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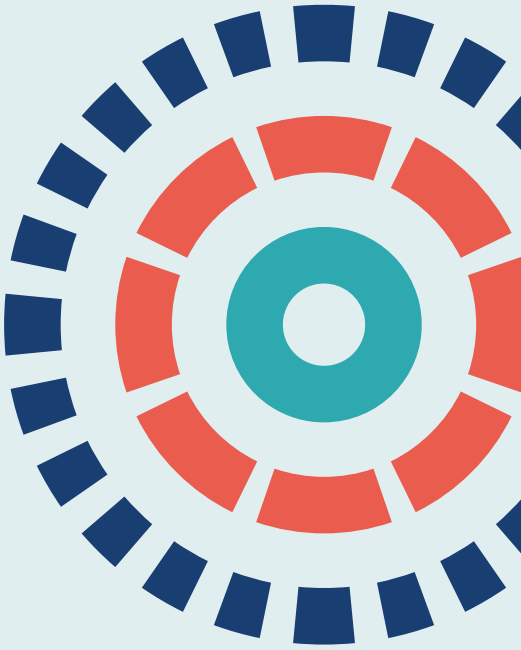

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Oral splints for patients with temporomandibular disorders or bruxism: a systematic review and economic evaluation

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This report

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Abstract

Oral splints for patients with temporomandibular disorders or bruxism: a systematic review and economic evaluation

Philip Riley,[1] Anne-Marie Glenny,[1] Helen V Worthington,[1*] Elisabet Jacobsen,[2] Clare Robertson,[3] Justin Durham,[4] Stephen Davies,[5] Helen Petersen[6] and Dwayne Boyers[2]

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Background: Splints are a non-invasive, reversible management option for temporomandibular disorders or bruxism. The clinical effectiveness and cost-effectiveness of splints remain uncertain.

Objectives: The objectives were to evaluate the clinical effectiveness and cost-effectiveness of splints for patients with temporomandibular disorders or bruxism. This evidence synthesis compared (1) all types of splint versus no/minimal treatment/control splints and (2) prefabricated versus custom-made splints, for the primary outcomes, which were pain (temporomandibular disorders) and tooth wear (bruxism).

Review methods: Four databases, including MEDLINE and EMBASE, were searched from inception until 1 October 2018 for randomised clinical trials. The searches were conducted on 1 October 2018. Cochrane review methods (including risk of bias) were used for the systematic review. Standardised mean differences were pooled for the primary outcome of pain, using random-effects models in temporomandibular disorder patients. A Markov cohort, state-transition model, populated using current pain and Characteristic Pain Intensity data, was used to estimate the incremental cost-effectiveness ratio for splints compared with no splint, from an NHS perspective over a lifetime horizon. A value-of-information analysis identified future research priorities.

Results: Fifty-two trials were included in the systematic review. The evidence identified was of very low quality with unclear reporting by temporomandibular disorder subtype. When all subtypes were pooled into one global temporomandibular disorder group, there was no evidence that splints reduced pain [standardised mean difference (at up to 3 months) −0.18, 95% confidence interval −0.42 to 0.06; substantial heterogeneity] when compared with no splints or a minimal intervention. There was no evidence that other outcomes, including temporomandibular joint noises, decreased mouth-opening, and quality of life, improved when using splints. Adverse events were generally not reported, but seemed infrequent when reported. The most plausible base-case incremental cost-effectiveness ratio was uncertain and driven by the lack of clinical effectiveness evidence. The cost-effectiveness acceptability curve showed splints becoming more cost-effective at a willingness-to-pay threshold of ≈£6000, but the probability never exceeded 60% at higher levels of willingness to pay. Results were

sensitive to longer-term extrapolation assumptions. A value-of-information analysis indicated that further research is required. There were no studies measuring tooth wear in patients with bruxism. One small study looked at pain and found a reduction in the splint group [mean difference (0–10 scale) −2.01, 95% CI −1.40 to −2.62; very low-quality evidence]. As there was no evidence of a difference between splints and no splints, the second objective became irrelevant.

Limitations: There was a large variation in the diagnostic criteria, splint types and outcome measures used and reported. Sensitivity analyses based on these limitations did not indicate a reduction in pain.

Conclusions: The very low-quality evidence identified did not demonstrate that splints reduced pain in temporomandibular disorders as a group of conditions. There is insufficient evidence to determine whether or not splints reduce tooth wear in patients with bruxism. There remains substantial uncertainty surrounding the most plausible incremental cost-effectiveness ratio.

Future work: There is a need for well-conducted trials to determine the clinical effectiveness and cost-effectiveness of splints in patients with carefully diagnosed and subtyped temporomandibular disorders, and patients with bruxism, using agreed measures of pain and tooth wear.

Study registration: This study is registered as PROSPERO CRD42017068512.

Funding: This project was funded by the National Institute for Health Research (NIHR) Health Technology Assessment programme and will be published in full in *Health Technology Assessment*; Vol. 24, No. 7. See the NIHR Journals Library website for further project information.

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List of abbreviations

AAOP	American Association of Orofacial Pain
CEAC	cost-effectiveness acceptability curve
CI	confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CPI	Characteristic Pain Intensity
CUA	cost–utility analysis
DC/TMD	Diagnostic Criteria for Temporomandibular Disorders
DEEP	Developing Effective and Efficient care pathways in chronic Pain
EQ-5D-5L	EuroQol-5 Dimensions, five-level version
EVPI	expected value of perfect information
EVPPI	expected value of perfect parameter information
GCPS	Graded Chronic Pain Scale
GRADE	Grading of Recommendations Assessment, Development and Evaluation
IADR	International Association of Dental Research
ICER	incremental cost-effectiveness ratio
MD	mean difference
NHS EED	NHS Economic Evaluation Database
NMB	net monetary benefit
NICE	National Institute for Health and Care Excellence
NRS	Numerical Rating Scale
NTI-tss	Nociceptive Trigeminal Inhibition Tension Suppression System
OHIP-14	14-item Oral Health Impact Profile
QALY	quality-adjusted life-year
RCT	randomised controlled trial
RDC/TMD	Research Diagnostic Criteria for Temporomandibular Disorders
RR	risk ratio
SCL-90-R	Modified Symptom Checklist-90-Revised
SD	standard deviation
SMD	standardised mean difference
TMD	temporomandibular disorder
UDA	unit of dental activity
VAS	visual analogue scale
VOI	value of information
WTP	willingness to pay

Plain English summary

Treatment options for people experiencing temporomandibular disorders (pain and/or restricted movement in and around the jaw joint) include splints, which are removable appliances, often similar to a mouthguard. They are provided to patients to help ease pain in the mouth, face or jaws. They are also used to manage the symptoms of temporomandibular disorders, such as frequent headaches/migraines, clicking jaws, restricted mouth-opening or tooth wear from the grinding of teeth (bruxism). There are many types of splints.

This research looked at the evidence addressing the primary question of whether or not splints work (regardless of type of splint) in reducing the pain associated with temporomandibular disorders and/or tooth wear, and if they offered value for money. Patients were involved in the research to ensure that the question and the outcomes that were measured were appropriate.

A systematic review of the literature was undertaken to find all randomised controlled trials including patients with temporomandibular disorders or bruxism. Online databases of research publications were searched, and these searches were checked, to identify relevant trials. All stages of the review process were undertaken to the highest standards by two people, independently and in duplicate, using well-respected and recognised Cochrane methods. We conducted a value-for-money assessment, comparing the trial data with the costs of splints to see if splints are a cost-effective use of NHS funding.

There was no evidence that splints reduced pain when compared with not wearing a splint or when compared with a minimal treatment (like jaw exercises, advice or education) in patients with temporomandibular disorders. The evidence was assessed as being of very low quality; therefore, it remains unclear whether or not splints are good value for money, or if they should be paid for by the NHS.

This research showed that more well-conducted trials on temporomandibular disorder patients are needed.

Scientific summary

Background

Splints have long been used as a non-invasive, reversible management option for patients presenting with certain orofacial signs and symptoms including orofacial pain, joint clicking, limited mouth-opening and tooth wear. Typically they have been used with patients presenting with temporomandibular disorders or bruxism. The clinical effectiveness and cost-effectiveness of splints remain uncertain.

Objectives

The objectives were to evaluate the clinical effectiveness and cost-effectiveness of splints for patients with temporomandibular disorders or bruxism. The comprehensive evidence synthesis compared (1) all types of splint versus no/placebo splints and (2) prefabricated splints versus custom-made splints, for the primary outcomes orofacial pain for temporomandibular disorder patients and tooth wear for bruxism patients.

Methods

In the systematic review, we included randomised controlled trials that included children (aged > 11 years) and adults with either temporomandibular disorders or bruxism, for whom the dental or other health-care worker was considering treatment with an oral splint, in either primary or secondary care. We excluded studies in which the majority of patients were undergoing fixed or removable orthodontic treatment. The no splint/control splint group also included watchful waiting or minimal treatment or self-management.

The primary outcome for the review was pain, which was measured in a variety of ways. For bruxism patients, we also considered tooth wear as a primary outcome. Harms were also a primary outcome, which included any problems such as soreness of the oral cavity caused by the splint. Secondary outcomes included clicking of the temporomandibular joint, change in restricted mouth-opening, frequency of headaches (secondary to pain-related temporomandibular disorders) and quality-of-life data (including physical and emotional function). Patient satisfaction and adherence to treatment data were collected whenever possible. For bruxism, the index and frequency of bruxism activity was recorded. Follow-up periods for the outcome data were divided into short-term follow-up (0–3 months), medium-term follow-up (3–6 months) or long-term follow-up (6–12 months). After discussion with the clinicians during the data extraction period, it was decided to present the results for the 0- to 3-month time period for the primary analysis. A systematic literature search was also undertaken to identify any cost-effectiveness evidence.

Four databases were searched on 1 October 2018: (1) Cochrane Central Register of Controlled Trials in The Cochrane Library, (2) MEDLINE via OvidSP (from 1946 onwards), (3) EMBASE via OvidSP (from 1980 onwards) and (4) Cumulative Index to Nursing and Allied Health Literature from EBSCO*host* (from 1937 onwards). When appropriate, the searches of these databases were linked to study design search filters developed by Cochrane for identifying reports of randomised and controlled clinical trials. They were undertaken without restrictions on language or date of publication.

We undertook the systematic review using Cochrane methods. All data extraction was undertaken independently in duplicate. The following domains were assessed for the risk-of-bias assessment for each included trial: sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessors (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias) and other bias.

Pain was frequently measured by a visual analogue scale and we had planned to use the mean and standard deviation of this as the treatment effect, using standardised mean difference if different scales were used (e.g. pain could be measured as pain experienced now or the worst pain experienced over the previous month). We used risk ratios with 95% confidence intervals for the effect estimates of the dichotomous data. We contacted authors, when feasible, for missing outcome data.

Heterogeneity was assessed by the chi-squared test and quantified by I^2. We undertook data syntheses, when appropriate, using random-effects models. We planned to undertake subgroup analyses for different splint types.

Summary of findings tables were used to summarise the results, and the quality of the body of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation methods.

A Markov cohort state-transition decision-analysis model was developed to assess the cost-effectiveness of splints compared with no splints for temporomandibular disorders from an NHS perspective. A separate model was structured for bruxism but could not be populated owing to a lack of cost, utility, transition probability or clinical effectiveness data.

The temporomandibular disorder model was structured to estimate cost-effectiveness based on three pain tertile health states (low, moderate or high) based on current pain or Characteristic Pain Intensity definitions. In each 3-monthly model cycle, the cohort had a probability of transiting between health states (or remaining in the current health state) based on a reanalysis of the Developing Effective and Efficient care pathways in chronic Pain (DEEP) UK cohort study (Durham J, Breckons M, Araujo-Soares V, Exley C, Steele J, Vale L. Developing Effective and Efficient care pathways in chronic Pain: DEEP study protocol. *BMC Oral Health* 2014;**14**:6) data conducted for this project. There was no additional risk of mortality, and the whole cohort, regardless of treatment arm, was exposed to general population all-cause mortality risks. The model was run over a lifetime horizon, with costs and quality-adjusted life-years occurring in the future being discounted at a rate of 3.5% per annum.

When possible, meta-analysis of clinical effectiveness studies was used to obtain mean differences (splints vs. no splints) in the alternative pain measures. Mean differences were translated into assumed relative risks in pain tertiles and applied to the transition probability data obtained from the DEEP study. DEEP study data were also used to inform the costs and utilities of different pain states in the model. All model input data were sampled probabilistically from respective sampling distributions for transition probabilities, mean differences in pain, costs and utilities.

The model was, therefore, fully probabilistic. Expected values of costs and quality-adjusted life-years were obtained using Monte Carlo simulation (1000 repetitions) and used to calculate incremental cost-effectiveness ratios. Results were reported using scatterplots of the cost-effectiveness plane, and cost-effectiveness acceptability curves were used to illustrate the decision uncertainty regarding the optimal strategy. It was assumed that the threshold value of willingness to pay for a quality-adjusted life-year gained was £20,000. Expected value of perfect information and expected value of perfect parameter information analyses were used to determine whether or not further research was worthwhile, and, if so, what model parameters should be researched to reduce future decision uncertainty.

Results

Fifty-two trials were included in the systematic review. Fifty trials were assessed as being at high risk of bias and the remaining two trials had an unclear risk of bias. Therefore, no studies were deemed to have a low risk of bias in this review.

Comparing splints with no splints/control or placebo splints/minimal intervention in patients with temporomandibular disorders (all subtypes of temporomandibular disorder pooled into one group)

From 35 studies comparing splints with no splints or a minimal intervention, there was no evidence that providing splints reduced pain (measured on continuous/discrete graded scales) in patients with temporomandibular disorders when all subtypes of temporomandibular disorder were pooled into one group [standardised mean difference (up to 3 months) −0.18, 95% confidence interval −0.42 to 0.06; substantial heterogeneity $I^2 = 70\%$; very low-quality evidence; 13 studies; 1076 participants]. There were fewer studies and patients contributing to the standardised mean difference estimates at the other time points and, similarly, no evidence that splints reduced pain. The standardised mean difference effect size at up to 3 months was considered to be small and we undertook an analysis for current pain measured on a visual analogue scale or numerical rating scale (scored from 0 to 100) to look at the effect size in standard units. Eleven studies and 874 patients were included and the mean difference during the 0- to 3-month time period was −4.48 (95% confidence interval −11.59 to 2.64; $I^2 = 94\%$), with insufficient evidence of any difference at the other time points. Data for the secondary outcomes of the review also failed to provide any evidence that splints improved these outcomes. There was no evidence of adverse events associated with splints, but reporting was poor regarding this outcome.

The literature review did not identify any studies evaluating the cost-effectiveness of splints for temporomandibular disorder; therefore, the results of the decision-analysis model are reported to address the clear gap in the evidence base. There was substantial uncertainty regarding the optimal treatment strategy. The base-case incremental cost-effectiveness ratios for splints versus no splints were £39,216 and dominated (i.e. splints were, on average, more costly and generated fewer quality-adjusted life-years) for the current pain and Characteristic Pain Intensity configurations, respectively. However, these incremental cost-effectiveness ratios were surrounded by considerable uncertainty and it is most informative to consider the decision uncertainty as reported for the probabilistic analysis. Assuming that society is willing to pay a maximum of £20,000 to achieve a one-unit quality-adjusted life-year gain, there was only a 58% and 29% chance that splints are the optimal (i.e. most cost-effective) treatment strategy using the current pain and Characteristic Pain Intensity configurations, respectively. Deterministic sensitivity and scenario analyses indicate that the cost-effectiveness results are most sensitive to assumptions made about (1) the long-term benefits of splints (mean differences in pain intensity), (2) long-term transition probabilities and (3) the frequency of splint replacement.

Comparing splints with no splints/control or placebo splints/minimal intervention in patients with bruxism

There were no studies measuring tooth wear in patients with bruxism. One small study looked at pain and found a reduction in the splint group (mean difference −2.01, 95% confidence interval −2.62 to −1.40; very low-quality evidence). There was no cost-effectiveness evidence in the literature. Furthermore, it was not possible to populate a decision-analysis model to determine cost-effectiveness because of a paucity of data regarding transition probabilities between tooth wear states, utilities or costs.

Comparing prefabricated and custom-made splints

As there was no evidence that splints reduced pain or improved other outcomes in the clinical effectiveness review, this comparison between different splint types became irrelevant. However, exploratory cost-effectiveness analyses were conducted to identify the main drivers of cost-effectiveness in a three-way comparison of custom-made versus prefabricated versus no splints. Results were highly uncertain and the model indicated an approximately equal chance of custom-made, prefabricated and none being the most cost-effective strategy, further emphasising the need for future research.

Limitations

There are a number of substantial limitations in this evidence synthesis due to the large variation in the diagnostic criteria, splint types and methods of outcome measurement and reporting. We performed sensitivity analyses based on these limitations, but did not demonstrate a reduction in pain.

Owing to a lack of relative risk data from the clinical effectiveness review to match the economic model structured around pain tertiles, assumptions were required to map mean differences to tertile-specific relative risks. This process was based on assumptions about the feasible changes in tertile for each possible mean difference. This assumption raises uncertainties in the model, as the results are not based on true relative risks. Furthermore, there were no data available to inform the long-term effectiveness of splints and assumptions were required about the impact of splints beyond 6–12 months. An advantage of the modelling approach taken is that, for the base-case analysis, different assumptions were incorporated probabilistically, meaning that each assumption had an equal chance of being applied in each Monte Carlo simulation.

Conclusions

The very low-quality evidence identified did not demonstrate that splints reduced pain in temporomandibular disorder as a group of conditions; data were poorly reported for different temporomandibular disorder subtypes. There is insufficient evidence to determine whether or not splints reduce tooth wear in patients with bruxism. It remains unclear whether or not splints offer value for money to the NHS.

Future work

There is a need for well-conducted trials to determine the clinical effectiveness and cost-effectiveness of splints in patients with carefully diagnosed and subtyped temporomandibular disorder, and patients with bruxism, using agreed measures of pain and tooth wear.

The value-of-information analysis revealed a very high expected value of perfect information, indicating that future research to resolve decision uncertainty regarding the optimal, most cost-effective strategy (splints or no splints) is beneficial. The expected value of perfect parameter information analysis identified future research priorities and indicated that further research regarding the clinical effectiveness of splints (in the short and longer term) is particularly worthwhile. In addition, the expected value of perfect parameter information analysis indicated that further research should be carried out to determine the long-term impact of temporomandibular disorders on pain states (beyond 2 years), as well as the frequency of splint replacement.

Study registration

The study is registered as PROSPERO CRD42017068512.

Funding

This project was funded by the National Institute for Health Research (NIHR) Health Technology Assessment programme and will be published in full in *Health Technology Assessment*; Vol. 24, No. 7. See the NIHR Journals Library website for further project information.

Chapter 1 Objective

Our objective was to evaluate the clinical effectiveness and cost-effectiveness of oral splints for patients with temporomandibular disorder (TMD) or bruxism.

We met our aim by undertaking a comprehensive evidence synthesis, utilising Cochrane methodology, evaluating:

- all oral splints provided by dentists or other health-care workers versus no splints for patients with TMD or bruxism
- prefabricated splints versus custom-made splints provided by dentists or other health-care workers for patients with TMD or bruxism.

Chapter 2 Background

Description of the condition

Temporomandibular disorders are the second most common cause (after dental pain) of orofacial pain, characterised by pain in the temporomandibular joint area and in the facial muscles. Apart from pain, patients may experience other signs and symptoms, such as clicking of the joint and restricted mouth-opening. It is estimated that around 5–12% of the population have TMD symptoms to some degree, varying by age group and sex.[2] There are many ways of managing TMD (e.g. pharmacological, psychological, physiotherapy and surgical interventions); one of the most common ways that dentists, particularly in primary care, manage symptomatic TMD is the provision of oral splints.[3]

Splints are also provided to help manage tooth wear caused by bruxism. Bruxism is the repetitive jaw-muscle activity characterised by clenching or grinding of the teeth and/or bracing or thrusting of the mandible. Bruxism has two distinct circadian manifestations: it can occur during sleep (indicated as sleep bruxism) or during wakefulness (indicated as awake bruxism).[4] The prevalence of bruxism ranges from 8% to 31% in the general population,[5] and it is estimated that sleep bruxism affects 16%, and awake bruxism 24%, of the adult population globally.[6]

In the UK it has been estimated that bruxism affects more than six million people. The severity of the symptoms and the frequency of grinding vary. Bruxism can occur in both children and adults, although it is most common in adults between the ages of 25 and 44 years. Although many patients are unaware of their bruxism habit, there can be an associated tooth wear, which can cause pathological damage and require treatment in the longer term. This is often diagnosed by the general dental practitioner when the patient is attending for a check-up or dental treatment. It is important that tooth wear alone is not taken as a sign that the patient is an active bruxist, as opposed to being a legacy of a previous bruxism habit.[7]

Description of the intervention

Oral splints are removable appliances that can cover all or some of the teeth in either the maxillary or the mandibular arches. The term 'oral splint' is used colloquially in (UK) dentistry and is really a misnomer, as oral splints do not actually splint (i.e. immobilise) anything. Splints can also be known variously throughout the literature and the world as oral appliances, devices, orthotics or biteplates.

Oral splints can resemble a device similar to a mouthguard used in contact sports, overlaying the biting surface of the teeth with some type of material. Numerous types of oral splints are available, varying in design, material, coverage and application. Splints cover either the upper teeth (upper splints) or the lower teeth (lower splints) and can be classified by the type of material they are made from: hard (hard acrylics), soft (soft polymers or plastics), or composite amalgams of the two aforementioned materials.[8] They can then be subdivided into whether they cover all the surfaces of the teeth in one jaw (full coverage) or only some of the teeth surfaces (partial coverage, e.g. covering only the front six to eight teeth, or

two to four of the anterior incisor teeth), and whether or not they provide an adjusted biting surface to equalise the way the teeth meet the splint ('occlusally adjusted' surface).[9,10] Finally, they may be made from impressions of a patient's teeth (custom made) or adapted directly onto the teeth from a non-specific blank (prefabricated or non-custom made).

It should be noted that there are multiple names for different types of splints, and many variations on a design theme. For example, an upper hard stabilisation splint is also known as a Michigan splint, and a Lucia jig is similar in design to the proprietary Nociceptive Trigeminal Inhibition Tension Suppression System (NTI-tss)™ (National Dentex LLC, Palm Beach Gardens, FL, USA) splint.

Traditionally, oral splints recommended by dentists have been custom made, often in dental laboratories, sometimes requiring a number of appointments. More recently, a vast array of prefabricated splints have become available, either for provision by the dentist or health-care worker at a single appointment, or as over-the-counter purchases for patients who wish to self-manage their symptoms.[11] Prefabricated splints include soft, rubber splints (which function by separating the teeth); hydrostatic splints, which are cushioned with fluid to redistribute occlusal force; and the NTI-tss device (semi-customisable).

The aims, duration of treatment, need for adjustments, perceived mode of action and the costs of the splints vary across splint types.

How the intervention might work

There is continuing debate about the exact mechanism of action of oral splints. However, mechanisms include:

- muscle relaxation/habit-breaking for patients with increased parafunctional or muscle-tightening habits
- protection of teeth and jaws, particularly when teeth clenching and grinding may lead to damage of teeth, resulting in the need for restorative treatment
- normalising periodontal ligament proprioception, by utilising a splint to spread the forces placed on individual teeth
- repositioning of the jaws and condyles into centric relation
- central effects that are yet to be fully understood.[12]

The mode of action varies according to the type of splint used, with some splints (permissive) allowing the teeth/jaw to move or glide over the biting surfaces unimpeded (permissive splints) and others having indentations that hold the jaw in a fixed position (directive or non-permissive).

Why it was important to do this review

This systematic review arose from a National Institute for Health Research Health Technology Assessment programme call addressing the research question: 'what is the clinical effectiveness and cost-effectiveness of prefabricated oral splints and custom-made splints for the treatment of orofacial symptoms?'. Our application was successful and we received funding to conduct this systematic review and economic evaluation, so the objectives of this review have been driven by this.

It should be noted that the original call focused on treatment for orofacial symptoms. The causes of orofacial pain are varied, but splint therapy for orofacial pain is primarily limited to pain resulting from TMD. Splint therapy is also used for non-painful TMD and bruxism. In order to reflect the use of oral splints in dental practice in the UK, the review will focus on TMD (pain related and non-pain related) and bruxism.

Although we used Cochrane methods, this was not undertaken as a Cochrane review; however, we will share all data from the screening of studies, data extraction forms and correspondence with authors of any future Cochrane reviews, or review updates that overlap with the scope of this review.

Dentists in the NHS in both primary and secondary care are currently providing oral splints for patients who have orofacial signs (such as tooth wear in patients with bruxism) or symptoms (primarily pain). In Scotland alone, the number of splints provided in NHS primary care is increasing from 1985 custom-made hard splints in 2005/06 to 3521 custom-made hard splints in 2015/16. Dentists in Scotland have also recently been allowed to provide custom-made soft splints on the NHS; 16,888 were provided in 2015/16. Oral splints are also provided privately and directly to patients, with a growing industry reported.[11]

Despite the frequent use of splints for the management of orofacial sign and symptoms, their clinical effectiveness and cost-effectiveness remain uncertain. This research proposal will inform the NHS, dentists and patients as to whether or not oral splints provided by dentists or other health-care workers are effective in reducing orofacial symptoms (primarily pain) and when they are indicated to prevent tooth wear. If oral splints are found to be effective, then the effectiveness of prefabricated splints compared with custom-made splints (laboratory made, requiring more than one visit to the health-care worker to fit) will be evaluated to help inform care pathways for the target population.

If prefabricated splints are found to be at least as effective as custom-made splints, then there is the potential for a cost saving to both the NHS and directly to patients. Currently, in primary care, the provision of custom-made oral splints for these patients is a band 3 charge to the patient under the 2016 NHS dental fee scale (£256.50). Prefabricated splits are a much cheaper alternative to custom-made splints as they require only one visit for fitting rather than two, do not require laboratory costs and are a band 2 charge in the NHS (£59.10 in 2016 values). Over-the-counter splints can be purchased for < £10.

Chapter 3 Assessment of clinical effectiveness

Review methods

Types of studies

We included randomised controlled trials (RCTs) but did not include crossover studies as we do not feel that this is an appropriate design owing to the transient nature of the TMD symptoms, or bruxism in patients (which may be due to external factors such as stress).

Types of participants

Inclusion criteria: children (aged > 11 years) and adults who have either TMD or bruxism, and the dentist or other health-care worker is considering treating the patient with an oral splint, in either primary or secondary care.

Exclusion criteria: studies in which the majority of participants were undergoing fixed or removable orthodontic treatment.

Types of interventions

Two comparisons are made:

1. Splints versus no splints, which included any type of splint provided for patients, as described in *Types of participants*. The no-splint group also included a control splint, which is used in some trials, watchful waiting or minimal treatment. Minimal treatment included advice/counselling, education or self-performed exercises (but could not involve multiple visits/appointments).
2. Prefabricated splints versus custom-made splints. No other head-to-head comparisons were included between different splint types.

For clarity, we refer to a splint according to the jaw in which it is used (upper/lower), its material (hard/soft/composite), its degree of coverage of teeth (full/partial) and then its most generic name, unless the proprietary name is particularly pertinent.

Types of outcome measures

Primary outcomes

The primary outcome for the review was pain. This was measured in a number of ways, including changes in the pain intensity from baseline, end-score pain measures or frequency of episodes of pain. Harms were a primary outcome, which included any problems such as soreness of the oral cavity caused by the splint.

For bruxism patients, tooth wear was also considered a primary outcome.

Secondary outcomes

Secondary outcomes included clicking of the temporomandibular joint, change in restricted mouth-opening, frequency of headaches (secondary to pain-related TMD) and quality-of-life data (including physical and emotional function). Patient satisfaction and adherence to treatment were collected whenever possible. For bruxism, the index and frequency of bruxism activity were also to be recorded.

Follow-up periods for the outcome data were divided into short-term follow-up (0–3 months), medium-term follow-up (3–6 months) or long-term follow-up (6–12 months). By consensus, the clinicians in the review team decided that the 0- to 3-month follow-up was the best time point to use for primary data analysis.

Search methods for identification of studies

An information specialist developed a search strategy (see *Appendix 1*) and conducted the literature searches. The searches were originally undertaken on 24 August 2017, and were updated on 1 October 2018 to ensure that more recent studies were considered for inclusion prior to publication.

Electronic searches

The following databases were searched:

- Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library (to issue 9, 2018, searched on 1 October 2018)
- MEDLINE via OvidSP (from 1946 to 1 October 2018)
- EMBASE via OvidSP (from 1980 to 1 October 2018)
- Cumulative Index to Nursing and Allied Health Literature (CINAHL) via EBSCO*host* (1937 to 1 October 2018).

When appropriate, the searches of these databases were linked to study design search filters developed by Cochrane for identifying reports of randomised and controlled clinical trials. They were undertaken without restrictions on language or date of publication.

Searching other resources

Unpublished data on clinical trials was sought via searches of the US National Institutes of Health trials register (ClinicalTrials.gov) and the World Health Organization International Clinical Trials Registry Platform, which includes trials data from the European Union, the UK, Australia, China, the Netherlands, Brazil, India and Republic of Korea (South Korea). Conference proceedings were searched via EMBASE in the main literature search, and the Web of Science. Abstracts of dissertations and theses were searched via the ProQuest database. Searches of these databases were also undertaken on 1 October 2018, without any restrictions on date of publication or language.

Additional grey literature was sourced through the American Academy of Dental Sleep Medicine website.[13] The International Association of Dental Research (IADR) annual conference abstracts were searched via the IADR website[14] on 1 October 2018. The protocol stated that we planned to search the conference proceedings of the American Academy of Orofacial Pain and the European Academy of Craniomandibular Disorders; however, these were not available to us.

Data collection and analysis

Selection of studies

Two review authors independently assessed the abstracts of retrieved studies. We obtained full-text copies of studies deemed to be relevant or potentially relevant, or for which there was insufficient information in the title and abstract to make a clear decision. Two review authors independently assessed the full-text papers and any disagreements on the eligibility of studies were resolved through discussion and consensus. If necessary, a third review author was consulted.

Data extraction and management

Two review authors independently extracted the following data from the included trials:

- location/setting, type of provider, number of centres, recruitment period, trials registry identifier
- inclusion/exclusion criteria, age and sex of participants, number randomised/analysed, any other important prognostic factors (i.e. comorbidities, concomitant prescription medicines/co-interventions)
- population characteristics – age, sex, presenting condition [bruxism, TMD (plus subtype) or mixed] and severity, duration since presenting condition began, comorbidities
- intervention – primary purpose of splint (e.g. pain reduction, bruxist motor activity reduction, to aid functional rehabilitation, to decrease tooth damage, jaw repositioning); type of splint in terms of jaw worn in (upper/lower), material (hard/soft/composite), teeth coverage (full/partial), design (prefabricated/custom made); duration of splint use
- detailed description of comparator
- details of the outcomes reported, including method of assessment and time(s) assessed
- details of sample size calculations, funding sources, declarations/conflicts of interest.

Assessment of risk of bias in included studies

The assessment of risk of bias was done independently and in duplicate, using the Cochrane Risk of Bias tool.[15] The following domains were assessed: sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessors (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias) and other bias. We realised that it would be difficult or impossible to blind participants and personnel to whether or not a participant had been randomised to receiving a splint. This could potentially introduce performance bias, and, in the case of subjective outcomes, detection bias.

The overall risk of bias of individual studies was categorised as being low, high or unclear according to the following:

- low risk of bias (plausible bias unlikely to seriously alter the results) if all domains had a low risk of bias
- unclear risk of bias (plausible bias that raises some doubt about the results) if one or more domains had an unclear risk of bias
- high risk if one or more domains had a high risk of bias.

Measures of treatment effect

For continuous outcomes [e.g. pain on a visual analogue scale (VAS)], we used the means and standard deviations (SDs) reported in the trials to express the estimate of effect as mean difference (MD) with a 95% confidence interval (CI). In the event that different scales were used, we expressed the treatment effect as a standardised mean difference (SMD).

For dichotomous outcomes (e.g. jaw clicking/no jaw clicking), we expressed the estimate of effect as a risk ratio (RR) with a 95% CI.

Unit-of-analysis issues

The patient was the unit of analysis for all included studies.

Dealing with missing data

We attempted to contact the author(s) of all included studies, if feasible, in the event of missing data. Missing SDs were estimated according to the methods for estimating missing SDs described in section 7.7.3 of the *Cochrane Handbook for Systematic Reviews of Interventions*.[15]

Assessment of heterogeneity

If a sufficient number of studies were included in any meta-analyses, we planned to assess any clinical heterogeneity by examining the following characteristics of the studies: the similarity between the types of participants [TMD, bruxism; age (< 18 and ≥ 18 years)], the type of health-care worker providing the splints, the type of splint, the control intervention and the outcomes.

We assessed heterogeneity statistically by using a chi-squared test, in which a p-value of < 0.1 indicates statistically significant heterogeneity. We quantified heterogeneity by using the I^2 statistic. A guide to the interpretation of the I^2 statistic, as given in the Cochrane Handbook,[15] is as follows:

- 0–40% – might not be important
- 30–60% – may represent moderate heterogeneity
- 50–90% – may represent substantial heterogeneity
- 75–100% – considerable heterogeneity.

Assessment of reporting biases

If a sufficient number of studies had been included in any meta-analyses, publication bias would have been assessed in accordance with the recommendations on testing for funnel plot asymmetry,[16] as described in section 10.4.3.1 of the Cochrane Handbook for Systematic Reviews of Interventions.[15] If asymmetry had been identified, other possible causes of asymmetry would have been assessed, as outlined in table 10.4.a of the Cochrane Handbook.[15] We were unable to undertake funnel plot analysis on the main primary outcome because the effect estimate was reported as SMD.

Data synthesis

We carried out meta-analyses only if there were studies of similar comparisons reporting the same outcomes. We performed meta-analyses using Cochrane's Review Manager software (RevMan version 5.3, The Cochrane Collaboration, The Nordic Cochrane Centre, Copenhagen, Denmark) and exported the forest plots into this document to graphically display the results. We combined MDs (or SMDs when different scales were used) for continuous data, and RRs for dichotomous data. Our general approach was to use a random-effects model. With this approach, the CIs for the average intervention effect are wider than those that would have been obtained using a fixed-effect approach, leading to a more conservative interpretation.

We used additional tables (see *Appendix 2*, *Tables 26–29*) to report the results from studies not suitable for meta-analysis.

For the meta-analysis of splints versus no splints, we planned to include prefabricated and custom-made splints as subgroups; however, there was an insufficient number of studies including prefabricated splints. Pooling across subgroups depended on the degree of heterogeneity/subgroup differences. As an additional analysis, if we had determined that there was evidence that the prefabricated splits, when placed by any health-care professional, are effective for the primary outcomes, then we planned to look at any head-to-head RCTs comparing the delivery of prefabricated splints by different types of health-care workers. There was insufficient evidence to undertake this.

We planned to consider undertaking a network meta-analysis for different splint types; however, there were insufficient data to undertake this.

Subgroup analysis and investigation of heterogeneity

For the meta-analysis of splints versus no splints, we planned to include the following subgroups:

- prefabricated
- hard custom-made splints that alter occlusion (jaw relationship)
- hard custom-made splints that do not alter occlusion (jaw relationship)
- soft custom-made splints that do not alter occlusion (jaw relationship).

There were insufficient data to undertake this.

Sensitivity analysis

For TMD patients, we undertook a sensitivity analysis restricted to trials in which the inclusion criteria were based on, or could be clearly mapped to, one of the following sets of diagnostic criteria:

- Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) guidelines[17]
- Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) guidelines[18]
- American Association of Orofacial Pain (AAOP) guidelines.[19]

Similarly, for bruxism patients, we planned to undertake a sensitivity analysis restricted to trials for which there was a clear diagnosis of bruxism.[4] The study should have used polysomnography to diagnose the bruxism. There were insufficient trials to do this.

We planned to test the robustness of our results by performing sensitivity analyses based on excluding studies deemed to be at high and unclear risks of bias from the analyses. However, we knew this was unlikely to be possible for the splint versus no splint comparison if we judged that there was a high risk of performance bias or detection bias or both.

If any meta-analyses had included several small studies and a single very large study, we planned to undertake sensitivity analyses comparing the effect estimates from both random-effects and fixed-effects models. If these were different, we intended to report on both analyses as part of the results section, and consider possible interpretation.

Presentation of main results

We developed a summary of findings table for each comparison and for the main outcomes of this review following Grading of Recommendations Assessment, Development and Evaluation (GRADE) methods,[20] and using the GRADEPro online tool.[21] The quality of the body of evidence was assessed with reference to the overall risk of bias of the included studies, the directness of the evidence, the inconsistency of the results, the precision of the estimates and the risk of publication bias. We categorised the quality of the body of evidence for each of the main outcomes for each comparison as being high, moderate, low or very low.

Patient and public involvement

We established a patient advisory group during the development of the application. We asked members of the patient advisory group to help devise the final list of outcomes to be included in the review protocol. The patient advisory group worked with the Cochrane Oral Health Consumer Co-ordinator (Ruth Floate), who has experience of consulting the public and patients to ensure full and honest input into the production of systematic reviews and their relevant outputs (particularly the production of plain language summaries). At least one member of the patient advisory group attended each of the face-to-face meetings of the research team held in Manchester, and took part in most of the monthly teleconferences.

Studies included in the review

A flow chart of included studies is shown in *Figure 1*. Fifty-two studies were included in the review. The full details of the characteristics and reference for each study are given in *Appendix 3*.

Characteristics of the studies

Study design

All included studies were of parallel design. In one of these studies, non-responders from the control group were allowed to cross over after 6 weeks, but we report data up to 6 weeks, thus treating the study as parallel (Wassell *et al.*[22]).

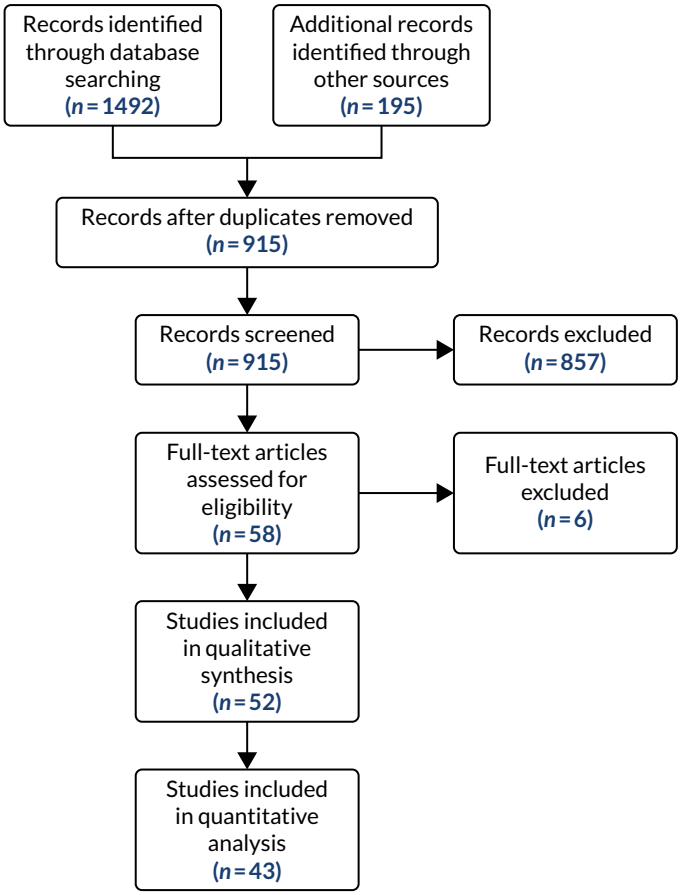

FIGURE 1 Flow of studies through the review process. Adapted from Riley *et al.*[1] This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. This includes minor additions and formatting changes to the original text.

