaltıldı (%95 GA, 1,68 ila -0,51). Ek olarak heterojenite de bulundu (Q=12,14).

Sonuç: Bu çalışmanın sonuçları, kimyasal ve bileşik yöntemlerin ağız kokusunu azaltmada etkili olduğunu göstermiştir.

Introduction

Bad breath, also referred to as halitosis and oral malodor, is one of the grave problems that many people try to avoid. Under normal conditions, the human breath is odorless and has a distinctive odor called 'human odor' (1,2). Approximately, a quarter of the world population have halitosis, with the majority exhibiting this condition occasionally (3). Patients usually do not express the primary complaint; instead, the patients' family members and relatives become aware of the condition (3,4).

Dental practitioners estimate that only 25% of the population has halitosis, and the remaining 75% only has a medical condition or halitophobia (5). Several treatment modalities have been suggested for the treatment of halitosis; however, there is no consensus yet on a standard protocol for this problem.

Although many studies have been undertaken on halitosis, no systematic review or meta analysis has been published on techniques to evaluate the halitosis and the treatment modalities of halitosis. Therefore, the present systematic review and meta-analysis were undertaken to review the treatment modalities of halitosis during the past 20 years.

Materials and Methods

Combinations of the words halitosis, bad breath, oral odor, pseudohalitosis, and halitophobia with the words treatment, management, therapy, and therapeutics were used for the initial search. The search in databases brought up 1175 records, which were transferred to the Mendeley software. Then, a search based on 'author', 'year', and 'title' revealed 441 repeated records. The approval for the this study was approved by ethical committee of Kerman University of Medical Sciences (approval code: IR.KMU.REC.1397.472.).

Statistical Analysis

At the end of this stage, 737 records remained after the elimination of 441 repeated records. Finally, 37 articles (Table 1), were evaluated (Figure 1).

Results

The effect of chemical techniques on halitosis was statistically significant; i.e., halitosis decreased by 1.19% [at 95% confidence interval (CI): -0.78-1.57]. Also, there was a heterogeneity between the studies (Q=11.325) (Table 2).

Despite the heterogeneity between the studies (Q=5.41), the p-value did not indicate statistical significance (p=0.15) (Table 2).

The effects of combined techniques on the elimination of halitosis were significant; i.e., halitosis decreased by 1.18% (at a 95% CI: -0.51 to -1.68). In addition, there was heterogeneity between the studies (Q=12.142) (Table 3).

All work included initial search of the articles, selection of them, record and interpretation of the articles and meta-analysis was done by two authors of the article.

Discussion

The results showed that the pharmaceutical techniques are useful in this respect; however, mechanical techniques are useful, too. Also, a combination of chemical and pharmaceutical techniques was found to be effective.

Akkaoui and Enhibi (6) and Buunk-Werkhoven et al. (7) reported the results only based on questionnaires, with no tools for measuring the severity of halitosis, including halitometers and volatile sulfur compounds (VSC) analyses; therefore, they were eliminated. These reports are studies that have a very small sample size (1 to 6) with a specific medical condition or specific manifestations of a medical condition (8-10). These studies are suitable for introducing new diseases but cannot be generalized due to their very small sample size. Therefore, they are not included in systematic reviews. For example, Lopes et al. (9) evaluated the effect of photodynamic therapy with the use of methylene on the oral surfaces in five 14-16 year-old subjects.

Another study whose abstract was available was carried out by Yaegaki and Sanada (11) in 1992 on the effect of olive oil and essential oils on decreasing halitosis in comparison with repeated rinsing of the oral cavity. The researchers concluded that the use of these oils could decrease halitosisby 65% (11).

A study by Rassameemasmaung et al. (12) showed that the use of a herbal extract of G. mangostana might be useful as an adjunct in the treatment of halitosis.

