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Disocclusion guides in occlusal splints on temporomandibular disorders and sleep bruxism: a systematic review

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Objective. To determine the best disocclusion guidance in occlusal splints (OSs) to manage and treat temporomandibular disorder (TMD) and sleep bruxism (SB).

Study Design. The research was conducted on 7 major electronic databases and 3 gray literature sources. We included randomized trials, nonrandomized clinical trials, and before-and-after studies. The risk of bias (RoB) was assessed by Joanna Briggs Institute of Critical Appraisal Tools. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was used to grade the certainty of evidence.

Results. Qualitative synthesis included 16 surveys reporting data from 620 participants. Canine guidance (CG) was widely searched. Bilateral balanced occlusion (BBO) and CG significantly decreased pain levels compared with the placebo splint. Comparing between OS and absence of therapy, only CG was assessed and showed significant improvements on mouth opening, pain, sleep quality, and muscle activity. When compared different guide types among themselves, no significant improvement was founded in any evaluated outcome. Three studies presented high RoB, 7 presented moderate RoB, and 6 presented low RoB.

Conclusions. It is suggested there is not enough evidence to support that there are any specific kind of guidance responsible for improving evaluated outcomes on TMD and SB. (Oral Surg Oral Med Oral Pathol Oral Radiol 2022;000:1−14)

Sleep bruxism (SB) is a movement disorder that affects approximately 3.5% to 49.6% of younger generations and 1.1% to 15.3% of adults,[1] characterized by repetitive jaw-muscle activity during sleep.[2] Temporomandibular disorder (TMD) is a common orofacial condition that affects approximately 5% to 12% of the world's population,[3] and it is defined by the American Academy of Orofacial Pain as an umbrella term to define a set of signs and symptoms related to the structures of the stomatognathic system.[4]

Due to the multifactorial etiology of SB and TMD, especially when associated with psychosocial factors,[5,6] multiple approaches might be considered to their management.[7,8] Among those, the use of hard occlusal splints (OSs) has been considered a minimally invasive technique that can be effective in reducing signs and symptoms of SB and TMD.[7,9]

The OS action mechanism is not completely elucidated, but up until now, they were known to promote an ideal occlusion and a stable relationship among the temporomandibular joint (TMJ) structures, as well as to protect them from tooth decay caused by attrition.[4] Additionally, some authors have reported a temporary decrease in muscle activity, pain reduction, and improvements in both life and sleep quality.[10-13] The OS design ranges according to the type of disocclusion guide, such as canine guidance (CG), bilateral balanced occlusion (BBO), anterior guidance,[14] and molar guidance.[15]

Primary studies have been performed to evaluate the effects of different OS designs,[10,16-22] but the results remain controversial. Some systematic reviews (SRs)

Statement of Clinical Relevance

Occlusal splints are a wide management for TMD and sleep bruxism. There is still no consensus around the type of disocclusion guide used on devices. This paper suggests that more well-conducted randomized controlled trials are performed to evaluate the outcomes.

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assessed the effects of OS in the management of SB and TMD.[9,23-25] To the best of our knowledge, no SR has studied the most effective disocclusion guides for OS. Therefore, this SR aimed to answer the following question: "What are the best disocclusion guidance in OS on managing TMD and SB?"

MATERIALS AND METHODS

Protocol and registration

This SR was carried out following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.[26] The protocol was prepared according to the PRISMA-p method[27] and registered in the International Prospective Register of Systematic Reviews[28] under the number CRD42020169797.

Eligibility criteria

Randomized controlled trials (RCTs), nonrandomized clinical trials (NRCTs), and before-and-after studies were used to investigate the OS effects with different types of guidance in adolescents (12-18 years old), adults, and older adults with either SB or TMD, or both. A comparison was made between CG, BBO, group function, molar guidance, anterior guidance, placebo, and lack of therapy. This SR included studies in all languages, with no restrictions regarding gender or time of publication. The acronym PICOS (Population, Intervention, Comparison, Outcomes, Study design) was used to formulate the question of this study. The inclusion criteria are exhibited in Table 1.

Table 1. Acronym PICOS

P	Adolescents, adults and older people.
I	Occlusal splints with disocclusion guides (CG, BBO, group function, molar guidance, and anterior guidance).
C	Occlusal splints with disocclusion guides (CG, BBO, group function, molar guidance, and anterior guidance), placebo or no therapy.
O	1) Mouth opening. 2) TMJ sounds. 3) Pain alteration. 4) Headache. 5) TMD index—according to the HCDI or the RDC/TMD. 6) Sleep quality. 7) Splint comfort. 8) Masticatory muscle activity. 9) Bite force.
S	Randomized clinical trials, nonrandomized clinical trials, and before-and-after studies.

P, population; *I*, intervention; *C*, comparison; *O*, outcomes; *S*, study design; *CG*, canine guidance; *BBO*, bilateral balanced occlusion; *TMJ*, the temporomandibular joint; *TMD*, temporomandibular disorder; *HCDI*, Helkimo Clinical Dysfunction Index; *RDC/TMD*, Research Diagnostic Criteria for Temporomandibular Disorders.

Exclusion criteria

The following exclusion criteria were applied: 1) studies that did not perform clinical examination as diagnostic criteria for TMD; 2) studies that did not perform instrumental or non-instrumental assessment of SB; 3) studies that did not perform follow-up for ≥7 days; 4) studies with samples of diagnostic for sleep disturbance; 5) studies that used prefabricated or partial occlusal splints; 6) studies that used other therapies for SB and TMD management; 7) studies that included patients with comorbidities; 8) studies that included edentulous patients; 9) studies that used only imaging methods to evaluate the outcome; 10) studies that did not report the disocclusion guidance of the OSs; 11) studies with no reported outcome of interest; 12) studies that did not assess sleep quality with validated questionnaires; 13) studies with duplicated data from another included study; 14) reviews, letters, books, conference abstracts, case reports, case series, animal studies, opinion articles, technical articles, posters, and guidelines; and 15) full-text not available.

Information sources and search

The search strategies were performed in the following databases: Cochrane, Embase, Latin American and Caribbean Health Sciences Literature, LIVIVO, PubMed (including MedLine), Scopus, and Web of Science. Additional research was performed in gray literature, Google Scholar, OpenGrey, and ProQuest Dissertation and Thesis. All research was conducted on April 10th, 2020, with an update performed on March 6th, 2021. Furthermore, manual research was also conducted on reference lists of the included manuscripts. A complete research strategy can be found on Supplemental Table SI. Field experts were consulted to improve the research findings, following the recommendations of Greenhalgh and Peacock.[29] A reference management software package (EndNote X8; Thomson Reuters, Philadelphia, PA, USA) was employed to collect references and delete duplicates.