Number of arms

Many studies had more than two arms as they assessed more than one splint type or more than one control type or both. Twenty-four studies had two arms, 19 had three arms, eight had four arms and one had five arms.

Setting

Fifty-one studies were conducted in universities or public hospitals/clinics. The remaining study was carried out at the Mexican Institute for Clinical Research (Tavera *et al.*[23]).

Eleven studies were carried out in Brazil,[24–34] 10 in Sweden,[35–44] seven in the USA,[45–51] three in Turkey,[52–54] two in India,[55,56] two in Egypt,[57,58] two in China,[59,60] two in Germany,[61,62] two in the UK,[22,63] two in Italy,[64,65] two in Japan,[66,67] one in Canada,[68] one in the Netherlands,[69] one in Mexico,[23] one in Poland[70] and one in Finland.[71] The remaining two studies[72,73] were carried out in both Sweden and Finland.

Forty-seven studies were conducted at a single centre. One study was conducted at 11 general dental practices in the UK (Wassell *et al.*[22]), one study was conducted at two locations in Sweden (Lundh *et al.*[40]), one study was conducted at two locations in the USA (DeVocht *et al.*[45]), one study was conducted at two locations (Sweden and Finland; Nilner *et al.*[73]) and one study was conducted at three locations (two in Sweden and one in Finland; Christidis *et al.*[72]).

Sample size calculation

Ten studies reported sample size calculations that were met, although one of studies was not powered on a relevant outcome (Gomes *et al.*[32]), one sample size was met at 10 weeks but not at 6 and 12 months (Nilsson *et al.*[43]) and one stated only that a sample size calculation had been done and that it had been met (Zhang *et al.*[60]). A further study reported a sample size calculation but it was unclear if it was met (Costa *et al.*[29]). Four studies[50,66,71,72] reported sample size calculations that were not met. Three studies reported only post hoc sample size calculations (Giannakopoulos *et al.*,[62] Michelotti *et al.*[64] and Sharma[49]). One study did not perform an a priori sample size calculation as it was a feasibility study, so it was not powered to detect differences between groups (DeVocht *et al.*[45]). In the remaining 33 studies, sample size calculations were not mentioned so it was unclear whether or not they were done.

Funding and conflicts of interest

Twenty-three studies[22,24–27,29,31,35,36,38,43,44,46,47,50,53,66,68–73] declared what appeared to be public funding. Five studies[39–41,45,63] reported both public and industry funding. One study declared only industry funding (Ficnar *et al.*[61]). Five studies[32,52,54,55,67] declared that they received no funding. One study reported the funding source but it was unclear whether this represented public or industry funding (Yu and Qian[59]). The remaining 17 studies did not mention funding.

Sixteen studies[27,29,32,52,54,55,57,61,62,64,65,67,70–73] declared that the authors had no conflicts of interest. However, in one of those studies, one of the authors had designed and patented the splint used in the study (Rampello *et al.*[65]). In a further study (DeVocht *et al.*[45]), one author declared instructing for the manufacturers of one of the interventions. However, that intervention was excluded from the review because it was ineligible. The remaining 35 studies did not mention conflicts of interest.

Characteristics of the participants

Number randomised/analysed

The studies randomised 3229 participants to the arms we included in this review (i.e. some trial arms were not eligible or were not used; therefore, those participants are not included in this number). The number of participants included in analyses varied by the time at which the outcomes were assessed, and sometimes it was unclear how many were analysed.

Age and sex

The reported age range of the participants was 10–76 years. In the majority of studies (31 studies), the participants' mean or median age range was 30–39 years. The vast majority of participants were female.

Diagnosis

Fifty-two studies were included in this evidence synthesis. The majority of studies [47/52 (90%)] focused on people with TMD, with only four studies recruiting people with bruxism (8%). One study evaluated the use of splints in people with bruxism with comorbid TMD.

For the studies evaluating the effectiveness of splints for people with TMD, the diagnostic criteria for TMD varied. However, the predominantly used criteria were the RDC/TMD, used in 26 studies. Two studies used the DC/TMD criteria (Sharma[49] and Tatli *et al.*[54]) and an additional five studies used criteria that approximated to the RDC/TMD (either by citing the instrument and/or their description matched a similar process) (Conti *et al.*,[25] de Felício *et al.*,[30] Ekberg *et al.*,[35] Wassell *et al.*[22] and Wright *et al.*[51]). One study used the AAOP criteria (Alencar and Becker[24]).

The remaining studies used criteria that we had not prespecified in our protocol (RDC/TMD, DC/TMD or AAOP)[17–19] or were undefined/unclear:

- Three had used the Helkimo index[74] (Daif,[57] Johansson *et al.*[37] and List *et al.*[38]).
- Two used arthrography (Lundh *et al.*[41] and Lundh *et al.*[40]).

- One used MRI (Haketa *et al.*[66]).
- One had defined myofascial pain dysfunction syndrome (Rubinoff *et al.*[48]).
- Six used diagnostic systems that it was not possible to classify (Elsharkawy and Ali,[58] Leeson,[63] Lundh *et al.*,[39] Magnusson and Syrén,[42] Rampello *et al.*[65] and Zuim *et al.*[34]).

If studies had not clearly used the prespecified criteria (RDC/TMD, DC/TMD or AAOP),[17–19] an expert reviewer examined the information available in the paper, alongside any correspondence from authors, to identify the probable subgroup of TMD included in the study. When possible, a 'probable' RDC/TMD (sub)group diagnosis was assigned. If a (sub)group diagnosis was not possible, then the sample was regarded as 'painful TMD' (Conti *et al.*,[25] de Felício *et al.*,[30] Elsharkawy and Ali,[58] Johansson *et al.*,[37] Katyayan *et al.*,[56] Leeson,[63] Lundh *et al.*[39] and Rampello *et al.*[65]).

Table 1 provides an overview of the number of studies, including participants for each probable RDC/TMD subgroup diagnoses.

All studies that did not use the prespecified diagnostic criteria were excluded from the sensitivity analyses.

The four studies (Gomes *et al.*,[33] Karakis *et al.*,[53] Pierce and Gale[46] and van der Zaag *et al.*[69]) examining the effects of splints on bruxism all used the Lobbezoo *et al.*[4] criteria for likelihood of a bruxism diagnosis: 'possible' self-report of bruxism, 'probable' clinical evidence of bruxism with or without self-report, and 'definite' defined by polsomnography. On this basis, one study examined 'definite' sleep bruxism and all the other studies examined 'probable' sleep bruxism.

TABLE 1 Probable RDC/TMD subgroup diagnoses for included studies examining TMD

RDC/TMD group	RDC/TMD subgroup	Number of studies with people in specified subgroup
Group I: muscle disorders	Ia	12
	Ib	12
	Subgroup not specified[a]	18
	Total	42
Group II: disc disorders	IIa	10
	IIb	4
	IIc	1
	Subgroup not specified[a]	8
	Total	23
Group III: arthralgia and arthritides	IIIa	10
	IIIb	2
	IIIc	3
	Subgroup not specified[a]	5
	Total	20
Painful TMD[b]		8
Total		93

a Participants were categorisable only at the highest group level (e.g. examined Group I), but it was impossible to identify if this was Group Ia or Ib.
b When it was not possible to categorise under the RDC/TMD from the information provided in the paper or information received from the research team, the sample was defined as 'painful TMD'.

The study that examined bruxism with comorbid TMD used the Fonseca index[75] for TMD and examined 'probable' bruxism (Gomes *et al.*[32]). This study was classified as examining 'painful TMD' and excluded from the sensitivity analyses.

Characteristics of the interventions and comparisons

Most of the studies included one comparison eligible for inclusion in this review. There were four studies that included two different eligible comparisons (Ficnar *et al.*,[61] Giannakopoulos *et al.*,[62] Gomes *et al.*[32] and Truelove *et al.*[50]).

Splint versus no splint for temporomandibular disorder

Comparison type

Thirty-five studies compared splints with no splints for TMD patients.

Ten of these studies used a no-treatment control group (Conti *et al.*,[25] Daif,[57] de Felício *et al.*,[31] Johansson *et al.*,[37] List *et al.*,[38] Lundh *et al.*,[39] Lundh *et al.*,[41] Nitecka-Buchta *et al.*,[70] Rampello *et al.*[65] and Wright *et al.*[51]).

Twenty had a co-intervention in each arm (e.g. splint + co-intervention vs. co-intervention alone). Of these 20 studies, 13 had a co-intervention of usual treatment, counselling, information or exercise (Conti *et al.*,[27] Conti *et al.*,[28] Costa *et al.*,[29] DeVocht *et al.*,[45] Ficnar *et al.*,[61] Giannakopoulos *et al.*,[62] Hasanoglu *et al.*,[52] Katyayan *et al.*,[56] Lundh *et al.*,[40] Nagata *et al.*,[67] Niemelä *et al.*,[71] Truelove *et al.*[50] and Wahlund *et al.*[44]), whereas seven had a co-intervention of 'acuhealth', manipulative and physical therapy, massage, fluoxetine (Prozac®, Eli Lilly and Company, Indianapolis, IN, USA) microcurrent electrical nerve stimulation, physical therapy with vapocoolant spray, arthrocentesis and sodium hyaluronate {Elsharkawy and Ali,[58] Gomes *et al.*,[32] Leeson,[63] Sharma,[49] Tatli *et al.*,[54] Yu and Qian[59] [this study had four arms with which we made two separate pairwise comparisons: (1) splint + co-intervention vs. co-intervention alone and (2) splint vs. minimal treatment] and Zuim *et al.*[34]}.

The remaining six studies had minimal treatment controls: three were self-exercises (Haketa *et al.*,[66] Magnusson and Syrén[42] and Tavera *et al.*[23]), and three were information-based {de Felício *et al.*,[30] Michelotti *et al.*[64] and Yu and Qian[59] [this study had four arms with which we made two separate pairwise comparisons: (1) splint + co-intervention vs. co-intervention alone and (2) splint vs. minimal treatment]}.

Splint type

Seven studies compared more than one splint against no splint:

1. Conti *et al.*[25] – (1) stabilisation splint compared with (2) anterior repositioning splint for 3 or 4 months and then converted into stabilisation splints for the remainder of the treatment period.
2. Conti *et al.*[27] – (1) stabilisation splint compared with (2) nociceptive trigeminal inhibition splint.
3. Conti *et al.*[28] – (1) anterior repositioning splint compared with (2) NTI-tss splint.
4. Ficnar *et al.*[61] – (1) stabilisation splint compared with (2) prefabricated, semi-finished occlusal splint (SOLUBrux®; W3 Solutions SÀRL, Crassier Switzerland).
5. Giannakopoulos *et al.*[62] – (1) vacuum-formed splint compared with (2) prefabricated oral splint with water-filled elastic pads.
6. Lundh *et al.*[39] – (1) anterior repositioning splint compared with (2) flat occlusal splint.
7. Truelove *et al.*[50] – (1) flat-plane splint compared with (2) prefabricated soft thermoplastic athletic mouthguard splint.

Fifteen studies used a stabilisation splint, 12 of which were in the upper jaw (Michigan-style splints) (Costa *et al.*,[29] de Felício *et al.*,[31] Gomes *et al.*,[32] Haketa *et al.*,[66] Katyayan *et al.*,[56] Leeson,[63] List *et al.*,[38] Magnusson and Syrén,[42] Michelotti *et al.*,[64] Nagata *et al.*,[67] Wahlund *et al.*[44] and Yu and Qian[59]). The remaining three studies did not clearly report whether the splint was in the upper or lower jaw (Niemelä *et al.*,[71] Tatli *et al.*[54] and Tavera *et al.*[23]).

The splint used in two studies was described as a flat-plane splint (Daif[57] and Sharma[49]).

The splint used in two studies was described as a flat occlusal splint (Lundh *et al.*[40] and Lundh *et al.*[41]).

The splint used in five studies was described only as an occlusal splint (de Felício *et al.*,[30] Elsharkawy and Ali,[58] Johansson *et al.*,[37] Nitecka-Buchta *et al.*[70] and Zuim *et al.*[34]).

The splint used in one study was described only as a soft splint (Wright *et al.*[51]).

The splint used in one study was described as a reversible interocclusal splint (DeVocht *et al.*[45]).

One study used a NTI-tss splint (Hasanoglu *et al.*[52]).

One study used a Universal Neuromuscular Immediate Relaxing Appliance (UNIRA) splint, designed and patented by the study author (Rampello *et al.*[65]).

Custom-made splint versus prefabricated splint for temporomandibular disorders

Six studies compared custom-made splints with prefabricated splints for TMD patients:

1. Amin *et al.*[55] – (1) prefabricated readily available liquid occlusal splint (Aqualizer®; Bainbridge Island, WA, USA), (2) hard occlusal splint and (3) soft occlusal splint.
2. Christidis *et al.*[72] – (1) prefabricated occlusal splint (Relax; Unident AB, Falkenberg, Sweden) and (2) stabilisation splint.
3. Ficnar *et al.*[61] – (1) prefabricated, semi-finished occlusal splint (SOLUBrux) and (2) stabilisation splint.
4. Giannakopoulos *et al.*[62] – (1) prefabricated oral splint with water-filled elastic pads (Aqualizer) and (2) vacuum-formed splint.
5. Nilner *et al.*[73] – (1) prefabricated occlusal splint (Relax) and (2) stabilisation splint.
6. Truelove *et al.*[50] – (1) prefabricated soft thermoplastic athletic mouthguard splint and (2) flat-plane hard splint.

Splint versus control splint for temporomandibular disorders

Ten studies compared control splints that did not alter the occlusion with active splints for TMD patients. In six of the studies, the active splint was described as a stabilisation splint (Dao *et al.*,[68] Ekberg *et al.*,[35] Ekberg *et al.*,[36] Rubinoff *et al.*,[48] Wassell *et al.*[22] and Zhang *et al.*[60]). In one study it was described as a flat-plane splint (Raphael and Marbach[47]) and in another only as an occlusal splint (Nilsson *et al.*[43]). The remaining studies compared two active splints against the control splint:

- Alencar and Becker[24] – (1) hard occlusal splint and (2) soft occlusal splint.
- Conti *et al.*[26] – (1) modified stabilisation splint and (2) conventional stabilisation splint.

Splint versus no splint for bruxism

Three studies compared splints with no splints for bruxism patients:

1. Gomes *et al.*[32] – Michigan splint + massage versus massage.
2. Gomes *et al.*[33] – (1) Michigan splint versus no treatment and (2) Michigan splint + massage versus massage (i.e. two pairwise comparisons).
3. Pierce and Gale[46] – flat-plane splint versus no treatment.

Custom-made splint versus prefabricated splint for bruxism

One study compared custom-made stabilisation splints with prefabricated splints (Bruxogard™; Myofunctional Research Europe B.V., Waalwijk, the Netherlands) for bruxism patients (Karakis *et al.*[53]).

Splint versus control splint for bruxism

One study compared stabilisation splints with control splints for bruxism patients (van der Zaag *et al.*[69]).

Characteristics of the outcomes

Nine of the 52 studies did not contribute any outcome data to this review, either in the meta-analyses or the data analysis presented in the additional tables (Conti *et al.*,[25] Conti *et al.*,[26] Dao *et al.*,[68] Ficnar *et al.*,[61] Gomes *et al.*,[32] Karakis *et al.*,[53] Pierce and Gale,[46] Rampello *et al.*[65] and Zuim *et al.*[34]).

Primary outcomes

Pain

Only five studies did not report some form of pain outcome (Daif,[57] Gomes *et al.*,[32] Karakis *et al.*,[53] Pierce and Gale[46] and van der Zaag *et al.*[69]). Four of those were bruxism studies; therefore, this was to be expected.

Table 2 demonstrates how pain was reported in the studies and that a lot of studies reported pain in multiple ways.

The most commonly used measures of pain in the included studies were VAS/numerical rating scales (NRS) and pain on palpation/pressure. In this review, we prioritised VAS/NRS for the main meta-analysis, also including Characteristic Pain Intensity (CPI) (which was reported as a composite measure encompassing current, worst and average pain over a specified period of time). Despite the majority of studies reporting one of the three pain measures, many studies did not report the data sufficiently for us to include them in the meta-analysis. Furthermore, some measured current pain intensity, whereas others measured average pain over a specified period of time or worst pain experienced. Pain at rest was favoured over pain while chewing or during any other movement.

Harms/adverse effects

Nine studies reported on harms (Christidis *et al.*,[72] Haketa *et al.*,[66] Nilner *et al.*,[73] Nitecka-Buchta *et al.*,[70] Tatli *et al.*,[54] Tavera *et al.*,[23] Truelove *et al.*,[50] Wahlund *et al.*[44] and Wright *et al.*[51]). Eight of these were reported narratively, with one study reporting raw data for occlusal contact changes (Wright *et al.*[51]).

Tooth wear (bruxism only)

None of the five bruxism studies reported on tooth wear.

Secondary outcomes

Temporomandibular joint clicking

Fourteen studies reported this outcome (Conti *et al.*,[25] Conti *et al.*,[26] Conti *et al.*,[28] de Felício *et al.*,[30] de Felício *et al.*,[31] Ekberg *et al.*,[35] Ekberg *et al.*,[36] Lundh *et al.*,[39] Lundh *et al.*,[40] Magnusson and Syrén,[42] Nagata *et al.*,[67] Rubinoff *et al.*,[48] Truelove *et al.*[50] and Wassell *et al.*[22]). One further study measured this outcome but did not report it (Wahlund *et al.*[44]). Some studies reported on joint sounds and did not specify clicking. The majority of studies reported this outcome dichotomously.

Change in restricted mouth-opening

Twenty-seven studies reported on this outcome (Christidis *et al.*,[72] Conti *et al.*,[25] Conti *et al.*,[28] de Felício *et al.*,[30] de Felício *et al.*,[31] Ekberg *et al.*,[35] Ekberg *et al.*,[36] Ficnar *et al.*,[61] Giannakopoulos *et al.*,[62] Haketa *et al.*,[66] Hasanoglu *et al.*,[52] Katyayan *et al.*,[56] Leeson,[63] Magnusson and Syrén,[42] Michelotti *et al.*,[64] Nagata *et al.*,[67] Niemelä *et al.*,[71] Nilner *et al.*,[73] Rampello *et al.*,[65] Rubinoff *et al.*,[48] Sharma,[49] Tatli *et al.*,[54] Truelove *et al.*,[50] Wahlund *et al.*,[44] Wassell *et al.*,[22] Wright *et al.*[51] and Yu and Qian[59]).

TABLE 2 Pain outcomes reported in the included studies

Study First author and year	VAS	50% reduction in VAS	NRS	CPI	Mod-SSI (0.035 to 1)	Pain on palpation/ pressure (measured in various ways)	GCPS	Overall improvement (0–5)	Catastrophising Thoughts Subscale (0–4)	Pain (various yes/no)	Pain intensity (various ordinal scales)	Frequency (various ordinal and continuous scales)	Duration (ordinal 0–4)	Pain during mandibular movements (number of movements)	Impaired/ unchanged/ improved/ symptom free	Pain index (VAS × frequency)	Aggregate joint tenderness
Alencar 2009[24]					✗	✗											
Amin 2016[55]					✗	✗											
Castroflorio 2018[76]																	
Christidis 2014[72]	✗						✗	✗									
Conti 2005[25]	✗					✗											
Conti 2006[26]	✗					✗											
Conti 2012[27]	✗	✗				✗											
Conti 2015[28]	✗					✗											
Costa 2015[29]									✗								
Daif 2012[57]																	
Dao 1994[68]	✗																
de Felício 2006[30]			✗							✗							
de Felício 2010[31]			?														
DeVocht 2013[45]			✗														
Ekberg 1998[35]	✗					✗				✗	✗	✗	✗	✗			
Ekberg 2003[36]	✗					✗				✗	✗	✗		✗			
Elsharkawy 1995[58]	✗										✗				✗		
Ficnar 2013[61]						✗											
Giannakopoulos 2016[62]			✗														
Gomes 2014[32]																	
Gomes 2015[33]			✗														
Haketa 2010[66]	✗																

Study First author and year	VAS	50% reduction in VAS	NRS	CPI	Mod-SSI (0.035 to 1)	Pain on palpation/ pressure (measured in various ways)	GCPS	Overall improvement (0–5)	Catastrophising Thoughts Subscale (0–4)	Pain (various yes/no)	Pain intensity (various ordinal scales)	Frequency (various ordinal and continuous scales)	Duration (ordinal 0–4)	Pain during mandibular movements (number of movements)	Impaired/ unchanged/ improved/ symptom free	Pain index (VAS × frequency)	Aggregate joint tenderness
Hasanoglu 2017[52]	✗																
Johansson 1991[37]	✗										✗				✗		
Karakis 2014[53]																	
Katyayan 2014[56]	✗					✗											
Leeson 2007[63]	✗									✗	✗	✗			✗		
List 1992[38]	✗											✗					
Lundh 1985[39]	✗					✗											
Lundh 1988[40]	✗					✗											
Lundh 1992[41]						✗									✗		
Magnusson 1999[42]										✗	✗						
Michelotti 2012[64]	✗																
Nagata 2015[67]			✗														
Niemelä 2012[71]	✗					✗											
Nilner 2008[73]	✗	✗					✗					✗					
Nilsson 2009[43]	✗			✗								✗					
Nitecka-Buchta 2014[70]	✗																
Pierce 1988[46]																	
Rampello 2013[65]	✗														✗		
Raphael 2001[47]			✗			✗											
Rubinoff 1987[48]						✗					✗						

continued

TABLE 2 Pain outcomes reported in the included studies (*continued*)

Study First author and year	VAS	50% reduction in VAS	NRS	CPI	Mod-SSI (0.035 to 1)	Pain on palpation/ pressure (measured in various ways)	GCPS	Overall improvement (0–5)	Catastrophising Thoughts Subscale (0–4)	Pain (various yes/no)	Pain intensity (various ordinal scales)	Frequency (various ordinal and continuous scales)	Duration (ordinal 0–4)	Pain during mandibular movements (number of movements)	Impaired/ unchanged/ improved/ symptom free	Pain index (VAS × frequency)	Aggregate joint tenderness
Sharma 2016[49]				✗													
Tatli 2017[54]	✗			✗													
Tavera 2012[23]	✗																
Truelove 2006[50]				✗		✗							✗				
van der Zaag 2005[69]																	
Wahlund 2003[44]	✗	✗				✗						✗				✗	
Wassell 2004[22]	✗					✗											✗
Wright 1995[51]						✗											
Yu 2016[59]	✗																
Zhang 2013[60]	✗																
Zuim 2006[34]	✗																

CPI, Characteristic Pain Intensity; GCPS, Graded Chronic Pain Scale; Mod-SSI, Modified Symptom Severity Index; NRS, numerical rating scale.

Note

'?' means 'unclear', as it could not be determined from the paper if it used VAS or not.

Two studies reported the incidence of participants with a mouth-opening capacity of < 40 mm (Ekberg *et al.*[35] and Ekberg *et al.*[36]). One study reported this outcome as difficulty when opening the mouth (yes/no) (de Felício *et al.*[30]). One study reported a self-assessment of functional limitation of the jaw using a 0–100 mm VAS (Hasanoglu *et al.*[52]). One study reported only on the splint group and not on the control group, and only for those who started with restricted mouth-opening (Rampello *et al.*[65]). The remaining studies all reported maximum mouth-opening in various ways, namely without pain/with pain/until pain, and assisted/unassisted. One of them also reported the incidence of having difficulty opening the mouth wide (yes/no) (Magnusson and Syrén[42]).

Frequency of headaches (secondary to pain-related temporomandibular disorder)

Four studies reported this outcome. Three were reported categorically (Costa *et al.*,[29] Nilner *et al.*[73] and Nilsson *et al.*[43]) and one as number per week (Wassell *et al.*[22]).

Quality of life

Thirteen studies reported on this outcome. Four used the Modified Symptom Checklist-90-Revised (SCL-90-R) (Christidis *et al.*,[72] Nilner *et al.*,[73] Nilsson *et al.*[43] and Raphael and Marbach[47]). One of those also assessed average mood using a 0–10 scale (Raphael and Marbach[47]). Two studies used the 14-item Oral Health Impact Profile (OHIP-14) (DeVocht *et al.*[45] and Niemelä *et al.*[71]). One study used the Hospital Anxiety and Depression scale (Costa *et al.*[29]). One study used the Short Form questionnaire-36 items (SF-36) (Gomes *et al.*[33]). One study used the Limitation of Daily Functions for TMD Questionnaire (Haketa *et al.*[66]). One study used the RDC/TMD Axis II biobehavioural questionnaire (Tatli *et al.*[54]). One study used an unnamed scale (Dao *et al.*[68]) and the remaining two studies used multiple scales: Leeson[63] used the following: (1) Multidimensional Pain Inventory severity; (2) McGill Short Pain Questionnaire; (3) Kellner Illness Attitude Scale; and (4) Beck Depression Inventory scores, whereas Sharma[49] used the following: (1) Patient Health Questionnaire-9 items; (2) Patient Health Questionnaire-15 items; and (3) Generalised Anxiety Disorder-7.

Patient satisfaction

Four studies reported on patient satisfaction. In one study, this was assessed using a 0–10 scale (DeVocht *et al.*[45]); in another, it was reported dichotomously as satisfied or not (Ekberg *et al.*[36]). The data were not usable in the remaining two studies (Conti *et al.*[28] and Tavera *et al.*[23]).

Adherence to treatment

Nine studies reported on compliance (Christidis *et al.*,[72] Daif,[57] Ekberg *et al.*,[36] Nilner *et al.*,[73] Nilsson *et al.*,[43] Raphael and Marbach,[47] Tavera *et al.*,[23] Truelove *et al.*[50] and Wahlund *et al.*[44]).

Bruxism severity

Of the five bruxism studies, two reported on bruxism severity. One reported the duration of bruxing per hour (Pierce and Gale[46]) and the other used a bruxism time index, which was the percentage of total sleep time spent bruxing (van der Zaag *et al.*[69]).

Bruxism frequency

Of the five bruxism studies, two reported bruxism episodes per hour (Pierce and Gale[46] and van der Zaag *et al.*[69]).

Risk of bias in included studies

A summary of the risk-of-bias assessments for the seven domains is given in *Figure 2*.

Allocation (selection bias)

Random sequence generation

Twenty-nine studies[22,26,29–33,35,36,43,45,49–51,54–57,60,62–64,66,67,69–73] were judged to be at a low risk of bias for the domain of random sequence generation. The remaining 23 studies[23–25,27,28,34,37–42,44,46–48,52,53,58,59,61,65,68]

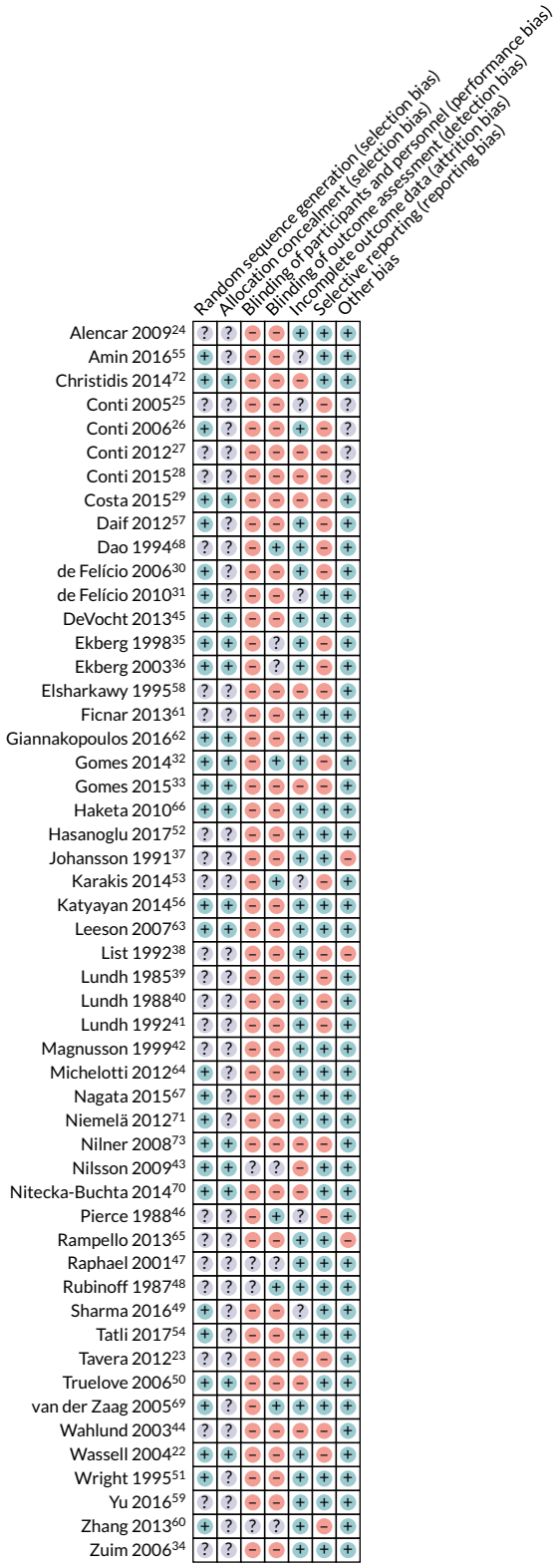

FIGURE 2 Summary of risk-of-bias assessments for each study. Adapted from Riley *et al.*[1] This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. This includes minor additions and formatting changes to the original text.

reported that participants were randomly allocated to interventions, but were judged to be at an unclear risk of bias owing to an inadequate description of the methods used.

Allocation concealment

Sixteen studies[22,29,32,33,35,36,43,45,50,56,62,63,66,70,72,73] described an adequate method of allocation concealment and we judged them to be at a low risk of bias for this domain. The remaining 36 studies[23–28,30,31,34,37–42,44,46–49,51–55,57–61,64,65,67–69,71] did not provide a description of the methods used to conceal the allocation sequence.

Overall, sixteen studies[22,29,32,33,35,36,43,45,50,56,62,63,66,70,72,73] were deemed to be at a low risk of selection bias as they were rated as being at a low risk for both of the above domains. The remaining 36 studies[23–28,30,31,34,37–42,44,46–49,51–55,57–61,64,65,67–69,71] had an unclear risk of selection bias as they had an unclear rating for one or both of the above domains.

Blinding of participants and personnel (performance bias)

Forty-eight studies[22–42,44–46,49–59,61–73] were rated as having a high risk of performance bias because of the inability to blind patients and personnel to splint/no splint or splint type. Four studies[43,47,48,60] were rated as having an unclear risk of bias. These studies all compared splints against control splints, and attempts were made to blind the personnel and/or patients; however, it was not clear if both were blinded.

Blinding of outcome assessment (detection bias)

Forty-one studies[22–31,33,34,37–42,44,45,49–52,54–59,61–67,70–73] were rated as having a high risk of detection bias based on the primary outcome of pain. This was because the patients were aware of their assigned group in the studies and would then subjectively rate their own pain.

Six studies were rated as being at a low risk of detection bias. In two of these studies, comparing splints with control splints, the patients were blinded (Dao *et al.*[68] and Rubinoff *et al.*[48]). Two studies used objective assessment of bruxism while the participants slept (Pierce and Gale[46] and van der Zaag *et al.*[69]). Two studies did not assess any outcomes of this review; therefore, detection bias was irrelevant (Gomes *et al.*[32] and Karakis *et al.*[53]).

The remaining five studies were rated as having an unclear risk of bias. These all compared splints with control splints and it was not clear whether or not the patients were blinded (Ekberg *et al.*,[35] Ekberg *et al.*,[36] Nilsson *et al.*,[43] Raphael and Marbach[47] and Zhang *et al.*[60]).

Incomplete outcome data (attrition bias)

Thirty-four studies[22,24,26,30,32,34–42,45,47,48,51,52,54,56,57,59–69,71] had limited or no attrition and were rated as being at a low risk of attrition bias. Twelve studies[23,27–29,33,43,44,50,58,70,72,73] were rated as being at a high risk of attrition bias because of high attrition rates, substantial differences between groups in attrition rate, or both. The remaining six studies[25,31,46,49,53,55] were rated as having an unclear risk of attrition bias owing to poor reporting of numbers randomised or analysed.

Selective reporting (reporting bias)

Twenty-eight studies[24,31,34,37,42,43,45,47–52,54–56,59,61–67,69–72] reported outcome data adequately and were assessed as being at a low risk of reporting bias. The remaining 24 studies[22,23,25–30,32,33,35,36,38–41,44,46,53,57,58,60,68,73] had problems with the way in which the data were reported and were rated as being at a high risk of reporting bias.

Other bias

For 45 studies,[22–24,29–36,39–64,66–73] we did not identify any other potential source of bias and rated them as being at a low risk of bias. Three studies were rated as having a high risk of bias because outcomes were followed up at different times for the two groups (Johansson *et al.*,[37] List *et al.*[38] and Rampello *et al.*[65]). For one of those studies, there was also a substantial sex imbalance between groups, potentially indicating that the randomisation process was inadequate or did not work (List *et al.*[38]). The remaining four studies were rated as having an unclear risk of bias because the reporting was poor and we were unable to properly assess them (Conti *et al.*,[25] Conti *et al.*,[26] Conti *et al.*[27] and Conti *et al.*[28]).

Overall risk of bias

Fifty studies[22–46,49–73] were rated as having a high risk of bias overall because they received at least one high risk-of-bias rating for the above domains. The remaining two studies[47,48] were rated as having an unclear risk of bias because they did not receive any high risk-of-bias ratings for the above domains, but received at least one unclear risk-of-bias rating. Therefore, no study included in this review was considered to be at a low risk of bias.

Studies excluded from the review

Six studies were excluded from the review for the following reasons: not random allocation (Al Quran and Kamal,[77] Alpaslan *et al.*[78] and Gavish *et al.*[79]), inappropriate study design [4-month difference in timing of outcomes between the groups (Madani and Mirmortazavi[80])], the counselling group had multiple reinforcement sessions and therefore not considered minimal treatment (Manfredini *et al.*[81]) and we were unable to obtain a full-text copy (Castroflorio *et al.*[76]).

Results of the systematic review

The results and presented for the two comparisons specified in *Chapter 1*.

Comparison 1: splints versus no splints/minimal intervention/control splints

The results for the two conditions, TMD (pain-related and non-pain-related) and bruxism, are considered separately, as trials included only TMD patients or only bruxism patients because they are considered discrete groups of patients.

Patients with temporomandibular disorder

One of the main questions posed in this investigation is whether or not there is evidence that splints are effective for reducing pain when compared with no splints. We undertook two analyses. One was for the splint group compared with no/minimal intervention, such as watchful waiting or minimal treatment or self-management. A second analysis was conducted for comparisons with a placebo/control splint, which was used in some trials. There was consensus among clinicians and methodologists that 0–3 months was an appropriate time point to use for the primary analysis of the data. The primary pain outcome was any continuous scale that was sensible to combine (e.g. VAS, NRS, CPI). VAS was the most frequently reported outcome, and 0–3 months was the most frequently reported time point. Other time points, 3–6 months and 6–12 months, were also analysed and reported.

Pain (splint versus no splint/minimal intervention)

Thirteen trials of 16 pairwise comparisons (three of the studies assessed more than one type of splint), all rated as having a high risk of bias, with 1076 patients contributed to the results for the no/minimal interventions at 3 months (*Figure 3*). There was considerable heterogeneity and the overall SMD was −0.18 (95% CI −0.42 to 0.06). Using a rule of thumb for SMD effect estimates, 0.18 would be considered a small effect[15] and, as this was not statistically significant, there is insufficient evidence, which is of very low quality,[20] to show that oral splints reduce pain (*Table 3*). Owing to differences in splint type, the control group no/minimal interventions and different types of TMD diagnoses between the individual studies, we were unable to investigate the heterogeneity any further. There were fewer studies and patients for the other time periods (3–6 months: two trials, 160 patients; and 6–12 months: two trials, three pairwise comparisons, 246 patients), and the effect sizes were SMD −0.31 (95% CI −1.31 to 0.68) and 0.11 (95% CI −0.16 to 0.38) for the 3- to 6-month and 6- to 12-month time periods, respectively, which also fail to demonstrate that oral splints reduced pain (*Table 4*) (see also *Appendix 4*, *Figures 15* and *16*).