An evaluation of the year of publication showed that 18 studies were published from 2015 on, and 19 articles were published from 2015 to 2018. Of all the studies published after 2015, almost half (nine

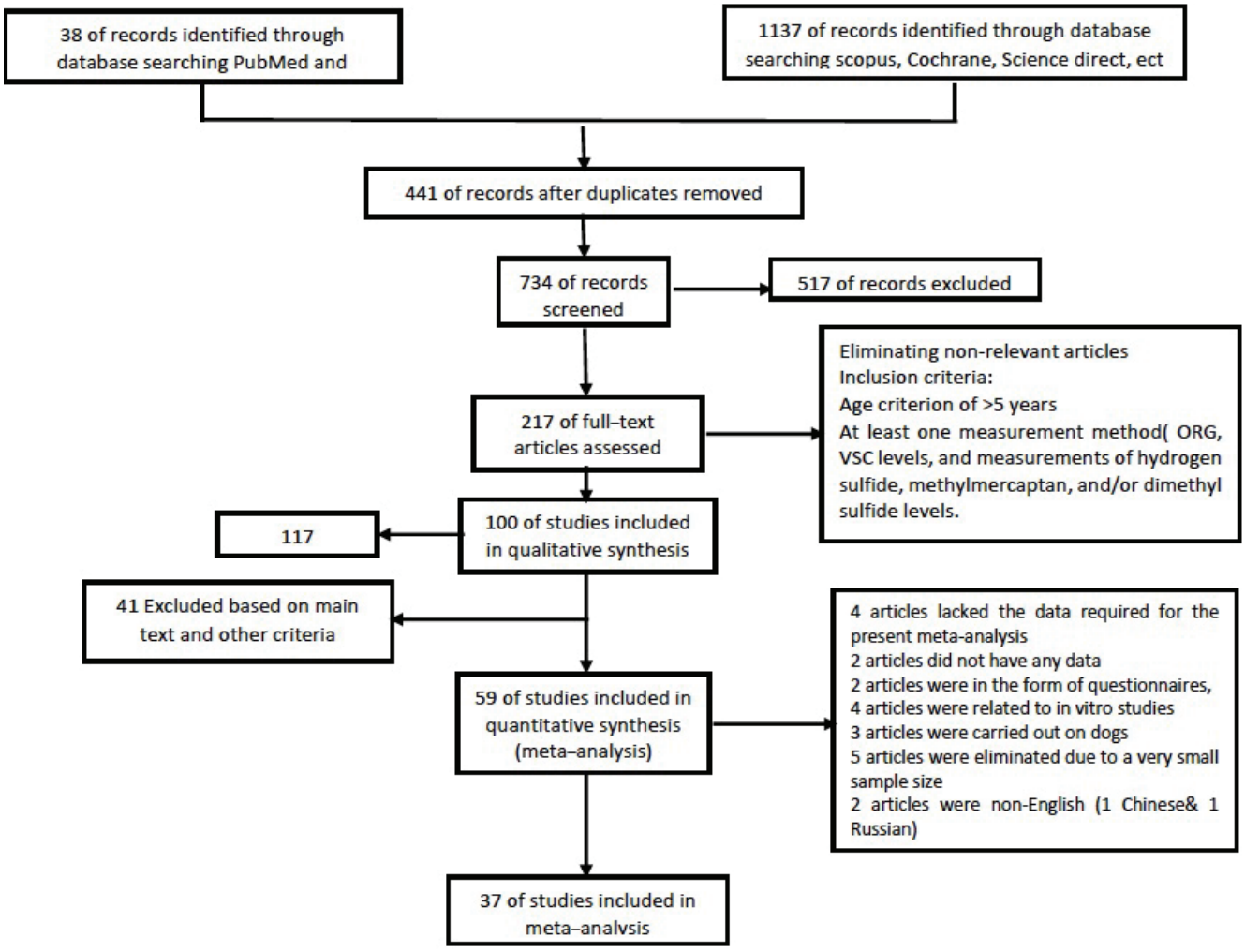

Figure 1. Flow diagram for study selection
ORG: Organoleptic scores, VSC: Volatile sulfur compounds

studies, 24.3% of all the studies) were published in 2016, indicating that the discrepancies in the results of studies on the treatment of halitosis have attracted the attention of researches more than ever.