Selection process

In phase 1, two blinded reviewers (A.C.D. and L.P.N.) analyzed titles and abstracts of all identified references and applied the eligibility criteria. In phase 2, the same reviewers analyzed the full-text content of the selected studies. A third author (L.F.V.) was consulted in case of disagreement and was responsible for the final decision in both phases. An online software (Rayyan; Qatar Computing Research Institute, Al-Rayyan, Qatar)[30] was used to facilitate this stage.

Data collection process and data items

The data were collected independently, in duplicate following a table previously elaborated by the 2 blinded

reviewers (A.C.D. and L.P.N.). Any controversies were discussed, and the final decision was made by the third reviewer (L.F.V.). The data collected included: study characteristics (e.g., authors, year of publication, country, guide type, group allocation, diagnostic criteria used for TMD and SB diagnosis, and time of follow-up), population characteristics (e.g., sample size, gender distribution, and mean age), outcomes assessed by each study, and main findings. The data that were not found in the articles were requested of each author by e-mail during the period of 3 consecutive weeks, after the first one if there was no answer up until that moment. In case that there was no response received at all by the end of this period, the data were calculated by the very authors of this SR. The descriptive characteristics of the included studies are shown in Table 2.

Risk of bias in individual studies

Two reviewers (A.C.D. and L.P.N.) performed the risk of bias (RoB) analysis separately and evaluated the included articles following the Joanna Briggs Institute Critical Appraisal Checklist, according to study design.[40] The scoring system and cut-off points followed previous SR,[41] and the studies were judged as follows: 1) low RoB, if the "yes" score of the studies reached >70%; 2) moderate RoB, if the "yes" score was between 50% and 69%; and 3) high RoB, if the "yes" score was <49%.[41] Figures were generated by the software RevMan 5.3 (Cochrane Collaboration, London, UK).

Effect measurements

Data were reported in accordance with each outcome. The continuous variables were described by mean (M) and SD. Furthermore, the outcomes expressed with dichotomous variables were described by percentage.

Synthesis of methods

Due to methodological heterogeneity regarding study design, follow-up time, condition of interest, and outcome, it was not possible to perform a meta-analysis. For that reason, only qualitative analyses were carried out.

Because a direct comparison among studies was not possible, the included articles were organized according to the following comparisons: OS (e.g., CG or BBO) vs lack of treatment, OS (e.g., CG, BBO, or anterior guidance) vs placebo splint, and papers that compared different types of disocclusion guides (e.g., CG, BBO, group function, and molar guidance).

Certainty assessment

The evidence of certainty overall was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria. The summary of the findings was generated by an online software (GRADEpro GDT; the GRADE Working Group).[42] The following domains were considered: RoB, inconsistency, indirectness, imprecision, and others (publication bias).

RESULTS

Study selection

Major databases research identified 6,053 citations. Gray literature turned 117 studies. After removing duplicates, 2,603 papers remained by the end of the first phase. In the second phase, 63 articles were selected for full-text reading, 48 of which were rejected (the reasons for manuscripts exclusion are available in Supplemental Table SII, and only 15 were included in the qualitative synthesis. The research update resulted in 501 articles, 5 of which were selected for full-text reading and only 1 was included in the qualitative synthesis. A flowchart summarizing the systematic selection process is presented in Figure 1.

Characteristics of the studies

Regarding study design, 5 NRCTs,[12,13,31-33] 5 RCTs,[10,22,34-36] and 6 before-and-after studies[11,17,21,37-39] were selected. The sample size ranged from 8[33] to 80 participants,[36] accounting 620 participants altogether, of which approximately 77.7% were female and between 14 and 73 years old. The follow-up time ranged from 1 week[10,33] to 6 months.[10,11,22,32] Only 2 studies assessed probable SB,[13,33] whereas 11 evaluated only TMD,[10,17,21,22,31,32,34,35-37,39] and 3 studies selected participants with probable both SB and TMD.[11,12,38] The studies selected took place in Brazil,[10,12,13,21,39] USA,[33,37] Croatia,[11,32] China,[35,36] Israel,[31] Singapore,[38] England,[34] Saudi Arabia,[17] and Italy.[22]

RoB in studies

One RCT study was assessed with high RoB,[34] another one with low RoB,[10] and 3 with moderate risk.[22,35,36] Among the NRCT studies, 3 were considered of low RoB[12,13,31] and 2 of moderate[32,33] RoB. Regarding before-and-after studies, 2 were judged with high[17,38] RoB, 2 with low risk,[11,21] and the other 2 with moderate risk.[37,39] The RoB graphs are available in Figure 2 (NRCT and before-and-after studies) and in Figure 3 (RCT). Detailed information on RoB assessment is available in Appendixes 3 and 4.

Results of individual studies

Sixteen articles were included in the qualitative synthesis, 14 of which investigated CG,[10-12,17,21,31-33,35-39] 3 assessed BBO,[10,13,17] and 2 studied molar guidance.[22,33] Both anterior guidance[34] and group function[21] were evaluated by 1 manuscript each. The raw data for each included article is presented in Appendix 5.

Table 2. Summary of descriptive characteristics of included articles (n = 16)