Study or subgroup	Splint Mean	Splint SD	Splint Total	Control Mean	Control SD	Control Total	Weight (%)	SMD IV, random (95% CI)	Risk of bias A	B	C	D	E	F	G
[a]Conti 2015[28]	9.23	22.5	12	37.62	22.5	9	3.8	−1.21 (−2.17 to −0.26)	?	?	−	−	−	−	?
[b]de Felício 2010[31]	14.56	8.14	10	13.6	9.49	10	4.2	0.10 (−0.77 to 0.98)	+	?	−	−	?	+	+
[c]Giannakopoulos 2016[62]	30	27	12	40.8	25	6	3.6	−0.39 (−1.38 to 0.60)	+	+	−	−	+	+	+
[d]Giannakopoulos 2016[62]	16.7	17.8	12	40.8	25	6	3.3	−1.13 (−2.19 to −0.06)	+	+	−	−	+	+	+
[e]Haketa 2010[66]	36.5	28.7	25	21.3	26.4	19	6.0	0.54 (−0.07 to 1.15)	+	+	−	−	+	+	+
[f]Hasanoglu 2017[52]	23	27.8	20	23.6	23.8	20	5.9	−0.02 (−0.64 to 0.60)	?	?	−	−	+	+	+
[g]Leeson 2007[63]	41.1	26.2	62	38	28.1	63	8.1	0.11 (−0.24 to 0.46)	+	+	−	−	+	+	+
[h]List 1992[38]	18	17	34	28	18	22	6.5	−0.57 (−1.11 to −0.02)	?	?	−	−	+	−	−
[i]Nagata 2015[67]	11.571	19.8797	96	8.268	15.6888	85	8.5	0.18 (−0.11 to 0.47)	+	?	−	−	+	+	+
[j]Niemelä 2012[71]	34	32	39	40	26	37	7.2	−0.20 (−0.65 to 0.25)	+	?	−	−	+	+	+
[k]Nitecka-Buchta 2014[70]	10	10.4	35	40	26	30	6.4	−1.54 (−2.10 to −0.98)	+	+	−	−	−	+	+
[l]Tatli 2017[54]	20	19	40	15	17	40	7.3	0.27 (−0.17 to 0.72)	+	?	−	−	+	+	+
[m]Truelove 2006[50]	47.83	20	56	47.6	20	27	7.2	0.01 (−0.45 to 0.47)	+	?	−	−	−	+	+
[n]Truelove 2006[50]	45.08	20	54	47.6	20	27	7.1	−0.12 (−0.59 to 0.34)	+	?	−	−	−	+	+
[o]Yu 2016[59]	20.5	8.7	42	21	11.7	42	7.4	−0.05 (−0.48 to 0.38)	?	?	−	−	+	+	+
[p]Yu 2016[59]	19.7	9.3	42	20.2	8.9	42	7.4	−0.05 (−0.48 to 0.37)	?	?	−	−	+	+	+
Total (95% CI)			591			485	100.0	−0.18 (−0.42 to 0.06)							

Heterogeneity: $\tau^2 = 0.15$; $\chi^2 = 50.22$, df = 15 ($p < 0.0001$); $I^2 = 70\%$

Test for overall effect: $Z = 1.50$ ($p = 0.13$)

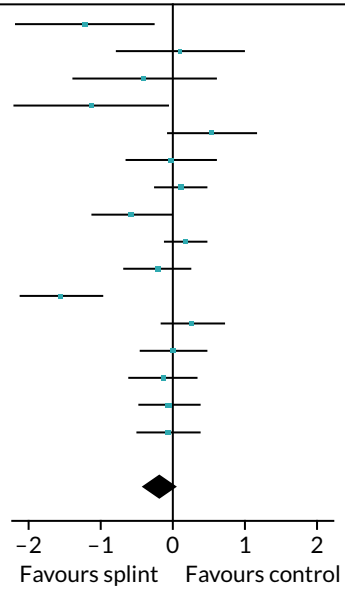

FIGURE 3 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: any combinable scale (higher = more pain), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Current pain intensity 0 to 100 mm VAS (custom anterior repositioning); b, muscle pain 0 to 10 for when (1) waking, (2) chewing, (3) speaking, (4) at rest (score summed = 0 to 40 scale); c, current pain intensity 0 to 10 NRS converted to a 0 to 100 scale (prefabricated splint); d, current pain intensity 0 to 10 NRS converted to a 0 to 100 scale (custom splint); e, current maximum daily pain intensity 0 to 100 mm VAS; f, current pain intensity 0 to 100 mm VAS; g, current pain intensity 0 to 10 cm VAS converted to 0 to 100 mm; h, 0 to 100 mm VAS, recorded three times daily with average calculated on weekly basis (appears to be reported in cm – we converted this to mm); i, current orofacial pain 0 to 10 NRS converted to a 0 to 100 scale; j, current facial pain intensity 0 to 10 cm VAS (we converted this to mm); k, current pain intensity – 0 to 10 cm VAS (we converted this to mm); l, current pain intensity – 0 to 10 cm VAS (we converted to mm); m, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in the paper; n, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in the paper (custom-made splint vs. control); o, current pain intensity 0 to 10 VAS – we converted to 0 to 100 (splint vs. control); p, current pain intensity 0 to 10 VAS – we converted to 0 to 100 (splint + manipulative and physical therapies vs. manipulative and physical therapies). Adapted from Riley *et al.*[1]

TABLE 3 Summary of findings for oral splints provided for TMD vs. no/minimal intervention/control splints[a]

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	Number of participants (*n* studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	No splint	Oral splint				
Pain SD units: • Pain measured on combinable scale • 0–3 months • (unable to use MD due to differences in the way pain was measured in the studies)	The pain score in the oral splint group was, on average, 0.18 SDs lower (0.06 higher to 0.42 lower) than the no/minimal intervention group			1076 (13 RCTs; 16 pairwise comparisons)	⊕⊖⊖⊖ very low[b]	• No evidence that splints reduced pain • As rule of thumb, 0.2 SD represents a small difference, 0.5 a moderate difference and 0.8 a large difference • Similar effect sizes at other time points • Comparisons between splint and control splint indicated a reduction in pain for the splint group at 0–3 months [SMD −0.67 (95% CI −1.16 to −0.17)] but not at other time points
• Current pain intensity measured on VAS (0–100 mm) or NRS (0 to 100) • 0–3 months	The mean pain intensity in the control groups ranged from 9.23 to 41.1 mm,[c] median = 20	The mean pain intensity in the splint groups was 4.48 mm lower (11.59 lower to 2.64 higher)		874 (11 RCTs; 13 pairwise comparisons)	⊕⊖⊖⊖ very low[b]	Results similar at other time points
Clicking of joint at 0–3 months (yes/no)	500[d] per 1000	425 per 1000 (255 to 715)	RR 0.85 (0.51 to 1.43)	252 (3 RCTs; 5 pairwise comparisons)	⊕⊖⊖⊖ very low[b]	• No evidence of a difference in joint clicking • Results similar at other time points • No evidence of a difference between splint and control splint at 0–3 months: RR 0.95 (95% CI 0.68 to 1.31). No data at other time points

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	Number of participants (*n* studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	No splint	Oral splint				
Maximum mouth-opening (mm) at 0–3 months	The mean maximum mouth-opening in the control groups ranged[c] from 33.08 to 47.1 mm; median 40 mm	The mean maximum mouth-opening in the splint groups was 1.17 mm higher (0.68 lower to 3.03 higher)		913 (13 RCTs; 16 pairwise comparisons)	⊕⊖⊖⊖ very low[b]	• No evidence of a difference in maximum mouth opening • The results from the 3- to 6-month time period: MD 0.29 mm (95% CI –0.63 to 1.20 mm). No data for the 6- to 12-month time period • No evidence of a difference in incidence of mouth-opening < 40 mm between splint and control splint in the 0- to 3-month time period: RR 0.40 (95% CI 0.05 to 3.41). No data at other time points
Quality of life using OHIP-14 (0 to 56, worsening scale) at 0–3 months	The mean[e] score in the control groups was 14.84	The mean score in the splint groups was 1.43 lower (5.11 lower to 2.24 higher)		80 (2 RCTs)	⊕⊖⊖⊖ very low[b]	• No evidence of a difference in quality of life • Similar results at other time points • Insufficient evidence for splint vs. control splint
Adverse events	None of the studies reported any adverse events					

a The evidence in this table is based purely on the data in the forest plots and not the data in the additional tables.
b Downgraded as all studies were rated as being at a high risk of bias, there was substantial heterogeneity between studies and there was a lack of precision in the pooled estimate.
c The range does not include two studies that reported change scores.
d Median event rate for no/minimal intervention group.
e This is the mean in the study that reported an end score, as the other study reported a change score.

Notes
Oral splints for patients with orofacial signs or symptoms to reduce orofacial pain.
Patient or population: patients provided with oral splints for TMD.
Setting: primary or secondary care.
Intervention: oral splint.
Comparison: no splint/minimal intervention/placebo splint.

TABLE 4 Summary of effect estimates for TMD pain: splint vs. no/minimal treatment

Outcome	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate	Heterogeneity	
				χ^2 *p*-value	I^2 (%)
Pain: any combinable scale (higher = more pain)					
0–3 months (see *Figure 3*)	13 (1076); 16 pairwise comparisons	SMD –0.18 (–0.42 to 0.06)	0.13	< 0.0001	70
3–6 months (see *Appendix 4*, *Figure 15*)	2 (160)	SMD –0.31 (–1.31 to 0.68)	0.54	0.002	90
6–12 months (see *Appendix 4*, *Figure 16*)	2 (246); 3 pairwise comparisons	SMD 0.11 (–0.16 to 0.38)	0.43	0.45	0
Pain: 50% reduction in VAS pain					
0–3 months (see *Appendix 4*, *Figure 17*)	2 (164); 3 pairwise comparisons	RR 1.38 (0.69 to 2.73)	0.36	0.19	39
6–12 months (see *Appendix 4*, *Figure 18*)	1 (51)	RR 0.49 (0.26 to 0.92)	0.03	N/A	N/A
CPI (0–100 worsening scale)					
0–3 months (see *Appendix 4*, *Figure 19*)	2 (93)	MD –0.24 (–7.55 to 7.08)	0.95	0.70	0
3–6 months (see *Appendix 4*, *Figure 20*)	1 (80)	MD 5.20 (–0.62 to 11.02)	0.08	N/A	N/A

N/A, not applicable.

The results for the other pain outcomes are shown as forest plots (see *Appendix 4*, *Figure 17*) and summarised in *Table 4*. There was no convincing evidence that the oral splints reduced pain (apart from a single study rated as having a high risk of bias that showed a statistically significant difference in incidence of 50% reduction in VAS pain, in favour of the control group, between 6 and 12 months), although the quality of the evidence was assessed as being very low.

Pain was also measured and reported in other ways that were not possible to meta-analyse, with mixed and inconclusive results (see *Appendix 2*, *Table 26*).

Pain (splints versus control splints)

Three trials (159 patients) were included in the comparison between splints and control splints for the 0- to 3-month time period (*Figure 4*). The SMD effect size was –0.67 (95% CI –1.16 to –0.17), which indicated a possible benefit for the oral splint compared with a control splint in reducing pain (very low-quality evidence). This result was not confirmed at the two longer-term time points, although the same single study was included in both (Nilsson *et al.*[43]) (see *Appendix 4*, *Figures 21* and *22*) (*Table 5*).

Pain was also measured and reported in other ways that were either not possible to meta-analyse or were not VAS/NRS/CPI, with mixed and inconclusive results (see *Appendix 2*, *Table 28*).

Other outcomes (splint versus no intervention/minimal intervention/control splint)

Several other outcomes were measured for these comparisons; these are summarised in *Tables 6* and *7*. When comparing splints with no/minimal interventions or with control splints, there was no evidence that they reduced TMD clicking or increased mouth-opening at any of the time points measured. There was no evidence that splints improved quality of life at any time point when compared with no/minimal interventions. There was also no evidence of a difference in compliance between the splints and the control splints at any time point. The quality of the evidence for all these other outcomes was assessed as being very low.

	Splint			Control splint				
Study or subgroup	Mean	SD	Total	Mean	SD	Total	Weight (%)	SMD IV, random (95% CI)
[a]Ekberg 2003[36]	41	28.7	30	56	30.1	30	36.5	−0.50 (−1.02 to 0.01)
[b]Raphael 2001[47]	26.16	20.1384	32	34.19	21.3245	31	37.4	−0.38 (−0.88 to 0.12)
[c]Zhang 2013[60]	12	10.2	18	30.3	16.4	18	26.2	−1.31 (−2.04 to −0.58)
Total (95% CI)			80			79	100.0	−0.67 (−1.16 to −0.17)

Heterogeneity: $\tau^2 = 0.11$; $\chi^2 = 4.52$, df = 2 ($p = 0.10$); $I^2 = 56\%$

Test for overall effect: $Z = 2.65$ ($p = 0.008$)

FIGURE 4 Forest plot of comparison: TMD, splint vs. control splint; outcome – pain: any combinable scale (higher = more pain), 0–3 months. a, Worst pain experienced 0 to 100 mm VAS; b, mean daily pain in the 2 weeks prior to follow-up – 0 to 10 scale (we converted to 0 to 100); c, current pain intensity 0 to 100 mm.

TABLE 5 Summary of effect estimates for TMD pain: splint vs. control splint

Outcome	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate	Heterogeneity	
				χ^2 *p*-value	I^2 (%)
Pain: any combinable scale (higher = more pain)					
0–3 months (see *Figure 4*)	3 (159)	SMD −0.67 (−1.16 to -0.17)	0.008	0.10	56
3–6 months (see *Appendix 4, Figure 21*)	1 (57)	MD −12.00 (−27.76 to 3.76)	0.14	N/A	N/A
6–12 months (see *Appendix 4, Figure 22*)	1 (51)	MD 3.00 (−14.31 to 20.31)	0.73	N/A	N/A

N/A, not applicable.

TABLE 6 Summary effect estimates for TMD outcomes other than pain for splints vs. no/minimal intervention

Outcome	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate	Heterogeneity	
				χ^2 *p*-value	I^2 (%)
TMJ clicking: presence of joint noises (detected during TMJ palpation/opening/closing)					
0–3 months (see *Appendix 4, Figure 23*)	3 (252); 5 pairwise comparisons	RR 0.85 (0.51 to 1.43)	0.55	0.001	77
3–6 months (see *Appendix 4, Figure 24*)	3 (131); 4 pairwise comparisons	RR 0.90 (0.79 to 1.03)	0.13	0.76	0
6–12 months (see *Appendix 4, Figure 25*)	2 (238); 4 pairwise comparisons	RR 0.90 (0.74 to 1.10)	0.30	0.15	43
Change in restricted mouth-opening: maximum mouth-opening (mm)					
0–3 months (see *Appendix 4, Figure 26*)	13 (913); 16 pairwise comparisons	MD 1.17 (−0.68 to 3.03)	0.22	< 0.00001	83
3–6 months (see *Appendix 4, Figure 27*)	3 (236)	MD 0.29 (−0.63 to 1.20)	0.54	0.30	18
Quality of life: OHIP-14 (0–56, worsening scale)					
0–3 months (see *Appendix 4, Figure 28*)	2 (80)	MD −1.43 (−5.11 to 2.24)	0.44	0.62	0
3–6 months (see *Appendix 4, Figure 29*)	2 (76)	MD 0.90 (−3.94 to 5.74)	0.72	0.21	36
6–12 months (see *Appendix 4, Figure 30*)	1 (43)	MD 1.31 (−5.11 to 7.73)	0.69	N/A	N/A

N/A, not applicable; TMJ, temporomandibular joint.

TABLE 7 Summary effect estimates for TMD outcomes other than pain for splints vs. control splints

Outcome	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate	Heterogeneity	
				χ^2 *p*-value	I^2 (%)
TMJ clicking: presence of joint noises (detected during TMJ palpation/opening/closing)					
0–3 months (see *Appendix 4*, *Figure 31*)	4 (218)	RR 0.95 (0.68 to 1.31)	0.74	0.87	0
Change in restricted mouth-opening					
Maximum mouth-opening of < 40 mm (see *Appendix 4*, *Figure 32*)	2 (120)	RR 0.40 (0.05 to 3.41)	0.40	0.12	59
Compliance: splint worn every night or most nights					
0–3 months (see *Appendix 4*, *Figure 33*)	3 (191)	RR 1.03 (0.94 to 1.12)	0.51	0.53	0
3–6 months (see *Appendix 4*, *Figure 34*)	1 (57)	RR 1.06 (0.68 to 1.66)	0.80	N/A	N/A
6–12 months (see *Appendix 4*, *Figure 35*)	1 (51)	RR 1.07 (0.58 to 1.97)	0.83	N/A	N/A

N/A, not applicable; TMJ, temporomandibular joint.

Analysis of the robustness of the results (sensitivity analyses)

For TMD patients, we planned to undertake a sensitivity analysis restricted to trials for which the inclusion criteria were based on, or could be clearly mapped to, one of the following sets of diagnostic criteria: RDC/TMD guidelines,[17] TMD (DC/TMD) guidelines[18] or AAOP guidelines.[19] For the primary analysis of splints versus no/minimal intervention in the 0- to 3-month time period (see *Figure 3*), there was no difference in the result when removing those trials that did not use the above diagnostic criteria: SMD −0.24 (95% CI −0.52 to 0.04; $p = 0.09$, $I^2 = 71\%$; 851 participants) (*Figure 5*).

We also carried out a sensitivity analysis restricting the meta-analysis in *Figure 3* to studies using stabilisation splints. Again, this did not change the result: SMD 0.04 (95% CI −0.13 to 0.22; $p = 0.62$, $I^2 = 27\%$; 750 participants) (*Figure 6*). This removed much of the heterogeneity seen in the other analyses.

We had also planned to test the robustness of the results by performing sensitivity analyses based on excluding studies deemed to be at high and unclear risks of bias from the analyses. This was not possible as all the studies in this comparison were assessed as being at a high risk of bias.

Current pain intensity on visual analogue scale/numerical rating scale

For the purposes of the economic modelling, the main pain results as SMDs needed to be presented as MDs. To do this, we undertook further sensitivity analyses including only studies that measured pain at the time of assessment (current pain), measured on a 0–100 VAS or NRS. Two studies (DeVocht *et al.*[45] and Michelotti *et al.*[64]) that reported the results as change scores, and therefore were not possible to include in the main SMD analysis, were added to this analysis for the 0- to 3-month time period because they reported current pain intensity on a VAS or NRS. The results were consistent with the main SMD results, as the point estimate represented a very small, clinically unimportant, reduction in pain for splints, with imprecision in the CI that included a benefit for both using splints and not using splints: MD −4.48 (95% CI −11.59 to 2.64; $p = 0.22$, $I^2 = 94\%$; 874 participants) (*Figure 7*). However, the extremely high heterogeneity means that the results should be interpreted with caution.

For the 3- to 6-month time period, DeVocht *et al.*[45] was again added to the analysis and the result was again consistent with the SMD analysis: MD −3.43 (95% CI −11.77 to 4.90; $p = 0.42$, $I^2 = 82\%$; 202 participants).

Study or subgroup	Splint Mean	Splint SD	Splint Total	Control Mean	Control SD	Control Total	Weight (%)	SMD IV, random (95% CI)	Risk of bias A B C D E F G
[a]Conti 2015[28]	9.23	22.5	12	37.62	22.5	9	4.9	−1.21 (−2.17 to −0.26)	? ? − − − − ?
[b]de Felício 2010[31]	14.56	8.14	10	13.6	9.49	10	5.4	0.10 (−0.77 to 0.98)	+ ? − − ? + +
[c]Giannakopoulos 2016[62]	16.7	17.8	12	40.8	25	6	4.3	−1.13 (−2.19 to −0.06)	+ + − − + + +
[d]Giannakopoulos 2016[62]	30	27	12	40.8	25	6	4.7	−0.39 (−1.38 to 0.60)	+ + − − + + +
[e]Hasanoglu 2017[52]	23	27.8	20	23.6	23.8	20	7.5	−0.02 (−0.64 to 0.60)	? ? − − + + +
[f]Nagata 2015[67]	11.571	19.8797	96	8.268	15.6888	85	10.5	0.18 (−0.11 to 0.47)	+ ? − − + + +
[g]Niemelä 2012[71]	34	32	39	40	26	37	9.0	−0.20 (−0.65 to 0.25)	+ ? − − + + +
[h]Nitecka-Buchta 2014[70]	10	10.4	35	40	26	30	8.0	−1.54 (−2.10 to −0.98)	+ + − − − + +
[i]Tatli 2017[54]	20	19	40	15	17	40	9.1	0.27 (−0.17 to 0.72)	+ ? − − + + +
[j]Truelove 2006[50]	45.08	20	54	47.6	20	27	8.9	−0.12 (−0.59 to 0.34)	+ + − − − + +
[k]Truelove 2006[50]	47.83	20	56	47.6	20	27	9.0	0.01 (−0.45 to 0.47)	+ + − − − + +
[l]Yu 2016[59]	19.7	9.3	42	20.2	8.9	42	9.3	−0.05 (−0.48 to 0.37)	? ? − − + + +
[m]Yu 2016[59]	20.5	8.7	42	21	11.7	42	9.3	−0.05 (−0.48 to 0.38)	? ? − − + + +
Total (95% CI)			470			381	100.0	−0.24 (−0.52 to 0.04)	
Heterogeneity: $\tau^2 = 0.17$; $\chi^2 = 41.77$, df = 12 ($p < 0.0001$); $I^2 = 71\%$									
Test for overall effect: $Z = 1.70$ ($p = 0.09$)									

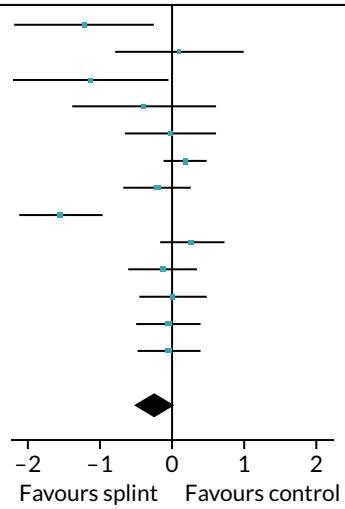

FIGURE 5 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: any combinable scale (higher = more pain); sensitivity analysis of studies using the recommended diagnostic criteria, 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Current pain intensity 0 to 100 mm VAS (custom anterior repositioning); b, muscle pain 0 to 10 for when (1) waking, (2) chewing, (3) speaking, (4) at rest, score summed = 0 to 40 scale; c, current pain intensity 0 to 10 NRS converted to a 0 to 100 scale (custom splint); d, current pain intensity 0 to 10 NRS converted to a 0 to 100 scale (prefabricated splint); e, current pain intensity 0 to 100 mm VAS; f, current orofacial pain 0 to 10 NRS converted to a 0 to 100 scale; g, current facial pain intensity 0 to 10 cm VAS (we converted this to mm); h, current pain intensity – 0 to 10 cm VAS (we converted this to mm); i, current pain intensity 0 to 10 cm VAS (we converted this to mm); j, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in the paper; k, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in the paper (custom-made splint vs. control); l, current pain intensity 0 to 10 VAS – we converted to 0 to 100 (splint + manipulative and physical therapies vs. manipulative and physical therapies); m, current pain intensity 0 to 10 VAS – we converted to 0 to 100 (splint vs. control).

Study or subgroup	Splint Mean	Splint SD	Splint Total	Control Mean	Control SD	Control Total	Weight (%)	SMD IV, random (95% CI)	Risk of bias A B C D E F G
[a]de Felício 2010[31]	14.56	8.14	10	13.6	9.49	10	3.6	0.10 (−0.77 to 0.98)	+ ? − − ? + +
[b]Haketa 2010[66]	36.5	28.7	25	21.3	26.4	19	6.9	0.54 (−0.07 to 1.15)	+ + − − + + +
[c]Leeson 2007[63]	41.1	26.2	62	38	28.1	63	15.6	0.11 (−0.24 to 0.46)	+ + − − + + +
[d]List 1992[38]	18	17	34	28	18	22	8.2	−0.57 (−1.11 to −0.02)	? ? − − + − −
[e]Nagata 2015[67]	11.571	19.8797	96	8.268	15.6888	85	19.4	0.18 (−0.11 to 0.47)	+ ? − − + + +
[f]Niemelä 2012[71]	34	32	39	40	26	37	11.0	−0.20 (−0.65 to 0.25)	+ ? − − + + +
[g]Tatli 2017[54]	20	19	40	15	17	40	11.4	0.27 (−0.17 to 0.72)	+ ? − − + + +
[h]Yu 2016[59]	19.7	9.3	42	20.2	8.9	42	11.9	−0.05 (−0.48 to 0.37)	? ? − − + + +
[i]Yu 2016[59]	20.5	8.7	42	21	11.7	42	11.9	−0.05 (−0.48 to 0.38)	? ? − − + + +
Total (95% CI)			390			360	100.0	0.04 (−0.13 to 0.22)	
Heterogeneity: $\tau^2 = 0.02$; $\chi^2 = 10.92$, df = 8 ($p = 0.21$); $I^2 = 27\%$									
Test for overall effect: $Z = 0.50$ ($p = 0.62$)									

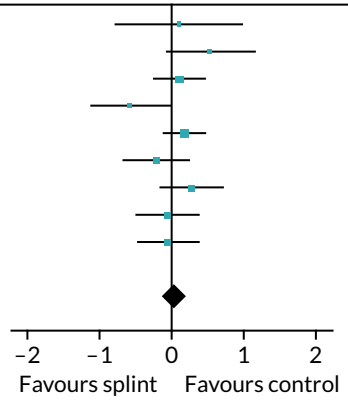

FIGURE 6 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: any combinable scale (higher = more pain); sensitivity analysis of studies using only stabilisation splints, 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Muscle pain 0 to 10 for when (1) waking, (2) chewing, (3) speaking, (4) at rest, score summed = 0 to 40 scale; b, current maximum daily pain intensity 0 to 100 mm VAS; c, current pain intensity 0 to 10 cm VAS converted to 0 to 100 mm; d, 0 to 100 mm VAS, recorded three times daily with average calculated on weekly basis (appears to be in cm – we converted this to mm); e, current orofacial pain 0 to 10 NRS converted to a 0 to 100 scale; f, current facial pain intensity 0 to 10 cm VAS (we converted this to mm); g, current pain intensity 0 to 10 cm VAS (we converted to mm); h, current pain intensity 0 to 10 VAS – we converted to 0 to 100 (splint + manipulative and physical therapies vs. manipulative and physical therapies); i, current pain intensity 0 to 10 VAS – we converted to 0 to 100 (splint vs. control).

Study or subgroup	Splint Mean	Splint SD	Splint Total	Control Mean	Control SD	Control Total	Weight (%)	SMD IV, random (95% CI)
Conti 2015[29]	9.23	22.5	12	37.62	22.5	9	5.7	−28.39 (−47.84 to −8.94)
[a]DeVocht 2013[45]	−14	23.5	20	−7	17.6	21	7.5	−7.00 (−19.76 to 5.76)
Giannakopoulos 2016[62]	16.7	17.8	12	40.8	25	6	5.0	−24.10 (−46.50 to −1.70)
Giannakopoulos 2016[62]	30	27	12	40.8	25	6	4.4	−10.80 (−35.97 to 14.37)
Hasanoglu 2017[52]	23	27.8	20	23.6	23.8	20	6.6	−0.60 (−16.64 to 15.44)
Leeson 2007[63]	41.1	26.2	62	38	28.1	63	8.4	3.10 (−6.42 to 12.62)
[a]Michelotti 2012[64]	2.798	2.012	18	−11.289	2.79	23	9.8	14.09 (12.62 to 15.56)
Nagata 2015[67]	11.571	19.8797	96	8.268	15.6888	85	9.3	3.30 (−1.89 to 8.49)
Niemelä 2012[71]	34	32	39	40	26	37	7.4	−6.00 (−19.08 to 7.08)
Nitecka-Buchta 2014[70]	10	10.4	35	40	26	30	8.3	−30.00 (−39.92 to −20.08)
Tatli 2017[54]	20	19	40	15	17	40	8.8	5.00 (−2.90 to 12.90)
Yu 2016[59]	19.7	9.3	42	20.2	8.9	42	9.6	−0.50 (−4.39 to 3.39)
Yu 2016[59]	20.5	8.7	42	21	11.7	42	9.5	−0.50 (−4.91 to 3.91)
Total (95% CI)			450			424	100.0	−4.48 (−11.59 to 2.64)

Heterogeneity: $\tau^2 = 133.99$; $\chi^2 = 190.50$, df = 12 ($p < 0.00001$); $I^2 = 94\%$

Test for overall effect: $Z = 1.23$ ($p = 0.22$)

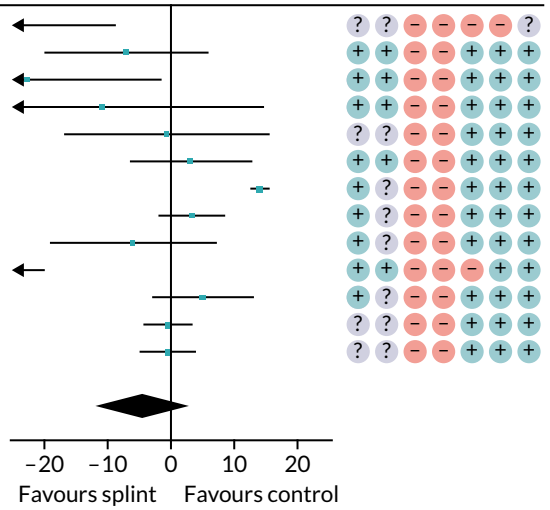

FIGURE 7 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: sensitivity analysis of studies reporting current pain intensity on a 0–100 VAS/NRS (higher = more pain), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Change score reported.

For the 6- to 12-month time period, when considering only studies that measured pain at the time of assessment (current pain) measured on a 0–100 VAS or NRS, this reduced the analysis to a single study. There was, again, insufficient evidence of a difference: MD 8.70 (95% CI −4.30 to 21.70; $p = 0.19$; 78 participants).

Patients with bruxism

An overview of the findings for bruxism is given in *Table 8*.

Two trials that focused on patients with bruxism provided usable outcome data for the 0- to 3-month time period; however, neither study looked at the primary outcome of tooth wear. The results for the other outcomes are presented in *Table 9* (compared with minimal intervention) and *Table 10* (compared with control splints). There is some very low-quality evidence that splints, when compared with minimal intervention, reduced pain intensity (see *Table 9*); however, there was insufficient evidence to determine whether or not the splints led to shorter bruxism times, or fewer episodes than control splints (see *Table 10*).

TABLE 8 Summary of findings table for oral splints provided for patients with bruxism vs. no/minimal intervention/control splints

	Illustrative comparative risks (95% CI)				
	Assumed risk	Corresponding risk			
Outcome	No splint (control splint where indicated)	Oral splint	Number of participants (*n* studies)	Quality of the evidence (GRADE)	Comments
Tooth wear	No studies reported our primary bruxism outcome of tooth wear				
Pain intensity measured on (0–10) NRS (0–3 months)	The mean pain intensity in the two control groups was 6.7	The mean reduction in the splint groups was 2.01 (1.40 to 2.62)	78 (1 study; 2 pairwise comparisons)	⊕⊖⊖⊖[a] very low	Reduction in pain intensity for the splint group
Bruxism time index (% of time spent bruxing)	The mean time in the control splint group was 1.9%	The mean in the splint group was 0.18 higher (1.76 lower to 2.12 higher)	21 (1 study)	⊕⊖⊖⊖[a] very low	Insufficient evidence to determine if there is a difference in bruxism time or not
Episodes of bruxism per hour (0–3 months)	The mean number of episodes in the control splint group was 10.6	The mean in the splint group was 0.54 higher (10.95 lower to 12.03 higher)	21 (1 studies)	⊕⊖⊖⊖[a] very low	Insufficient evidence to determine if there is a difference in episodes of bruxism or not
Quality of life	No studies reported quality of life				
Adverse events	No studies reported adverse events				

a Downgraded by three levels as a single, small study at a high risk of bias with lack of precision.

TABLE 9 Bruxism: splint vs. no/minimal treatment (other outcomes)

Outcome: pain	Number of studies (*n* participants)	Effect estimate[a] (95% CI) (random effects)	*p*-value for effect estimate
Current pain intensity [0 (no pain) to 10 (worst pain) NRS] (0–3 months)	1 (78)	MD −2.01 (−2.62 to −1.40) favours splint	$p < 0.00001$

a Pooling the effects with and without massage.

TABLE 10 Bruxism: splint vs. control splint (other outcomes)

Outcome: bruxism severity	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate
Bruxism time index (% of total sleep time spent bruxing) (0–3 months)	1 (21)	MD 0.18 (–1.76 to 2.12)	0.86 favours neither
Episodes per hour (0–3 months)	1 (21)	MD 0.54 (–10.95 to 12.03)	0.93 favours neither

Comparison 2: prefabricated splints versus custom-made splints

Once again, we undertook separate analyses for patients with TMD and patients with bruxism.

Patients with temporomandibular disorder

Pain

Table 11 indicates that three trials (178 patients) were included in the meta-analysis comparing custom-made with prefabricated splints for pain on a combinable scale (0–100) for the 0- to 3-month time period. There was no evidence of any heterogeneity and the pooled SMD was –0.14 (95% CI –0.44 to 0.15) (*Figure 8*). The evidence was assessed as being of very low quality (*Table 12*) and there was insufficient evidence to determine whether or not there were any differences between custom-made and prefabricated splints with respect to pain measured on a combinable scale.

Very low-quality data for pain on a combinable scale at the other time points also failed to determine whether or not there were any differences between custom-made and prefabricated splints (see *Appendix 4*, *Figures 36* and *37*).

A summary of all the pain outcome data comparing custom and prefabricated splints is shown in *Table 13*, with the forest plots shown in *Figure 8* and in *Appendix 4*, *Figures 36–40*.

Pain was also measured and reported in other ways that were not possible to meta-analyse, with mixed and inconclusive results (see *Appendix 2*, *Table 27*).

Other outcomes

Several other outcomes were measured for this comparison; these are summarised in *Table 13*. When comparing custom-made splints with prefabricated splints, there was no evidence that either improved maximum mouth-opening, quality of life or adherence to treatment at any of the time points measured. Some outcomes were measured for which data were reported that were not possible to meta-analyse in the forest plots; these are reported in *Appendix 2*, *Table 27*. There was no evidence of a benefit for either type of splint for any of these additional analyses, and the quality of the evidence was assessed as being very low.

Patients with bruxism

One study including patients with bruxism compared prefabricated splints with custom-made splints, but provided no data for this review (*Table 14*).

Harms

Harms/adverse events are reported for all comparisons in *Appendix 2*, *Table 29*. These were generally poorly reported and minor in nature.

TABLE 11 Oral splints provided for TMD: custom-made vs. prefabricated splints

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	Number of participants (*n* studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Custom-made splints	Prefabricated splints				
• Pain SD units: • Pain measured on combinable scale • 0–3 months	The pain score in the custom-made oral splint group was, on average, 0.14 SDs lower (0.15 higher to 0.44 lower) than that of the prefabricated splint group			178 (3 studies)	⊕⊖⊖⊖ very low[a]	• Insufficient evidence to determine if either splint type leads to less pain, at this and other time points, and also for pain measured on the GCPS, and pain on palpation • As rule of thumb, 0.2 SD represents a small difference, 0.5 a moderate difference and 0.8 a large difference
Clicking of joint at 0–3 months (yes/no)	500[b] per 1000	500 per 1000 (350 to 720)	RR 1.00 (0.70 to 1.44)	110 (1 study)	⊕⊖⊖⊖ very low[c]	Insufficient evidence to determine if either splint type leads to a reduction in joint clicking, at 0–3 months and at 6–12 months
Maximum mouth-opening at 0–3 months (mm)	The mean maximum mouth-opening in the custom-made splint group was 41 mm	The mean maximum mouth-opening in the prefabricated splint group was 4.47 mm higher than for the custom-made splint group (6.13 lower to 15.07 higher)		68 (2 studies)	⊕⊖⊖⊖ very low[d]	Insufficient evidence to determine if either splint type leads to an increase in maximum mouth-opening at any time point

continued

TABLE 11 Oral splints provided for TMD: custom-made vs. prefabricated splints (*continued*)

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	Number of participants (*n* studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Custom-made splints	Prefabricated splints				
Quality of life: SCL-90-R – depression 0–4 (higher = worse) at 0–3 months	The mean quality-of-life score in the custom-made splint group was 0.743	The mean quality-of-life score in the prefabricated splint group was 0.03 higher (0.46 lower to 0.53 higher)		44 (1 study)	⊕⊖⊖⊖ very low[c]	Insufficient evidence to determine if either splint type leads to an increase in quality of life at any time point
Quality of life: SCL-90-R – non-specific physical symptoms 0–4 (higher = worse) at 0–3 months	The mean quality-of-life score in the custom-made splint group was 0.685	The mean quality-of-life score in the prefabricated splint group was 0.02 higher (0.46 lower to 0.5 higher)		44 (1 study)	⊕⊖⊖⊖ very low[c]	Insufficient evidence to determine if either splint type leads to an increase in quality of life at any time point
Adverse events	Two studies reported that there had been no adverse events. A further study reported on an increased overbite in one patient in the prefabricated splint group, which was treated and not present at 12 months					

GCPS, Graded Chronic Pain Scale.
a Downgraded as all three studies were rated as having a high risk of bias and a lack of precision in the pooled estimate.
b Event rate for custom-made splint group.
c Downgraded as a single study was rated as having a high risk of bias, with lack of precision.
d Downgraded as two small studies were rated as having high risks of bias, substantial heterogeneity, with lack of precision.
Notes
Oral splints for patients with orofacial signs or symptoms to reduce orofacial pain.
Patient or population: patients provided with oral splints for TMD.
Setting: primary or secondary care.
Intervention: prefabricated oral splint.
Comparison: custom-made oral splint.

Study or subgroup	Custom splint Mean	SD	Total	Prefabricated splint Mean	SD	Total	Weight (%)	SMD IV, random (95% CI)
[a]Christidis 2014[72]	18.512	22.674	21	17.067	17.259	23	24.9	0.07 (−0.52 to 0.66)
[b]Giannakopoulus 2016[62]	16.7	17.8	12	30	27	12	13.0	−0.56 (−1.38 to 0.26)
[c]Truelove 2006[50]	45.08	20	54	47.83	20	56	62.2	−0.14 (−0.51 to 0.24)
Total (95% CI)			87			91	100.0	−0.14 (−0.44 to 0.15)

Heterogeneity: $\tau^2 = 0.00$; $\chi^2 = 1.51$, df = 2 ($p = 0.47$); $I^2 = 0\%$

Test for overall effect: $Z = 0.93$ ($p = 0.35$)

FIGURE 8 Custom splint vs. prefabricated splint: pain – any combinable scale (higher = more pain), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Assessed daily in a 1-week pain diary for the week prior to each assessment point using 0 to 100 (pain at rest); b, current pain intensity 0 to 10 NRS converted to a 0 to 100 scale; c, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in the paper.

TABLE 12 Effect estimates for TMD pain: prefabricated splint vs. custom-made splint

Outcome	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate	Heterogeneity	
				χ^2 *p*-value	I^2 (%)
Pain: any combinable scale (higher = more pain)					
0–3 months (see *Figure 8*)	3 (178)	SMD −0.14 (−0.44 to 0.15)	0.35; favours custom splint	0.47	0
3–6 months (see *Appendix 4, Figure 36*)	1 (37)	SMD 0.71 (−9.12 to 10.55)	0.89; favours prefabricated	N/A	N/A
6–12 months (see *Appendix 4, Figure 37*)	2 (153)	SMD −0.18 (−0.50 to 0.14)	0.26; favours custom splint	0.43	0
Pain: GCPS (incidence of grade III or IV)					
0–3 months (see *Appendix 4, Figure 38*)	1 (44)	RR 1.64 (0.30 to 8.89)	0.56; favours prefabricated	N/A	N/A
3–6 months (see *Appendix 4, Figure 39*)	2 (85)	RR 1.48 (0.29 to 7.41)	0.64; favours prefabricated	0.63	0
6–12 months (see *Appendix 4, Figure 40*)	2 (82)	RR 1.00 (0.03 to 33.30)	1.00	0.09	65

GCPS, Graded Chronic Pain Scale; N/A, not applicable.