A study by Porter and Scully (13) showed that the use of mechanical techniques, such as cleaning the surface of the tongue, brushing, use of dental floss, and periodontal treatments, could control the dental plaque and decrease halitosis.

In a study by Chen and Jin (14) 251 articles were included. These researchers showed that the mechanical cleaning of the tongue surface (brushing and scrubbing) significantly decreased halitosis (a decrease in VSC and Winkel tongue coating index, and an improvement in the periodontal status) in the case group. However, there was no significant difference between the case and control groups.

Several studies have shown a relationship between halitosis and periodontitis (15-17). At present, the majority of researchers believe that the two factors above affect each other (18).

Several studies have shown that chlorhexidine (CHX), essential oils, triclosan, cetylpyridinium chloride (CPC), chlorine dioxide, zinc salts, benzalkonium chloride, hydrogen peroxide, and sodium bicarbonate mouthwashes are successful when they are combined with mechanical techniques (19,20).

Studies by Thrane et al. (21), and Thaweboon and Thaweboon (22) showed that mouthwashes such as CHX, CPC, triclosan, essential oils, quaternary ammonium compounds, benzalkonium chloride, and hydrogen peroxide mouthwashes are effective in decreasing halitosis.

Table 1. Details of the information included in the systematic review and meta-analyses

No	Year - country	Author	QA score consort	Sample size and characteristics	Follow up period	Type of study and duration	Type of intervention	Methods of assessment halitosis
1	2002 Turkey	Ermis B	20	162 0 81 M, 71 F	--------	RCT	Mebendazole, placebo	Exitance of bad breath
2	2003 Netherland	Winkel EG		40 43.8±15.8 21 M, 19 F	At days 0 and 14	RCT	CHX (0.05%), CPC (0.05%), zinc-lactate (0.14%)	Organoleptic, VSC, WTCI, tooth staining
3	2004 Spain	Roldán S	21	19 40.4±19.1 9 M 10 F	1 and 3 months after baseline	RCT	Tongue scraper, CHX-0.05%, (CPC; 0.05%), zinc lactate (0.14%)	Organoleptic, VSC, tongue coating, periodontal, salivary flow, subgingival plaque
4	2006 Brazil	Faveri M	24	18 19.25±1.4 6 M, 12 F	--------	RCT	Tooth brushing; tooth brushing and inter-dental flossing; tooth brushing and tongue scraping; tooth brushing, inter-dental flossing and tongue scraping	VSC, organoleptically and by volatile sulphur
5	2006 Brazil	Dal Rio AC	25	38 0 13 M, 25 F	--------	Case control	CO_2 laser, shar plan lasers	VSC
6	2007 Greece	Katsinelos P	22	18 40.78±10.9 10 M, 8 F	6 weeks	Case control	20 mg omeprazole, 500 mg clarithromycin and 1,000 mg amoxicillin	Urea concentration H. pylori in the gastric mucosa
7	2009 Korea	Lee JS	25	88 47.7±8.4 39 M, 49 F	--------	RCT	Korea red ginseng	VSC, urea breath test, H.pylori culture, cell culture lyase, cystathionineγ
8	2009 Nigeria	Al-Abbasi AM	21	44	1 week	RCT	Tonsillectomy	Subjective and objective postoperative assessment
9	2010 Germany	Schaefer I	24	31 0 7 M, 24 F	3 months	RCT	0.06% Chlorhexamed, gum protection mouthrinse (plus 250 ppm sodium fluoride)	Stimulated saliva flow rate organoleptic, tongue coating, VSC, modified gingival index, plaque index, bleeding on probing index
10	2011 Turkey	Tanyeri HM	26	58 35.8 30 M, 28 F	------	RCT	Temperature-controlled RF tonsil ablation	Otolaryngologic examination
11	2011 India	Malhotra S	25	15 0 9 M, 6 F	7 days	RCT	CHX, essential oil mouth rinse Placebo	Organoleptic red complex organisms
12	2012 Korea	Song JA	24	N=66 Mean age =24.2±9.1 34 M, 32 F	14 day	Case control	A-solution, blended essential oils and diluted with distilled water	VSC, salivary pH, oral status