Study	*Sample*		*Materials and methods*				*Main findings*	
Author, Year Country	*Size/gender*	*Age (mean±SD)*	*Type of guide*	*Group allocation*	*Diagnostic criteria for TMD and/or SB assessment*	*Follow-up*	*Outcomes*	*Results/conclusions*
Okeson, 1982 USA	Final n = 33 (30 F) Drop-out n = 0	Overall 14-60 y (32 ± NR)	CG	Participants were evaluated before and after treatment	TMD AAOP	4 wk	-Mouth opening Pain (0-3)	84.8% of participants showed improvements on pain scores. The mean decrease was 4.4. 81.8% showed increase on comfortable mouth opening. The mean increase on maximal mouth opening was 5.3 mm. 63.6% of participants showed an increase in maximal mandibular opening; however, the increase of 1.7 mm was not statistically significant.
Rugh, 1989 USA	Initial n = 10 (8 F) Final n = 8 (6 F) Drop-out n = 2	Overall 23-46 y	CG and MG	GI—firstly wore CG (7-14 d); after used MG (7-14 d) GII—firstly wore MG (7-14 d); after used CG (7-14 d)	SB Clinical Examination and EMG	7-14 d	-Pain (eight-point Likert Scale) -Muscle activity (EMG) -TMD index (according to HDI)	The 2 appliances (CG and MG) provided nearly equivalent effects on SB in 87.5% of participants. Clinical examination and subjective pain ratings did not differ with the 2 disocclusion guide patterns.
Yap, 1998 Singapore	Final n = 21 (15 F) Drop-out n = 0	Overall 23-63 y (39 ± NR)	CG	Participants were evaluated before and after treatment	SB (n = 21) Clinical examination TMD (n = 14) AAOP	3 mo	-Mouth opening -TMJ sounds (clicking) -Tenderness on palpation (muscle and TMJ)	The use of CG was effective on reducing tenderness on muscle palpation (temporalis, masseter, and sternocleidomastoid). Improvements on mouth opening were observed on 38% of patients. TMJ click do not differ between before and after treatment.
Gavish, 2002 Israel	Final n = 37 (29 F) Drop-out n = 0	Overall 16-45 y EGr (30.3 ± 9.12) CGr (27.5 ± 6.65)	CG	EGr—Michigan splint n = 21 (16 F) CGr—placebo splint n = 16 (13 F)	TMD RDC/TMD	8 wk	-Mouth opening - Pain (VAS)	At the end of the experiment, the EGr had a statistically significant reduction in pain intensity and in mean muscle sensitivity to palpation compared with no change in the controls. A stabilization splint has a therapeutic value beyond its placebo effects.
Landulpho, 2004 Brazil	Final n = 22 (15 F) Drop-out n = 0	Overall 18-53 y (NR)	CG and group function[a]	CG—0-30 d of therapy n = 22 Group function—90-150 d of therapy n = 22	TMD NR	T1) 90 d T2) 120 d T3) 150 d	-Muscle activity (EMG)	Occlusal splint with group function disocclusion caused a shorter EMG activity compared with the canine guidance in rest position for the anterior temporalis muscle.
Conti, 2006 Brazil	Initial n = 60 (55 F) Final n = 57 (52 F) Drop out 3	Overall 14-73 y GI (28.9 ± NR) GII (31.3 ± NR) GIII (29.5 ± NR)	BBO and GC	GI BBO GII CG GIII Placebo splint	TMD RDC/TMD	T1) 7 d T2) 15 d T3) 1 mo T4) 3 mo T5) 6 mo	-Joint sounds -Pain (VAS) -TMJ tenderness -Muscle tenderness -Comfort	The type of lateral guidance did not influence the participants' improvement. All participants had a general improvement on the VAS, though participants in the occlusal splint groups had better results than participants in the placebo splint group.
Wassell, 2004 England[b]	Initial n = 93 Final n = 78 (69 F) Drop-out n = 21	Overall 19-65 y Control group 35.9 ± 10.3 Stabilization splint 37.9 ± 12.6	Stabilization splint Anterior guide Control splint Placebo splint	Stabilization splint n = 21 (NR) Control splint n = 27 (NR) Crossover n = 13 (NR)	TMD AAOP	T1) 3 wk T2) 6 wk T3) 12 wk T4) 21 wk	-Mouth opening -TMJ sounds (clicking) -Pain (VAS) -No. of tender muscles -TMJ tenderness -Headache	At 6 wk, patients wearing a control and stabilization splints had similar improvements for all outcome variables with no significant differences between groups.
Wassel, 2006 England	Initial n = 72 (63 F) Final n = 52 (NR) Drop-out n = 20	Overall 19-65 y Females 37.7 ± 11.9 y Males 35.1 ± 8.7 y	Stabilization splint Anterior guide Control splint Placebo splint	Stabilization splint n = 27 (NR) Control splint n = 12 (NR) Crossover[c] n = 13 (NR)	TMD AAOP	T1) 3 wk T2) 6 wk T3) 12 wk T4) 21 wk T5) 1 y	-Mouth opening -TMJ sounds (clicking) -Pain (VAS) -No. of tender muscles -TMJ tenderness -Headache	

(*continued on next page*)

Table 2. Continued

Study	*Sample*		*Materials and methods*				*Main findings*	
Badel, 2008 Croatia	Final *n* = 65 (49 F) Drop-out *n* = 0	GI—disk displacement 35.5 ± NR GII—control 23.4 ± NR	CG	GI—disk displacement *n* = 40 (31 F) GII—without clinical symptoms and signs of TMD *n* = 25 (18 F)	TMD RDC/TMD	3-6 mo	-TMJ pain (VAS) -Comfort	Michigan splint eliminated pain in 78% of TMJs. 67% of patients who regularly used the occlusal splint declared wearing the splint was comfortable.
Zhang, 2013 China	Final *n* = 36 (24 F) Drop-out *n* = 0	Overall 16-57 y GA 31.4 ± 9.0 GB 31.3 ± 8.3	CG	GI—stabilization splint *n* = 18 GII—placebo splint *n* = 18	TMD RDC/TMD	1 mo	-Pain (VAS) -Muscle activity (EMG)	GI: 89% patients showed reductions in subjective pain and pain upon pressure on masseter muscle, as well as increased mouth opening after the treatment, out of which 39% showed complete recovery and 50% showed clinical improvements. GII: 22% of patients had a spontaneous improvement
Alajbeg, 2014 Croatia	Final *n* = 30 (23 F) Drop out *n* = 0	MP 19-63 y (39.4 ± 13.11) DD 21-63 y (34.7 ± 14.13)	CG	MP *n* = 14 (11 F) DD *n* = 16 (12 F)	Bruxism Self-report and clinical examination TMD RDC/TMD	T1) 1 mo T2) 3 mo T3) 6 mo	-Mouth opening -Pain (VAS)	Significant improvements were observed in pain after the use of an occlusal splint with canine guidance in both groups MP and DD.
Al-Rafah, 2014 Saudi Arabia	Final *n* = 16 (0 F) Drop out *n* = 0	Overall 32-50 y (NR)	GI: Canine guide GII: Bilateral balanced occlusion	The groups were allocated according to splint design	TMD HDI	T0) Baseline T1) 3 wk T2) 3 mo	-TMD index (according to HDI)	The mean scores of HDI in both groups under investigation showed a significant reduction in the amount of dysfunction after 3 mo of using different occlusal design stabilization splints (BBO and CG stabilization splints)
Vilanova, 2014 Brazil	Initial *n* = 57 (NR) Final *n* = 50 (50 F) Drop out *n* = 7	Overall 26.7 ± 7.1	CG	Participants were evaluated before and after treatment	TMD TMD/RDC	8 wk	-Pain (VAS) -Sleep quality (PSQI)	Significant reduction of pain level was observed after treatment. 68% of participants being classified as good sleepers after treatment.
Rosar, 2017 Brazil	Initial *n* = 56 (NR) Final *n* = 43 (34 F) Drop out *n* = 13	Overall 19-30 y (NR) CGr 1.6 ± 1.7 SBG 22.6 ± 2.7	CG	CGr—without SB *n* = 15 (11 F) SBG *n* = 28 (23 F)	SB Self-report, clinical examination and polysomnography exam. TMD RDC/TMD	T1) 1 mo T2) 2 mo	-TMD index (according to RDC/TMD) -Sleep quality (PSQI) -Bite force (gnathodynamometer)	Decrease in perception of pain in mandibular region upon awakening was observed in SB during treatment, whereas it remained stable in the GCr. The SBG showed an increase in the bite force magnitude, whereas in the CGr these parameters did not differ. SBG showed an increase in the sleep quality indexes, whereas in the CGr these parameters did not differ.
He, 2019 China	Final *n* = 80 (42 F) Drop out *n* = 0	Overall 18-22 y (NR)	Canine guide	CGr—no TMD *n* = 34 (8 F) CGr1—occlusal splint *n* = 17 (NR) CGr2—no splint *n* = 17 (NR) EGr—TMD *n* = 46 (34 F) EGr1—occlusal splint *n* = 23 (NR) EGr2—no splint *n* = 23 (NR)	TMD RDC/TMD	3 mo	-TMD index (according to HDI) -Muscle activity (EMG)	The EMG values in EGr 1 decreased significantly for all the muscles at rest and on anterior/lateral movements, post-treatment.
Câmara-Souza, 2019 Brazil	Initial *n* = 37 (NR) Final *n* = 30 (17 F) Drop out *n* = 7	Overall 20-45 y CGr 32.0 ± 6.7 EGr 29.0 ± 5.1	Bilateral balanced occlusion	CGr— placebo splint *n* = 15 (8 F) EGr—occlusal splint *n* = 15 (9 F)	SB Clinical examination	T1) 30 d T2) 60 d	-Sleep Quality (PSQI)	Subjective sleep quality had improved after 30 d of using both occlusal and placebo device. On 60 d, sleep quality did not show significant alterations. The use of occlusal splints with and without occlusal coverage has a similar effect on subjective sleep quality in bruxers.