TABLE 13 Effect estimates for TMD outcomes other than pain for custom-made splints vs. prefabricated splints

Outcome	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate	Heterogeneity	
				χ^2 *p*-value	I^2 (%)
Change in restricted mouth-opening: maximum mouth-opening (mm)					
0–3 months (see *Appendix 4, Figure 41*)	2 (68)	MD (mm) −4.47 (−15.07 to 6.13)	0.41	0.07	70
3–6 months (see *Appendix 4, Figure 42*)	1 (37)	MD (mm) −1.00 (−6.74 to 4.74)	0.73	N/A	N/A
6–12 months (see *Appendix 4, Figure 43*)	1 (33)	MD (mm) −1.00 (−7.82 to 5.82)	0.77	N/A	N/A
Quality of life: SCL-90-R – depression, 0–4 (higher = worse)					
0–3 months (see *Appendix 4, Figure 44*)	1 (44)	MD −0.03 (−0.53 to 0.46)	0.89	N/A	N/A
3–6 months (see *Appendix 4, Figure 45*)	2 (89)	MD 0.04 (−0.31 to 0.39)	0.83	0.22	35
6–12 months (see *Appendix 4, Figure 46*)	2 (82)	MD 0.11 (−0.54 to 0.75)	0.75	0.95	0
Quality of life: SCL-90-R – non-specific physical symptoms, 0–4 (higher = worse)					
0–3 months (see *Appendix 4, Figure 47*)	1 (44)	MD −0.02 (−0.50 to 0.46)	0.93	N/A	N/A
3–6 months (see *Appendix 4, Figure 48*)	2 (89)	MD −0.07 (−0.47 to 0.33)	0.73	0.17	48
6–12 months (see *Appendix 4, Figure 49*)	2 (82)	MD 0.17 (−0.14 to 0.49)	0.29	0.34	0

TABLE 13 Effect estimates for TMD outcomes other than pain for custom-made splints vs. prefabricated splints (*continued*)

Outcome	Number of studies (*n* participants)	Effect estimate (95% CI) (random effects)	*p*-value for effect estimate	Heterogeneity	
				χ^2 *p*-value	I^2 (%)
Adherence to treatment: use of appliance for several nights per week or more					
0–3 months (see *Appendix 4*, *Figure 50*)	2 (109)	RR 0.99 (0.91 to 1.08)	0.84	0.38	0
3–6 months (see *Appendix 4*, *Figure 51*)	1 (37)	RR 1.02 (0.71 to 1.47)	0.92	N/A	N/A
6–12 months (see *Appendix 4*, *Figure 52*)	1 (33)	RR 1.09 (0.65 to 1.82)	0.74	N/A	N/A

N/A, not applicable.

TABLE 14 Prefabricated splints provided to patients with bruxism vs. custom-made splints

Outcomes	Illustrative comparative risks (95% CI)		Number of participants (*n* studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk			
	No splint	Oral splint			
Tooth wear	No studies looked at tooth wear				
Pain	No studies looked at pain				
Bruxism time index (% of time spent bruxing)	No studies looked at bruxism time				
Episodes of bruxism per hour	No studies looked at episodes of bruxism				
Quality of life	No studies reported quality of life				
Adverse events	No studies reported adverse events				

Patient and public involvement

Three people (Mrs Coldrick, Mrs Lear and Mrs Palmer) who wear oral splints for TMD and/or bruxism agreed to be involved in our research to provide a patient perspective. At the stage of writing the protocol for the effectiveness review, we wanted to find out what questions and outcomes were important to them. Two patients identified pain relief as the most important outcome and found relief within 7–10 days of wearing the first splint. However, there was a discrepancy with regard to the ease of using the splint. These comments helped to assure us that the outcomes to be measured in the review and how they were measured were appropriate and that we had not missed specifying any important outcomes in the protocol.

Members of the patient advisory group provided feedback on the *Plain English summary* that had been written by Ruth Floate, and agreed the final version.

Chapter 4 Assessment of cost-effectiveness

Overview of the principles of economic evaluations

Highly constrained public funding for health means that health-care resources are scarce. Economic evaluation is a useful tool that compares the relative costs and benefits of different health-care interventions. It is widely used by health-care decision-makers to assess whether or not new interventions generate value for money.

The most common framework of economic evaluation is cost–utility analysis (CUA). In a CUA, health-care benefits are measured in terms of quality-adjusted life-years (QALYs). QALYs combine an individual's length of life with the quality (utility) of those life-years. The additional costs of an intervention are compared with the additional QALYs gained to generate an incremental cost-effectiveness ratio (ICER). In the UK, an intervention is typically considered cost-effective if the ICER is < £20,000 to £30,000 per QALY gained. Interventions that are more costly and less effective than the comparator are dominated, whereas interventions that are cost-saving and also more effective are dominant. Decision modelling is often used to extrapolate trial results over the longer term to ensure that the economic evaluation captures all the costs and consequences of importance.

Systematic review of economic evaluations

This section reports the findings of cost-effectiveness studies comparing (1) splints versus no splints or (2) prefabricated splints versus custom-made splints for patients with orofacial signs or symptoms, presenting with either TMD or bruxism (tooth grinding).

Review methods

This section provides detailed methods used for the search strategy, inclusion criteria and exclusion criteria.

Search strategy

Literature searches were conducted in four databases: MEDLINE via OvidSP (including Epub Ahead Of Print, pre-indexed, etc.), EMBASE via OvidSP, NHS Economic Evaluation Database (NHS EED) and CINAHL via EBSCO*host*. The initial search was conducted in October 2017. The detailed search strategy is provided in *Appendix 1*. *Table 15* includes a summary of the studies retrieved from each database. The searches

TABLE 15 Economic evaluation search strategy results

Database	Version/issue	Date of search	Records retrieved (*n*)
MEDLINE via OvidSP (including Epub Ahead Of Print, pre-indexed, etc.)	1946 to 1 October 2018	1 October 2018	19 (with filter)
EMBASE via OvidSP	1980 to 1 October 2018	1 October 2018	13 (with filter)
NHS EED	To issue 1, 2016 (database discontinued after this date)	1 October 2018	0
CINAHL via EBSCO*host*	1937 to 1 October 2018	1 October 2018	14

Notes
Total references retrieved from electronic searches for this review: $n = 46$.
Total references left after deduplication for this review: $n = 38$.
Total sent to authors for this search: $n = 38$.

were updated on 1 October 2018, to ensure that more recent studies were considered for inclusion prior to publication. The update search did not identify any additional cost-effectiveness records.

Inclusion and exclusion criteria

Study inclusion and exclusion criteria regarding types of participants and types of interventions were identical to those specified for the clinical effectiveness review (see *Chapter 3*, *Review methods*). Studies were included only if they could be classified as full economic evaluations with a comparative analysis of costs and outcomes using any of the following frameworks: cost-effectiveness, cost–utility, cost–benefit or cost minimisation. Economic evaluations of any design, including evaluations alongside single effectiveness studies and decision-analysis models, were all deemed eligible for inclusion. Partial economic evaluations (i.e. studies that did not explicitly compare costs and outcomes of two or more treatments), review articles, cost-of-illness studies and methodological studies were all excluded.

Data extraction strategy

All titles and abstracts identified from the literature search were assessed against the inclusion and exclusion criteria by one health economist (EJ). All full texts were also assessed against the inclusion and exclusion criteria, with a second health economist (DB) checking the inclusion of each study. Disagreements were addressed through mutual consensus. The plan for data extraction was for one health economist (EJ) to conduct the data extraction and quality assess the studies against standardised checklists for economic evaluations alongside trials (using the Drummond checklist[82]) and for economic models (using the Philips checklist[83]).

Review results

The number of studies identified from the database searches is provided in *Figure 9*.

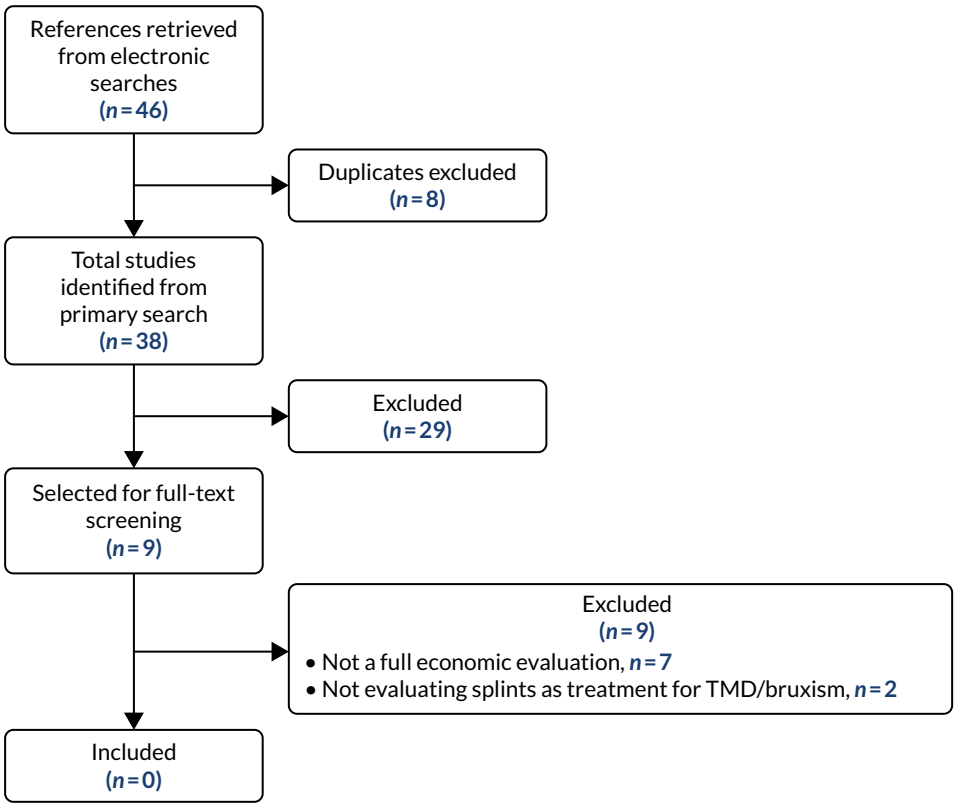

FIGURE 9 Flow diagram for the identification of studies (cost-effectiveness).

A total of 38 studies were identified from the literature searches. After screening titles and abstracts, 29 studies (76%) were excluded as they did not include an economic evaluation. Full-text versions were obtained for 9 studies (24%),[11,84–91] but none were included in the review because (1) they did not conduct a formal economic evaluation ($n = 7$ studies) or (2) they did not evaluate splints for the treatment of orofacial signs or symptoms ($n = 2$).

Economic analysis methods

Introduction

As there was no evidence available from the systematic review to inform the cost-effectiveness of splints, or different types of splints for patients with orofacial signs and symptoms with TMD or bruxism, it was decided to develop a de novo decision-analysis model to answer the research question.

The overall project aim was to assess the cost-effectiveness of splints for orofacial signs and symptoms. From the outset, TMD and bruxism were considered as distinct entities that required different economic models to evaluate. However, as highlighted in *Chapter 3*, there is insufficient evidence regarding the effects of splints to populate a meaningfully structured model for bruxism, and the limited data that do exist cannot readily be translated into meaningful, patient-relevant health states. However, in consultation with clinical expert opinion, we propose an outline structure of a Markov cohort state-transition decision-analysis model that might be used in the future if more data become available. The suggested structure, provided in *Appendix 5*, might be used to guide the data collection in future research studies that could be used to help inform the cost-effectiveness of splints for treating bruxism.

Given the lack of data, this chapter focuses solely on the model developed to determine the cost-effectiveness of splints for treating TMD. The economic analysis first seeks to determine the cost-effectiveness of all splints compared with none (as defined in *Chapter 3*) for treating TMD and to determine if sufficient data exist to determine the most cost-effective form of splints by comparing custom-made with prefabricated splints. It is important to note from the outset that the clinical effectiveness evidence base is limited and these uncertainties inevitably translate into the economic model. The cost-effectiveness results should, therefore, be considered as exploratory in nature. The model is, however, informative in determining the key parameters that drive the cost-effectiveness results, and importantly, value-of-information (VOI) analysis is conducted to steer the future research agenda to minimise decision uncertainty.

Model structure

A Markov cohort state-transition model was developed in TreeAge Pro (TreeAge Software Inc., Williamstown, MA, USA) to evaluate the cost-effectiveness of splints in patients with TMD. The comparator was no splints. The model population was the adult population with TMD, with a starting age of 25 years, which is a common age for symptoms of TMD to start, as the 18–35 years age group are significantly more likely to experience first-onset persistent orofacial pain.[92,93] The proportion of the cohort that are male is taken from the Developing Effective and Efficient care pathways in chronic Pain (DEEP) study (19.1% male).[94] *Figure 10* outlines the model structure.

The model simulated a cohort through the health states depicted in *Figure 10*. The health states include pain tertiles, 'low pain', 'moderate pain' and 'high pain', and 'death'. The health states defined using a NRS of pain intensity (from 0 to 10) in which low-intensity pain was definied as a NRS score of 0–3, moderate pain was defined as a NRS score of 4–6 and high-intensity pain was defined as a NRS score of 7–10.

The preferred instrument to measure the impact of TMD is the Graded Chronic Pain Scale (GCPS), of which the CPI scale is a subcomponent. GCPS is preferable because it incorporates both the pain intensity and disability associated with TMD.[95] However, there was insufficient evidence comparing the use of splints with no splints in relation to the GCPS; therefore, it was not possible to parameterise the model using the preferred measure of treatment effect. In the absence of sufficient clinical effectiveness

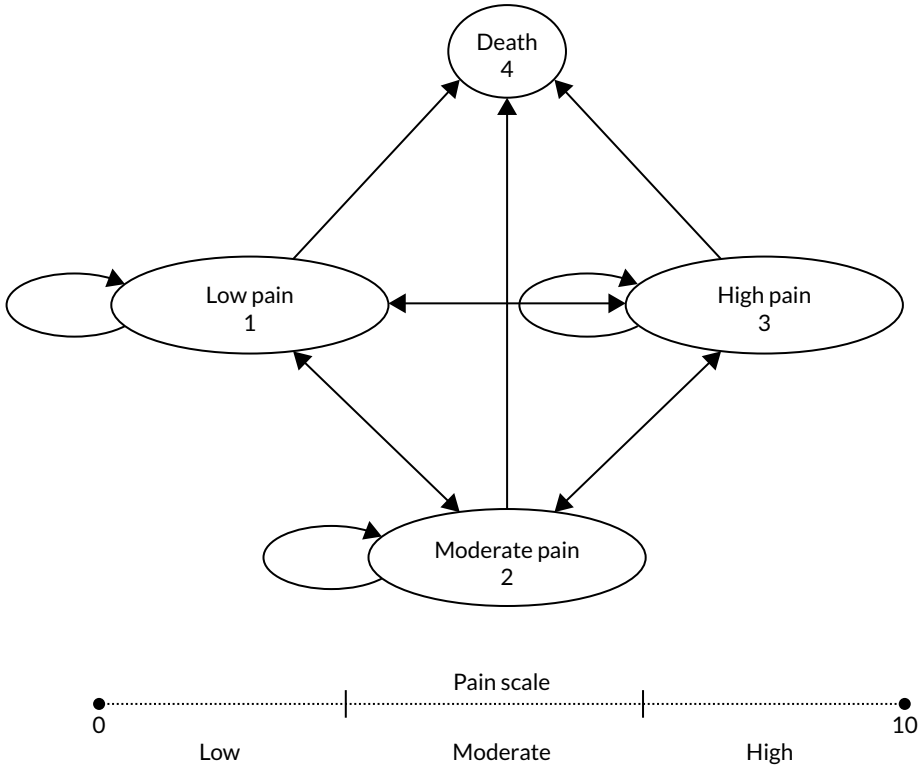

FIGURE 10 State-transition diagram and pain NRS.

data to structure a model around GCPS, it was felt that pain tertiles provided the most feasible and practical balance between a meaningful structure to capture the potential impact of treatment on outcomes (pain) that could be populated using clinical effectiveness data, as well as cost and utility data from the DEEP cohort study. The state classification was chosen for practicality, but future research should aim to collect sufficient data to populate a TMD model structured around GCPS.

The economic model has therefore been designed to allow population of the health states (transition probabilities, effect sizes, costs and utilities) using two alternative definitions of pain (CPI and current pain intensity). CPI is a combination of three factors measuring current pain, average pain (in the previous 6 months) and worst pain intensity (in the previous 6 months) using a NRS, with the final score based on an average of the three domains. Current pain intensity asks patients to report their present pain state, on, for example, a NRS or VAS.

The proportion of the cohort entering the model in each of the pain states is determined by the corresponding proportions from the DEEP study cohort. Using a pain definition of 'current pain', 34%, 34% and 32% enter the cohort in low, moderate and high states, respectively. For pain defined as CPI, the corresponding proportions are 41%, 27% and 31%, respectively.

At the end of each 3-monthly model cycle, a proportion of the cohort move between pain states. A proportion of the cohort are also assumed to die in the model following age- and sex-adjusted general population all-cause mortality rates.[96] The cycle length defines the fixed period of time, at which point the cohort is introduced to a new set of transition probabilities, costs and utilities. The model estimates the accumulated costs and QALYs using a UK NHS perspective, over an 85-year time horizon in the base case, running for 340 (3-monthly) cycles in the base case up until a maximum of age 110 years to reflect all the costs and outcomes associated with pain states over a lifetime horizon. Half-cycle corrections were applied to the costs and outcomes, to reflect that, on average, events occur in the middle of a cycle rather than at the start or end of a cycle. Costs and QALYs occurring into the future are discounted at a rate of 3.5% per annum, as recommended by the National Institute for Health and Care Excellence (NICE) in England and Wales.[97]

Model parameters

The model was populated using best-available data on transition probabilities, costs, utilities and clinical treatment effects. Clinical treatment effects were estimated as MDs using random-effects meta-analysis of studies included in the clinical effectiveness review (see *Chapter 3*) to obtain MDs between splints and no splints at 3, 6 and 12 months. Longer-term effect size estimates were unavailable, or insufficient for populating the model. The transition probabilities, costs and utilities were sourced from a reanalysis of the DEEP study data. The DEEP study was an observational study in the UK, including 35 dental and medical practices, with a total of 198 patients.[94,98,99] The cohort was followed up over a 2-year period. The reanalysis, performed and provided by the DEEP study chief investigator (Professor Durham) was tailored to provide model parameter estimates (transition probabilities, costs and utilities) applicable for a population of the desired model health states. DEEP study data are the most appropriate source of model parameter estimates, being the largest available cohort, with the longest follow-up and from a UK perspective.

Transition probabilities

Table 16 illustrates the transition probabilities used to populate the model, obtained from the DEEP study for tertiles (low, moderate and high) of both current pain and CPI. Transition probabilities are incorporated probabilistically in the model using beta distributions, with alpha and beta distribution parameters obtained using the method of moments approach.[100] Alpha is the number of individuals that transition between states in the DEEP study in a given 6-monthly time frame (0–6 months, 6–12 months, 12–18 months and 18–24 months) and beta is given as the total sample minus alpha. For example, the total number of individuals starting in the lowest tertile for the 0- to 6-month time period was 26 (and 26 individuals started with moderate pain and 24 with high pain). Six-monthly probabilities were converted to 3-monthly cycle-specific probabilities using *Equation 1*:[101]

$$1 - exp\left[-\left(-\frac{LN(1 - \text{6-monthly transition probability})}{\frac{\text{Time to be converted from}}{\text{Time to be converted to}}}\right)\right], \quad (1)$$

where the time to be converted from is 6 months (0.5 years) and the time to be converted to is 3 months (0.25 years). The approach was implemented in TreeAge, using the inbuilt 'probtoprob' function.

Transition probabilities for TMD patients beyond 24 months are unknown; therefore, assumptions must be made about how the cohort will progress through pain states in the longer term. Two options were considered and discussed with clinical experts. The first assumes that, for the duration of the model, the distribution of the cohort across pain states does not change further over time, with the cohort remaining in the modelled health state at 2 years for the duration of the model until death (all-cause mortality rates). The second assumption is that the transitions observed between 18 and 24 months from the DEEP study continue until the whole cohort transits to a single pain health state or dies. Both assumptions are surrounded by considerable uncertainty, and both are considered equally plausible. To incorporate this structural uncertainty in the model-based cost-effectiveness outputs, a switch is incorporated in the model, which is sampled probabilistically from a uniform distribution, where switch = 1 means the cohort remain in their current state and switch = 2 means the cohort transition according to the DEEP study data. The switch is sampled at the start of each model stage following cycle 8 (2 years). The approach taken means that, in each model stage, either approach to estimating long-term state transitions is equally probable.

Treatment effects

Existing evidence identified from the clinical effectiveness review was used to inform the relative treatment effects of splints compared with no splints. Relative treatment effects are incorporated in the model as MDs on the VAS/NRS scale. MDs are estimated at 3 and 6 months for current pain and at 3, 6 and 12 months for CPI, using random-effects meta-analysis of studies included in the systematic

TABLE 16 Transition probabilities used in the model

Transition probabilities	Current pain intensity			CPI		
	Probability at 3 months (%)	Alpha	Beta	Probability at 3 months (%)	Alpha	Beta
0–6 months						
Low to high	4	2	24	7	4	25
Low to moderate	24	11	15	7	4	25
Moderate to high	10	5	21	15	5	17
Moderate to low	6	3	23	15	6	16
High to moderate	13	6	18	15	7	18
High to low	2	1	23	4	2	23
6–12 months						
Low to high	0	0	17	0	0	29
Low to moderate	31	9	8	19	10	19
Moderate to high	8	5	29	14	5	14
Moderate to low	16	10	24	8	3	16
High to moderate	14	5	14	15	6	16
High to low	3	1	18	2	1	21
12–18 months						
Low to high	3	1	15	0	0	20
Low to moderate	17	5	11	13	5	15
Moderate to high	13	7	22	19	8	15
Moderate to low	11	6	23	9	4	19
High to moderate	18	6	12	13	5	15
High to low	0	0	18	0	0	20
18–24 months						
Low to high	3	1	14	0	0	17
Low to moderate	7	2	13	3	1	16
Moderate to high	17	8	18	7	3	18
Moderate to low	17	8	18	18	7	14
High to moderate	14	5	14	23	9	13
High to low	11	4	15	2	1	21

Note
Low, moderate and high refers to the health states 'low pain', 'moderate pain' and 'high pain', respectively.

review of clinical effectiveness. Further details regarding the studies included in these meta-analyses are provided in the sensitivity analysis section of the clinical effectiveness review (see *Chapter 3*). MDs are sampled probabilistically in the economic model from a normal distribution with standard error (SD of the sampling distribution) calculated as [(CI high – CI low) ÷ 2 × 1.96]. MD data used to populate each of the model effect sizes are summarised in *Table 17*.

TABLE 17 Mean differences in current pain and CPI used to populate the economic model

Time point (months)	Current pain, MD (95% CI)	CPI, MD (95% CI)
3	−0.448 (−1.159 to 0.264)	−0.074 (−1.176 to 0.672)
6	−0.343 (−1.177 to 0.490)	0.520 (−0.062 to 1.102)
12	N/A	0.006 (−0.664 to 0.676)

NA, not available.

The long-term effect size of splints versus no splints beyond 6 months is highly uncertain. A number of assumptions are thus required to populate the model over the longer term. The first assumption is that the MD in current pain at 12 months equals the MD at 6 months, namely there is no difference between the MD score at 6 months and 12 months. This assumption reflects the lack of adequate-quality data from the systematic review to populate the model. No data exist to inform the long-term impact of splints on any pain measure beyond 12 months; therefore, further assumptions are required. Two possible scenarios are considered: (1) the MD beyond 12 months is zero and (2) the MD in the longer term is the same as the MD at 6 months. These assumptions represent lower (pessimistic) and upper (optimistic) bounds on the long-term effect of splints on pain. To incorporate this structural uncertainty, the model includes a switch, sampled probabilistically at each model stage, from a uniform distribution, to allow an equal chance of either assumption being applied in the model.

Mean difference data cannot be incorporated directly in the model structure when health states are defined as pain tertiles. An algorithm was therefore developed to infer an approximated relative risk of each possible transition (low to moderate, low to high, moderate to low, moderate to high, high to low and high to moderate) based on the sampled MD data. First, transition probability data (by tertile) from the DEEP study were summarised for each possible state transition. Second, all possible MDs (ranging from −10 to 10) were converted to plausible transitions. For example, a MD of 0 had a 0% probability of changing state, whereas a MD of −10 had a 100% chance of moving to the low-pain state, regardless of the starting point. This process was repeated for the impact of each MD (ranging from −10 to 10) on all possible transitions between tertiles, accounting for the ceiling and floor effects of the scale. All possible transitions, by MD, are reported in *Table 18*.

To obtain an assumption of the relative risk, these inferred transitions were divided through by the transition probabilities from the DEEP study cohort to obtain an approximation of the relative risk by MD. For example, using our approach, with a MD in pain of −3, the splints cohort is more likely to move to a better health state than the comparator group (represented by the DEEP study cohort). Those that are already in the 'low pain' health state will remain in that health state, accounting for the floor effects of the scale. Those in the 'moderate pain' health state are more likely to move to a better health state ('low pain') than remain in the moderate pain health state. Those in the 'high pain' health state are more likely to move to a better health state ('moderate pain') than remain in the high-pain health state.

The approach taken should be interpreted with caution, as it does not directly incorporate relative risk estimates. Future research is required to obtain effect size estimates (i.e. relative risks) that are more amenable for use in populating decision-analysis models structured around different pain states in TMD.

Mortality parameters

General population all-cause mortality risks (adjusted for age and sex) were applied in the model, obtained from UK lifetables.[96] There is no evidence to suggest an added mortality risk to those with TMD; therefore, no excess mortality is applied to either arm of the model.

TABLE 18 Plausible state transitions (splints) for alternative MD values

MD	*p* (low to low)	*p* (low to moderate)	*p* (low to high)	*p* (moderate to low)	*p* (moderate to moderate)	*p* (moderate to high)	*p* (high to low)	*p* (high to moderate)	*p* (high to high)
−10	1	0	0	1	0	0	1	0	0
−9	1	0	0	1	0	0	1	0	0
−8	1	0	0	1	0	0	1	0	0
−7	1	0	0	1	0	0	1	0	0
−6	1	0	0	1	0	0	0.60	0.40	0
−5	1	0	0	1	0	0	0.33	0.67	0
−4	1	0	0	1	0	0	0.14	0.86	0
−3	1	0	0	0.75	0.25	0	0	0.75	0.25
−2	1	0	0	0.44	0.56	0	0	0.44	0.56
−1	1	0	0	0.20	0.80	0	0	0.2	0.80
0	1	0	0	0	1	0	0	0	1
1	0.80	0.20	0	0	0.80	0.20	0	0	1
2	0.56	0.44	0	0	0.56	0.44	0	0	1
3	0.25	0.75	0	0	0.25	0.75	0	0	1
4	0	0.86	0.14	0	0	1	0	0	1
5	0	0.67	0.33	0	0	1	0	0	1
6	0	0.40	0.60	0	0	1	0	0	1
7	0	0	1	0	0	1	0	0	1
8	0	0	1	0	0	1	0	0	1
9	0	0	1	0	0	1	0	0	1
10	0	0	1	0	0	1	0	0	1

Utilities and quality-adjusted life-years

Health-state utilities, by pain tertile, for both CPI and current pain definitions, were obtained from a reanalysis of the DEEP study,[94] conducted specifically for this project. An average utility value for each pain tertile was calculated using the generalised estimating equation approach, using Stata® version 13.1 software (StataCorp LP, College Station, TX, USA).

Those in the low-pain state had the highest utility value, and those in the high-pain state had the lowest utility value. Utilities are incorporated in the model probabilistically, using beta distributions. The mean and SD (of the sampling distribution) of utilities by health state are listed in *Table 19*, rounded to the nearest two decimals.

The utility values obtained from the DEEP study were based on a generic EuroQol-5 Dimensions, five-level version, (EQ-5D-5L) quality-of-life measurement, with corresponding utility values obtained using an interim scoring approach to map between the EQ-5D-5L and the EuroQol-5 Dimensions, three-level version (EQ-5D-3L).[102] The EQ-5D-5L questionnaire includes five dimensions of quality of life (mobility, self-care, usual activities, anxiety/depression and pain/discomfort), each with five levels of impact (ranging from no problems to extreme problems). All utilities used in the model were age- and sex-adjusted for UK general population norms.[103]

Intervention costs

All model costs are reported in 2016 Great British pounds. Intervention costs are calculated using the payment system for dentistry used in England and Wales. Every treatment in primary care dentistry is categorised into one of three treatment bands. Each treatment band is associated with a predefined number of units of dental activity (UDAs), where more UDAs reflect more complex treatments. UDAs are assigned to treatment bands as follows: band 1 (1 UDA), band 2 (3 UDAs) and band 3 (12 UDAs). Each UDA is associated with a value, with the values of each UDA varying across dental practices. Currently, the average UDA value in England is approximately £25.[104,105] An alternative estimate of the UDA value can be obtained from data published by the NHS Business Services Authority for general dental services contracts across dental practices with contracts to provide services on behalf of NHS England. Using this approach, the mean UDA value was £26.74, with a SD across practices of £18.94.[106] Using this alternative approach, it is possible to include the value of a UDA probabilistically in the model.

In the UK, patients pay a proportion of the UDA value (approximately 80% of the treatment value), unless they are exempt from payment charges (e.g. low income), in which case the full treatment value is paid for by the NHS. The cost to the NHS of each treatment band therefore depends on the proportion of patients exempt from charges. The following formula was used to calculate the average cost to the NHS of a band 1, 2 or 3 course of treatment:

$$\begin{aligned}\text{NHS cost} = [&((\text{treatment value} - \text{patient charge}) \times \text{proportion eligible to pay}) \\ &+ (\text{treatment value} \times (1 - \text{proportion eligible to pay}))].\end{aligned} \quad (2)$$

Table 20 includes the inputs to the formula for the calculation of the band 1 to 3 courses of treatment.

TABLE 19 Health-state utilities

	Current pain			CPI		
Health state (pain tertile)	Mean (SD)[a]	Alpha	Beta	Mean (SD)[a]	Alpha	Beta
Low	0.782 (0.004)	8737	2439	0.770 (0.005)	6241	1863
Moderate	0.682 (0.004)	7591	3535	0.709 (0.004)	8294	3397
High	0.596 (0.005)	6747	4565	0.601 (0.005)	6285	4181

a SD of the sampling distribution, equivalent to the standard error of the source data.

TABLE 20 Payment for dental care in England and Wales

NHS band treatment	UDA	Treatment value (£)	Patient charge (2016) (£)	Paying adults (%)	Sources
1	1	25	19.70	82	*NHS Dental Statistics for England – 2016–17*[107]
2	3	75	53.90	69	
3	12	300	233.70	49	

Splints can be custom made or prefabricated. Custom-made splints are typically provided as a band 3 treatment charge on the NHS in England, while prefabricated splints are likely to be charged as a band 2 service because less resources are required to make the splints. The cost of splints included in the model is an average of the two types, weighted by the proportion of patients receiving each splint type in the clinical effectiveness review.

Of those studies that used current pain as their primary outcome, 91% reported using custom-made splints. Of those studies that used CPI as their primary outcome, 75% reported using custom-made splints. The weighted average approach taken ensures that the distribution of splint type used for the costing is congruent with that used to generate the treatment effect estimates used in the model. A sensitivity analysis explores the impact of alternative assumptions on the results.

The cost of replacing a splint was assumed to be the same as the cost of providing an initial splint. However, there was substantial uncertainty among the clinical expert advisors as to the most probable frequency of splint replacement, and whether or not this would differ by custom-made or prefabricated splint. Expert opinion suggested that splints would be replaced, on average, every 2–5 years, but in some cases patients may use a splint for up to 20 years. To incorporate this uncertainty in the model, three alternative values were considered based on expert opinion: every 2 years, every 5 years and every 20 years. These values were sampled from a log-normal distribution with mean = replacement every 9 years, and median = replacement every 5 years. It is clear that clinical expert opinion regarding the frequency of replacement varied widely among the project advisory group. Therefore, further deterministic analyses are considered in sensitivity analyses to explore the impact of the following alternative assumptions on the cost-effectiveness results: (1) no replacement, (2) 2-yearly replacement, (3) 5-yearly replacement and (4) 20-yearly replacement.

Health-state costs

Health-state costs were obtained from the DEEP study and include the cost of resources consumed in both the dental and general health-care budgets. Costs include contact with all health professionals (dental and general) for dental-related problems. Drug costs are also incorporated. Full details of the costing methodology are reported in the DEEP study.[98,99] For the purposes of this economic analysis, the cost of splints was excluded from the analysis to avoid a risk of double-counting. To estimate the health-care costs by health state ('low pain', 'moderate pain' and 'high pain'), a regression analysis was conducted using Stata. As was done with the utilities, an average cost for each pain tertile was estimated using the generalised estimating equation approach separately for tertile of current pain and CPI. All costs from the DEEP study are reported in 2012 values, and have therefore been updated to 2016/17 values using the Cochrane and Campbell online tool.[108] The estimated means and SDs of the sampling distribution for health-care costs are provided in *Table 21*. Cost data provided reflect total costs (excluding splint provision costs) by health state of the 2-year follow-up period of the DEEP study. These costs are converted to 3-monthly cycle-specific costs and are sampled probabilistically from gamma distributions for inclusion in the model.

TABLE 21 Health-state costs

	Current pain			CPI		
Health state	Mean (SD)[a] (£)	Alpha	Lambda[b]	Mean (SD)[a] (£)	Alpha	Lambda[b]
Low pain	345.43 (10.10)	1303	3.57	332.70 (11.20)	983	2.80
Moderate pain	519.17 (12.27)	1995	3.64	479.80 (11.40)	1974	3.90
High pain	675.41 (13.45)	2810	3.94	697.63 (13.19)	3117	4.23

a SD of the sampling distribution, equivalent to the standard error of the source data.
b Note that TreeAge Pro software parameterises the gamma distribution using lambda, equivalent to 1/beta.

Assessment of cost-effectiveness

A CUA was conducted using QALYs as the measure of benefits. The results presented are over the lifetime of the simulated cohort (with a starting age of 25 years in the base case). The model is fully probabilistic, with model outputs calculated using Monte Carlo simulation with 1000 repetitions, sampling from distributions for transition probabilities, MDs, utilities and costs as described in *Tables 16*, *17*, *19* and *21*, respectively. The probabilistic analysis is advantageous because it varies all parameters simultaneously. Model results are reported as expected values of costs and QALYs over the modelled time horizon. An incremental comparison of costs and QALYs between splints and no splints is reported and ICERs are calculated as the MD in costs divided by the MD in QALYs. The ICER is then compared with a commonly used cost per QALY threshold recommended by NICE.[97] If the ICER is within the desired range (£20,000–30,000, or below), an intervention would generally be considered cost-effective. However, in all cases, determination of cost-effectiveness must also consider the variability around the point estimates of incremental costs, incremental QALYs and, hence, the ICER. Consideration of such uncertainty is important to determine if current evidence is sufficient for decision-making, and if decision-makers can be confident that the ICER is likely to fall below commonly accepted threshold values.

As all models are run probabilistically, it is possible to determine the probability of cost-effectiveness at threshold values of willingness to pay (WTP) for a QALY gained (e.g. £20,000 per QALY) for each scenario analysis. Uncertainty in the base-case results is also illustrated using scatterplots of the cost-effectiveness plan and cost-effectiveness acceptability curves (CEACs). Scatterplots and CEACs are particularly informative as they demonstrate the uncertainty arising due to the combined statistical variability in all the models' parameter inputs. The CEAC shows the probability that splints or no splints are the most efficient use of resources at difference threshold values of society's WTP for a QALY gain.

A range of scenario analyses were also conducted to account for structural and methodological uncertainty as well as heterogeneity. In economic models, some structural assumptions are made that come with some uncertainty. An example of this would be to vary the time horizon or vary the frequency at which individuals are assumed to replace their splints. There is also uncertainty surrounding the methods that could be used in the model. For example, there are uncertainties regarding the discount rates that should be applied to costs and benefits. The results from the analysis might be subject to heterogeneity. To account for heterogeneity, conducting the analysis in, for example, different age groups would be beneficial. All sensitivity and scenario analyses are listed in *Table 22*. It should be noted that all analyses, including the base-case and scenario analyses, are reported for different definitions of pain (current and CPI).

Value-of-information analysis

Value-of-information analysis is a useful tool for identifying what contributes to the decision uncertainty in the model. The expected value of perfect information (EVPI) is the difference between the expected value with perfect information and the expected value with current information, and can be used to determine whether or not future research to resolve current decision uncertainty is a worthwhile

TABLE 22 Scenario and sensitivity analyses conducted

Assumption/model parameter	Base-case assumption	Alternative assumption in scenario analysis	Justification
Definition of pain	Current pain and CPI definitions considered as a joint base-case analysis		A joint base case is provided for current pain and CPI. Although CPI is the preferred measure (as part of the GCPS), data to populate effect sizes are more complete for current pain, and based on a greater number of studies
Cohort starting age	25 years	Alternative starting ages of 40 and 56 years	Age varied to reflect alternative ages at TMD onset and presentation for treatment with splints (informed by the project advisory group)
Discount rate for costs and QALYs	3.5%	Vary between 0% and 6%	Recommended variation of discount rate according to NICE methods for technology appraisal[97]
Modelled time horizon	85 years	2, 10, 20 and 30 years	The base case reflects best-practice methods to incorporate all the possible costs and benefits over a lifetime. However, long-term uncertainty is extensive; therefore, shorter time horizons could be expected to yield better estimates of cost-effectiveness
Splint replacement	Frequency of splint replacement based on wide variation in expert opinion (0, 2, 5 and 20 years), sampled probabilistically	Scenarios include no replacement, replacement every 2, 5 and 20 years	There is likely to be substantial heterogeneity across the TMD population with regards to how often splints are replaced. This sensitivity analysis explores a range of assumptions, discussed with the project advisory board, and is based on clinical and patient expert opinion
Cost of splints	Weighted average of custom-made and prefabricated splints using current estimated banding	Assuming all splints are (1) band 1, (2) band 2 and (3) band 3 treatment	Reflects uncertainty in the current banding system for payment that is not necessarily based on the opportunity cost of time and resource use required for different splint treatments
Long-term MD (beyond 12 months)	Assumes equal likelihood of (1) long-term MD of 0 and (2) long-term MD = MD at 12 months	Varies the assumption between long-term MD = 0 and long-term MD = MD at 12 months	Long-term MD data do not exist, but are an important driver of cost-effectiveness. Clinical expert opinion considered each scenario equally probable
Long-term transition probabilities	Assumes equal likelihood that transition probabilities beyond the DEEP study cohort time horizon (2 years) are (1) zero and (2) equal to the transitions between 18 and 24 months	Varies the assumption between long-term probabilities equal to zero and equal to transitions between 18 and 24 months	Long-term transition probability data do not exist beyond the 2-year follow-up of the DEEP study cohort. However, they are an important driver of cost-effectiveness. Clinical expert opinion considered each scenario equally probable

investment. The EVPI is calculated using the net monetary benefit (NMB). The NMB is calculated from the results of the probabilistic analysis. The intervention with the highest NMB is the most cost-effective intervention. The EVPI is the maximum NMB of each iteration from the Probabilistic Sensitivity Analysis, averaged:[109]

$$NMB(i,\theta) = \lambda \times Effect(i,\theta) - Cost(i,\theta), \quad (3)$$

where λ = threshold, and

$$EVPI = Expected_{\theta}\, Maximum_i NMB(i,\theta) - Maximum_i Expected_{\theta} NMB(i,\theta). \quad (4)$$

The population EVPI is the value of doing further research in the population of interest, namely those who would benefit from the intervention, for example the value of conducting further research on the relative effectiveness of splints compared with no splints in the TMD population in the UK. The expected value of perfect parameter information (EVPPI) estimates which parameters contribute to the decision uncertainty. The EVPPI is conducted by taking an iteration from the Monte Carlo simulation of a parameter in the outer loop and running the model for a defined number of simulations (e.g. 1000 runs), and repeating this exercise for all the parameter iterations from the probabilistic analysis.