13	2012 Sweden	Erovic Ademovski S	23	21 45.7±13.3 11 M, 10 F	Day 1: 30 min after interand Day 14: 8-12 h after the last inter	RCT	Zinc acetate (0.3%) and CHX (0.025%) with and without adjunct tongue scraping	Measurements of H_2S, MM, and dimethyl sulfide levels VSC, bacterial samples from the tongue
14	2013 Sewden	Erovic Ademovski S	25	70 48.6±14.8 36 M, 34 F	3 months after treatment	RCT	Non-surgical periodontal therapy	Organoleptic scores, VSC, gas chromatograph, tongue coating
15	2013 Brazil	Oliveira-Neto JM	23	20 35.9 30 M, 14 F	--------	RCT	Tongue scraper. 2 mouthrinses (0.05% CPC and 0.12% CHX, soft-bristled toothbrush and fluoride toothpaste	VSC
16	2013 Germany	Wilhelm D	24	54	5 and 60 min after treatment	RCT	Tongue cleaning with tooth and tongue gel applied to the tongue cleaner	VSC, organoleptic
17	2014 Turkey	Ata N	23	34 28.28±9.3 26 M, 8 F	12 months	RCT	RF cryptolysis	VSC
18	2015 Italy	Marchetti E	24	20	--------	RCT	Lactobacillus brevis (CD2) - containing lozenges, compared with placebo	Tongue coating, VSC organoleptic, breath print constructed by BIONOTE®
19	2015 Iran	Sayedi SJ	23	77 case: 5.23±2.61 control: 5.78±2.29 40 M, 37 F	--------	RCT	Balsam fir, cinnamon, coriander, labrador tea, myrrh, peppermint, sage, sweet marjoram, thyme, winter savory	Biofilm formation, biofilm killing
20	2015 Japan	Aung EE	24	30 19.80±2.9 14 M, 16 F	14 Day	RCT	Tooth brushing, mouth washing with chlorine dioxide, tongue cleaning	VSC
21	2015 Turkey	Ileri Keceli T	23	69 NR 32 M, 37 F	14 Day	RCT	Scaling-polishing + tooth brushing + tongue brushing and scaling-polishing + tooth brushing	VSC, organoleptic assessment
22	2015 Brazil	Feres M	22	70 24.3±8.5 30 M, 40 F	12 Hours	RCT	Brushing with regular fluoride toothpaste alone, brushing with regular fluoride toothpaste followed by rinsing with a 0.075% CPC	Organoleptic examination, VSC
23	2016 India	Penala S	27	32 45.3 0	--------	RCT	Probiotics (Lactobacillus salivarius and Lactobacillus reuteri, scaling and root planning)	Microbial assessment, halitosis assessment, red complex organisms
24	2016 Turkey	Dereci O	23	60 43.7±3.1 31 M, 29 F	1st, 3rd and 6th months	RCT	Er, Cr:YSGG laser supported periodontal therapy	VSC, plaque index, probing depth, clinical attachment level, bleeding on probing
25	2016 Brazil	Costa da Mota AC	25	46 14.80±2.50 22 M, 24 F	--------	RCT	Antimicrobial photodynamic therapy	Microbiological analysis, VSC