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Table 2. Continued

Study	Sample		Materials and methods			Main findings		
Deregibus, 2021 Italy	Initial $n = 40$ (27 F)	Overall 22-56 y	CG and MG	GI—Michigan splint $n = 20$	TMD DC/TMD	T1) 1 mo T2) 3 mo	- Mouth opening - Pain (VAS)	Independently from being built on the upper (canine guide) or lower (molar guide) arch, had no significant effects in reducing pain over a 6-mo period in TMD patients. There were no significant intra-group differences on mouth opening and muscle activity.
	Final $n = 40$ (27 F)	47.2 ± 12.8 G1		GII—Molar guide $n = 20$		T3) 6 m o	- Muscle activity (EMG)	
	Drop out $n = 0$	46.0 ± 14.8 G2						
		48.5 ± 10.6						

TMD, temporomandibular disorder; *SB*, sleep bruxism; *NR*, not reported; *AAOP*, American Academy of orofacial pain; *CG*, canine guide; *MG*, molar guide; *G*, Group; *EMG*, electromyography; *HDI*, Helkymo Clinical Dysfunction Index; *TMJ*, temporomandibular joint; *BBO*, bilateral balanced occlusion; *VAS*, visual analogue scale; *EGr*; experimental group; *RDC/TMD*, research diagnostic criteria for temporomandibular disorders.

[a]All patients received splints with Canine Guidance at begin, at 30th day the authors change the guide for group function.

[b]The results of this article did not included on qualitative synthesis, only the raw data were used in order to better describe the results reported during the 21 weeks of treatment.

[c]Cross over Group: 13 subjects in the control group were relocated to the stabilization splint group in the 12weeks of treatment *MP*; myofascial pain; *DD*, disk displacement; *PSQI*, Pittsburgh Sleep Quality Index; *SBG*, sleep bruxism group.

Occlusal splint vs no treatment. Six studies evaluated occlusal devices with CG,[11,12,32,37-39] 3 of which included participants with only TMD[32,37,39] and the other 3 included sample with probable both SB and TMD.[11,12,38]

One of the articles that evaluated only TMD patients reported significant improvements in main pain levels, assessed with a 0 to 3 pain scale ($P = .01$), after 4 weeks of therapy.[37] When pain levels were analyzed with a visual analog scale (VAS), authors that evaluated TMJ pain noted elimination of pain on 78% of the people with TMJ disorders. However, there were no sufficient data to conclude the significance of this change.[32] Furthermore, a second study showed a significant decrease ($P < .001$) in pain levels assessed by VAS after 8 weeks of therapy with CG, from 3.22 ± 2.52 to 0.69 ± 1.25.[39] A reduction in the TMD index was observed after 2 months of therapy in all participants with TMD who wore OS with CG.[12] Patient comfort was assessed in patients with TMD using OS with CG, and 67% of them reported improvements after OS use.[32] Regarding mouth opening, there was a mean increase of 5.3 mm after 4 weeks of treatment ($P < .01$).[37] Besides, patients using OSs with CG showed enhancement on sleep quality, assessed by the Pittsburgh Sleep Quality Index (PSQI) ($P = .04$).[12]

Regarding patients with probable SB, measures on bite force found a significant increase ($P = .0003$) on the right side for patients using devices with CG compared with patients without SB who did not receive treatment.[12]

Three manuscripts included samples with the probability of both SB and TMD,[11,12,38] one of which reported significantly reduced pain on palpation ($P < .05$) after 3 months of OS therapy with CG.[38] Similarly, the authors of a before-and-after study found a considerable decrease in VAS ($P < .001$) in participants using devices with CG occlusal scheme.[11] Moreover, an improvement in pain levels was observed upon waking on SB participants after 2 months of using OS with CG ($P = .0025$).[12] Two studies assessed mouth opening on patients using devices with CG, 1 of which showed improvement on 80% of participants.[38] Similar results were found on a second trial,[11] which reported enhancements on maximum mouth opening ($P = .003$) and maximum assisted mouth opening (myofascial pain [$P < .001$]; disk displacement [$P = .006$]) after 6 months of therapy. There was a significant increase in the magnitude of bite force ($P = .003$) in patients with the probable SB. Nevertheless, these patients showed improvement in sleep quality measured using PSQI ($P = .0006$).[12]