To calculate the population EVPI, a number of assumptions were made both regarding the population likely to benefit from the intervention and the lifetime of the health technology evaluated. The population likely to benefit each year was assumed to be 2,311,407 (based on an annual prevalence of examiner-verified TMD of 3.5% obtained from Slade,[110] and a UK-wide population of approximately 66 million[111]). The expected lifetime of the technology was assumed to be 10 years, in line with typical practice for the conduct of a VOI analysis, and the threshold value of WTP for a QALY gained was assumed to be £20,000, in line with typical UK decision-making processes.[97]

The VOI analysis was conducted on the Sheffield Accelerated Value of Information (SAVI) application.[112] If the EVPI is positive, further research might be worthwhile. If this is the case, EVPPIs would be calculated to identify the source(s) of uncertainty in the results and the value of future research to resolve decision uncertainty surrounding the most important drivers of cost-effectiveness results.

Cost-effectiveness results

Base-case results

The base-case analyses used either current pain as the measurement of pain intensity or CPI, because the majority of included RCTs focused on current pain or CPI (see *Chapter 3* for further details). *Table 23* reports the base-case analysis for both current pain and CPI specifications of the model.

TABLE 23 Base-case cost-effectiveness results for splints vs. no splints

Intervention	Total costs (£)	Incremental costs (£)	Total QALYs	Incremental QALYs	ICER (£)	Probability of cost-effectiveness at different WTP thresholds (%)		
						£0	£20,000	£30,000
Current pain								
No splints	6375		17.999			93.3	42.5	41.0
Splints	7463	1088	18.027	0.028	39,216	6.7	57.5	59.0
CPI								
No splints	5681		18.575			97.3	70.9	66.8
Splints	6660	980	18.557	−0.018	Dominated	2.7	29.1	33.2

The point estimate of the ICER indicates that splints are not cost-effective using a model structured around current pain. Splints are less likely to be cost-effective using the CPI specification of the model, in which, on average, splints appear to be more costly and less beneficial in terms of QALYs gained. The unfavourable results for splints are driven by the point estimate of the MD for CPI at 6 months, which non-significantly favours the no-splint group. However, these results should be interpreted with caution and must be considered in the light of the very poor quality of the trials used to generate the effect size estimates used in the model. The optimal strategy is highly uncertain and estimates of the ICER should be considered as exploratory in nature.

For all analyses, considering the point estimates of the ICER in isolation may be misleading regarding the true cost-effectiveness of splints using either definition of pain. It may be more appropriate to consider the illustrations of cost-effectiveness provided by scatterplots of the cost-effectiveness plane and CEACs, which more adequately characterise the substantial uncertainty surrounding the results. *Figures 11* and *12* illustrate the scatterplot of the cost-effectiveness plane and the CEACs, illustrating the probability that each strategy (splints/no splints) is the most efficient use of resources at alternative threshold values of society's WTP for a QALY gained.

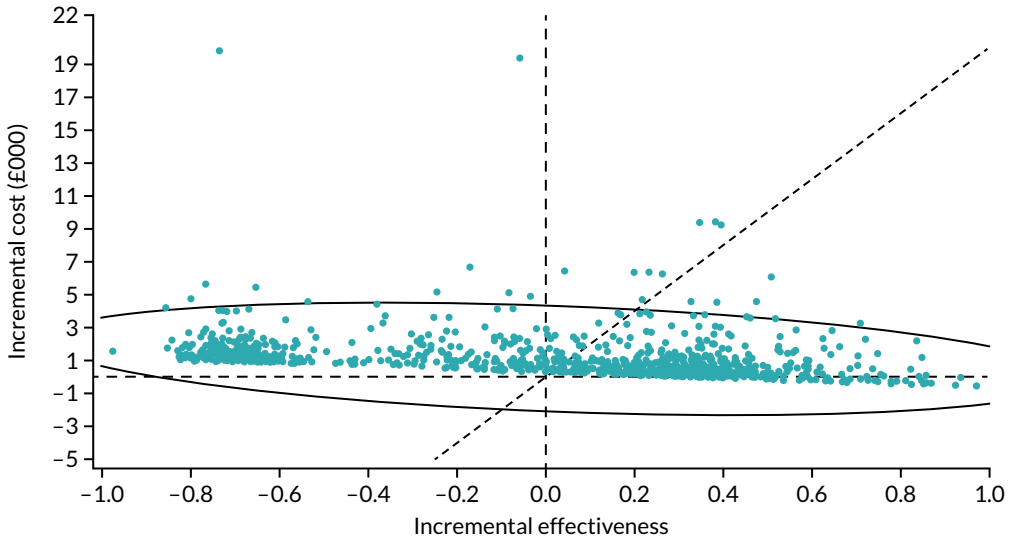

FIGURE 11 Cost-effectiveness plane for splints vs. no splints (current pain specification).

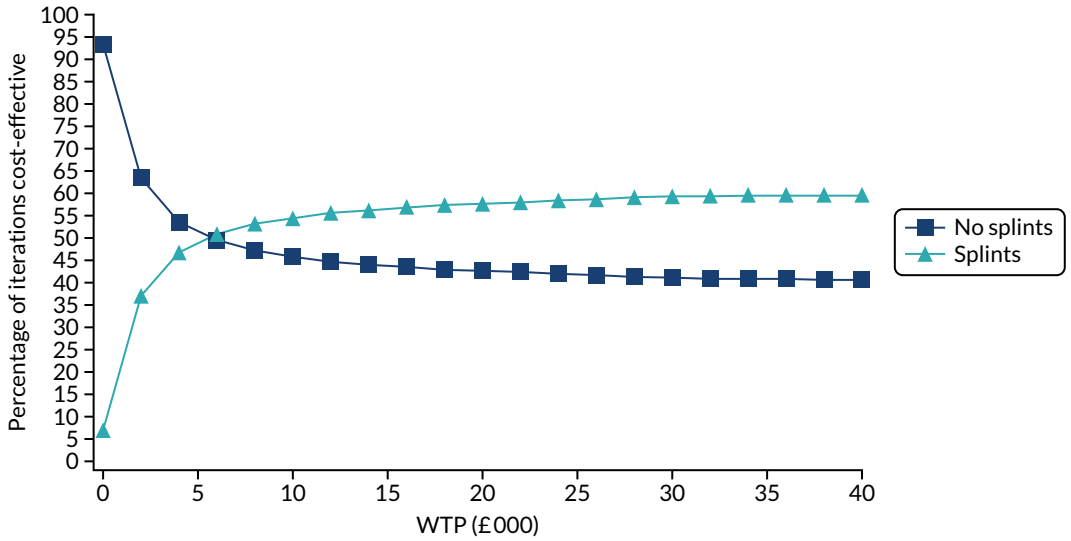

FIGURE 12 Cost-effectiveness acceptability curve for current pain specification.

The scatterplot indicates a high level of uncertainty surrounding the incremental QALYs gained, driven by uncertainty in the effect size for pain MDs identified in the review of clinical effectiveness (see *Chapter 3*).

The CEAC indicates substantial uncertainty regarding the optimal strategy, with probabilities of the cost-effectiveness of splints never increasing above 60% at WTP threshold values of between £10,000 and £40,000 per QALY.

Figures 13 and *14* report similar data for the CPI specification of the model.

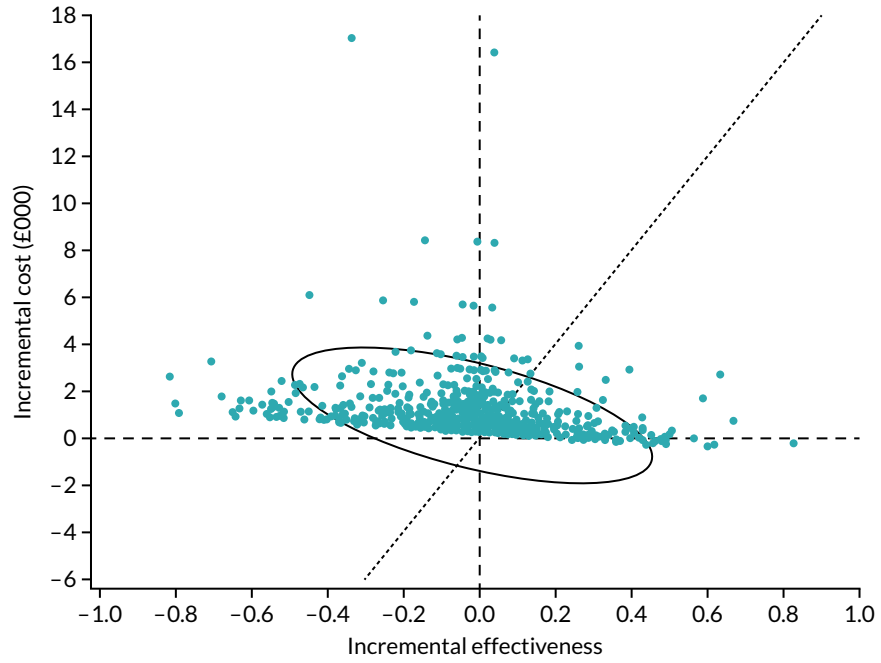

FIGURE 13 Cost-effectiveness plane for splints vs. no splints (CPI specification).

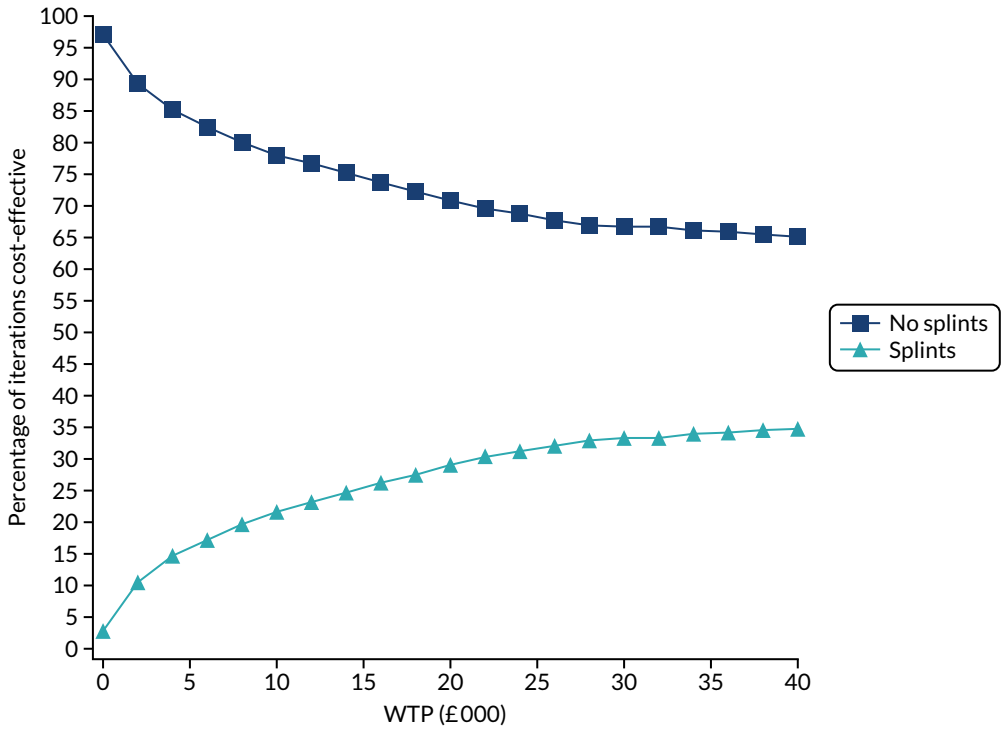

FIGURE 14 Cost-effectiveness acceptability curve for CPI specification.

The scatterplot for CPI also indicates a high level of uncertainty surrounding the incremental QALYs gained, again driven by uncertainty in the effect size from poor-quality studies regarding the MDs in CPI between splints and no splints used to populate the model (see *Chapter 3*). Although the results indicate a lower likelihood of splints being cost-effective using the CPI specification, it should be noted that this is driven by the MD favouring no splints at 6 months. However, as discussed in *Chapter 3*, *Results of the systematic review*, this finding should be interpreted with caution and in the light of the poor methodological quality of the included studies in the clinical effectiveness review.

Scenario and sensitivity analyses

The base-case analysis should be interpreted with caution. A range of scenario and sensitivity analyses have also been undertaken, the results of which are presented in *Table 24* and serve to illustrate the wider variation in the ICER depending on the assumptions applied in the model. All scenario and sensitivity analyses were conducted probabilistically and report results for both current pain and CPI. These analyses are informative in determining the key assumptions that drive the cost-effectiveness results.

TABLE 24 Sensitivity and scenario analyses

Intervention	Total costs (£)	Incremental costs (£)	Total QALYs	Incremental QALYs	ICER (£)	Probability of cost-effectiveness at difference WTP thresholds (%)		
						£0	£20,000	£30,000
Base case *Current pain*								
No splints	6375		17.999			93.3	42.5	41.0
Splints	7463	1088	18.027	0.028	39,216	6.7	57.5	59.0
CPI								
No splints	5681		18.575			97.3	70.9	66.8
Splints	6660	980	18.557	−0.018	Dominated	2.7	29.1	33.2
Assume long-term MD beyond 12 months = 0 and long-term transition probabilities continue as per DEEP study *Current pain*								
No splints	6088		18.310			100.0	100.0	100.0
Splints	7849	1761	17.614	−0.697	Dominated	0.0	0.0	0.0
CPI								
No splints	5054		19.115			100.0	76.1	70.4
Splints	6014	960	19.115	0.000	9,502,983	0.0	23.9	29.6
Assume long-term MD beyond 12 months = MD at 12 months and long-term transition probabilities continue as per DEEP study *Current pain*								
No splints	6088		18.310			93.3	1.1	0.3
Splints	6893	805	18.645	0.334	2407	6.7	98.9	99.7
CPI								
No splints	5054		19.115			100.0	85.3	80.2
Splints	6040	986	19.092	−0.023	Dominated	0.0	14.7	19.8

TABLE 24 Sensitivity and scenario analyses (*continued*)

Intervention	Total costs (£)	Incremental costs (£)	Total QALYs	Incremental QALYs	ICER (£)	Probability of cost-effectiveness at difference WTP thresholds (%)		
						£0	£20,000	£30,000
Assume long-term MD beyond 12 months = MD at 12 months and long-term transition probabilities = 0 *Current pain*								
No splints	6626		17.728			83.4	17.5	16.1
Splints	7394	768	18.102	0.374	2054	16.6	82.5	83.9
CPI								
No splints	6243		18.092			95.4	61.8	59.4
Splints	7252	1009	18.047	−0.045	Dominated	4.6	38.2	40.6
Assume long-term MD beyond 12 months = 0 and long-term transition probabilities = 0 *Current pain*								
No splints	6626		17.728			96.8	58.0	55.3
Splints	7730	1104	17.739	0.011	98,645	3.2	42.0	44.7
CPI								
No splints	6243		18.092			96.7	59.6	56.9
Splints	7214	971	18.081	−0.011	Dominated	3.3	40.4	43.1
Starting age of cohort set to 40 years *Current pain*								
No splints	5670		15.247			94.4	42.5	41.0
Splints	6655	985	15.275	0.027	35,988	5.6	57.5	59.0
CPI								
No splints	5059		15.731			98.0	70.6	66.6
Splints	5948	889	15.716	−0.016	Dominated	2.0	29.4	33.4
Starting age of cohort set to 56 years *Current pain*								
No splints	4524		11.394			95.5	42.4	41.4
Splints	5343	819	11.420	0.026	31,032	4.5	57.6	58.6
CPI								
No splints	4049		11.749			98.4	70.4	67.1
Splints	4792	743	11.737	−0.012	Dominated	1.6	29.6	32.9
Discount rate of 0% *Current pain*								
No splints	14,658		39.733			86.4	42.8	41.6
Splints	16,953	2296	39.754	0.021	107,798	13.6	57.2	58.4
CPI								
No splints	12,982		41.048			96.0	72.4	68.4
Splints	15,023	2040	41.010	−0.038	Dominated	4.0	27.6	31.6

continued

TABLE 24 Sensitivity and scenario analyses (*continued*)

Intervention	Total costs (£)	Incremental costs (£)	Total QALYs	Incremental QALYs	ICER (£)	Probability of cost-effectiveness at difference WTP thresholds (%)		
						£0	£20,000	£30,000
Discount rate of 6% *Current pain*								
No splints	4289		12.291			96.0	42.3	40.9
Splints	5077	788	12.320	0.029	27,437	4.0	57.7	59.1
CPI								
No splints	3840		12.675			98.7	69.4	66.5
Splints	4555	715	12.662	−0.013	Dominated	1.3	30.6	33.5
Time horizon of 2 years *Current pain*								
No splints	539		1.459			100.0	38.2	31.4
Splints	825	285	1.482	0.022	12,787	0.0	61.8	68.6
CPI								
No splints	513		1.490			100.0	74.1	67.7
Splints	778	264	1.489	−0.001	Dominated	0.0	25.9	32.3
Time horizon of 10 years *Current pain*								
No splints	2222		6.482			98.7	44.2	42.5
Splints	2708	486	6.509	0.027	18,275	1.3	55.8	57.5
CPI								
No splints	2021		6.665			100.0	64.7	61.3
Splints	2463	442	6.662	−0.003	Dominated	0.0	35.3	38.7
Time horizon of 20 years *Current pain*								
No splints	3748		10.963			95.7	43.4	41.5
Splints	4451	703	10.989	0.026	26,700	4.3	56.6	58.5
CPI								
No splints	3366		11.299			99.3	69.3	65.4
Splints	4005	640	11.288	−0.011	Dominated	0.7	30.7	34.6
Time horizon of 30 years *Current pain*								
No splints	4813		13.979			95.0	43.3	41.9
Splints	5674	861	14.004	0.026	33,212	5.0	56.7	58.1
CPI								
No splints	4304		14.418			98.5	67.2	63.2
Splints	5078	774	14.407	−0.011	Dominated	1.5	32.8	36.8
Cost of splints and replacement set at band 3 charge *Current pain*								
No splints	6375		17.999			94.8	42.7	41.2
Splints	7548	1173	18.027	0.028	42,289	5.2	57.3	58.8

TABLE 24 Sensitivity and scenario analyses (*continued*)

Intervention	Total costs (£)	Incremental costs (£)	Total QALYs	Incremental QALYs	ICER (£)	Probability of cost-effectiveness at difference WTP thresholds (%)		
						£0	£20,000	£30,000
CPI								
No splints	5681		18.575			98.5	73.9	68.9
Splints	6897	1216	18.557	−0.018	Dominated	1.5	26.1	31.1
Cost of splints and replacement set at band 2 charge *Current pain*								
No splints	6375		17.999			56.9	40.1	40.0
Splints	6601	226	18.027	0.028	8139	43.1	59.9	60.0
CPI								
No splints	5681		18.575			87.1	61.4	60.3
Splints	5950	269	18.557	−0.018	Dominated	12.9	38.6	39.7
Cost of splints and replacement set at band 1 charge *Current pain*								
No splints	6375		17.999			43.4	39.6	39.6
Splints	6413	38	18.027	0.028	1352	56.6	60.4	60.4
CPI								
No splints	5681		18.575			73.4	57.9	57.4
Splints	5761	81	18.557	−0.018	Dominated	26.6	42.1	42.6
Replacing splints every 2 years *Current pain*								
No splints	6375		17.999			100.0	45.7	43.4
Splints	8903	2528	18.027	0.028	91,119	0.0	54.3	56.6
CPI								
No splints	5681		18.575			100.0	83.0	78.1
Splints	7904	2223	18.557	−0.018	Dominated	0.0	17.0	21.9
Replacing splints every 5 years *Current pain*								
No splints	6375		17.999			99.5	42.0	41.3
Splints	7489	1114	18.027	0.028	40,156	0.5	58.0	58.7
CPI								
No splints	5681		18.575			100.0	74.5	69.1
Splints	6683	1002	18.557	−0.018	Dominated	0.0	25.5	30.9
Replacing splints every 20 years *Current pain*								
No splints	6375		17.999			88.6	40.5	40.0
Splints	6790	415	18.027	0.028	14,951	11.4	59.5	60.0

continued

TABLE 24 Sensitivity and scenario analyses (*continued*)

Intervention	Total costs (£)	Incremental costs (£)	Total QALYs	Incremental QALYs	ICER (£)	Probability of cost-effectiveness at difference WTP thresholds (%)		
						£0	£20,000	£30,000
CPI								
No splints	5681		18.575			96.0	63.8	61.6
Splints	6079	398	18.557	−0.018	Dominated	4.0	36.2	38.4
Cost of replacing splints set to £0 *Current pain*								
No splints	6375		17.999			51.0	39.8	39.7
Splints	6543	168	18.027	0.028	6041	49.0	60.2	60.3
CPI								
No splints	5681		18.575			87.2	59.9	59.0
Splints	5865	185	18.557	−0.018	Dominated	12.8	40.1	41.0

The model results for the current pain configuration were most sensitive to varying structural assumptions about the long-term MD and long-term transition probabilities. Assuming a long-term MD of zero, namely that splints have no additional effectiveness beyond 1 year of usage, generates additional costs to the NHS with mean QALY losses, and thus a very low probability of cost-effectiveness. However, assuming that the MD observed at 6 months continues over a patient's lifetime, splints would be a highly cost-effective use of resources, with an ICER of just over £2000 per QALY gained. These analyses serve to illustrate the sensitivity of the model to long-term assumptions about differences in pain, and highlight the need for further research to adequately determine the appropriate long-term trajectory of the effectiveness of splints. The CPI-configured model is also sensitive to this assumption, but less so given that the distribution of the MD in CPI at 12 months is centred closer to zero. It should also be noted that extrapolation of MD data to the longer term are based on poor-quality shorter-term MDs (at 3, 6 or 12 months), adding a further layer of uncertainty to the results. It is imperative that high-quality data are obtained for MD in pain related to TMD to generate more robust estimates of cost-effectiveness from the modelling analysis.

The model is also somewhat sensitive to assumptions around the costs of splints and the frequency of splint replacement. There is substantial uncertainty over the actual banded change that might be applied to splints, particularly for prefabricated splints, which could feasibly incur a band 1 or 2 charge, with custom-made splints more likely to incur a band 2 or 3 charge. As anticipated, lower banding improves the cost-effectiveness case for splints. Similarly, there was much uncertainty among the project's clinical advisors regarding the most probable frequency of splint replacement. This is an important driver of incremental costs in the model, with more frequent replacement generating lower likelihoods of cost-effectiveness. For the current pain configuration, the probability of cost-effectiveness (at £20,000 per QALY) drops from 60% when never replaced to 54% when replaced every 2 years. The CPI results are more sensitive to this assumption, decreasing from 40% to only 17% for the same replacement frequencies.

The scenario indicates that the model results were not particularly sensitive to the discount rate or time horizon chosen.

Value-of-information results

This section reports the results of the VOI analysis. Given the high level of uncertainty described in the previous section, it is important to determine the value of additional research to determine the cost-effectiveness of splints. The EVPI results in *Table 25* indicate that future research is worthwhile.

TABLE 25 Value-of-information (EVPI and EVPPI) results

VOI	Current pain (£)	CPI (£)
EVPI		
Per person	3961	867
Population (10 years)	91.57B	20.04B
EVPPI *Transition probabilities*		
Per person	2318	404
Population (10 years)	53.59B	9.34B
Mean difference		
Per person	2847	15
Population (10 years)	65.80B	0.35B
Costs		
Per person	201	26
Population (10 years)	4.64B	0.59B
Utilities		
Per person	40	2
Population (10 years)	0.93B	0.06B

The EVPPI results build on this to identify the parameters in the model for which further research is most valuable to reduce uncertainty regarding the optimal treatment decision (splints or no splints).

The VOI analysis further emphasises the decision uncertainty, and identified the key drivers of the cost-effectiveness results. The large positive values of EVPI indicate that further research would be a good investment. EVPPI helps to indicate the parameters in the model that contribute most to decision uncertainty. Large EVPPI values (for current pain in particular) indicate that further research should be prioritised to resolve decision uncertainty about the impact of splints on pain (i.e. the MDs used in the model). This should also encompass an assessment of the long-term effectiveness to more accurately guide extrapolation in the model. In addition, further research regarding the long-run trajectory of disease would be worthwhile, to determine transition probabilities over the full life course. Research on the costs of splints and, in particular, the replacement cost of splints over time is also worthy of further research, although EVPPIs are lower than for the clinical effectiveness data. Although generating positive values of EVPPI, further research with regard to health-state utilities is less valuable, and should be considered only after decision uncertainty in clinical effectiveness and costs of splints has been resolved.

It is noted that parameter EVPPI is positive, but remains consistently lower in models parameterised around CPI than in those parameterised around current pain. This finding must be considered in the light of the other findings in the report, and, in particular, the poor methodological quality of the underlying effect size studies. VOI is a useful tool in prioritising future research, but is driven solely by sampling uncertainty around the input parameters. It does not consider the methodological quality of the clinical effectiveness studies. Details of the economic evaluation results, including VOI results, comparing custom-made and prefabricated splints with no splints can be found online.[113]

Chapter 5 Discussion

Summary of main results

Despite the inclusion of 35 studies comparing oral splints with no splints or a minimal intervention in patients with TMD, the body of evidence was assessed as being of very low quality. There was no evidence that oral splints reduced pain, reduced clicking of the temporomandibular joint or increased mouth-opening, when TMD is considered as a group of conditions. When comparing oral splints with control splints, there was some very low-quality evidence from three studies[36,47,60] that oral splints reduced pain when compared with control splints for a time period of 0–3 months; however, this was not supported at the other time periods (3–6 months and 6–12 months). In the light of the absence of any evidence showing that splints reduce pain against no/a minimal control, the benefit for splints, when compared with control splints, seen at 3 months may indicate that such control splints are actually detrimental. It is therefore unclear if the provision of control splints is an appropriate control to use in RCTs of this type.

The economic analysis was configured to report cost-effectiveness based on differences in pain measured as current pain or CPI. The modelling for TMD is based on poor-quality clinical effectiveness data and estimates of cost-effectiveness should be considered exploratory in nature. The base-case results showed that there was substantial uncertainty regarding the most cost-effective treatment strategy. The scatterplots of the cost-effectiveness plane depict the high uncertainty in the results. For the current pain configuration, about half the point estimates of the ICER favour splints and the other half favour the no-splint group, meaning that there is an equal chance that either strategy may be cost-effective. The results were slightly less uncertain for the CPI configuration, with a ≈29% chance that splints are cost-effective and a 71% chance that no splints offers the best value for money. However, as described by the scenario analyses undertaken, substantial variability exists in incremental costs and incremental QALYs, depending on the assumptions applied, meaning that the most cost-effective treatment strategy cannot be determined. The estimates of cost-effectiveness should be interpreted with caution. It is probably more informative to consider the substantial impact of plausible variations in important assumptions on the ICER and to thus use the modelling results to identify the key parameters that drive the cost-effectiveness results, on which further research would be informative.

For patients with bruxism, there was insufficient evidence to conclude whether or not the provision of oral splints reduced tooth wear, as no studies reported this. Although a small number of studies reported pain and other outcomes, there was also insufficient evidence to conclude whether or not oral splints were beneficial. With regard to cost-effectiveness, there was no evidence to support or refute the use of splints for bruxism and there was no evidence available to populate a decision model.

Six studies[50,55,61,62,72,73] compared prefabricated splints with custom-made splints in patients with varying subtypes of TMD. There was insufficient evidence to determine whether or not there was a difference

between the splint types for any outcomes included in this review. This evidence was assessed as being of very low quality, and insufficient to draw any robust conclusions regarding either clinical effectiveness or cost-effectiveness. It should be noted that many types of prefabricated splints exist, some of which are readily available to patients via the internet, without the need for dental consultation/fitting. Such splints were not evaluated in the trials identified for this review.

Overall completeness and applicability of evidence

For TMD, we undertook a sensitivity analysis restricted to trials for which the inclusion criteria were based on, or could be clearly mapped to, one of the following sets of diagnostic criteria: RDC/TMD guidelines,[17] TMD (DC/TMD) guidelines[18] or AAOP guidelines.[19] There was no difference in the results when removing studies that did not use these diagnostic criteria.

Similarly, for bruxism patients, we planned to undertake a sensitivity analysis restricted to trials for which there was a clear diagnosis of bruxism.[4] We were unable to do this for the five bruxism trials included in the systematic review owing to the lack of outcome data reported in these studies.

For both patients with TMD and with bruxism, owing to differences in the diagnoses of the included trial participants and differences in the types of splints and control groups used, the applicability of the evidence is questionable, and certainly incomplete for patients with bruxism. We suspect that this same variability and lack of diagnostic criteria is mirrored in primary care when splints are being prescribed.

Pain was reported in numerous different ways, at different times, and this reduced the number of studies that could be combined in a meta-analysis to produce a pooled estimate. The use of an agreed measure for pain and how and when this is measured would enable the pain data from all the studies to contribute to one single pooled estimate. It is also important to consider what would be a clinically important reduction in pain. It is suggested that around a 20% reduction represents a minimally important decrease, 30% a moderately important decrease and 50% a substantial decrease.[114]

Several of the studies reported study outcomes but we were unable to use the data. The main reason for this was missing SDs. Once again, this compromised the completeness of the results of the meta-analyses.

Numerous studies reported on some of our outcomes but did not report the data in a suitable format for inclusion in our meta-analyses. This can mean that meta-analyses are biased by missing information. However, the Cochrane Risk of Bias tool[15] and meta-analyses do not currently address this issue adequately. A study may be assessed as having a high risk of selective outcome reporting, but if that study is not included in a meta-analysis because it has no data, then this is not reflected or accounted for. This highlights the need for standardisation in both 'what to measure' and 'how to measure it' in clinical trials in this area of research. Otherwise, there will continue to be research waste, with data that are not able to be pooled in data syntheses. There are initiatives such as Initiative on Methods, Measurement and Pain Assessment in Clinical Trials (IMMPACT),[114,115] Core Outcome Measures in Effectiveness Trials (COMET)[116] and COnsensus-based Standards for the selection of health Measurement Instruments (COSMIN)[117] that can help with these issues, and future research in these areas would be beneficial.

The use of a control/placebo splint is also questionable in trials conducted on patients with TMD or bruxism. It is unclear what effect the control splint may have on the outcomes measured, and this may explain why the comparisons of splints versus minimal interventions, and splints versus control splints, led to different findings.

Meta-analysis is the key tool for facilitating progress in science by quantifying what is known and identifying what is not known.[118] The most consequential effect of introducing formal research synthesis

methodology has been a profound change in the way scientists think about the outcomes of scientific research. An individual primary study may now be seen as a contribution towards the accumulation of evidence, rather than revealing the conclusive answer to a scientific problem.[118,119] In the field of TMD, it could be considered that each new trial be designed with the current evidence in mind (as part of a funding application). This could help to ensure that the trial is asking an important question, on the right population using the right methodology, especially the measurement of pain using consistent methods. Unless research in this area does not address these issues, then there may continue to be a mismatch of poor-quality trials on different interventions, in different groups of patients, with different diagnoses, and using different ways of measuring pain or other TMD outcomes. So, rather than there being a call for a reduction in evidence synthesis in this area,[120] it is vital that there is a methodologically sound evidence base that is kept up to date in order for the science in this area to progress.

Quality of the evidence

The quality of the evidence for comparing splints with no splints/minimal interventions/control splints in patients with all subtypes of TMD was downgraded to 'very low' owing to the studies being at a high risk of bias, heterogeneity and a lack of precision in the estimates. Most studies were assessed as being at a high risk of bias because of the inability of researchers to blind patients to wearing a splint or not, or wearing different types of splint. As the primary outcome for the TMD patients was pain assessed by the patients, this meant that this outcome measurement was also assessed as being at a high risk of bias. It is difficult to design trials to overcome this problem. We were unable to investigate the heterogeneity of the effect estimates because of the different splint types used, different patient diagnoses and the different minimal interventions being used as control groups.

There were no studies looking at tooth wear, and very few studies and a lack of useable other data for patients with bruxism, so we were unable to determine whether or not splints are effective in these patients. The quality of the evidence was therefore deemed to be very low for the reported outcomes.

The risk of bias of 50[22–46,49–73] of the 52 studies was high. Although patient blinding is not possible when comparing oral splints with no splints or a minimal intervention, there were also problems with selective reporting bias and incomplete outcome data. The majority of the studies were assessed as having an unclear risk for selection bias, with researchers not reporting the trial methodology and data according to the Consolidated Standards of Reporting Trials (CONSORT).[121]

Patient and public involvement

The project benefited from the establishment of a patient advisory group during the development of the application. At least one member of the patient advisory group attended each of the face-to-face meetings of the research team held in Manchester, and took part in most of the monthly teleconferences. On reflection, involving patients in discussions about the questions and outcomes for the protocol, and in the readability of the *Plain English summary* was helpful. It is more difficult to involve patients in the more detailed work of the effectiveness review, as this is a specialist methodological exercise with clinical involvement.

Economic modelling

A decision-analysis model was developed to fill a gap in the literature regarding the cost-effectiveness of splints. Although the project intended to evaluate cost-effectiveness separately for bruxism and TMD, it was possible to build a model for TMD only. There were insufficient data available to populate a model focused around degrees of tooth wear resulting from bruxism activity. A suggested model structure is provided in *Appendix 5*, and further research is required to refine the structure and populate the model. Further research will be required to determine the long-term care pathway for bruxism patients, the long-term impact of bruxing on tooth wear and treatment need, the effectiveness of splints, and the costs and utilities of different bruxism health states.

The TMD model was populated using the best-available evidence from a UK decision-making perspective. A systematic approach was taken to search for the clinical effectiveness data. Costs, utilities and transition probabilities were based on detailed cohort data from the DEEP study, a UK cohort study on people with TMD.

There was a lack of available long-term data to inform the economic model, particularly with regards to the long-run transition probabilities beyond 2 years. The effects of splints on pain are a particular area of uncertainty, especially over longer time periods beyond 3 months. This uncertainty is evident in the model results, with VOI analysis being used to inform further research priorities

One important limitation of the economic analysis is that there was no RR data available from the clinical effectiveness review to inform the economic model. To populate the model, structured around tertiles of pain, it was necessary to make assumptions about the probable RR obtained from a range of plausible MDs observed in the clinical effectiveness review. The approach taken adds substantial additional uncertainty to the results. Although the resulting data behave in a manner that is encouraging for face validity, further work is required to determine the true RR of health-state occupation. The results provided by the economic analysis are subject to the same limitations of the clinical effectiveness data described previously.

This project initially set out to also compare custom-made with prefabricated splints. However, the majority of studies in the clinical effectiveness review used custom-made splints in their comparison, meaning that a robust assessment of the cost-effectiveness of custom-made versus prefabricated splints was not possible.

Chapter 6 Conclusions

Implications for health care

From this systematic review, there is no clear evidence to support the provision of splints for the various subtypes of TMD or bruxism. However, the body of evidence that this conclusion is based on is of very low quality. The studies included in this review differed in three important factors: (1) diagnoses, (2) splint type and (3) outcome measurement/reporting. This made it difficult to draw clear and definitive conclusions. We addressed these problems by performing sensitivity analyses to investigate the effects of the three factors on the results, but this resulted in a decrease in the numbers of studies and patients available with which to perform further analyses. We were still unable to demonstrate that splints reduce pain in the study participants.

With regard to cost-effectiveness, there was no published evidence to determine the most efficient allocation of resources. Our decision-analysis model identifies important drivers of cost-effectiveness and highlights the need for future research, but definitive statements regarding cost-effectiveness cannot be made as a result of the limited evidence on clinical effectiveness, identified in *Chapter 3, Results of the systematic review*.

Recommendations for future research

Further research is urgently needed to determine whether or not the use of splints is clinically effective, generates meaningful patient benefit and whether or not splints offer an efficient use of scarce NHS resources for both bruxism and TMD. There is a need for well-conducted RCTs involving both TMD and bruxism patients. These trials should compare oral splints with an agreed minimal intervention such as advice/counselling, education or self-performed exercises (applied to both the intervention and control groups). Multiple trials will be required to answer questions about patients with different subtypes of TMD. The selection of patients for inclusion in these studies should, ideally, conform to the DC/TMD diagnostic guidelines to ensure that patients have well-defined conditions and are a homogeneous group. Trials should be conducted in those settings that reflect the current provision of splints provided in the NHS. Triallists should carefully report the data for the patients included in each TMD subgroup separately, to ensure that the data can be pooled for each subgroup in future meta-analyses.

The results of the EVPI analysis indicate that there is substantial decision uncertainty and that future research is worthwhile. The EVPPI analysis identified two important areas of future research to reduce decision uncertainty with regards to cost-effectiveness, as well as two areas of research in which further research is unlikely to reduce decision uncertainty. The priority areas for further research are:

1. The treatment effectiveness of splints and, consequently, that of custom-made versus prefabricated splints. Future economic evaluations should also include provision for extended follow-up to resolve longer-term decision uncertainty in pain trajectory and clinical effectiveness.

2. Further data are required to determine the long-term costs to the NHS of different types of splint provision. This includes generating evidence regarding the appropriate banding for different splint types on the NHS in England, as well as determining the frequency at which splints will require replacement if rolled out to TMD patients.

The VOI analysis indicated that further research to determine the costs or utilities associated with pain states would not be worthwhile, as current evidence obtained from the DEEP study[94] is sufficient to aid decision-making.

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Publication

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Data-sharing statement

Further data from the systematic review can be obtained from the corresponding author on request.