26	2016 Germany	Seemann R	22	34 44.2 17 M, 17 F	12 h after the evening rinse and 12 h after the daytime rinse	RCT	Mouthwash Cb12 contains 0.3% zinc acetate dihydrate, 0.025% CHX, aqua, glycerin, hydrogenated starch hydrolysate, alcohol, sodium fluoride, PEG-40 hydrogenated castor oil, potassium acesulfame, citric acid and aroma Cb12 (a mixture of 0.3% zinc acetate and 0.025% CHX)	VSC, organoleptic score
27	2016 Turkey	Sökücü O	24	13 0 5 M, 8 F	1, 3, 5, 7, 9, 11, and 13 months after bonding	RCT	Orthodontic therapy consisted of molar bands with edgewise triple buccal tubes with vertical hooks	VSC, plaque index, gingival index, probing pocket depth
28	2016 Sweden	Erovic Ademovski S	24	21 45.7±13.3 11 M, 10 F	12 h after rinsing with placebo and five mouth rinse	RCT	Zinc acetate and CHX diacetate; zinc lactate, CHX, CPC; zinc acetate and CHX diacetate with reduced amounts of mint and menthol; zinc chloride and essential oil and chlorine dioxide	Gas chromatograph organoleptic
29	2016 Brazil	Lopes RG	22	45	--------	RCT	Antimicrobial photodynamic therapy, tongue scrabing	VSC
30	2017 Brazil	Silveira JO	21	30 FMD: 48.13 (±7.78) QS: 47.0 8 M, 22 F	90 days after treatment	RCT	Scaling and root planing	Organoleptic, VSC
31	2017 Turkey	Caygur A	21	60	Days 7, 14, 30	RCT	Glycine powder air-polishing combined with scaling and root planing	VSC
32	2017 Sweden	Erovic Ademovski S	22	46 48.89 0	3 Month	RCT	Zinc acetate and CHX diacetate containing mouth rinse, mouth rinse contained the same ingredients except for the active substances (0.3% Zn and 0.025% CHX)	Probing pocket depth, bleeding on probing, plaque index, organoleptic, VSC, H_2S and tongue coating
33	2017 India	Mamgain P	23	60 0 0	14th day, and the 21st day	RCT	Triphala and Ela decoction, CHX 0.2%	Gingival inflammation plaque, organoleptic
34	2018 Iran	Hashemian F	25	52 0 18 M, 34 F	7 days,1 month, and 6 months after the procedure	RCT	Temperature controlled RF, tonsil ablation, CO_2 laser cryptolysis	Tonsil smelling, pain bleeding
35	2018 Brazil	Gonçalves MLL	24	60 control: 37 case: 39 0	--------	Case control	Antimicrobial photodynamic therapy	VSC
36	2018 Turkey	Sezen Erhamza T	26	30		Case control	Rapid maxillary expansion	VSC, organoleptic
37	2018 Brazil	Gonçalves MLL	21	39	--------	RCT	Tongue scraping, Photodynamic therapy	Microbiological analysis halimetry

RCT: Randomized controlled trial, M: Male, F: Female, QA score: Quality score, VSC: Volatile sulfur compounds, CHX: Chlorhexidine, WTCI: Winkel tongue coating index, H. pylori: Helicobacter pylori, H_2S: Hydrogen sulfide, MM: Methyl mercaptan, CPC: Cetylpyridinium chloride, RF: Radiofrequency, FMD: Full-mouth debridement

Table 2. Overall estimate of the difference between the mean standard for reducing bad breath with pharmacological methods, mechanical methods and chi-square heterogeneity test