Occlusal splint vs placebo splint. Six studies compared the use of OS and placebo splints.[10,13,31,34-36]

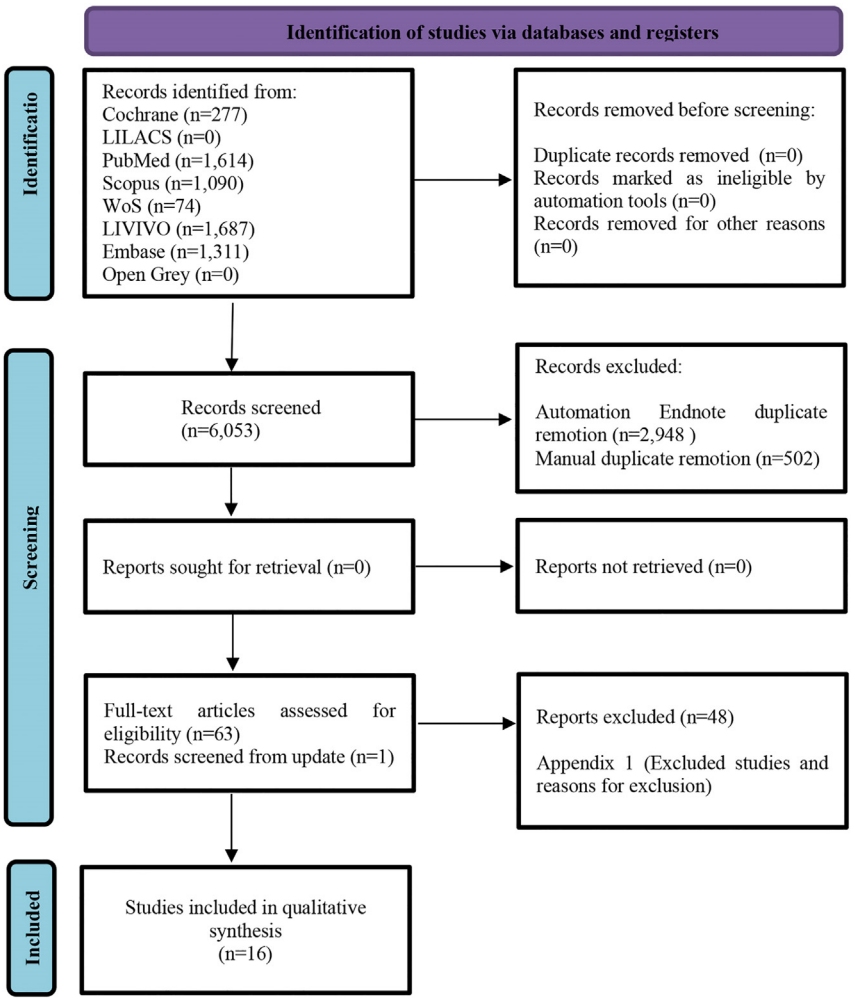

Fig. 1. Flow diagram of literature search and selection criteria. *LILACS*, Literatura Latino-Americana e do Caribe em Ciências da Saúde; *Scopus*, SciVerse Scopus; *WoS*, Web of Science.

Five papers evaluated only TMD,[10,31,34-36] whereas one assessed only probable SB.[13] The CG was evaluated in 4 studies,[10,31,35,36] BBO in 2 studies,[10,13] and only 1 assessed anterior guidance.[34]

A far more significant decrease in pain levels was reported in the group using devices with CG (30.24 ± 32.19) compared with placebo splint (4.75 ± 17.23), (P = .0083).[31] Two RCTs reported similar results, as a significant reduction in VAS ($P < .05$)[10] and pain levels (baseline [49.0 ± 16.1]; 1 month [12.0 ± 10.2])[35] was observed in patients who wore an OS with CG. One manuscript assessed VAS in participants using OS with anterior guidance but reported no significant differences in improvement between patients using placebo splint and CG.[34] Regarding BBO, the authors described a considerable decrease in VAS in participants who wore OS with BBO (P = .064) compared with placebo splint.[10]

Muscle activity was evaluated by electromyography (EMG) at the mandibular position and showed that after 1 month of therapy, CG promoted a significant decrease ($P < .01$) in the amplitude index (RMS values) compared to the placebo splint, which can contribute to relieving muscle fatigue.[35] No significant differences ($P > .05$) were found regarding joint sounds between the disocclusion guides evaluated (CG and BBO) and placebo splint.[10]

Significant improvements in sleep quality were observed in patients who wore OS with BBO after the first 30 days of therapy (baseline [7.13 ± 3.87]; 30 days [6.60 ± 4.34]). The same was described for placebo splint (baseline [7.00 ± 2.56]; 30 days [5.27 ± 1.91]). However, at the end of the therapy period (60 days), no significant improvements were noted in either of the 2 groups.[13] Regarding passive mouth opening, authors have reported that patients using placebo splint and OS with CG presented an increase in amplitude but without a statistically significant difference between the groups.[31] Likewise, when comparing patients using OS with anterior guidance and those

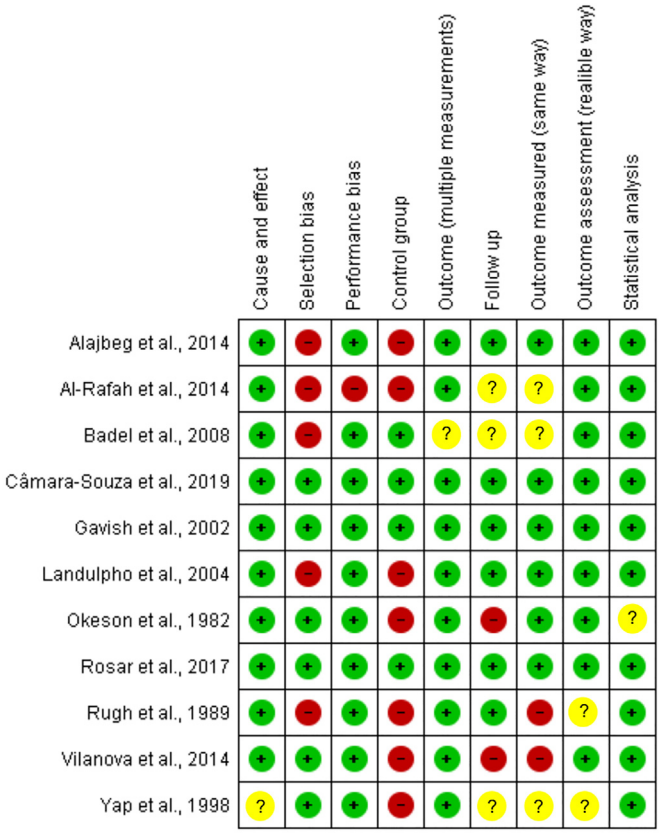

Fig. 2. Risk of bias summary (nonrandomized clinical trials and before and after studies). (+), low; (?), unclear; (−) high.