References

1. Riley P, Glenny AM, Worthington HV, Jacobsen E, Robertson C, Durham J, *et al.* Oral splints for temporomandibular disorder or bruxism: a systematic review. *Br Dent J* 2020;**228**:191–7.
2. National Institute of Dental and Craniofacial Research. *Prevalence of TMJD and Its Signs and Symptoms*. 2014. URL: www.nidcr.nih.gov/datastatistics/finddatabytopic/facialpain/prevalencetmjd.htm (accessed March 2019).
3. Aggarwal VR, Joughin A, Zakrzewska J, Appelbe P, Tickle M. Dentists' preferences for diagnosis, management and referral of chronic oro-facial pain: results from a national survey. *Health Educ J* 2012;**71**:662–9. https://doi.org/10.1177/0017896911419350
4. Lobbezoo F, Ahlberg J, Glaros AG, Kato T, Koyano K, Lavigne GJ, *et al.* Bruxism defined and graded: an international consensus. *J Oral Rehabil* 2013;**40**:2–4. https://doi.org/10.1111/joor.12011
5. Manfredini D, Winocur E, Guarda-Nardini L, Paesani D, Lobbezoo F. Epidemiology of bruxism in adults: a systematic review of the literature. *J Orofac Pain* 2013;**27**:99–110. https://doi.org/10.11607/jop.921
6. Lobbezoo F, Ahlberg J, Manfredini D, Winocur E. Are bruxism and the bite causally related? *J Oral Rehabil* 2012;**39**:489–501. https://doi.org/10.1111/j.1365-2842.2012.02298.x
7. Marbach JJ, Raphael KG, Janal MN, Hirschkorn-Roth R. Reliability of clinician judgements of bruxism. *J Oral Rehabil* 2003;**30**:113–18. https://doi.org/10.1046/j.1365-2842.2003.01146.x
8. Klasser GD, Greene CS. Oral appliances in the management of temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;**107**:212–23. https://doi.org/10.1016/j.tripleo.2008.10.007
9. Clark GT, Minakuchi H. Oral Appliances. In Laskin DM, Greene CS, Hylander WL, editors. *Temporomandibular Disorders: An Evidence-based Approach to Diagnosis and Treatment*. Hanover Park, IL: Quintessence Publishing Co. Inc.; 2006. pp. 377–390.
10. Wright EF. Occlusal Appliance Therapy. In Wright EF, editor. *Manual of Temporomandibular Disorders*. Ames, IA: Wiley-Blackwell; 2014. pp. 149–222.
11. Wassell RW, Verhees L, Lawrence K, Davies S, Lobbezoo F. Over-the-counter (OTC) bruxism splints available on the Internet. *Br Dent J* 2014;**216**:E24. https://doi.org/10.1038/sj.bdj.2014.452
12. Lickteig R, Lotze M, Kordass B. Successful therapy for temporomandibular pain alters anterior insula and cerebellar representations of occlusion. *Cephalalgia* 2013;**33**:1248–57. https://doi.org/10.1177/0333102413491028
13. American Academy of Dental Sleep Medicine. *About Dental Sleep Medicine*. URL: https://aadsm.org (accessed 9 October 2019).
14. Abstract Archives. *Welcome to the IADR Abstract Archive*. URL: https://iadr.abstractarchives.com/home (accessed 9 October 2019).
15. The Cochrane Collaboration. *Cochrane Handbook for Systematic Reviews of Interventions*. URL: https://training.cochrane.org/handbook (accessed 24 October 2019).
16. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997;**315**:629–34. https://doi.org/10.1136/bmj.315.7109.629
17. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord* 1992;**6**:301–55.

18. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, *et al.* Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group†. *J Oral Facial Pain Headache* 2014;**28**:6–27. https://doi.org/10.11607/jop.1151

19. De Leeuw R, Klasser GD, editors. *Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management*. 5th edn. Hanover Park, IL: Quintessence Publishing Co. Inc.; 2013.

20. Atkins D, Best D, Briss PA, Eccles M, Falck-Ytter Y, Flottorp S, *et al.* Grading quality of evidence and strength of recommendations. *BMJ* 2004;**328**:1490. https://doi.org/10.1136/bmj.328.7454.1490

21. GRADEPro. *GRADE your Evidence and Improve your Guideline Development in Health Care*. URL: www.guidelinedevelopment.org (accessed 9 October 2019).

22. Wassell RW, Adams N, Kelly PJ. Treatment of temporomandibular disorders by stabilising splints in general dental practice: results after initial treatment. *Br Dent J* 2004;**197**:35–41. https://doi.org/10.1038/sj.bdj.4811420

23. Tavera AT, Montoya MC, Calderón EF, Gorodezky G, Wixtrom RN. Approaching temporomandibular disorders from a new direction: a randomized controlled clinical trial of the TMDes ear system. *Cranio* 2012;**30**:172–82. https://doi.org/10.1179/crn.2012.027

24. Alencar F, Becker A. Evaluation of different occlusal splints and counselling in the management of myofascial pain dysfunction. *J Oral Rehabil* 2009;**36**:79–85. https://doi.org/10.1111/j.1365-2842.2008.01913.x

25. Conti PC, Miranda JE, Conti AC, Pegoraro LF, Araújo Cdos R. Partial time use of anterior repositioning splints in the management of TMJ pain and dysfunction: a one-year controlled study. *J Appl Oral Sci* 2005;**13**:345–50. https://doi.org/10.1590/S1678-77572005000400006

26. Conti PC, dos Santos CN, Kogawa EM, de Castro Ferreira Conti AC, de Araujo Cdos R. The treatment of painful temporomandibular joint clicking with oral splints: a randomized clinical trial. *J Am Dent Assoc* 2006;**137**:1108–14. https://doi.org/10.14219/jada.archive.2006.0349

27. Conti PC, de Alencar EN, da Mota Corrêa AS, Lauris JR, Porporatti AL, Costa YM. Behavioural changes and occlusal splints are effective in the management of masticatory myofascial pain: a short-term evaluation. *J Oral Rehabil* 2012;**39**:754–60. https://doi.org/10.1111/j.1365-2842.2012.02327.x

28. Conti PC, Corrêa AS, Lauris JR, Stuginski-Barbosa J. Management of painful temporomandibular joint clicking with different intraoral devices and counseling: a controlled study. *J Appl Oral Sci* 2015;**23**:529–35. https://doi.org/10.1590/1678-775720140438

29. Costa YM, Porporatti AL, Stuginski-Barbosa J, Bonjardim LR, Conti PC. Additional effect of occlusal splints on the improvement of psychological aspects in temporomandibular disorder subjects: a randomized controlled trial. *Arch Oral Biol* 2015;**60**:738–44. https://doi.org/10.1016/j.archoralbio.2015.02.005

30. de Felício CM, Mazzetto MO, de Silva MA, Bataglion C, Hotta TH. A preliminary protocol for multi-professional centers for the determination of signs and symptoms of temporomandibular disorders. *Cranio* 2006;**24**:258–64. https://doi.org/10.1179/crn.2006.041

31. de Felício CM, de Oliveira MM, da Silva MA. Effects of orofacial myofunctional therapy on temporomandibular disorders. *Cranio* 2010;**28**:249–59. https://doi.org/10.1179/crn.2010.033

32. Gomes CA, El Hage Y, Amaral AP, Politti F, Biasotto-Gonzalez DA. Effects of massage therapy and occlusal splint therapy on electromyographic activity and the intensity of signs and symptoms in individuals with temporomandibular disorder and sleep bruxism: a randomized clinical trial. *Chiropr Man Therap* 2014;**22**:43. https://doi.org/10.1186/s12998-014-0043-6

33. Gomes CA, El-Hage Y, Amaral AP, Herpich CM, Politti F, Kalil-Bussadori S, *et al.* Effects of massage therapy and occlusal splint usage on quality of life and pain in individuals with sleep bruxism: a randomized controlled trial. *J Jpn Phys Ther Assoc* 2015;**18**:1–6. https://doi.org/10.1298/jjpta.18.1

34. Zuim PR, Garcia AR, Turcio KH, Hamata MM. Evaluation of microcurrent electrical nerve stimulation (MENS) effectiveness on muscle pain in temporomandibular disorders patients. *J Appl Oral Sci* 2006;**14**:61–6. https://doi.org/10.1590/S1678-77572006000100012

35. Ekberg EC, Vallon D, Nilner M. Occlusal appliance therapy in patients with temporomandibular disorders. A double-blind controlled study in a short-term perspective. *Acta Odontol Scand* 1998;**56**:122–8. https://doi.org/10.1080/00016359850136102

36. Ekberg E, Vallon D, Nilner M. The efficacy of appliance therapy in patients with temporomandibular disorders of mainly myogenous origin. A randomized, controlled, short-term trial. *J Orofac Pain* 2003;**17**:133–9.

37. Johansson A, Wenneberg B, Wagersten C, Haraldson T. Acupuncture in treatment of facial muscular pain. *Acta Odontol Scand* 1991;**49**:153–8. https://doi.org/10.3109/00016359109005900

38. List T, Helkimo M, Andersson S, Carlsson GE. Acupuncture and occlusal splint therapy in the treatment of craniomandibular disorders. Part I. A comparative study. *Swed Dent J* 1992;**16**:125–41.

39. Lundh H, Westesson PL, Kopp S, Tillström B. Anterior repositioning splint in the treatment of temporomandibular joints with reciprocal clicking: comparison with a flat occlusal splint and an untreated control group. *Oral Surg Oral Med Oral Pathol* 1985;**60**:131–6. https://doi.org/10.1016/0030-4220(85)90280-4

40. Lundh H, Westesson PL, Jisander S, Eriksson L. Disk-repositioning onlays in the treatment of temporomandibular joint disk displacement: comparison with a flat occlusal splint and with no treatment. *Oral Surg Oral Med Oral Pathol* 1988;**66**:155–62. https://doi.org/10.1016/0030-4220(88)90084-9

41. Lundh H, Westesson PL, Eriksson L, Brooks SL. Temporomandibular joint disk displacement without reduction. Treatment with flat occlusal splint versus no treatment. *Oral Surg Oral Med Oral Pathol* 1992;**73**:655–8. https://doi.org/10.1016/0030-4220(92)90003-9

42. Magnusson T, Syrén M. Therapeutic jaw exercises and interocclusal appliance therapy. A comparison between two common treatments of temporomandibular disorders. *Swed Dent J* 1999;**23**:27–37.

43. Nilsson H, Limchaichana N, Nilner M, Ekberg EC. Short-term treatment of a resilient appliance in TMD pain patients: a randomized controlled trial. *J Oral Rehabil* 2009;**36**:547–55. https://doi.org/10.1111/j.1365-2842.2009.01973.x

44. Wahlund K, List T, Larsson B. Treatment of temporomandibular disorders among adolescents: a comparison between occlusal appliance, relaxation training, and brief information. *Acta Odontol Scand* 2003;**61**:203–11. https://doi.org/10.1080/00016350310003891

45. DeVocht JW, Goertz CM, Hondras MA, Long CR, Schaeffer W, Thomann L, *et al.* A pilot study of a chiropractic intervention for management of chronic myofascial temporomandibular disorder. *J Am Dent Assoc* 2013;**144**:1154–63. https://doi.org/10.14219/jada.archive.2013.0034

46. Pierce CJ, Gale EN. A comparison of different treatments for nocturnal bruxism. *J Dent Res* 1988;**67**:597–601. https://doi.org/10.1177/00220345880670031501

47. Raphael KG, Marbach JJ. Widespread pain and the effectiveness of oral splints in myofascial face pain. *J Am Dent Assoc* 2001;**132**:305–16. https://doi.org/10.14219/jada.archive.2001.0173

48. Rubinoff MS, Gross A, McCall WD. Conventional and nonoccluding splint therapy compared for patients with myofascial pain dysfunction syndrome. *Gen Dent* 1987;**35**:502–6.

49. Sharma AR. *Short Term Efficacy of Appliance and Physical Therapy for the Treatment of Bilateral Masseter Myalgia: a Double Blinded Randomized Clinical Trial*. PhD thesis. Buffalo, NY: University at Buffalo; 2016.

50. Truelove E, Huggins KH, Mancl L, Dworkin SF. The efficacy of traditional, low-cost and nonsplint therapies for temporomandibular disorder: a randomized controlled trial. *J Am Dent Assoc* 2006;**137**:1099–107. https://doi.org/10.14219/jada.archive.2006.0348

51. Wright E, Anderson G, Schulte J. A randomized clinical trial of intraoral soft splints and palliative treatment for masticatory muscle pain. *J Orofac Pain* 1995;**9**:192–9.

52. Hasanoglu Erbasar GN, Alpaslan C, Eroglu Inan G. Can an NTI-tss device be effective as a first-line therapy in patients with TMD myofascial pain? *J Oral Rehabil* 2017;**44**:589–93. https://doi.org/10.1111/joor.12524

53. Karakis D, Dogan A, Bek B. Evaluation of the effect of two different occlusal splints on maximum occlusal force in patients with sleep bruxism: a pilot study. *J Adv Prosthodont* 2014;**6**:103–8. https://doi.org/10.4047/jap.2014.6.2.103

54. Tatli U, Benlidayi ME, Ekren O, Salimov F. Comparison of the effectiveness of three different treatment methods for temporomandibular joint disc displacement without reduction. *Int J Oral Maxillofac Surg* 2017;**46**:603–9. https://doi.org/10.1016/j.ijom.2017.01.018

55. Amin A, Meshramkar R, Lekha K. Comparative evaluation of clinical performance of different kind of occlusal splint in management of myofascial pain. *J Indian Prosthodont Soc* 2016;**16**:176–81. https://doi.org/10.4103/0972-4052.176521

56. Katyayan PA, Katyayan MK, Shah RJ, Patel G. Efficacy of appliance therapy on temporomandibular disorder related facial pain and mandibular mobility: a randomized controlled study. *J Indian Prosthodont Soc* 2014;**14**:251–61. https://doi.org/10.1007/s13191-013-0320-4

57. Daif ET. Correlation of splint therapy outcome with the electromyography of masticatory muscles in temporomandibular disorder with myofascial pain. *Acta Odontol Scand* 2012;**70**:72–7. https://doi.org/10.3109/00016357.2011.597776

58. Elsharkawy TM, Ali NM. Evaluation of acupuncture and occlusal splint therapy in the treatment of temporomandibular joint disorders. *Egypt Dent J* 1995;**41**:1227–32.

59. Yu CH, Qian HX. Evaluation of short term efficacy of the stabilized splint and the combination of manipulative and physical therapies for temporomandibular joint disc displacement without reduction. [Chinese.] *J Shanghai Jiaotong Univ (Sci)* 2016;**36**:850–5.

60. Zhang FY, Wang XG, Dong J, Zhang JF, Lü YL. Effect of occlusal splints for the management of patients with myofascial pain: a randomized, controlled, double-blind study. *Chin Med J* 2013;**126**:2270–5.

61. Ficnar T, Middelberg C, Rademacher B, Hessling S, Koch R, Figgener L. Evaluation of the effectiveness of a semi-finished occlusal appliance – a randomized, controlled clinical trial. *Head Face Med* 2013;**9**:5. https://doi.org/10.1186/1746-160X-9-5

62. Giannakopoulos NN, Katsikogianni EN, Hellmann D, Eberhard L, Leckel M, Schindler HJ, Schmitter M. Comparison of three different options for immediate treatment of painful temporomandibular disorders: a randomized, controlled pilot trial. *Acta Odontol Scand* 2016;**74**:480–6. https://doi.org/10.1080/00016357.2016.1204558

63. Leeson RMA. *A Comparison of Medical and Physical Therapies in the Management of Facial Arthromyalgia (Temporomandibular Joint Dysfunction)*. PhD thesis. London: University of London; 2007.

64. Michelotti A, Iodice G, Vollaro S, Steenks MH, Farella M. Evaluation of the short-term effectiveness of education versus an occlusal splint for the treatment of myofascial pain of the jaw muscles. *J Am Dent Assoc* 2012;**143**:47–53. https://doi.org/10.14219/jada.archive.2012.0018

65. Rampello A, Saccucci M, Falisi G, Panti F, Polimeni A, Di Paolo C. A new aid in temporomandibular joint disorders' therapy: the universal neuromuscular immediate relaxing appliance. *J Biol Regul Homeost Agents* 2013;**27**:1011–19.

66. Haketa T, Kino K, Sugisaki M, Takaoka M, Ohta T. Randomized clinical trial of treatment for TMJ disc displacement. *J Dent Res* 2010;**89**:1259–63. https://doi.org/10.1177/0022034510378424

67. Nagata K, Maruyama H, Mizuhashi R, Morita S, Hori S, Yokoe T, Sugawara Y. Efficacy of stabilisation splint therapy combined with non-splint multimodal therapy for treating RDC/TMD axis I patients: a randomised controlled trial. *J Oral Rehabil* 2015;**42**:890–9. https://doi.org/10.1111/joor.12332

68. Dao TT, Lavigne GJ, Charbonneau A, Feine JS, Lund JP. The efficacy of oral splints in the treatment of myofascial pain of the jaw muscles: a controlled clinical trial. *Pain* 1994;**56**:85–94. https://doi.org/10.1016/0304-3959(94)90153-8

69. van der Zaag J, Lobbezoo F, Wicks DJ, Visscher CM, Hamburger HL, Naeije M. Controlled assessment of the efficacy of occlusal stabilization splints on sleep bruxism. *J Orofac Pain* 2005;**19**:151–8.

70. Nitecka-Buchta A, Marek B, Baron S. CGRP plasma level changes in patients with temporomandibular disorders treated with occlusal splints – a randomised clinical trial. *Endokrynol Pol* 2014;**65**:217–23. https://doi.org/10.5603/EP.2014.0030

71. Niemelä K, Korpela M, Raustia A, Ylöstalo P, Sipilä K. Efficacy of stabilisation splint treatment on temporomandibular disorders. *J Oral Rehabil* 2012;**39**:799–804. https://doi.org/10.1111/j.1365-2842.2012.02335.x

72. Christidis N, Doepel M, Ekberg E, Ernberg M, Le Bell Y, Nilner M. Effectiveness of a prefabricated occlusal appliance in patients with temporomandibular joint pain: a randomized controlled multicenter study. *J Oral Facial Pain Headache* 2014;**28**:128–37. https://doi.org/10.11607/ofph.1216

73. Nilner M, Ekberg E, Doepel M, Andersson J, Selovuo K, Le Bell Y. Short-term effectiveness of a prefabricated occlusal appliance in patients with myofascial pain. *J Orofac Pain* 2008;**22**:209–18.

74. Helkimo M. Studies on function and dysfunction of the masticatory system. II. Index for anamnestic and clinical dysfunction and occlusal state. *Sven Tandlak Tidskr* 1974;**67**:101–21.

75. Fonseca DM, Bonfante G, Valle AL, de Freitas SFT. Diagnóstico pela anamnese da disfunção craniomandibular. *Rev Gauch de Odontol* 1994;**4**:23–32.

76. Castroflorio T, Bargellini A, Lucchese A, Manuelli M, Casasco F, Cugliari G, *et al.* Effects of clear aligners on sleep bruxism: randomized controlled trial. *J Biol Regul Homeost Agents* 2018;**32**(2 Suppl. 2):21–9.

77. Al Quran FA, Kamal MS. Anterior midline point stop device (AMPS) in the treatment of myogenous TMDs: comparison with the stabilization splint and control group. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;**101**:741–7. https://doi.org/10.1016/j.tripleo.2005.04.021

78. Alpaslan C, Kahraman S, Guner B, Cula S. Does the use of soft or hard splints affect the short-term outcome of temporomandibular joint arthrocentesis? *Int J Oral Maxillofac Surg* 2008;**37**:424–7. https://doi.org/10.1016/j.ijom.2008.01.022

79. Gavish A, Winocur E, Ventura YS, Halachmi M, Gazit E. Effect of stabilization splint therapy on pain during chewing in patients suffering from myofascial pain. *J Oral Rehabil* 2002;**29**:1181–6. https://doi.org/10.1046/j.1365-2842.2002.00994.x

80. Madani AS, Mirmortazavi A. Comparison of three treatment options for painful temporomandibular joint clicking. *J Oral Sci* 2011;**53**:349–54. https://doi.org/10.2334/josnusd.53.349

81. Manfredini D, Favero L, Cocilovo F, Monici M, Guarda-Nardini L. A comparison trial between three treatment modalities for the management of myofascial pain of jaw muscles: a preliminary study. *Cranio* 2018;**36**:327–31. https://doi.org/10.1080/08869634.2017.1349571

82. Drummond MF, Jefferson TO. Guidelines for authors and peer reviewers of economic submissions to the BMJ. The BMJ Economic Evaluation Working Party. *BMJ* 1996;**313**:275–83. https://doi.org/10.1136/bmj.313.7052.275

83. Philips Z, Ginnelly L, Sculpher M, Claxton K, Golder S, Riemsma R, *et al.* Review of guidelines for good practice in decision-analytic modelling in health technology assessment. *Health Technol Assess* 2004;**8**(36). https://doi.org/10.3310/hta8360

84. Lincoff NS. Treatment of chronic facial pain. *Curr Treat Options neurol* 2006;**8**:69–79. https://doi.org/10.1007/s11940-996-0025-7

85. Patel K, Hemmings KW, Vaughan S. The provision of occlusal splints in primary dental care. *Prim Dent Care* 2000;**7**:109–13. https://doi.org/10.1308/135576100322694196

86. Banhiran W, Kittiphumwong P, Assanasen P, Chongkolwatana C, Metheetrairut C. Adjustable thermoplastic mandibular advancement device for obstructive sleep apnea: outcomes and practicability. *Laryngoscope* 2014;**124**:2427–32. https://doi.org/10.1002/lary.24607

87. Wiedel AP. Fixed or removable appliance for early orthodontic treatment of functional anterior crossbite. *Swed Dent J Suppl* 2015;**238**:10–72.

88. Yekkalam N, Wänman A. Factors associated with clinical decision-making in relation to treatment need for temporomandibular disorders. *Acta Odontol Scand* 2016;**74**:134–41. https://doi.org/10.3109/00016357.2015.1063159

89. Vos LM, Stant AD, Quik EH, Huddleston Slater JJR, Stegenga B. Cost effectiveness of arthrocentesis as initial treatment for temporomandibular joint arthralgia: a randomized controlled trial. *Int J Oral Maxillofac Surg* 2013;**42**:1369. https://doi.org/10.1016/j.ijom.2013.07.710

90. Koyano K, Tsukiyama Y, Ichiki R, Kuwata T. Assessment of bruxism in the clinic. *J Oral Rehabil* 2008;**35**:495–508. https://doi.org/10.1111/j.1365-2842.2008.01880.x

91. Korthals-de Bos IB, Hoving JL, van Tulder MW, Rutten-van Mölken MP, Adèr HJ, de Vet HC, *et al.* Cost effectiveness of physiotherapy, manual therapy, and general practitioner care for neck pain: economic evaluation alongside a randomised controlled trial. *BMJ* 2003;**326**:911. https://doi.org/10.1136/bmj.326.7395.911

92. Aggarwal VR, Macfarlane GJ, Farragher TM, McBeth J. Risk factors for onset of chronic oro-facial pain – results of the North Cheshire oro-facial pain prospective population study. *Pain* 2010;**149**:354–9. https://doi.org/10.1016/j.pain.2010.02.040

93. Macfarlane TV, Glenny AM, Worthington HV. Systematic review of population-based epidemiological studies of oro-facial pain. *J Dent* 2001;**29**:451–67. https://doi.org/10.1016/S0300-5712(01)00041-0

94. Durham J, Steele JG, Breckons M, Story W, Vale L. DEEP Study: does EQ-5D-5L measure the impacts of persistent oro-facial pain? *J Oral Rehabil* 2015;**42**:643–50. https://doi.org/10.1111/joor.12296

95. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain* 1992;**50**:133–49. https://doi.org/10.1016/0304-3959(92)90154-4

96. Office for National Statistics. *National Life Tables, UK: 2013 to 2015*. URL: www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/bulletins/nationallifetablesunitedkingdom/20132015 (accessed 10 October 2018).

97. National Institute for Health and Care Excellence. *Guide to the Methods of Technology Appraisal 2013*. London: NICE; 2013.

98. Durham J, Breckons M, Araujo-Soares V, Exley C, Steele J, Vale L. Developing Effective and Efficient care pathways in chronic Pain: DEEP study protocol. *BMC Oral Health* 2014;**14**:6. https://doi.org/10.1186/1472-6831-14-6

99. Durham J, Shen J, Breckons M, Steele JG, Araujo-Soares V, Exley C, Vale L. Healthcare cost and impact of persistent orofacial pain: the DEEP study cohort. *J Dent Res* 2016;**95**:1147–54. https://doi.org/10.1177/0022034516648088

100. Briggs A, Claxton K, Sculpher M. *Decision Modelling for Health Economic Evaluation*. Oxford: Oxford University Press, 2006.

101. Welton NJ, Ades AE. Estimation of Markov chain transition probabilities and rates from fully and partially observed data: uncertainty propagation, evidence synthesis, and model calibration. *Med Decis Making* 2005;**25**:633–45. https://doi.org/10.1177/0272989X05282637

102. van Hout B, Janssen MF, Feng YS, Kohlmann T, Busschbach J, Golicki D, *et al.* Interim scoring for the EQ-5D-5L: mapping the EQ-5D-5L to EQ-5D-3L value sets. *Value Health* 2012;**15**:708–15. https://doi.org/10.1016/j.jval.2012.02.008

103. Ara R, Brazier JE. Populating an economic model with health state utility values: moving toward better practice. *Value Health* 2010;**13**:509–18. https://doi.org/10.1111/j.1524-4733.2010.00700

104. Steele J. *NHS Dental Services in England: An Independent Review Led by Professor Jimmy Steele*. 2009. URL: www.sigwales.org/wp-content/uploads/dh_101180.pdf (accessed October 2018).

105. Lord J, Longworth L, Singh J, Onyimadu O, Fricke J, Bayliss S, Meads C. *Oral Health Guidance – Economic Analysis of Oral Health Promotion Approaches for Dental Teams. Birmingham & Brunel Consortium External Assessment Centre (BBC EAC)*. 2015. URL: www.nice.org.uk/guidance/ng30/documents/oral-health-promotion-approaches-for-dental-teams-health-economic-analysis2 (accessed October 2018).

106. NHS Business Services Authority. *NHS Payments to General Practice, England, 2015–16*. URL: https://www.nhsbsa.nhs.uk/search?aggregated_field=contract+payment (accessed October 2018).

107. NHS Digital. *NHS Dental Statistics for England – 2016–17*. 2017. URL: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-dental-statistics/nhs-dental-statistics-for-england-2016-17 (accessed October 2018).

108. Campbell Collaboration, EPPI Centre. *CCEMG – EPPI-Centre Cost Converter*. 2016. URL: http://eppi.ioe.ac.uk/costconversion/default.aspx (accessed April 2018).

109. Tuffaha HW, Roberts S, Chaboyer W, Gordon LG, Scuffham PA. Cost-effectiveness and value of information analysis of nutritional support for preventing pressure ulcers in high-risk patients: implement now, research later. *Appl Health Econ Health Policy* 2015;**13**:167–79. https://doi.org/10.1007/s40258-015-0152-y

110. Slade GD. Epidemiology of temporomandibular joint disorders and related painful conditions. *Molecular Pain* 2014;**10**(Suppl. 1):O16. https://doi.org/10.1186/1744-8069-10-S1-O16

111. Office for National Statistics. *Population Estimates*. URL: www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates (accessed October 2018).

112. Strong M, Brennan A, Oakley J. How to calculate value of information in seconds using 'SAVI', the Sheffield Accelerated Value of Information web app. *Value Health* 2015;**18**:A725–6. https://doi.org/10.1016/j.jval.2015.09.2759

113. Health Economics Research Unit, University of Aberdeen. *Oral Splints for Orofacial Symptoms: An Evidence Synthesis*. URL: www.abdn.ac.uk/heru/research/assessment-of-technologies/inuse-tech/oral-splints-for-orofacial-symptoms–an-/ (accessed 23 October 2019).

114. Dworkin RH, Turk DC, Wyrwich KW, Beaton D, Cleeland CS, Farrar JT, *et al.* Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. *J Pain* 2008;**9**:105–21. https://doi.org/10.1016/j.jpain.2007.09.005

115. Dworkin RH, Turk DC, Farrar JT, Haythornthwaite JA, Jensen MP, Katz NP, *et al.* Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain* 2005;**113**:9–19. https://doi.org/10.1016/j.pain.2004.09.012

116. Williamson PR, Altman DG, Bagley H, Barnes KL, Blazeby JM, Brookes ST, *et al.* The COMET Handbook: version 1.0. *Trials* 2017;**18**:280. https://doi.org/10.1186/s13063-017-1978-4

117. Prinsen CA, Vohra S, Rose MR, Boers M, Tugwell P, Clarke M, *et al.* How to select outcome measurement instruments for outcomes included in a 'Core Outcome Set' – a practical guideline. *Trials* 2016;**17**:449. https://doi.org/10.1186/s13063-016-1555-2

118. Gurevitch J, Koricheva J, Nakagawa S, Stewart G. Meta-analysis and the science of research synthesis. *Nature* 2018;**555**:175–82. https://doi.org/10.1038/nature25753

119. Murad MH, Montori VM. Synthesizing evidence: shifting the focus from individual studies to the body of evidence. *JAMA* 2013;**309**:2217–18. https://doi.org/10.1001/jama.2013.5616

120. Manfredini D, Greene CS, Ahlberg J, De Laat A, Lobbezoo F, Klasser GD. Evidence-based dentistry or meta-analysis illness? A commentary on current publishing trends in the field of temporomandibular disorders and bruxism. *J Oral Rehabil* 2019;**46**:1–4. https://doi.org/10.1111/joor.12707

121. Schulz KF, Altman DG, Moher D, CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *BMJ* 2010;**340**:c332. https://doi.org/10.1136/bmj.c332

122. The Cochrane Library. *How CENTRAL is Created*. URL: www.cochranelibrary.com/help/central-creation-details.html (accessed 22 October 2019).

123. Healthcare Improvement Scotland, Scottish Intercollegiate Guidelines Network. *Search Filters*. URL: www.sign.ac.uk/search-filters.html (accessed 22 October 2019).

124. Doepel M, Nilner M, Ekberg E, Vahlberg T, Bell Yl. Headache: short- and long-term effectiveness of a prefabricated appliance compared to a stabilization appliance. *Acta Odontol Scand* 2011;**69**:129–36. https://doi.org/10.3109/00016357.2010.538719

125. NHS Digital. *2: Disease and Related Disorders – A Report from the Adult and Dental Health Survey 2009*. URL: https://files.digital.nhs.uk/publicationimport/pub01xxx/pub01086/adul-dent-heal-surv-summ-them-the2-2009-rep4.pdf (accessed March 2019).

Appendix 1 Literature search strategies

Clinical effectiveness

Cochrane Central Register of Controlled Trials

Date range searched: inception to issue 9 2018.

Date searched: 1 October 2018.

Search strategy

#1 [mh ^'Occlusal adjustment']

#2 [mh ^'Occlusal splints']

#3 [mh ^'Orthodontic appliances']

#4 ((occlusal or oral or temporomandibular or jaw* or mandib* or mouth* or bite* or TMJ or dental) near/5 splint*)

#5 ((dental or mouth or gum) next (guard* or shield*))

#6 (mouthguard* or gumguard* or nightguard* or gumshield* or 'bite plane*' or toothprotector*or 'tooth protector*')

#7 'splint therapy'

#8 ((oral or TMJ or orofacial) next appliance*)

#9 {or #1-#8}

#10 [mh 'craniomandibular disorders']

#11 [mh ^'facial pain']

#12 [mh ^'facial neuralgia']

#13 [mh ^'trigeminal neuralgia']

#14 [mh ^arthralgia]

#15 [mh ^'temporomandibular joint']

#16 #14 and #15

#17 [mh bruxism]

#18 (bruxism or (teeth near/5 grind*) or (teeth near/5 clench) or (jaw* near/5 clench) or (jaw* near/5 grind*))

#19 ((craniofacial or myofacial or myofascial or facial or orofacial) near/5 (pain* or syndrome*))

#20 ('trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen* syndrome*')

#21 (('temporomandibular joint' or craniomandibular or jaw* or mandib*) near/5 (pain* or disorder* or dysfunction* or arthralgia or syndrome*))

#22 (TMD or TMJD or (TMJ near/3 (disorder* or dysfunction* or syndrome* or pain*))):ti,ab

#23 ((temporomandibular or jaw* or mandib*) near/5 (disk or disc) next displac*)

#24 #10 or #11 or #12 or #13 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23

#25 #9 and #24

MEDLINE (via OvidSP)

Date range searched: 1946 to 1 October 2018.

Date searched: 1 October 2018.

Search strategy

1. Occlusal adjustment/
2. Occlusal splints/
3. Orthodontic appliances/
4. ((occlusal or oral or temporomandibular or jaw$ or mandib$ or mouth$ or bite$ or TMJ or dental) adj5 splint$).mp.
5. ((dental or mouth or gum) adj (guard$ or shield$)).mp.
6. (mouthguard$ or gumguard$ or nightguard$ or gumshield$ or 'bite plane$' or toothprotector$ or 'tooth protector$').mp.
7. 'splint therapy'.mp.
8. ((oral or TMJ or orofacial) adj appliance$).mp.
9. or/1-8
10. exp Craniomandibular disorders/
11. Facial pain/
12. Facial neuralgia/
13. Trigeminal neuralgia/
14. Arthralgia/ and temporomandibular joint/
15. exp bruxism/
16. (bruxism or (teeth adj5 grind$) or (teeth adj5 clench) or (jaw$ adj5 clench) or (jaw$ adj5 grind$)).mp.
17. ((craniofacial or myofacial or myofascial or facial or orofacial) adj5 (pain$ or syndrome$)).mp.
18. ('trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen$ syndrome$').mp.
19. (('temporomandibular joint' or craniomandibular or jaw$ or mandib$) adj5 (pain$ or disorder$ or dysfunction$ or arthralgia or syndrome$)).mp.
20. (TMD or TMJD or (TMJ adj3 (disorder$ or dysfunction$ or syndrome$ or pain$))).ti,ab.
21. ((temporomandibular or jaw$ or mandib$) adj5 (disk or disc) adj displac$).mp. 22. or/10-21
22. 9 and 22

Cochrane search filter for MEDLINE Ovid

Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomized trials in MEDLINE: sensitivity maximising version (2008 revision) as referenced in Chapter 6.4.11.1 and detailed in box 6.4.c of The Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011].

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. drug therapy.fs.
6. randomly.ab.
7. trial.ab.
8. groups.ab.
9. or/1-8
10. exp animals/ not humans.sh.
11. 9 not 10

EMBASE

Date range searched: 1980 to 1 October 2018.

Date searched: 1 October 2018.

Search strategy

1. Occlusal splint/
2. Orthodontic device/
3. ((occlusal or oral or temporomandibular or jaw$ or mandib$ or mouth$ or bite$ or TMJ or dental) adj5 splint$).mp.
4. ((dental or mouth or gum) adj (guard$ or shield$)).mp.
5. (mouthguard$ or gumguard$ or nightguard$ or gumshield$ or 'bite plane$' or toothprotector$ or 'tooth protector$').mp.
6. 'splint therapy'.mp.
7. ((oral or TMJ or orofacial) adj appliance$).mp.
8. or/1-7
9. Temporomandibular joint disorder/
10. Face pain/
11. Trigeminus neuralgia/
12. Arthralgia/ and temporomandibular joint/
13. exp bruxism/
14. (bruxism or (teeth adj5 grind$) or (teeth adj5 clench) or (jaw$ adj5 clench) or (jaw$ adj5 grind$)).mp.
15. ((craniofacial or myofacial or myofascial or facial or orofacial) adj5 (pain$ or syndrome$)).mp.
16. ('trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen$ syndrome$').mp.
17. (('temporomandibular joint' or craniomandibular or jaw$ or mandib$) adj5 (pain$ or disorder$ or dysfunction$ or arthralgia or syndrome$)).mp.
18. (TMD or TMJD or (TMJ adj3 (disorder$ or dysfunction$ or syndrome$ or pain$))).ti,ab.
19. ((temporomandibular or jaw$ or mandib$) adj5 (disk or disc) adj displac$).mp. or/9-19
20. 8 and 20

The above subject search was linked to adapted version of the Cochrane EMBASE Project filter for identifying RCTs in EMBASE Ovid (see online[122] for information):

1. Randomized controlled trial/
2. Controlled clinical study/
3. Random$.ti,ab.
4. randomization/
5. intermethod comparison/
6. placebo.ti,ab.
7. (compare or compared or comparison).ti.
8. ((evaluated or evaluate or evaluating or assessed or assess) and (compare or compared or comparing or comparison)).ab.
9. (open adj label).ti,ab.
10. ((double or single or doubly or singly) adj (blind or blinded or blindly)).ti,ab.
11. double blind procedure/
12. parallel group$1.ti,ab.
13. (crossover or cross over).ti,ab.
14. ((assign$ or match or matched or allocation) adj5 (alternate or group$1 or intervention$1 orpatient$1 or subject$1 or participant$1)).ti,ab.
15. (assigned or allocated).ti,ab.
16. (controlled adj7 (study or design or trial)).ti,ab.
17. (volunteer or volunteers).ti,ab.
18. trial.ti.
19. or/1-18
20. (exp animal/ or animal.hw. or nonhuman/) not (exp human/ or human cell/ or (human or humans).ti.)
21. 19 not 20

Cumulative Index to Nursing and Allied Health Literature (via EBSCOhost)

Date range searched: 1937 to 1 October 2018.

Date searched: 1 October 2018.

Search strategy

S22 S8 and S21

S21 S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20

S20 ((temporomandibular or jaw* or mandib*) N5 (disk or disc))

S19 (TMD or TMJD or (TMJ N3 (disorder* or dysfunction* or syndrome* or pain*)))

S18 (('temporomandibular joint' or craniomandibular or jaw* or mandib*) N5 (pain* or disorder* or dysfunction* or arthralgia or syndrome*))

S17 ('trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen* syndrome*')

S16 ((craniofacial or myofacial or myofascial or facial or orofacial) N5 (pain* or syndrome*))

S15 (bruxism or (teeth N5 grind*) or (teeth N5 clench) or (jaw* N5 clench) or (jaw* N5 grind*))

S14 (MH bruxism+)

S13 (MH arthralgia) AND (MH 'temporomandibular joint')

S12 (MH 'trigeminal neuralgia')

S11 (MH 'facial neuralgia')

S10 (MH 'facial pain')

S9 (MH 'craniomandibular disorders+')

S8 S1 or S2 or S3 or S4 or S5 or S6 or S7

S7 ((oral or TMJ or orofacial) N1 appliance*)

S6 'splint therapy'

S5 ((dental or mouth or gum) N1 (mouthguard* or gumguard* or nightguard* or gumshield* or 'bite plane*' or toothprotector* or 'tooth protector*') guard* or shield*))

S4 ((dental or mouth or gum) N1 (guard* or shield*))

S3 ((occlusal or oral or temporomandibular or jaw* or mandib* or mouth* or bite* or TMJ or dental) N5 splint*)

S2 (MH 'Orthodontic appliances')

S1 (MH 'Splints')

The above subject search was linked to Cochrane Oral Health's filter for identifying RCTs in CINAHL EBSCO*host*:

S1 MH Random Assignment or MH Single-blind Studies or MH Double-blind Studies or MH Triple-blind Studies or MH Crossover design or MH Factorial Design

S2 TI ('multicentre study' or 'multicenter study' or 'multi-centre study' or 'multi-center study') or AB ('multicentre study' or 'multicenter study' or 'multi-centre study' or 'multi-center study') or SU ('multicentre study' or 'multicenter study' or 'multi-centre study' or 'multi-center study')

S3 TI random* or AB random*

S4 AB 'latin square' or TI 'latin square'

S5 TI (crossover or cross-over) or AB (crossover or cross-over) or SU (crossover or cross-over)

S6 MH Placebos

S7 AB (singl* or doubl* or trebl* or tripl*) or TI (singl* or doubl* or trebl* or tripl*)

S8 TI blind* or AB mask* or AB blind* or TI mask*

S9 S7 and S8

S10 TI Placebo* or AB Placebo* or SU Placebo*

S11 MH Clinical Trials

S12 TI (Clinical AND Trial) or AB (Clinical AND Trial) or SU (Clinical AND Trial)

S13 S1 or S2 or S3 or S4 or S5 or S6 or S9 or S10 or S11 or S12

ProQuest Dissertations & Theses

Date range searched: no restriction.