Pharmacological methods					
1st Author	**Year**	**SEM**	**95% CI**		**% weight**
			Lower	**Upper**	
Song JA	2012	-1.32	-1.95	-0.90	8.21
Ermis B	2002	-0.75	-1.35	-0.25	7.14
Winkel EG	2002	-1.56	-2.09	-1.20	7.29
Mamgain P	2016	-2.65	-2.69	-1.49	8.03
Seemann R	2016	-0.35	-0.078	0.80	7.02
Sayedi SJ	2015	-0.93	-0.25	-0.65	7.56
Costa da Mota AC	2016	-1.42	-2.15	1.17	7.23
Gonçalves MLL	2017	-1.71	-2.16	-1.18	8.19
Katsinelos P	2007	-2.52	-2.91	-1.81	7.95
Malhotra S	2011	-2.59	-2.94	-0.91	7.98
Schaefer I	2010	-2.19	-2.65	-1.65	7.15
Lee JS	2009	-0.64	-1.07	-0.20	8.02
Marchetti E	2015	-1.09	-0.22	-1.19	7.21
ErovicAdemovski S	2016	-1.31	-2.06	-0.34	7.78
ErovicAdemovski S	2013	-1.57	-1.59	-0.54	9.23
Pooled SMD		-1.19	-1.57	-0.78	100
Heterogeneity chi-squared = (P=0.001)					
I-squared (variation in OR attributable to heterogeneity) =82.1%					
Mechanical methods					
1st Author	**Year**	**SEM**	**95% CI**		**% weight**
			Lower	**Upper**	
Dal Rio AC	2006	-2.23	-2.89	-0.85	7.25
Hashemian F	2018	-2.23	-2.91	-0.65	7.45
Silveira JO	2016	-1.85	-1.89	-0.48	7.31
Ata N	2014	1.22	0.07	1.98	7.12
Faveri M	2014	-0.21	-0.54	0.97	6.90
Gonçalves MLL	2018	0.98	-0.09	-0.44	7.45
Tanyeri HM	2010	-1.44	-2.09	-0.44	7.51
Sökücü O	2016	-1.52	-2.21	-0.51	6.15
ErovicAdemovski S	2016	-1.31	-2.06	-0.34	7.78
Dereci O	2016	-1.57	-1.59	-0.54	7.56
Al-Abbasi AM	2009	-1.37	-2.01	-0.54	7.97
IleriKeceli T	2015	-.25	-1.45	0.88	6.21
SezenErhamza T	2018	-0.98	-0.46	-0.89	7.25
Pooled SMD		-1.12	-1.27	-0.62	100
Heterogeneity chi-squared = (P=0.015)					
I-squared (variation in OR attributable to heterogeneity) =71.2%					
SEM: Standard error of the mean, CI: Confidence interval, OR: Odds ratio					

Table 3. Overall estimate of the difference between the mean standard for reducing bad breath with combination methods and chi-square heterogeneity test

1st Author	Year	SEM	95% CI		% weight
			Lower	Upper	
ErovicAdemovski S	2012	-1.48	-2.09	-0.89	9.21
Feres M	2015	-1.45	-1.89	-0.71	9.65
Wilhelm D	2013	-2.47	-2.87	-0.95	10.25
Oliveira-Neto JM	2013	0.12	0.75	-0.62	8.65
Lopes RG	2015	-0.089	-1.18	-0.25	11.20
Caygur A	2017	1.32	0.21	2.01	9.54
Penala S	2016	-0.21	-1.75	0.62	9.41
Silvia Roldán	2005	-1.61	-2.42	-1.20	9.52
Aung EE	2015	-1.05	-0.45	1.22	6.54
Pooled SMD		-1.18	-1.68	-0.68	100
Heterogeneity chi-squared = (p=0.001)					
I-squared (variation in OR attributable to heterogeneity) =85.4%					
SEM: Standard error of the mean, CI: Confidence interval, OR: Odds ratio					

CHX has been considered the gold standard for the treatment of halitosis. CHX, in combination with CPC, decreased VSC levels to a great extent and decreased the counts of both aerobic and anaerobic bacteria in three hours. However, patients might not be interested in using CHX for a long time, because it has an unpleasant taste and stains the teeth reversibly (23).

These research works have shown that brushing the tongue with toothpaste could reduce the levels of VSCs for at least 1 h, and this was more effective than only brushing the teeth (24,25).

Conclusion

The results of the present study showed that the chemical and combined techniques are effective in decreasing halitosis.

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Ethics

Ethics Committee Approval: The approval for the this study was approved by ethical committee of Kerman University of Medical Sciences (approval code: IR.KMU.REC.1397.472.).

Informed Consent: This study is a systematic review and meta-analysis.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: M.A.H., Design: M.A.H., Data Collection or Processing: E.I., Analysis or Interpretation: E.I., Literature Search: E.I., Writing: M.A.H.

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