with placebo splint, improvements were reported, but without significant differences between them.[34]

Patient comfort was assessed by only 1 study, which reported improvements in 67% of the patient's using OS with CG and BBO, independent of disocclusion guides.[10] When analyzing complaints of headache, the authors observed a decrease in the percentage of episodes per week (baseline [39%]; 21 weeks [31%]) on patients using OS with anterior guidance.[34]

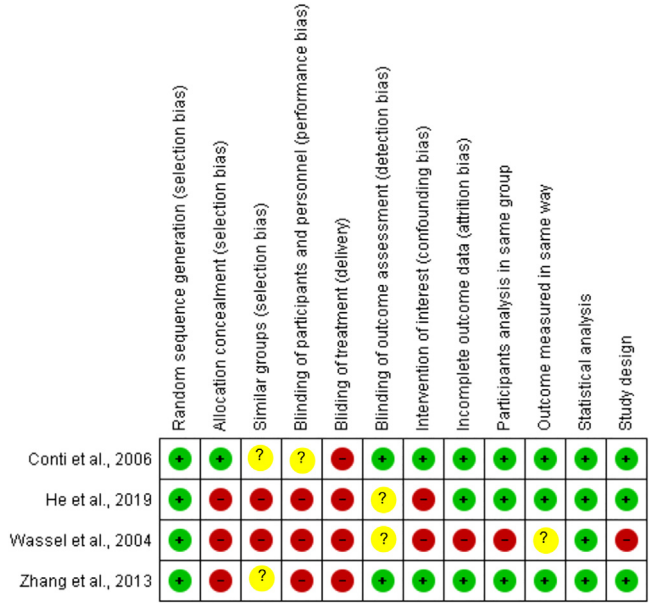

Fig. 3. Risk of bias summary (randomized clinical trial studies). (+), low; (?), unclear; (−) high.

Different disocclusion guides. Among the included studies, 4 performed a direct comparison between 2 different disocclusion guides.[17,21,22,33] Three of them evaluated only TDM,[17,21,22] and 1 assessed only probable SB.[33] Regarding the type of guidance, 2 articles compared CG and molar guidance,[22,33] 1 evaluated CG vs BBO,[17] and 1 assessed CG vs group function.[21]

The TMD index was evaluated by 2 studies, in which a decrease in the index after using OS was described.[17,33] However, there was no significant difference between the type of guidance when comparing CG and molar guidance ($P = .654$),[33] or CG and group function [3 weeks ($P = .102$); 3 months ($P = .146$)].[17]

Regarding pain, participants using devices with molar guidance (baseline [4.1 ± 2.1; 6 months [3.8 ±1.9]) showed some improvement, but with no significant difference compared with those with CG devices (baseline [5.1 ± 2.5]; 6 months [3.9±1.6]) ($P > .05$).[22] Similar results were found in a second article evaluating pain but with no difference between the types of guidance ($P = .221$).[32]

Muscle activity was assessed by 3 studies.[21,22,33] Comparison between CG and molar guidance[22,33] found no significant difference in EMG levels between the two. However, in a manuscript that evaluated CG vs group function, a considerable decrease ($P < .05$) in temporalis muscle EMG levels was reported.[21] Both passive and active mouth opening were evaluated by only 1 article, which reported enhancements with no significant difference between the investigated types of guidance (CG vs molar guidance).[22]

Synthesis of results

A summary of results can be found in Table 3.

Pain. Eleven studies[10,11,22,31-34,35,37-39] assessed pain. All authors observed a decrease in pain in patients using OS with CG,[11,32,37-39] including studies comparing OS with CG and placebo splint.[10,31,35] However, the comparison between molar guidance and CG returned no significant difference in pain levels.[22,33] The use of occlusal device with BBO showed significant improvements in pain level in 1 RCT.[10]

Maximum mouth opening. Six studies evaluated maximum mouth opening[11,22,31,34,37,38]; 5 of which investigated patients using devices with CG and reported improvements after treatment.[11,22,31,37,38]

Temporomandibular joint sounds. The presence of TMJ sounds was evaluated by 4 studies.[10,32,34,38] Regardless of the guidance types (e.g., CG, BBO, and anterior guidance), there was no significant difference in the patients before and after treatment.

Headache. One study reported a decrease in headache episodes in patients with TMD using OS with anterior guidance in comparison to patients who used placebo splint.[34]

TMD index. The TMD index was evaluated on 3 studies.[17,33,36] No significant differences were observed between CG and molar guidance,[33] or between CG and BBO.[17] Moreover, the use of OS with CG showed improvements in the TMD index levels compared with patients who did not receive treatment.[36]

Muscle activity. Five studies assessed muscle activity.[21,22,33,35,49] A decrease in EMG values without a significant difference between disocclusion guides was observed with molar guidance, CG, and group function.[21,22,33] On the other hand, when comparing CG, PS, and lack of treatment, a notable improvement in EMG levels was described.[35,36]

Bite force. An increase in bite force was reported in patients with SB who wore OS with CG compared to participants who did not receive treatment.[12]

Sleep quality. Sleep quality was assessed by 3 studies[12,13,39] using the PSQI. Patients with TMD using devices with CG and BBO showed notable improvements in this regard.[12,39] One study evaluated participants with probable SB and found some increase in sleep quality, but no different from what was reported for PS.[13]

Splint comfort. Two clinical trials investigated splint comfort.[10,32] The study that evaluated CG and BBO reported that 67% of the patients expressed better comfort regardless of the disocclusion guides available.[10] Authors who assessed OS with CG observed that patients who used OS reported improved comfort compared to the control group, with no clinical symptoms or signs of TMDs.[32]

Certainty of evidence

The GRADE approach was employed according to the selected outcomes (e.g., pain, maximum opening, joint sounds, headache, TMD index, muscle activity, bite force, sleep quality, and splint comfort). The certainty in cumulative evidence was very low for all categories, except for bite force, which was considered moderate. The domains that downgraded certainty were the RoB of included studies (−1 point); inconsistency (−2 points) due to the high methodological and clinical heterogeneity among studies; indirectness (−1 point) due to differences in outcome measures; and imprecision (−1 point), as studies included relatively few patients (<400) and few events and therefore have a wide CI around the estimate of the effect. Publication bias was