Date searched: 1 October 2018.

Search strategy

all((splint or guard or shield or mouthguard or gumguard or gumshield or mouthshield or 'tooth protector' or orthodontic)) AND all(('temporomandibular joint' or TMD or TMJD or 'facial pain' or (face and pain) or bruxism))

Conference Proceedings Citation Index (via Web of Science)

Date range searched: no restriction.

Date searched: 1 October 2018.

Search strategy

15 #6 and #14

14 #7 or #8 or #9 or #10 or #11 or #12 or #13

13 TS=((temporomandibular or jaw* or mandib*) AND (disk or disc))

12 TS=(TMJ AND (disorder* or dysfunction* or syndrome* or pain*))

11 TS=(TMD or TMJD)

10 TS=(('temporomandibular joint' or craniomandibular or jaw* or mandib*) AND (pain* or disorder* or dysfunction* or arthralgia or syndrome*))

9 TS='trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen* syndrome*'

8 TS=((craniofacial or myofacial or myofascial or facial or orofacial) AND (pain* or syndrome*))

7 TS=(bruxism or (teeth and grind*) or (teeth and clench) or (jaw* and clench) or (jaw* and grind*))

6 #1 or #2 or #3 or #4 or #5

5 TS=((oral or TMJ or orofacial) AND appliance*)

4 TS='splint therapy'

3 TS=((dental or mouth or gum) and (guard* or shield*))

2 TS=(mouthguard* or gumguard* or nightguard* or gumshield* or 'bite plane*' or toothprotector or 'tooth protector*)

1 TS=((occlusal or oral or temporomandibular or jaw* or mandib* or mouth* or bite* or TMJ or dental) AND splint*)

US National Institutes of Health trials registry (ClinicalTrials.gov)
Date range searched: no restriction.

Date searched: 1 October 2018.

Search strategy
Condition: temporomandibular joint disorder

Other terms: splint*

Condition: Facial pain

Other terms: splint*

World Health Organization International Clinical Trials Registry Platform
Date range searched: no restriction.

Date searched: 1 October 2018.

Search strategy
Condition: temporomandibular joint disorder

Intervention: splint*

Condition: face AND pain

Intervention: splint*

American Academy of Dental Sleep Medicine website
Date range searched: no restriction.

Date searched: 1 October 2018.

Search strategy
temporomandibular and splint

International Association of Dental Research conference abstracts
Date range searched: no restriction.

Date searched: 1 October 2018.

Search strategy
occlusal splint and temporomandibular

occlusal splint and pain

occlusal splint and bruxism

Cost-effectiveness

MEDLINE (via OvidSP)
Date range searched: 1946 to 1 October 2018.

Date searched: 1 October 2018.

Search strategy

1. Occlusal adjustment/
2. Occlusal splints/
3. Orthodontic appliances/
4. ((occlusal or oral or temporomandibular or jaw$ or mandib$ or mouth$ or bite$ or TMJ or dental or 'vacuum form$') adj5 splint$).mp.
5. ((dental or mouth or gum) adj (guard$ or shield$)).mp.
6. (mouthguard$ or gumguard$ or nightguard$ or gumshield$ or 'bite plane$' or toothprotector$ or 'tooth protector$').mp.
7. 'splint therapy'.mp.
8. ((oral or TMJ or orofacial) adj appliance$).mp.
9. ('bite rais$' adj appliance$).mp.
10. or/1-9
11. exp Craniomandibular disorders/
12. Facial pain/
13. Facial neuralgia/
14. Trigeminal neuralgia/
15. Arthralgia/ and temporomandibular joint/
16. exp bruxism/
17. (bruxism or (teeth adj5 grind$) or (teeth adj5 clench) or (jaw$ adj5 clench) or (jaw$ adj5 grind$)).mp.
18. ((craniofacial or myofacial or myofascial or facial or orofacial) adj5 (pain$ or syndrome$)).mp.
19. ('trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen$ syndrome$').mp.
20. (('temporomandibular joint' or craniomandibular or jaw$ or mandib$) adj5 (pain$ or disorder$ or dysfunction$ or arthralgia or syndrome$)).mp.
21. (TMD or TMJD or (TMJ adj3 (disorder$ or dysfunction$ or syndrome$ or pain$))).ti,ab.
22. ((temporomandibular or jaw$ or mandib$) adj5 (disk or disc) adj displac$).mp.
23. or/11-22
24. 10 and 23

The above search was linked to the economic studies filter used by the Scottish Intercollegiate Guidelines Network[123] (an adaptation of the strategy designed by the NHS Centre for Reviews and Dissemination at the University of York).

1. Economics/
2. 'costs and cost analysis'/
3. Cost allocation/
4. Cost-benefit analysis/
5. Cost control/
6. Cost savings/
7. Cost of illness/
8. Cost sharing/
9. 'deductibles and coinsurance'/
10. Medical savings accounts/
11. Health care costs/
12. Direct service costs/
13. Drug costs/
14. Employer health costs/
15. Hospital costs/
16. Health expenditures/
17. Capital expenditures/
18. Value of life/

19. Exp economics, hospital/
20. Exp economics, medical/
21. Economics, nursing/
22. Economics, pharmaceutical/
23. Exp 'fees and charges'/
24. Exp budgets/
25. (low adj cost).mp.
26. (high adj cost).mp.
27. (health?care adj cost$).mp.
28. (fiscal or funding or financial or finance).tw.
29. (cost adj estimate$).mp.
30. (cost adj variable).mp.
31. (unit adj cost$).mp.
32. (economic$ or pharmacoeconomic$ or price$ or pricing).tw.
33. Or/1-32

EMBASE (via OvidSP)

Date range searched: 1980 to 1 October 2018.

Date searched: 1 October 2018.

Search strategy

1. Occlusal splint/Orthodontic device/((occlusal or oral or temporomandibular or jaw$ or mandib$ or mouth$ or bite$ or TMJ or dental or 'vacuum form$') adj5 splint$).mp.
2. ((dental or mouth or gum) adj (guard$ or shield$)).mp.
3. (mouthguard$ or gumguard$ or nightguard$ or gumshield$ or 'bite plane$' or toothprotector$ or 'tooth protector$').mp.
4. 'splint therapy'.mp.
5. ((oral or TMJ or orofacial) adj appliance$).mp.
6. ('bite rais$' adj appliance$).mp.
7. or/1-8
8. Temporomandibular joint disorder/
9. Face pain/
10. Trigeminus neuralgia/
11. Arthralgia/ and temporomandibular joint/
12. exp bruxism/
13. (bruxism or (teeth adj5 grind$) or (teeth adj5 clench) or (jaw$ adj5 clench) or (jaw$ adj5 grind$)).mp.
14. ((craniofacial or myofacial or myofascial or facial or orofacial) adj5 (pain$ or syndrome$)).mp.
15. ('trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen$ syndrome$').mp.
16. (('temporomandibular joint' or craniomandibular or jaw$ or mandib$) adj5 (pain$ or disorder$ or dysfunction$ or arthralgia or syndrome$)).mp.
17. (TMD or TMJD or (TMJ adj3 (disorder$ or dysfunction$ or syndrome$ or pain$))).ti,ab.
18. ((temporomandibular or jaw$ or mandib$) adj5 (disk or disc) adj displac$).mp
19. or/10-20
20. 9 and 21

The above search was linked to the economic studies filter used by the Scottish Intercollegiate Guidelines Network[123] (an adaptation of the strategy designed by the NHS Centre for Reviews and Dissemination at the University of York).

1. Socioeconomics/
2. Cost benefit analysis/
3. Cost effectiveness analysis/
4. Cost of illness/
5. Cost control/
6. Economic aspect/
7. Financial management/
8. Health care cost/
9. Health care financing/
10. Health economics/
11. Hospital cost/
12. (fiscal or financial or finance or funding).tw.
13. Cost minimization analysis/
14. (cost adj estimate$).mp.
15. (cost adj variable$).mp.
16. (unit adj cost$).mp.
17. Or/1-16

NHS EED Database (via OvidSP)

Date range searched: inception to issue 1 2016.

Date searched: 1 October 2018.

Search strategy

1. Splints/
2. (splint$ or guard$ or shield$ or mouthguard$ or gumguard$ or nightguard$ or gumshield$ or plane$ or 'tooth protector$' or toothprotector$ or 'oral appliance$' or 'orofacial appliance$' or 'bite rais$ appliance$').mp.
3. 1 or 2
4. Temporomandibular Joint Disorders/
5. Facial pain/
6. (TMD or TMJD).mp.
7. (bruxism or (teeth and grind$) or (teeth and clench$) or (jaw and clench$) or (jaw and grind$)).mp.
8. ((temporomandibular$ or (craniofacial or myofacial or myofascial or facial or orofacial or face)) adj5 (pain$ or syndrome$)).mp.
9. or/4-8
10. 3 and 9

Cumulative Index to Nursing and Allied Health Literature (via EBSCOhost)

Date range searched: 1937 to 1 October 2018.

Date searched: 1 October 2018.

Search strategy

S22 S8 and S21

S21 S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20

S20 ((temporomandibular or jaw* or mandib*) N5 (disk or disc))

S19 (TMD or TMJD or (TMJ N3 (disorder* or dysfunction* or syndrome* or pain*)))

S18 (('temporomandibular joint' or craniomandibular or jaw* or mandib*) N5 (pain* or disorder* or dysfunction* or arthralgia or syndrome*))

S17 ('trigeminal neuralgia' or 'sphenopalatine neuralgia' or 'Costen* syndrome*')

S16 ((craniofacial or myofacial or myofascial or facial or orofacial) N5 (pain* or syndrome*))

S15 (bruxism or (teeth N5 grind*) or (teeth N5 clench) or (jaw* N5 clench) or (jaw* N5 grind*))

S14 (MH bruxism+)

S13 (MH arthralgia) AND (MH 'temporomandibular joint')

S12 (MH 'trigeminal neuralgia')

S11 (MH 'facial neuralgia')

S10 (MH 'facial pain')

S9 (MH 'craniomandibular disorders+')

S8 S1 or S2 or S3 or S4 or S5 or S6 or S7

S7 ((oral or TMJ or orofacial or 'bite rais*') N1 appliance*)

S6 'splint therapy'

S5 ((dental or mouth or gum) N1 (mouthguard* or gumguard* or nightguard* or gumshield* or 'bite plane*' or toothprotector* or 'tooth protector*') guard* or shield*))

S4 ((dental or mouth or gum) N1 (guard* or shield*))

S3 ((occlusal or oral or temporomandibular or jaw* or mandib* or mouth* or bite* or TMJ or dental or 'vacuum form') N5 splint*)

S2 (MH 'Orthodontic appliances')

S1 (MH 'Splints')

The above search was linked to the economic studies filter used by the Scottish Intercollegiate Guidelines Network[123] (an adaptation of the strategy designed by the NHS Centre for Reviews and Dissemination at the University of York).

S23 S20 NOT (S21 or S22)

S22 AU Anonymous

S21 SO Cochrane

S20 S18 NOT S19

S19 (MH 'Animal Studies')

S18 S13 NOT S17

S17 S14 or S15 or S16

S16 PT News

S15 PT Letter

S14 PT Editorial

S13 S11 or S12

S12 (cost or costs or economic* or pharmacoeconomic* or price* or pricing*)

S11 S7 or S10

S10 S8 OR S9

S9 SU health resource utilization

S8 SU health resource allocation

S7 S1 NOT S6

S6 S2 or S3 or S4 or S5

S5 (MH 'Business+')

S4 (MH 'Financing, Organized+')

S3 (MH 'Financial Support+')

S2 (MH 'Financial Management+')

S1 (MH 'Economics+')

Appendix 2 Additional data tables

TABLE 26 TMD: Splint vs. no/minimal treatment – other data

Outcome: pain	Assessment point (months)	Study	Splint, mean (SD); number of events, or number of events/ total number analysed	No/minimal treatment, mean (SD); number of events	Result: MD/RR (95% CI)
Pain					
Catastrophizing Thoughts subscale of the Pain Related Self-Statement Scale. Self-reported questionnaire consisting of nine statements related to catastrophising thoughts involved in pain perception. Respondent asked to answer each statement indicating the frequency of thinking about pain during a pain crisis, on a 0–4 scale. The sum of all frequencies was divided by the total number of questions. Higher values demonstrate higher levels of pain catastrophising	3–6	Costa 2015[29]	0.76 (0.82); $n = 24$	1.14 (1.28); $n = 17$	MD −0.38 (−1.07 to 0.31); $p = 0.28$; favours splint
Presence of muscular pain (yes/no)	0–3	de Felício 2006[30]	22/42	41/42	RR 0.54 (0.40 to 0.72); $p < 0.0001$; favours splint
Current pain intensity using a 0 (no pain) to 10 (worst pain) NRS; reported as change from baseline score (unable to combine change score in primary meta-analysis using SMD; used in sensitivity analyses of studies reporting current pain intensity on VAS/NRS at 0–3 months and at 3–6 months)	0–3	DeVocht 2013[45]	1.4 (2.3504); $n = 20$	0.7 (1.7575); $n = 21$	MD 0.70 (−0.58 to 1.98); $p = 0.28$; favours splint
	3–6	DeVocht 2013[45]	2 (1.923); $n = 20$	1.7 (1.7575); $n = 21$	MD 0.30 (−0.83 to 1.43); $p = 0.6$; favours splint
Changes in pain assessed according to the following scale: impaired, unchanged, improved, symptom free (we dichotomised this as incidence of improved and symptom free)	0–3	Elsharkawy 1995[58]	21/23	20/23	RR 1.05 (0.86 to 1.29); $p = 0.64$; favours splint
Changes in facial pain and headache: reported as incidence of impaired, unchanged, improved, symptom free (we dichotomised the data to report the incidence of improved and symptom free)	0–3	Johansson 1991[37]	13/15	2/15	RR 6.50 (1.76 to 23.98); $p = 0.005$; favours splint
Number of painful muscle sites on palpation (out of 20 sites); 2 lb of pressure for extraoral muscles, 1 lb of pressure on the joints and intraoral muscles	3–6	Katyayan 2014[56]	8.725 (3.088); $n = 40$	7.375 (3.2); $n = 40$	MD 1.35 (−0.03 to 2.73); $p = 0.05$; favours control
TMJ pain as part of clinical dysfunction index Di (Helkimo[74]) categorised as none, mild and severe – we dichotomised as incidence of being pain free	0–3	Magnusson 1999[42]	7/9	9/9	RR 0.79 (0.54 to 1.16); $p = 0.23$; favours control
	3–6	Magnusson 1999[42]	8/9	9/9	RR 0.89 (0.67 to 1.20); $p = 0.46$; favours control

Outcome: pain	Assessment point (months)	Study	Splint, mean (SD); number of events, or number of events/ total number analysed	No/minimal treatment, mean (SD); number of events	Result: MD/RR (95% CI)
Muscle pain as part of clinical dysfunction index Di (Helkimo[74]) categorised as none, mild and severe – we dichotomised as incidence of being pain free	0–3	Magnusson 1999[42]	4/9	5/9	RR 0.80 (0.31 to 2.04); $p = 0.64$; favours control
	3–6	Magnusson 1999[42]	6/9	9/9	RR 0.68 (0.42 to 1.10); $p = 0.12$; favours control
Pain on movement as part of clinical dysfunction index Di (Helkimo[74]) categorised as none, mild and severe – we dichotomised as incidence of being pain free	0–3	Magnusson 1999[42]	8/9	8/9	RR 1.00 (0.72 to 1.39); $p = 1$; favours neither
	3–6	Magnusson 1999[42]	9/9	9/9	RR 1.00 (0.82 to 1.22); $p = 1$; favours neither
Spontaneous muscle pain and pain on chewing (chew bilaterally for 60 seconds on a stick of chewing gum) assessed separately using 0 mm (no pain) to 100 mm (worst pain) VAS; reported as change from baseline score (unable to combine change score in primary meta-analysis using SMD; used in sensitivity analyses of studies reporting current pain intensity on VAS/NRS at 0–3 months)	0–3	Michelotti 2012[64]	2.798 (2.012); $n = 18$	−11.289 (2.79); $n = 23$	MD 14.09 (12.62 to 15.56); $p = < 0.00001$; favours control
Pain on palpation: number of extraoral muscle sites (0–16)	0–3	Truelove 2006[50]	Arm 1: custom splint • 5.6 (5.4); $n = 54$ Arm 2: prefabricated splint • 4.7 (4.1); $n = 56$	4.3 (4); $n = 54$	MD 0.80 (−0.59 to 2.18); $p = 0.26$; favours control
	6–12	Truelove 2006[50]	Arm 1: custom splint • 3.6 (4.1); $n = 65$ Arm 2: prefabricated splint • 4.1 (4.4); $n = 55$	4.5 (4.5); $n = 48$	MD −0.66 (−2.14 to 0.82); $p = 0.38$; favours splint

continued

TABLE 26 TMD: Splint vs. no/minimal treatment – other data (*continued*)

Outcome: pain	Assessment point (months)	Study	Splint, mean (SD); number of events, or number of events/ total number analysed	No/minimal treatment, mean (SD); number of events	Result: MD/RR (95% CI)
Pain on palpation: number of intraoral muscle sites (0–4)	0–3	Truelove 2006[50]	Arm 1: custom splint • 3 (1.4); $n = 54$ Arm 2: prefabricated splint • 2.8 (1.6); $n = 56$	2.5 (1.6); $n = 54$	MD 0.40 (–0.11 to 0.91); $p = 0.12$; favours control
	6–12	Truelove 2006[50]	Arm 1: custom splint • 2.6 (1.6); $n = 65$ Arm 2: prefabricated splint • 3 (1.4); $n = 55$	2.6 (1.4); $n = 48$	MD 0.20 (–0.28 to 0.68); $p = 0.41$; favours control
Pain on palpation: number of TMJ sites (0–4)	0–3	Truelove 2006[50]	Arm 1: custom splint • 1.3 (1.5); $n = 54$ Arm 2: prefabricated splint • 1.1 (1.4); $n = 56$	1.1 (1.3); $n = 54$	MD 0.10 (–0.34 to 0.54); $p = 0.67$; favours control
	6–12	Truelove 2006[50]	Arm 1: custom splint • 0.9 (1.1); $n = 65$ Arm 2: prefabricated splint • 1 (1); $n = 55$	0.8 (0.9); $n = 48$	MD 0.15 (–0.17 to 0.47); $p = 0.35$; favours control

Outcome: pain	Assessment point (months)	Study	Splint, mean (SD); number of events, or number of events/ total number analysed	No/minimal treatment, mean (SD); number of events	Result: MD/RR (95% CI)
Pressure pain threshold measured using a pressure algometer that applied pressure on the skin surface (scale/units of measurement not stated but higher score = better outcome): TMJ	0–3	Wahlund 2003[44]	164.7 (51.5); $n = 37$	148.3 (53.8); $n = 39$	MD 16.40 (–7.27 to 40.07); $p = 0.17$; favours splint
	3–6	Wahlund 2003[44]	158.4 (39.3); $n = 37$	161.3 (61.1); $n = 39$	MD –2.90 (–25.88 to 20.08); $p = 0.8$; favours control
Pressure pain threshold measured using a pressure algometer that applied pressure on the skin surface (scale/units of measurement not stated but higher score = better outcome): masticatory muscles	0–3	Wahlund 2003[44]	334 (100.3); $n = 37$	295 (99.3); $n = 39$	MD 39.00 (–5.90 to 83.90); $p = 0.09$; favours splint
	3–6	Wahlund 2003[44]	344.5 (100.7); $n = 37$	335 (94.3); $n = 39$	MD 9.50 (–34.42 to 53.42); $p = 0.67$; favours splint
Muscle pain threshold assessed with a pressure algometer on the anterior temporal muscle and on the superior and inferior areas of the masseter muscle (psi: higher score = better outcome)	0–3	Wright 1995[51]	45.3 (12.7); $n = 10$	38.1 (22.8); $n = 10$	MD 7.20 (–8.98 to 23.38); $p = 0.38$; favours splint
TMJ clicking					
Articular noise (yes/no) – 'The predominant type of articular noise was a click (83.33% of cases)'	0–3	de Felício 2006[30]	25/42	37/42	RR 0.68 (0.51 to 0.89); $p = 0.005$; favours splint
Assessed using printed 0 (absence of symptom) to 10 (worst severity) for the following four situations: (1) when waking up, (2) during chewing, (3) when speaking and (4) at rest. The score was then summed and is therefore a 0–40 scale	0–3	de Felício 2010[31]	10.22 (8.11); $n = 10$	10.8 (6.68); $n = 10$	MD –0.58 (–7.09 to 5.93); $p = 0.86$; favours splint
Measured using a 0–10 worsening NRS	0–3	Nagata 2015[67]	1.856 (2.211); $n = 96$	1.5 (1.9565); $n = 85$	0.36 (–0.25 to 0.96); $p = 0.25$; favours control
Change in restricted mouth-opening					
Difficulty opening mouth (yes/no)	0–3	de Felício 2006[30]	17/42	31/42	RR 0.55 (0.36 to 0.83); $p = 0.004$; favours splint

continued

TABLE 26 TMD: Splint vs. no/minimal treatment – other data (*continued*)

Outcome: pain	Assessment point (months)	Study	Splint, mean (SD); number of events, or number of events/ total number analysed	No/minimal treatment, mean (SD); number of events	Result: MD/RR (95% CI)
Self-assessment of functional limitation of jaw using 0 (no limitation) to 100 (severe limitation) mm VAS	0–3	Hasanoglu 2017[52]	12.1 (18); $n = 20$	19.2 (19.2); $n = 20$	MD −7.10 (−18.63 to 4.43); $p = 0.23$; favours splint
Incidence of having difficulty in opening the mouth wide	0–3	Magnusson 1999[42]	1/9	1/9	RR 1.00 (0.07 to 13.64); $p = 1$; favours neither
	3–6	Magnusson 1999[42]	0/9	0/9	Not estimable
Frequency of headaches (secondary to pain-related TMD)					
Categorised as number having either infrequent/absent headache (< 1 day/month), frequent headache (1–14 days/ month) or chronic headache (> 14 days/month) – we dichotomised the data as incidence of frequent or chronic headache	3–6	Costa 2015[29]	18/24	11/17	RR 1.16 (0.76 to 1.76); $p = 0.49$; favours control
Quality of life (including physical and emotional function)					
Pain-related disability (0–100 worsening scale) assessed using RDC/TMD Axis II biobehavioural questionnaire	0–3	Tatli 2017[54]	14.9 (12.7); $n = 40$	17.7 (9.3); $n = 40$	MD −2.80 (−7.68 to 2.08); $p = 0.26$; favours splint
	3–6	Tatli 2017[54]	4.9 (6.4); $n = 40$	4.1 (6.6); $n = 40$	MD 0.80 (−2.05 to 3.65); $p = 0.58$; favours control
Psychological status (0–4 worsening scale) assessed using RDC/TMD Axis II biobehavioural questionnaire	0–3	Tatli 2017[54]	0.7 (0.4); $n = 40$	0.8 (0.4); $n = 40$	MD −0.10 (−0.28 to 0.08); $p = 0.26$; favours splint
	3–6	Tatli 2017[54]	0.5 (0.3); $n = 40$	0.6 (0.3); $n = 40$	MD −0.10 (−0.23 to 0.03); $p = 0.26$; favours splint
Patient satisfaction					
0 (not at all satisfied) to 10 (extremely satisfied) NRS	0–3	DeVocht 2013[45]	7.2 (1.4); $n = 20$	4.9 (2.3); $n = 21$	2.30 (1.14 to 3.46); $p = 0.0001$; favours splint
Adherence to treatment					
Incidence of those not totally complying with postoperative instructions	3–6	Daif 2012[57]	5/20	Not applicable	Not applicable

TMJ, temporomandibular joint.

TABLE 27 TMD: custom splint vs. prefabricated splint – other data

Outcome	Assessment point (months)	Study	Custom splint: mean (SD); number of events	Prefabricated splint: mean (SD); number of events	Result: MD/RR (95% CI)
Pain					
Modified Symptom Severity Index (Mod-SSI) – 28 characters for each of three variables: intensity, frequency and pain duration. Average of the three variables obtained and final scores ranged from 0.035 to 1 (higher = worse)	0–3	Amin 2016[55]	Arm 1: hard splint • 0.02 (0.14); $n = 15$ Arm 2: soft splint • 0.03 (0.13); $n = 15$	0.02 (0.13); $n = 15$	MD 0.00 (–0.08 to 0.09); $p = 0.91$; favours neither
Muscular palpation (masseter, temporalis and pterygoid muscles) performed bilaterally with tight and constant pressure of 1500 g, classified on 0–3 scale (0, no pain; 1, verbally reported pain; 2, pain or discomfort followed by facial musculature contraction and 3, patient backed away or showed lacrimation)	0–3	Amin 2016[55]	Arm 1: hard splint • 0 (0); $n = 15$ Arm 2: soft splint • 0 (0); $n = 15$	0 (0); $n = 15$	Not estimable
Overall improvement in TMJ pain assessed by the patient on a six-point rating scale: 0 = symptom free; 1 = much better; 2 = better; 3 = unchanged; 4 = worse; 5 = much worse (we dichotomised as incidence of unchanged or worse/much worse)	0–3	Christidis 2014[72]	4/21	9/23	RR 0.49 (0.18 to 1.35); $p = 0.17$; favours custom splint
	3–6	Christidis 2014[72]	2/17	6/20	RR 0.39 (0.09 to 1.70); $p = 0.21$; favours custom splint
	6–12	Christidis 2014[72]	1/15	2/18	RR 0.60 (0.06 to 5.99); $p = 0.66$; favours custom splint
Incidence of 30% reduction in worst reported VAS pain	0–3	Nilner 2008[73]	22/33	23/32	RR 0.93 (0.67 to 1.28); $p = 0.65$; favours prefabricated splint
	3–6	Nilner 2008[73]	22/24	23/28	RR 1.12 (0.90 to 1.38); $p = 0.31$; favours custom splint
	6–12	Nilner 2008[73]	21/22	26/27	RR 0.99 (0.88 to 1.11); $p = 0.31$; favours neither

continued

TABLE 27 TMD: custom splint vs. prefabricated splint – other data (*continued*)

Outcome	Assessment point (months)	Study	Custom splint: mean (SD); number of events	Prefabricated splint: mean (SD); number of events	Result: MD/RR (95% CI)
Incidence of 50% reduction in worst reported VAS pain	0–3	Nilner 2008[73]	18/33	21/32	RR 0.83 (0.56 to 1.24); $p = 0.36$; favours prefabricated splint
	> 3–6	Nilner 2008[73]	21/24	22/28	RR 1.11 (0.87 to 1.42); $p = 0.39$; favours custom splint
	> 6–12	Nilner 2008[73]	17/22	24/27	RR 0.87 (0.67 to 1.13); $p = 0.3$; favours prefabricated splint
Pain on palpation: number of extraoral muscle sites (0–16)	0–3	Truelove 2006[50]	5.6 (5.4); $n = 54$	4.7 (4.1); $n = 56$	MD 0.90 (–0.90 to 2.70); $p = 0.33$; favours prefabricated splint
	> 6–12	Truelove 2006[50]	3.6 (4.1); $n = 65$	4.1 (4.4); $n = 55$	MD –0.50 (–2.03 to 1.03); $p = 0.52$; favours custom splint
Pain on palpation: number of intraoral muscle sites (0–4)	0–3	Truelove 2006[50]	3 (1.4); $n = 54$	2.8 (1.6); $n = 56$	MD 0.20 (–0.36 to 0.76); $p = 0.48$; favours prefabricated splint
	> 6–12	Truelove 2006[50]	2.6 (1.6); $n = 65$	3 (1.4); $n = 55$	MD –0.40 (–0.94 to 0.14); $p = 0.14$; favours custom splint
Pain on palpation: number of TMJ sites (0–4)	0–3	Truelove 2006[50]	1.3 (1.5); $n = 54$	1.1 (1.4); $n = 56$	MD 0.20 (–0.34 to 0.74); $p = 0.47$; favours prefabricated splint
	> 6–12	Truelove 2006[50]	0.9 (1.1); $n = 65$	1 (1); $n = 55$	MD –0.10 (–0.48 to 0.28); $p = 0.6$; favours custom splint
TMJ clicking					
On opening, closing or both	0–3	Truelove 2006[50]	28/54	29/56	RR 1.00 (0.70 to 1.44); $p = 0.99$; favours neither
	6–12	Truelove 2006[50]	37/65	25/55	RR 1.25 (0.87 to 1.79); $p = 0.22$; favours prefabricated splint

Outcome	Assessment point (months)	Study	Custom splint: mean (SD); number of events	Prefabricated splint: mean (SD); number of events	Result: MD/RR (95% CI)
Frequency of headaches (secondary to pain-related TMD)					
During the preceding 6 months on a verbal scale, as follows: no headache; rarely; once a month; once a week; at least 15 times a month; continuous (we dichotomised this as once per week or more)	0–3	Nilner 2008[73]	7/32	12/32	RR 0.58 (0.26 to 1.29); $p = 0.18$; favours custom splint
	> 3–6	Nilner 2008[73]	3/24	7/28	RR 0.50 (0.15 to 1.72); $p = 0.27$; favours custom splint
	> 6–12	Nilner 2008[73]	2/22	7/27	RR 0.35 (0.08 to 1.52); $p = 0.16$; favours custom splint
Adherence to treatment					
Not clear what level of compliance (e.g. using splint all the time/majority of the time, etc.)	0–3	Truelove 2006[50]	48/54	42/56	RR 1.19 (0.99 to 1.42); $p = 0.06$; favours custom splint
	6–12	Truelove 2006[50]	47/65	17/55	RR 2.34 (1.53 to 3.57); $p < 0.0001$; favours custom splint

TMJ, temporomandibular joint.

TABLE 28 TMD: splint vs. control splint – other data

Outcome	Assessment point (months)	Study	Splint: mean (SD)/number of events	Control splint: mean (SD)/number of events	Result: MD/RR (95% CI)
Pain					
Modified Symptom Severity Index (Mod-SSI) – 28 characters for each of three variables: intensity, frequency and pain duration. Average of the three variables obtained and final scores ranged from 0.035 to 1 (higher = worse)	0–3	Alencar 2009[24]	Arm 1: hard splint • 0.31 (0.2); $n = 14$ Arm 2: soft splint • 0.3 (0.26); $n = 14$	0.24 (0.24); $n = 14$	MD 0.07 (–0.09 to 0.22); $p = 0.4$; favours control splint
Muscular palpation (masseter, temporalis and pterygoid muscles) performed bilaterally with tight and constant pressure of 1500 g, classified on 0–3 scale (0, no pain; 1, verbally reported pain; 2, pain or discomfort followed by facial musculature contraction and 3, patient backed away or showed lacrimation)	0–3	Alencar 2009[24]	Arm 1: hard splint • 0.3 (0.5); $n = 14$ Arm 2: soft splint • 0.3 (0.6); $n = 14$	0.3 (0.7); $n = 14$	MD 0.00 (–0.42 to 0.42); $p = 1$; favours neither
Incidence of > 30% reduction in current pain intensity on VAS	0–3	Dao 1994[68]	13/18	15/19	RR 0.91 (0.63 to 1.32); $p = 0.64$; favours control splint
Incidence of 50% reduction of worst pain on VAS	0–3	Ekberg 1998[35]	11/30	6/30	RR 1.83 (0.78 to 4.32); $p = 0.17$; favours splint
Current pain intensity assessed using a five-point verbal scale: 0 = no pain, 1 = slight pain, 2 = moderate pain, 3 = severe pain, 4 = very severe pain (we dichotomised as incidence of moderate to very severe pain)	0–3	Ekberg 1998[35] Ekberg 2003[36]	19/30 13/30	26/30 22/30	RR 0.68 (0.53 to 0.88); $p = 0.004$; favours splint
Pain frequency assessed using a nine-point verbal scale: 0 = never, 1 = rarely, 2 = once a month, 3 = once every second week, 4 = once a week, 5 = twice a week, 6 = 3 or 4 times a week, 7 = daily, 8 = constantly (we dichotomised as incidence of once a week or more)	0–3	Ekberg 1998[35] Ekberg 2003[36]	19/30 8/30	25/30 16/30	RR 0.68 (0.46 to 1.01); $p = 0.06$; favours splint
Decrease in pain at rest (yes/no)	0–3	Ekberg 1998[35]	29/30	22/30	RR 1.32 (1.05 to 1.65); $p = 0.02$; favours splint

Outcome	Assessment point (months)	Study	Splint: mean (SD)/number of events	Control splint: mean (SD)/number of events	Result: MD/RR (95% CI)
Pain at rest (yes/no)	0–3	Ekberg 2003[36]	7/30	13/30	RR 0.54 (0.25 to 1.16); $p = 0.11$; favours splint
Decrease in pain during mandibular movements (yes/no)	0–3	Ekberg 1998[35]	15/30	22/30	RR 0.68 (0.45 to 1.04); $p = 0.07$; favours control splint
Pain during mandibular movements (yes/no)	0–3	Ekberg 2003[36]	12/30	21/30	RR 0.57 (0.35 to 0.94); $p = 0.03$; favours splint
Pain during non-guided mandibular movements (we dichotomised as incidence of pain during 2–4 movements)	0–3	Ekberg 1998[35]	12/30	24/30	RR 0.52 (0.34 to 0.80); $p = 0.003$; favours splint
		Ekberg 2003[36]	5/30	8/30	
Number of painful masticatory muscles on palpation (we dichotomised as incidence of ≥ 4 sites)	0–3	Ekberg 1998[35]	20/30	24/30	RR 0.73 (0.52 to 1.03); $p = 0.07$; favours splint
		Ekberg 2003[36]	13/30	22/30	
Degree of tenderness of masticatory muscles on palpation assessed using a four-point scale: 0 = no tenderness, 1 = tenderness reported by the patient, 2 = tenderness with a palpebral reflex, 3 = tenderness with a defence reaction (we dichotomised as incidence of scores 2 or 3)	0–3	Ekberg 1998[35]	26/30	28/30	RR 0.93 (0.82 to 1.05); $p = 0.23$; favours splint
		Ekberg 2003[36]	26/30	28/30	
Incidence of 30% reduction in worst pain VAS score	0–3	Nilsson 2009[43]	22/40	17/40	RR 1.29 (0.82 to 2.04); $p = 0.27$; favours splint
	6–12	Nilsson 2009[43]	19/40	14/40	RR 1.36 (0.80 to 2.31); $p = 0.26$; favours splint
Characteristic pain intensity (0 to 100 worsening scale: mean of three scales – current pain, worst and average in previous 6 months)	3–6	Nilsson 2009[43]	19 (18); $n = 32$	29 (23); $n = 25$	MD −10.00 (−20.96 to 0.96); $p = 0.07$; favours splint
	6–12	Nilsson 2009[43]	23 (18); $n = 28$	24 (21); $n = 23$	MD −1.00 (−11.87 to 9.87); $p = 0.86$; favours splint
Incidence of 30% reduction in characteristic pain intensity (described above)	0–3	Nilsson 2009[43]	24/35	20/33	RR 1.13 (0.79 to 1.61); $p = 0.5$; favours splint
	6–12	Nilsson 2009[43]	20/40	17/40	RR 1.18 (0.73 to 1.89); $p = 0.5$; favours splint

continued

TABLE 28 TMD: splint vs. control splint – other data (*continued*)

Outcome	Assessment point (months)	Study	Splint: mean (SD)/number of events	Control splint: mean (SD)/number of events	Result: MD/RR (95% CI)
Frequency of pain reported categorically: we dichotomised the data as incidence of recurrent or persistent (vs. never/one-time experience)	0–3	Nilsson 2009[43]	19/35	18/33	RR 1.00 (0.64 to 1.54); $p = 0.98$; favours neither
	3–6	Nilsson 2009[43]	10/32	11/25	RR 0.71 (0.36 to 1.40); $p = 0.32$; favours splint
	6–12	Nilsson 2009[43]	7/28	10/23	RR 0.57 (0.26 to 1.27); $p = 0.17$; favours splint
Mean value of worst pain 0 (no pain) to 10 (worst pain) NRS (author informed us that pain was probably recorded daily for 2 weeks prior to the follow-up)	0–3	Raphael 2001[47]	5.16 (2.5456); $n = 32$	6.13 (2.4498); $n = 31$	MD −0.97 (−2.20 to 0.26); $p = 0.12$; favours splint
Pain on palpation using 2 lb of pressure: mean number of painful facial muscles (unclear how many muscles were palpated)	0–3	Raphael 2001[47]	9.97 (5.4871); $n = 32$	10.94 (5.5678); $n = 31$	MD −0.97 (−3.70 to 1.76); $p = 0.49$; favours splint
Tenderness on palpation scored 0 (no response) to 3 (retreat of head in anticipation and report of considerable pain on contact) on multiple regions and scores summed to obtain a palpation score (length of scale unclear) – change scores reported (mean decrease in score)	0–3	Rubinoff 1987[48]	4.1 (4.4); $n = 15$	1.82 (4.51); $n = 11$	MD 2.28 (−1.19 to 5.75); $p = 0.2$; favours splint
Change in restricted mouth-opening					
Maximal interincisal distance in mm – change scores reported (mean increase in score)	0–3	Rubinoff 1987[48]	2.0 (4.8); $n = 15$	0.55 (2.98); $n = 11$	MD 1.45 (−1.55 to 4.45); $p = 0.34$; favours splint
Frequency of headaches (secondary to pain-related TMD)					
Reported categorically at 6 and 12 months: we dichotomised the data as incidence of recurrent or persistent (vs. never/one-time experience)	3–6	Nilsson 2009[43]	12/32	11/25	RR 0.85 (0.45 to 1.60); $p = 0.62$; favours splint
	6–12	Nilsson 2009[43]	10/28	9/23	RR 0.91 (0.45 to 1.86); $p = 0.8$; favours splint