Table 3. Summary of results according to outcomes

Author, year	*SB and/or TMD*	*Type of guidance*	*Mouth opening*	*TMJ sounds*	*Pain*	*Headache*	*TMD index*	*Sleep quality*	*Splint comfort*	*Muscle activity*
Okeson et al., 1982	TMD	CG	63.6% (+)*; 30.3% (−)	-	84.8% (+)*; 3% (−)	-	-	-	-	-
Rugh et al., 1989	*SB*	*CG*	-	*25% (+)*		-	*12.5% (=)*		-	*12.5% (−)*
		MG	-	*50% (+)*		-	*37.5% (+); 50% (−)*		-	*12.5% (=)*
Yap, 1998	SB and TMD	CG	80% (+)* (=)	75% (+) T*; 93% (+) M*; 83% (+) SCM*		-	-		-	-
Gavish et al., 2002	*TMD*	*CG*	*(+)*	-	*(+)**	-	-	-	-	-
Landulpho et al., 2004	TMD	GF	-	-	-	-	-	-	-	(+) T;(=) M
Conti et al., 2006	*TMD*	*CG*	-	*30% (+)*	*86% (+)**	-	-	-	*67% (+)*	-
		BBO	-	*15.79% (+)*	*83.4% (+)**	-	-	-	*67% (+)*	-
Wassel et al., 2006	TMD	AG	(+)	(+)	(+)	(+)	-	-	-	-
Badel et al., 2008	*TMD*	*CG*	-	*35.6% (=)*	*78% (+) TMJ*	-	-	-	*67% (+)*	-
Zhang et al., 2013	TMD	CG	-	-	89% (+)	-	-	-	-	(+)*
Alajbeg et al., 2014	*Bruxism and TMD*	*CG*	*(+)**	-	*(+)**	-	-	-	-	-
Al-Rafah et al., 2014	TMD	CG	-	-	-	-	(+)	-	-	-
		BBO	-	-	-	-	(+)	-	-	-
Vilanova et al., 2014	*TMD*	*CG*	-	-	*(+)**	-	-	*(+)**	-	-
Rosar et al., 2017	SB and TMD	CG	-	-	-	-	-	(+)*	-	(−)*
He et al., 2019	*TMD*	*CG*	-	-	-	-	*82% (+)*	-	-	*(+)**
Câmara-Souza et al., 2019	SB	BBO	-	-	-	-	-	(+)	-	-
Deregibus, 2021	TMD	CG	(+)	-	(+)	-	-	-	-	(+)
		MG	(+)	-	(+)	-	-	-	-	(+)

SB, sleep bruxism; *TMD*, temporomandibular disorder; *TMJ*, temporomandibular joint; *CG*, canine guide; (+), improved; (−), worst; (=), without alterations on reported outcome; *GF*, group function; *BBO*, bilateral balanced occlusion; *AG*, anterior guide; *MG*, molar guide; *SCM*, sternocleidomastoid; *M*, masseter; *T*, temporal.
*Statically significant.

not detected because of the broad search strategy, including gray literature. Complementary information on GRADE evaluation is shown in Table 4.

DISCUSSION

Hard and soft occlusal surface splints are the standard reference to manage SB[7] and are also recommended for TMD.[8] The OS are a noninvasive and reversible therapy with no side effects[24] accessible to both clinical staff and patients. Despite being widely used, there is still a gap in literature regarding the role of OS in controlling signs and symptoms of these conditions.[25,43] Furthermore, clinicians still find it tricky to choose the right guidance. This paper investigated the best guidance in OS for TMD and SB management.

Were studied 5 types of guidance. Thirteen surveys assessed CG devices.[10-12,17,22,31-33,35-39] Canine guidance causes disengagement of posterior teeth in the lateral movement of the mandible. This kind of guidance is widely used because it reproduces an ideal occlusion.[44] Furthermore, previous papers reported a reduction in muscle activity after 1 month, which may result from a possible decrease in bite force during lateral movements caused by this guidance.[16,35] Anterior guidance is also part of an ideal occlusion; however, only 1 included paper[34] studied it. A device with anterior guidance is characterized by disocclusion of posterior teeth guided by anterior teeth during protrusive movements.[44] Three surveys investigated that BBO[10,13,17] is a bilateral-balanced contact between anterior and posterior teeth during all mandibular movements. Contacts in posterior teeth appear to protect the TMJ from overload caused by teeth grinding.[15] Furthermore, only 1 paper investigated OS with group function guidance,[21] characterized by the contact between at least 1 posterior tooth, besides the canine, in the working side during lateral movements, and it seemed to normalize muscle activity.[21] Although not commonly used, 2 surveys evaluated molar guidance[22,33] (characterized by teeth disocclusion patterns through the first or second molars).[15]

Besides the various kinds of disocclusion guidance, it was found that different groups of comparisons among the 16 eligible studies and clustered results according to comparison type to facilitate data interpretation: OS vs no treatment, OS vs placebo splint, and different types of disocclusion guidance. This SR showed significant improvements in the following outcomes: mouth opening, pain levels, sleep quality, and muscle activity (CG evaluation). In contrast, the authors of a previous SR compared OS to other treatments and found no significant improvements in pain, joint sounds, and mouth opening levels between patients who used OS and those without therapy or only subjected to minimal interventions.[25] This difference may result from minimal intervention therapies (advice/counselling, education, or self-performed exercises) in addition to OS treatment and different pain assessment methods.

Six surveys approached only CG when comparing OS to lack of treatment.[11,12,32,37-39] Participants using CG reported reduction in pain levels,[11,32,37-39] increase in mouth opening amplitude,[37] and improved sleep quality.[12,39] These findings may result from the fact that CG promotes a stable position for the TMJ and adjacent structures[23] and improved load distribution on TMJ during clenching and grinding.[45,46] The occlusal stability promoted by CG devices can normalize the proprioception of the periodontal ligament, easing symptoms such as dental sensitivity,[24] and increases comfort.[15] Furthermore, patients initiating treatment with OS usually experience a change in proprioception and this may decrease muscle activity.[16,35] However, these findings cannot be attributed to CG alone because there was no comparison to other types of guidance or to a control group. The positive effect may result from the presence of the device itself, regardless of the disocclusion guidance.[9]

This SR also included 6 articles comparing different types of guidance in OS (either CG or BBO, or both) to placebo splints.[10,13,31,34-36] Placebo splints involve the palatal and vestibular surfaces of the dental arch and presented a design without coverage on the occlusal surface.[10] This device was widely used on the control group to minimize the placebo effect of OS.[47] Nevertheless, a previous SR appointed limitations to the use of this device, because findings showed improvements on pain levels in the first 3 months of treatment, both in patients who used OS and patients who used placebo splint.[25] The presence of a lingual surface may change the oral perception of patients and improves signs and symptoms of TMD.[34]

Studies assessing CG[10,31] and BBO[10] revealed significant improvements in pain levels compared to participants using placebo splint. However, this may result only from using an OS, regardless of its disocclusion pattern.[9] Patients with OSs and patients with placebo splints both reported improvements in joint sounds, sleep quality, and mouth opening, with no significant differences by the end of the follow-up.

Anterior guidance also improved joint sounds, pain, and mouth opening[34] in both groups (i.e., OS and placebo splint), with no significant differences between them. The authors did not inform the disocclusion guidance on lateral movements.[34]

The last group compared different types of guidance (i.e., molar guidance,[22,33] group function,[21] BBO,[17] and/or CG[17,21,22,33]). Although improvements on TMD index, pain levels, or muscle activity were observed,

Table 4. Summary of findings by GRADE

Certainty assessment							*Certainty*
No. of studies	*Study design*	*RoB*	*Inconsistency*	*Indirectness*	*Imprecision*	*Other considerations*	
Pain							
11	RCT; NRCT; before and after	Serious*	Serious‡‡	Not serious	Serious|||	None	⊕x̂x̂x̂ VERY LOW
Mouth opening							
6	RCT; NRCT; before and after	Serious†	Serious‡‡	Serious§§	Serious|||	None	⊕x̂x̂x̂ VERY LOW
Muscle activity							
5	RCT; NRCT; before and after	Serious‡	Serious‡‡	Not serious	Serious|||	None	⊕x̂x̂x̂ VERY LOW
Bite force							
1	NRCT	Not serious	Not serious	Not serious	Serious|||	None	⊕⊕⊕x̂ MODERATE
TMD index							
4	RCT; NRCT; before and after	Serious§	Serious‡‡	Serious§§	Serious|||	None	⊕x̂x̂x̂ VERY LOW
Joint Sounds							
4	RCT; before and after	Serious‖	Serious‡‡	Serious§§	Serious|||	None	⊕x̂x̂x̂ VERY LOW
Comfort							
2	RCT; NRCT	Serious¶	Serious‡‡	Serious§§	Serious|||	None	⊕x̂x̂x̂ VERY LOW
Headache							
1	RCT	Serious**	Serious‡‡	Serious§§	Serious|||	None	⊕x̂x̂x̂ VERY LOW
Sleep quality							
3	NRCT; before and after	Serious††	Serious‡‡	Not serious	Serious|||	None	⊕x̂x̂x̂ VERY LOW

RoB, risk of bias; *GRADE*, Grading of Recommendations Assessment, Development and Evaluation"; *RCT*, randomized clinical trial; *NRCT*, non-randomized clinical trial; *TMD*, temporomandibular disorder.
*Majority studies presented high (3 included studies) or moderate (6 included studies) risk of bias when the RoB check list was applied
†Four studies presented high or moderate risk of bias, whereas only 2 presented low risk when the RoB check list was applied
‡Four studies presented moderate risk of bias, whereas only 1 presented low risk when the RoB check list was applied
§Majority studies presented moderate (2 included studies) risk of bias, whereas 1 presented low and 1 presented high risk when the RoB check list was applied
‖Two studies presented high risk of bias, whereas only one presented low risk when the RoB check list was applied
¶One included study presented moderate risk of bias and other presented low risk when the RoB check list was applied.
**The study presented high risk of bias when the RoB check list was applied.
††Two studies presented low risk of bias, whereas 1 presented moderate risk when the RoB check list was applied.
‡‡Was observed high heterogeneity between studies designs, as well as among sample and in relation to method.
§§This outcome was not assessed firstly in some studies.
|||Absence of enough data described on articles that enable judgment of this criteria and small sample size (>400).

no significant difference was found. However, these surveys did not include a control group, so it is possible that the type of guidance does not play a fundamental role on the evaluated outcomes.

The included papers revealed a high heterogeneity, precluding a meta-analysis. Within the present SR, as well as previous ones,[25,43] discrepancies among diagnostic criteria (TMD) and assessment methods (SB) were also observed. Different TMD instruments were evaluated, such as AAOP,[34,37,38] RDC/TMD,[10-12,31,32,35,36,39] DC/TMD,[22] or Helkimo Clinical Dysfunction Index. For SB, only clinical assessments,[13,38] self-report associated with clinical assessments,[11] or self-reports associated with clinical examination and instrumental approaches were used.[12,33]

The assessed conditions also revealed heterogeneity, as some included surveys evaluated probable presence of SB and TMD,[11,12,38] whereas others evaluated only TMD.[32,37,39] Although there is not enough evidence regarding the association of bruxism with TMD,[1] assessing either SB, awake bruxism, or both may have influenced the results. Both can promote an overload on stomatognathic system structures, which contributes to perpetuating the signs and symptoms of TMD.[46] Further research should assess the presence of associated comorbidities, chronic pain, and psychosocial factors because these conditions can hamper managing patients with TMD.[4,48]

Furthermore, the certainty of evidence was very low for most outcomes (e.g., pain, maximum opening, joint

sounds, headache, TMD index, muscle activity, sleep quality, and splint comfort), as occurred in previous SRs.[25,43] This showed the lack of well-conducted studies with OS.

This SR highlighted the importance of using OS to manage TMD and SB. Although the OS can contribute to reducing signs and symptoms of these conditions, the development of personalized therapies, patients phenotyping,[48] as well as a multimodal approach, such as physical therapy, self-management, and counseling are widely recommended.[49,50]

Limitations

Imprecision and inconsistency contributed to downgrade the certainty of evidence in most outcomes, probably because of the small sample size and high heterogeneity observed among the included papers.

A high heterogeneity of study design, diagnostic criteria, and methods of assessment of conditions of interest was observed, besides variations in the follow-up periods, precluding a meta-analysis. For future studies, the standardized evaluation of orofacial conditions, such as TMD (diagnostic according to subtype), bruxism (according to subtype), and associated comorbidities were recommend.

CONCLUSION

This SR did not find enough evidence suggesting there is a specific kind of guidance responsible for improving the evaluated TMD and SB outcome. On this account, we recommend performing more RCTs.

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DISCLOSURE

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.oooo.2022.07.009.

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