Outcome	Assessment point (months)	Study	Splint: mean (SD)/number of events	Control splint: mean (SD)/number of events	Result: MD/RR (95% CI)
Quality of life (including physical and emotional function)					
Depression (20 questions) from subscales of the SCL-90-R – reported as incidence of normal, moderate or severe (we dichotmised as incidence of moderate to severe)	3–6	Nilsson 2009[43]	11/32	7/25	RR 1.23 (0.56 to 2.71); $p = 0.61$; favours control splint
	6–12	Nilsson 2009[43]	10/28	8/23	RR 1.03 (0.49 to 2.17); $p = 0.94$; favours neither
Somatisation (12 questions) from subscales of the SCL-90-R – reported as incidence of normal, moderate or severe (we dichotmised as incidence of moderate to severe)	3–6	Nilsson 2009[43]	13/32	13/25	RR 0.78 (0.44 to 1.37); $p = 0.39$; favours splint
	6–12	Nilsson 2009[43]	10/28	11/23	RR 0.75 (0.39 to 1.44); $p = 0.38$; favours splint
Average mood assessed using a 0 (best possible mood) to 10 (worst possible mood) scale	0–3	Raphael 2001[47]	3.44 (2.2062); $n = 32$	4.23 (2.3941); $n = 31$	MD −0.79 (−1.93 to 0.35); $p = 0.17$; favours splint
Depression (13 items) from subscales of the SCL-90-R (higher score = worse depression) (length of scale not reported but is 0–4 in other included studies)	0–3	Raphael 2001[47]	1.5 (0.6223); $n = 32$	1.66 (0.6681); $n = 31$	MD −0.16 (−0.48 to 0.16); $p = 0.33$; favours splint
Patient satisfaction					
Satisfied with treatment (yes/no)	0–3	Ekberg 2003[36]	26/30	13/30	RR 2.00 (1.30 to 3.08); $p = 0.002$; favours splint

TABLE 29 TMD: harms/adverse effects

Study	Results
Custom splint vs. prefabricated splint	
Christidis 2014[72]	*There were no reported adverse events*
Nilner 2008[73]	*At the 6-month follow-up, one patient in the R group with a vertical overbite of –1 mm at baseline had an overbite of –3 mm. The patient was given a stabilisation appliance, and no further increase in vertical overbite could be registered at the 12-month follow-up*
Truelove 2006[50]	*No subjects reported an adverse effect with any of the treatments*
Splint vs. no splint	
Haketa 2010[66]	*No significant adverse effect was reported resulting from either treatment*
Nitecka-Buchta 2014[70]	*No complications or any unintended effects in either group*
Tatli 2017[54]	There were no adverse effects reported that were due to splint use. Both groups had arthrocentesis and sodium hyaluronate, and the adverse events, which were mild transient swelling of the TMJ area and transient hemifacial paralysis, were related to this Group 1 = arthrocentesis plus sodium hyaluronate (control); Group 2 = splint + arthrocentesis plus sodium hyaluronate Comment: there were no adverse effects reported that were due to splint use
Tavera 2012[23]	Treatment-related adverse events: • Discomfort or pain – group A: 9.4% (6/64); group B: 7.1% (2/28) • Diminished hearing acuity – group A: 1.6% (1/64); group B: 0% (0/28) • Headache – group A: 4.7% (3/64); group B: 3.6% (1/28) • Dizziness or nausea – group A: 3.1% (2/64); group B: 3.6% (1/28) • Other – group A: 3.1% (2/64) – jaw muscle/gum-related; group B: 0% (0/28)
Truelove 2006[50]	*No subjects reported an adverse effect with any of the treatments*
Wahlund 2003[44]	*None of the patients in any of the treatment modes reported any major adverse effects*
Wright 1995[51]	There was insufficient evidence of a difference in occlusal contact changes: MD –0.60 (95% CI –1.48 to 0.28; $p = 0.18$) Splint: mean 1.3 (SD 1.1); $n = 10$ Control splint: mean 1.9 (SD 0.9); $n = 10$

Appendix 3 Characteristics and risk of bias of included studies

Attribute	Study details
Alencar 2009[24] *Characteristics*	
Study details	• Trial design: parallel (three arms) • Location: Occlusion, TMD and Orofacial Pain Clinic, Araraquara School of Dentistry, São Paulo State University, Brazil • Number of centres: one • Recruitment period: not reported • Sample size calculation: not reported • Funding: public (CAPES – Brazilian government, partial funding) • Declarations/conflicts of interest: not reported
Participants	• Diagnosis: myofascial pain based on a standardised and complete clinical examination, based on the diagnostic criteria of the AAOP. Patients were included if they received a diagnosis of myofascial pain with reproduction of the chief complaint with palpation of a trigger point in the masseter muscle • Duration since presenting condition began: not reported, but patients were excluded if they had previous experience with occlusal splint • Age at baseline (years): group A – mean 39 (range 24–65); group B – mean 33 (range 18–52); group C – mean 31 (range 18–51) • Sex (% male): group A: 14; group B: 7; group C: 14 • Number randomised: 45 (group A: 15; group B: 15; group C: 15) • Number evaluated: 42 (group A: 14; group B: 14; group C: 14)
Interventions	Comparison: splint vs. control splint for TMD Group A • Splint type: custom hard occlusal splint • Lower jaw • Material: hard • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: patients were taught the resting postural position of the mandible (teeth apart, lips slightly touching and tongue not pushing against the teeth). They were also instructed to perform simultaneous bilateral mastication, so as not to load any TMJ or masticatory muscles, including the masseter. Patients were also instructed not to take any pain medication, to wear the splint 24 hours a day during the first 7 days and to take it out during meals. After the first week, splint wear was restricted to bedtime

Attribute	Study details
	• Monitoring of patients: evaluations at 7, 30, 60 and 90 days after splint insert. Splint installation, adjustment and follow-up were carried out by researcher Group B • Splint type: custom soft occlusal splint (using mouthguard material over mandibular cast) • Lower jaw • Material: EVA soft rubber-like plate • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: same as for groups A and C • Monitoring of patients: same as for groups A and C Group C • Splint type: custom non-occluding splint • Lower jaw • Material: chemically activated acrylic resin and stainless steel wires • Teeth coverage: partial • Details of impression-taking: not reported • Instructions to patients: same as for groups A and B • Monitoring of patients: same as for groups A and B Duration of treatment: 90 days

Outcomes	Assessed at 7, 30, 60 and 90 days; we used the 90-day data for our 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ subjective pain: Mod-SSI – this scale has 28 characters for each of the three variables: intensity, frequency and pain duration. An average of the three variables was obtained and final scores ranged from 0.035 to 1 (higher = worse)
	  ○ objective pain: muscular palpation (masseter, temporalis and pterygoid muscles) was performed bilaterally with tight and constant pressure of approximately 1500 g and was classified on a scale from 0 to 3 (0, no pain; 1, verbally reported pain; 2, pain or discomfort followed by facial musculature contraction; and 3, when the patient backed away or showed lacrimation)

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Patients were randomly assigned' • Comment: unclear how this was done
Allocation concealment (selection bias): • Unclear risk of bias	• 'Selection bias was considered through a defined and concealed randomization process with rather [sic] and subject blind of group assignment' • Comment: unclear who the randomisation was concealed from and how this was done
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients to type of splint used
Blinding of outcome assessment (detection bias): • High risk of bias	Patient-assessed pain is subjective; unclear if objective assessment is really objective (muscular palpation)

Attribute	Study details
Incomplete outcome data (attrition bias): • Low risk of bias	• 'We initially enroled 45 patients and ended up with 42. Three patients dropped out (one from each group) and the main reason for this was that they were feeling better, with no necessity to come back to the University' • Comment: as only one patient per group dropped out this is unlikely to have caused any bias
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No apparent other bias
Amin 2016[55] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Department of Prosthodontics and Department of Oral Medicine and Radiology, Sri Dharmasthala Manjunatheshwara (SDM) College of Dental Sciences and Hospital, Karnataka, India Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: 'Nil' Declarations/conflicts of interest: 'There are no conflicts of interest'
Participants	Diagnosis: diagnosed with myofascial pain based on a standardised and complete clinical examination based on the RDC/TMD Duration since presenting condition began: not reported Age at baseline (years): not reported (inclusion was 18–65) Sex: not reported Number randomised: 45 (group A: 15; group B: 15; group C: 15) Number evaluated: 45 (group A: 15; group B: 15; group C: 15) – assuming no attrition but not clearly reported
Interventions	Comparison: custom-made splint vs. prefabricated splint for TMD Group A • Splint type: custom-made hard occlusal splint • Upper jaw • Material: hard acrylic • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: not reported • Monitoring of patients: seen at 7, 30, 60 and 90 days Group B • Splint type: custom-made soft occlusal splint • Lower jaw • Material: soft polyvinyl sheet • Teeth coverage: full

Attribute	Study details
	• Details of impression-taking: thermally controlled infrared heater over the mandibular cast • Instructions to patients: not reported • Monitoring of patients: seen at 7, 30, 60 and 90 days Group C • Splint type: prefabricated readily available liquid occlusal splint (Aqualizer) • Upper jaw • Material: hard acrylic • Teeth coverage: full • Details of impression-taking: not done • Instructions to patients: not reported • Monitoring of patients: seen at 7, 30, 60 and 90 days Duration of treatment: 90 days

Outcomes	Assessed at 7, 30, 60 and 90 days: we used the 90-day data for our 0–3 months' analysis
	
	Primary:
	
	• Pain –
	  ○ subjective pain: Mod-SSI – this scale has 28 characters for each of the three variables: intensity, frequency and pain duration. An average of the three variables was obtained and final scores ranged from 0.035 to 1 (higher = worse)
	  ○ objective pain: muscular palpation (masseter, temporalis and pterygoid muscles) was performed bilaterally with tight and constant pressure of approximately 1500 g and was classified on a scale from 0 to 3 (0, no pain; 1, verbally reported pain; 2, pain or discomfort followed by facial musculature contraction and 3, when the patient backed away or showed lacrimation)

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	'Randomly assigned using randomization table' Comment: appropriate method
Allocation concealment (selection bias): • Unclear risk of bias	Not mentioned
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients to type of splint used
Blinding of outcome assessment (detection bias): • High risk of bias	Patient-assessed pain is subjective; unclear if objective assessment is really objective (muscular palpation)
Incomplete outcome data (attrition bias): • Unclear risk of bias	Assuming no attrition but not entirely clear
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No apparent other bias

Attribute	Study details
Christidis 2014[72] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Orofacial Pain and Jaw Function, Malmö University, Sweden; Section of Orofacial Pain and Jaw Function, Karolinska Institutet, Sweden; Department of Stomatognathic Physiology, University of Turku, Finland Number of centres: three Recruitment period: not reported, but conducted from October 2008 to December 2011 Sample size calculation: yes (not met) Funding: public (supported by Finska Lakaresallskapet – scientific organisation of Swedish-speaking physicians in Finland) Declarations/conflicts of interest: 'no conflicts of interest. None of the authors have any commercial affiliation or financial interest in any of the appliances used in this study' Authors provided unpublished data
Participants	Diagnosis: a diagnosis of arthralgia or osteoarthritis of the TMJ according to RDC/TMD; self-assessed worst TMJ pain during the previous 6 months of at least 4 on a 0–10 (higher = worse) graded NRS; and duration of pain ≥ 3 months Duration since presenting condition began: group A: mean 57 weeks; group B: mean 40 weeks Age at baseline (years): group A (stabilisation appliance) – mean 41 (range 19–73); group B (prefabricated) – mean 40 (range 21–71) Sex: group A: 8% male; group B: 4% male Number randomised: 48 (group A: 24; group B: 24) Number evaluated: 10 weeks – 44 (group A: 21; group B: 23); 6 months – 37 (group A: 17; group B: 20); 12 months – 33 (group A: 15; group B: 18)
Interventions	Comparison: custom-made splint vs. prefabricated splint for TMD Group A • Splint type: custom occlusal stabilisation splint • Upper/lower jaw: not reported • Material: hard (methylmetacrylate) • Teeth coverage: partial – canines and incisors • Details of impression-taking: alginate impressions • Instructions to patients: wear the appliance every night for the first 10 weeks and when needed thereafter • Monitoring of patients: seen at 2 and 10 weeks and 6 and 12 months Group B • Splint type: prefabricated occlusal splint (Relax) • Upper jaw • Material: hard ['The prefabricated appliance (polymethylmetacrylate) was individually fitted with a self-curing silicone material (polyvinyl siloxane)'] • Teeth coverage: partial – covers the edges of the incisors and canines with palatal extension of approximately 1 cm • Details of impression-taking: not done

Attribute	Study details
	• Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 12 months

Outcomes	Assessed at 10 weeks, 6 months and 12 months: we used these in our 0–3 months', 3–6 months' and 6–12 months' analyses
	
	Primary:
	
	• Pain –
	  ○ pain intensity, 0–100 VAS (higher = more pain), assessed each evening in a 1-week pain diary in the week prior to each assessment point (author provided unpublished means and SDs for pain at rest and during movement – we used the pain-at-rest data)
	  ○ GCPS reported by incidence of grades 0–IV, which is included in the RDC/TMD Axis II questionnaire. Divided into two parts: (1) assessment of pain intensity (0–100 worsening scale) and (2) assessment of pain-related disability/limitations in physical functioning (0–6 worsening scale). GCPS grade 0: no TMD pain in the previous 6 months; grade I: low disability (< 3) and low-intensity pain (< 50); grade II: low disability (< 3) and high-intensity pain (> 50); grade III: high disability that was moderately limiting (3 or 4 regardless of pain score); grade IV: high disability that was severely limiting (5 or 6 regardless of pain score) (we dichotomised as incidence of grade III or IV)
	  ○ overall improvement in TMJ pain as assessed by patients using a six-point scale: 0 = no symptoms; 1 = much better; 2 = better; 3 = unchanged; 4 = worse; 5 = much worse; reported as incidence (dichotomised as incidence of unchanged or worse/much worse)
	
	• Harms/adverse effects – reported as number of tooth contacts in centric occlusion, changes in tooth sensitivity and occlusal trauma
	
	Secondary:
	
	• Change in restricted mouth-opening: reported as maximum voluntary mouth-opening capacity (mm)
	• Quality of life (including physical and emotional function): SCL-90-R instrument in the RDC/TMD Axis II questionnaire – 20 questions for depression and 12 questions for non-specific physical symptoms. Each used a 0–4 worsening scale. Depression was scored as normal (< 0.535), moderate (1.105) or severe (> 1.105). Non-specific physical symptoms were scored as: normal (< 0.5), moderate (0.5–1) or severe (> 1) (author provided unpublished means and SDs)
	• Adherence to treatment: reported as incidence of use of appliance for several nights per week or more

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	'For each center, 16 consecutively numbered, opaque, sealed envelopes containing a note with the treatment (8 for each treatment) were made and placed in a larger envelope. For each patient, an independent person at each center randomly drew an envelope and handed it to Dentist B. This was repeated until 16 patients at each center were included' Comment: adequate method (lottery)
Allocation concealment (selection bias): • Low risk of bias	'For each center, 16 consecutively numbered, opaque, sealed envelopes containing a note with the treatment (8 for each treatment) were made and placed in a larger envelope. For each patient, an independent person at each center randomly drew an envelope and handed it to Dentist B. This was repeated until 16 patients at each center were included' Comment: the next assignment was adequately concealed from the person randomising patients

Attribute	Study details
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients to type of splint used
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening' which may be considered objective and was measured by a blinded assessor)
Incomplete outcome data (attrition bias): • High risk of bias	31% attrition at 12 months (group A: 38%; group B: 25%). This could potentially bias the results
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No apparent other bias
Conti 2005[25] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Orofacial Pain Clinic at Bauru Dental School, University of São Paulo, Brazil Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public (CAPES – Brazilian Government) Declarations/conflicts of interest: not reported We emailed authors for data but none provided so far
Participants	Diagnosis: presence of TMJ disc displacement with reduction and chief complaint of pain in the joint followed by positive TMJ tenderness to manual palpation, accompanied or not by muscle symptoms. The presence of at least a clicking joint during opening, eliminated on opening in protrusion, was also an inclusion criterion Duration since presenting condition began: not reported Age at baseline (years): group A (stabilisation splint) – mean 32.7; group B (repositioning splint) – mean 31.4; group C (no treatment) – mean 31.1 Sex: not reported Number randomised: 60 Number evaluated: 52
Interventions	Comparison: splint vs. no splint for TMD Group A • Splint type: custom stabilisation splint • Upper/lower jaw: not reported • Material: not reported • Teeth coverage: unclear • Details of impression-taking: not reported

Attribute	Study details
	• Instructions to patients: wear at night and when sleeping • Monitoring of patients: only at planned visits (1 and 2 weeks, and 1, 3, 6 and 12 months) Group B • Splint type: custom anterior repositioning splint for 3 to 4 months and then converted into stabilisation splints for the remainder of the treatment period • Upper/lower jaw: not reported • Material: not reported • Teeth coverage: unclear • Details of impression-taking: not reported • Instructions to patients: wear at night and when sleeping for repositioning splint (not reported for stabilisation splint) • Monitoring of patients: only at planned visits (1 and 2 weeks, and 1, 3, 6 and 12 months) Group C • No treatment or initial counselling Duration of treatment: 12 months

Outcomes	Assessed at 1 and 2 weeks and at 1, 3, 6 and 12 months: we would have used the the 3-, 6- and 12-month data in our 0–3 months', 3–6 months' and 6–12 months' analyses, respectively
	
	Primary:
	
	• Pain –
	  ○ pain on a 0–100 VAS (higher = more pain) (no usable data – no SD/SE/*p*-values)
	  ○ pain on TMJ and masticatory and cervical muscle palpation (digital pressure of 1.5 kg) (no usable data – no mean + SD/SE/*p*-values or incidence data)
	
	Secondary:
	
	• TMJ clicking – presence of joint noises (detected during TMJ palpation) no usable data – no mean + SD/SE/*p*-values)
	• Change in restricted mouth-opening: maximum mouth-opening (mm) (no usable data – no mean + SD/SE/*p*-values)

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	'Subjects were randomly located into one of the following groups' Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	'Subjects were randomly located into one of the following groups' Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'TMJ clicking' and 'change in restricted mouth-opening', which may be considered objective and were measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Unclear risk of bias	Numbers per group at randomisation and assessment points were not reported
Selective reporting (reporting bias):	Results very poorly reported with very limited data for all outcomes

Attribute	Study details
• High risk of bias	
Other bias:	Level of reporting extremely poor so unable to assess this
• Unclear risk of bias	
Conti 2006[26] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Orofacial Pain Centre, Bauru Dental School, University of São Paulo, Brazil Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public [supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq BRAZIL) grant number 14164312000–5] Declarations/conflicts of interest: not reported We emailed authors for data but none provided so far
Participants	Diagnosis: RDC/TMD – subjects who met the diagnosis criteria for group II (disk displacement) and group IIIa (arthralgia) Duration since presenting condition began: TMJ pain for at least 3 months Age at baseline (years): group A – mean 28.9; group B – mean 31.3; group C – mean 29.5 Sex: 8% male (not reported by group) Number randomised: 60 (not reported by group) Number evaluated: 57 (not reported by group)
Interventions	Comparison: splint versus control splint for TMD Group A • Splint type: custom modified occlusal stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: instructed to wear splints only at night, while sleeping • Monitoring of patients: monitored at 15 days, 1 month, 3 months and 6 months Group B • Splint type: custom conventional occlusal stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above

Attribute	Study details
	Group C • Splint type: custom non-occluding splint • Lower jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 6 months

Outcomes	Assessed at 1 and 2 weeks and at 1, 3 and 6 months: we would have used the 3- and 6-month data in our 0–3 months' and 3–6 months' analyses, respectively
	
	Primary:
	
	• Pain –
	  ○ pain on a 0–100 mm VAS (higher = more pain) (no usable data – no SD/SE/*p*-values)
	  ○ pain on TMJ and muscle palpation (temporal and masseter) (no usable data – no means or incidence data)
	
	Secondary:
	
	• TMJ clicking: incidence of joint sounds detected at examination (not possible to use data as the numbers of patients analysed at each follow-up point were not reported)

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	'We used a table generated by a computer to perform the randomization' Comment: appropriate method
Allocation concealment (selection bias): • Unclear risk of bias	'We used a table generated by a computer to perform the randomization' Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients to type of splint used
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'TMJ clicking', which may be considered objective and was measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	Only three patients dropped out so unlikely to affect the results
Selective reporting (reporting bias): • High risk of bias	Data not reported in full for any outcome
Other bias: • Unclear risk of bias	Poorly reported so difficult to assess
Conti 2012[27] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Bauru School of Dentistry, University of São Paulo, Brazil

Attribute	Study details
	Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public [supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil] Declarations/conflicts of interest: 'The authors declare that they have no conflicts of interest' We emailed authors for data but none provided so far
Participants	Diagnosis: RDC/TMD – myofascial pain with or without jaw opening limitation (Ia and Ib) Duration since presenting condition began: not reported Age at baseline (years): group A – mean 38.1; group B – mean 35.3; group C – mean 38.1 Sex: group A – 19% male; group B – 12% male; group C – 0% male Number randomised: 51 (group A: 21; group B: 16; group C: 14) Number evaluated: at 3 months = 39 (group A: 17; group B: 13; group C: 9)
Interventions	Comparison: splint vs. no splint for TMD All patients received counselling for habits and behavioural changes (reinforced at each visit): instructed about beneficial behavioural changes and received a printed version of the instructions, containing information about relaxation techniques, sleep hygiene, diet modification, thermotherapy and massage in the painful area, as well as avoidance of caffeine and daytime clenching Group A • Splint type: custom occlusal stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: advised to wear the appliance only at night while sleeping • Monitoring of patients: seen at 2, 6 weeks and 3 months for adjustments Group B • Splint type: custom occlusal nociceptive trigeminal inhibition (NTI) splint • Upper jaw • Material: not reported • Teeth coverage: partial • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Group C • No other treatment Duration of treatment: 3 months

Attribute	Study details

Outcomes	Assessed at 2 and 6 weeks and at 3 months: we used the 3-month data for our 0–3 months' analysis
	
	Primary:
	
	• Pain –
	  ○ current pain 0 (no pain) to 100 (worst pain) mm VAS (no usable data – no SD/SE/*p*-values)
	  ○ pressure pain threshold (PPT): digital algometer used to put pressure on muscles (patient presses button when she/he feels pain); reported as kgf/cm^2 (higher score = less pain) (reported separately for left and right side for five muscles – data not used)
	  ○ incidence of patients who halved their VAS scores

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	'The patients were randomly allocated into one of the following three groups' Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	'The patients were randomly allocated into one of the following three groups' Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients
Incomplete outcome data (attrition bias): • High risk of bias	Very high overall attrition (24%) and especially high in the control group (group A: 19%; group B: 19%; group C: 36%)
Selective reporting (reporting bias): • High risk of bias	Data not adequately reported for pain on 0–100 VAS
Other bias: • Unclear risk of bias	Lacking in detail so unable to assess
Conti 2015[28] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Orofacial Pain Clinic at Bauru Dental School, University of São Paulo, Brazil Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported We emailed authors for data but none provided so far

Attribute	Study details
Participants	Diagnosis: disc displacement with reduction (IIa) and arthralgia (IIIa) according to RDC/TMD (myofascial pain, disc displacement without reduction and osteoarthritis according to RDC/TMD were all excluded) Duration since presenting condition began: not reported Age at baseline (years): group A – mean 38.4; group B – mean 38.4; group C – mean 46 Sex: 3% male (not reported by group) Number randomised: 60 (group A: 20; group B: 20; group C: 20) Number evaluated: 3 months – 33 (group A: 12; group B: 12; group C: 9
Interventions	Comparison: splint vs. no splint for TMD All patients received counselling: instructions containing information about relaxation techniques, sleep hygiene, diet modification and hot thermotherapy, as well as avoidance of caffeine and awaking clenching Group A • Splint type: custom anterior repositioning occlusal splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: unclear • Details of impression-taking: not reported • Instructions to patients: wear only while sleeping • Monitoring of patients: visits at 2 and 6 weeks and at 3 months; at each visit, a comprehensive assessment of splint adjustments was performed and the counselling and behavioural changes information was reinforced in all groups Group B • Splint type: custom NTI-tss occlusal splint • Upper jaw • Material: not reported • Teeth coverage: partial • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Group C • No other treatment Duration of treatment: 3 months

Outcomes	Assessed at 2 and 6 weeks and at 3 months: we used the 3-month data for our 0–3 months' analysis
	
	Primary
	
	• Pain:
	  ○ current pain intensity 0 (no pain) to 100 (worst pain) mm VAS (reported by graph but no SDs – a *p*-value was presented for the comparison of group A vs. group C, so we have used this in the meta-analysis)
	  ○ pressure pain threshold of each TMJ, using a digital pressure algometer, where patients press button when they feel pain, reported at 3 months (data presented at 3 months as means and SDs for each joint, described as VAS score – not used)

Attribute	Study details
	Secondary • TMJ clicking: presence of TMJ sounds according to RDC/TMD. Data presented as bar charts with % joints on *y*-axis, so not used because of clustering of data • Change in restricted mouth-opening: unassisted maximum mouth-opening in mm (between the top and bottom edges, taking the mid-line as reference) until pain felt • Patient satisfaction: comfort level reported at 2 weeks (more comfortable or not) – data reported only for splint groups so not usable in meta-analyses
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'TMJ clicking' and 'change in restricted mouth-opening', which may be considered objective and were measured by a blinded assessor)
Incomplete outcome data (attrition bias): • High risk of bias	Overall attrition: 32% at 6 weeks and 45% at 3 months
Selective reporting (reporting bias): • High risk of bias	Data not adequately reported (e.g. for VAS pain, no SD reported and *p*-value reported only for comparison between groups A and C)
Other bias: • Unclear risk of bias	Lacking in detail so unable to assess
Costa 2015[29] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Orofacial Pain Clinic at Bauru Dental School, University of São Paulo, Brazil Number of centres: one Recruitment period: August 2011 to November 2012 Sample size calculation: reported incompletely (unclear if met) Funding: public (grant number 2011/04441–6 from FAPESP – São Paulo Research Foundation) Declarations/conflicts of interest: 'The authors declare no conflicts of interest' We emailed authors for data but none provided so far

Attribute	Study details
Participants	Diagnosis: RDC/TMD – myofascial pain Duration since presenting condition began: pain duration at least 3 months Age at baseline (years) (inclusion was 18–50): group A – mean 27.7 (SD 6.7); group B – mean 36 (SD 6.6) Sex: group A: 10% male; group B: 10% male Number randomised: 60 (group A: 30; group B: 30) Number evaluated: 5 months – 41 (group A: 24; group B: 17); unclear how many participants were evaluated at 2 months
Interventions	Comparison: splint vs. no splint for TMD All patients received counselling: verbal and written information about TMD aetiology and prognostics, diet modification in the sense of avoiding hard foods, use of reminders to avoid parafunctional habits, relaxation techniques of the jaw, application of a heating pad on painful muscles followed by stretching and self-massage, as well as sleep hygiene and encouragement to practise social and aerobic activities Group A • Splint type: custom occlusal stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear splints at night only while sleeping • Monitoring of patients: adjustments during visits at 2 and 5 months Group B • No other treatment Duration of treatment: 5 months
Outcomes	Assessed at 2 and 5 months: we used the 5-month data for our 3–6 months' analysis (we were unable to use the 2-month data as the numbers analysed were not reported) Primary • Pain: Catastrophizing Thoughts subscale of the Pain Related Self-Statement Scale. Self-reported questionnaire consisting of nine statements related to catastrophising thoughts involved in pain perception. Respondent asked to answer each statement indicating the frequency of thinking about pain during a pain crisis, on a 0–4 scale. The sum of all frequencies was divided by the total number of questions. Higher values demonstrate higher levels of pain catastrophising (reported in additional table – not used for SMD of pain) Secondary • Frequency of headaches (secondary to pain-related TMD): categorised as number having either infrequent/absent headache (< 1 day per month), frequent headache (1–14 days per month), or chronic headache (> 14 days per month) – we dichotomised the data as incidence of frequent or chronic headache • Quality of life (including physical and emotional function): anxiety and depression reported using HADS. Self-reported questionnaire consisting of 14 multiple choice questions involving two interspersed subscales: one for anxiety (seven questions) and the other for depression (seven questions). The scores ranged from 0 to 21 points and were

Attribute	Study details
	divided into four categories: 0–7 (no anxiety or depression), 8–10 (mild anxiety or depression), 11–14 (moderate anxiety or depression) and 15–21 (severe anxiety or depression) – we dichotomised the data as incidence of moderate or severe anxiety/depression (data not used – some do not appear to add up to 100%)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Randomly assigned, by a computer-generated list' • Comment: appropriate method
Allocation concealment (selection bias): • Low risk of bias	• 'The allocation of groups was concealed and designated according to sequentially numbered, opaque, sealed envelopes given to a person who did not know the allocation sequence' • Comment: the next assignment was adequately concealed from the person randomising patients
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients
Incomplete outcome data (attrition bias): • High risk of bias	Overall attrition at 5 months was 32% and also differed by group (group A: 20%; group B: 43%). This could potentially bias the results
Selective reporting (reporting bias): • High risk of bias	We would have expected the authors to also report a more simple pain intensity outcome in line with other RCTs in this field (e.g. 0–100 mm VAS)
Other bias: • Low risk of bias	No apparent other bias
Daif 2012[57] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Oral and Maxillofacial, Faculty of Oral & Dental Medicine, Cairo University, Egypt Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: 'The authors report no conflicts of interest'
Participants	Diagnosis: TMD with myofascial pain by the presence of a non-teeth-related chronic orofacial pain with localised areas of tenderness in the masticatory muscles. Signs and symptoms were recorded according to the clinical dysfunction index of Helkimo[74] Duration since presenting condition began: not reported Age at baseline (years): overall – mean 32 (range 22–46)

Attribute	Study details
	Sex: overall – 42.5% male Number randomised: 40 (group A: 20; group B: 20) Number evaluated: 40 (group A: 20; group B: 20)
Interventions	Comparison: splint vs. no splint for TMD Group A • Splint type: custom-made flat-plane occlusal splint • Upper jaw • Material: hard (acrylic resin) • Teeth coverage: full • Details of impression-taking: fabricated on articulated dental casts. The vertical pin of the articulator was adjusted to create a 2- to 3-mm space between the molars • Instructions to patients: wear the splints during the whole night and as much as possible during the daytime for 6 months • Monitoring of patients: not reported Group B • No treatment Duration of treatment: 6 months
Outcomes	Assessed at 6 months: grouped under 3–6 months' analysis Secondary • Adherence to treatment: incidence of those not totally complying with postoperative instructions • The other outcome assessed at 6 months (clinical dysfunction index of Helkimo[74]) was not an outcome of this review
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Randomization was performed using a computer-generated random number list' • Comment: appropriate method
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomization was performed using a computer-generated random number list' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Patients were not blinded but self reported compliance
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised participants were included in analysis
Selective reporting (reporting bias): • High risk of bias	The study focused on TMD with pain; therefore, we would have expected pain to have been measured separately
Other bias: • Low risk of bias	No apparent other bias

Attribute	Study details
Dao 1994[68] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Faculty of Dentistry and Neuroscience Research Centre, University of Montreal, Montreal, QC, Canada Number of centres: one Recruitment period: not reported Sample size calculation: yes (met) Funding: public (Medical Research Council of Canada and the Fonds de la Recherche en Sante du Quebec) Declarations/conflicts of interest: not reported
Participants	Diagnosis: chief complaint of frequent pain (at least four times per week) in the jaw muscles of at least 12 weeks duration; positive report of tenderness to palpation of at least three sites in the masticatory muscles Duration since presenting condition began: history of myofascial pain varied from 3 months to 12 years, with a mean of 43.4 months Age at baseline (years): group A – mean 29 (range 16–40); group B – mean 28 (range 16–42) Sex: group A – 18% male; group B – 20% male Number randomised: 43 (group A: 22; group B: 21) Number evaluated: 42 (group A: 22; group B: 20)
Interventions	Comparison: splint vs. control splint for TMD Group A • Splint type: custom occlusal stabilising splint • Upper jaw • Material: not reported • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear day and night; remove only at meal times • Monitoring of patients: adjustments made at 1, 3, 5 and 8 weeks Group B • Splint type: palatal U-shaped splint that did not interfere with occlusion • Upper jaw • Material: not reported • Teeth coverage: partial (retained with clasps on maxillary teeth) • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Group C • Wearing same splint as group A for 30 minutes at each appointment (excluded from this review) Duration of treatment: 8 weeks

Attribute	Study details

Outcomes	Assessed at 1, 3, 5 and 8 weeks: we would have used the 8-week data for our 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ current pain intensity and pain unpleasantness assessed separately on a 0 (no pain) to 100 (worst pain) mm VAS; both were assessed separately at rest and after chewing for 3 minutes – we used only current pain intensity at rest (unable to use the mean VAS scores – no SD/SE/CI or *p*-values reported; we used data for incidence of > 30% reduction in VAS pain)
	
	Secondary:
	
	• Quality of life (including physical and emotional function) –
	  ○ pain-related disability and psychosocial status assessed on a 0–4 worsening scale assessing how the pain affected six daily activities or states: sleep, efficiency at work, social activities, depression, anxiety and appetite – summed to obtain an overall score (no usable data – means on a graph with no SD/SE/CI/*p*-value

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	'Patients were randomly allocated to 1 of the 3 experimental groups' Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Patients were randomly allocated to 1 of the 3 experimental groups' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	• 'All patients were given the same description of the study. They were told that the etiology of their pain remains unknown and that different designs of splints and different methods of wearing these were being tested, in order to find out which was the most practical and effective therapy for their condition' • Comment: although patients were probably effectively blinded, personnel providing treatment were not
Blinding of outcome assessment (detection bias): • Low risk of bias	Subjective outcomes assessed by blinded patients
Incomplete outcome data (attrition bias): • Low risk of bias	Only one participant was missing from the control group
Selective reporting (reporting bias): • High risk of bias	It was not possible to use any VAS pain or quality-of-life data
Other bias: • Low risk of bias	No apparent other bias
de Felício 2006[30] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Dental School of Ribeirão Preto of the University of São Paulo, Brazil Number of centres: one

Attribute	Study details
	Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported
Participants	Diagnosis: presence of signs and symptoms characteristic of TMD: pain in the masticatory muscles and/or in the TMJ during mandibular function and palpation of the structures, limitation or deviation of mandibular movements, noises in the TMJ, and abnormal static or dynamic occlusal relation Duration since presenting condition began: not reported Age at baseline (years): not reported Sex: not reported Number randomised: 84 (group A: 42; group B: 42) Number evaluated: 84 (group A: 42; group B: 42)
Interventions	Comparison: splint vs. minimal treatment for TMD Group A • Splint type: custom occlusal splint • Upper jaw • Material: hard (heat-polymerizable colourless acrylic resin) • Teeth coverage: full • Details of impression-taking: dental arches moulded with irreversible hydrocolloid (alginate) and the plaster casts obtained were mounted on a semi-adjustable articulator in the mandibular position of centric relation • Instructions to patients: use during the day and at night for the first 15 days, and only at night thereafter • Monitoring of patients: not reported Group B Continued to attend occlusion outpatient clinic, receiving information about TMD Duration of treatment: 50 days

Outcomes	Assessed at 50 days: grouped under 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ presence of muscular pain (yes/no)
	  ○ severity of muscular pain and TMJ pain assessed separately using a 0–10 NRS – when waking up, during mastication, when speaking and at rest all assessed separately for each type of pain and summed (no usable data – no mean with SD/SE/CI or *p*-value)
	
	Secondary:
	
	• TMJ clicking –
	  ○ articular noise (yes/no) – 'The predominant type of articular noise was a click (83.33% of cases)'
	  ○ joint noise assessed using a 0–10 NRS – when waking up, during mastication, when speaking and at rest all assessed separately and summed (no usable data – no mean with SD/SE/CI or *p*-value)
	
	• Change in restricted mouth-opening: difficulty opening mouth (yes/no)

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Patients with TMD were randomly divided into two groups using GraphPad software' (GraphPad Software Inc., San Diego, CA, USA) • Comment: author provided this information by e-mail
Allocation concealment (selection bias): • Unclear risk of bias	Not mentioned
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessed by the patients
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • High risk of bias	Poor reporting of NRS severity scores
Other bias: • Low risk of bias	No apparent other bias
de Felício 2010[31] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Faculty of Medicine of Ribeirão Preto of the University of São Paulo, Brazil Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public (supported by Fundação de Amparo à Pesquisa do Estado de São Paulo -FAPESP, Process N. 2004/08478–8 and Conselho Nacional de Pesquisa – CNPq, Process N. 300950/2007–1) Declarations/conflicts of interest: not reported
Participants	Diagnosis: long-lasting associated articular and muscular TMD based on RDC/TMD Duration since presenting condition began: mean duration of TMD was 74.4 months (range 6–300 months) Age at baseline (years): group A – mean 29 (range 17–64); group B – mean 34 (range 14–63) Sex: not reported Number randomised: 20 (group A: 10; group B: 10) Number evaluated: 20 (group A: 10; group B: 10) – this is assumed as attrition was not mentioned

Attribute	Study details

Interventions	Comparison: splint vs. no splint for TMD
	
	• Group A
	  ○ Splint type: custom occlusal splint (Michigan)
	  ○ Upper/lower jaw not specified
	  ○ Material: not reported
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: continuous use recommended during first 15 days, except during eating and teeth cleaning, followed by only nighttime use after this period
	  ○ Monitoring of patients: not reported
	
	• Group B: no treatment
	• Group C: orofacial myofunctional therapy (not eligible for inclusion in this review)
	• Group D: asymptomatic controls (not eligible for inclusion in this review)
	
	Duration of treatment: 45 days

Outcomes	Assessed at 45 days: grouped under 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ muscle pain assessed on a printed 0 (absence of symptom) to 10 (worst severity) for the following four situations: (1) when waking up, (2) during chewing, (3) when speaking and (4) at rest. The score was then summed and is, therefore, a 0–40 scale
	
	Secondary:
	
	• TMJ clicking –
	  ○ assessed on a printed 0 (absence of symptom) to 10 (worst severity) for the following four situations: (1) when waking up, (2) during chewing, (3) when speaking and (4) at rest. The score was then summed and is, therefore, a 0–40 scale
	  ○ Change in restricted mouth-opening: maximal mandibular opening in mm (unclear if with/without/until pain or assisted/unassisted)
	
	• Change in restricted mouth-opening: maximal mandibular opening in mm (unclear if with/without/until pain or assisted/unassisted)

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Randomly assigned to three groups using the GraphPad software' • Comment: appropriate method
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned to three groups using the GraphPad software' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening' and 'TMJ clicking' which were objective but blinded assessor not mentioned)
Incomplete outcome data (attrition bias): • Unclear risk of bias	Assuming no attrition but not entirely clear

Attribute	Study details
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No other apparent bias
DeVocht 2013[45] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Craniofacial Clinical Research Centre, University of Iowa, Iowa City, IA, USA; Palmer College of Chiropractic, Davenport, IA, USA Number of centres: two Recruitment period: over 18 months, ending in July 2011 Sample size calculation: no ('We chose the sample size to determine feasibility and, therefore, the study was not powered to detect differences between groups') Funding: public and industry (grants from National Institutes of Health; ineligible interventions mentioned above were provided by the manufacturer) Declarations/conflicts of interest: one author declared instructing for Activator Methods International, Phoenix (manufacturers of the ineligible interventions mentioned above). None of the other authors reported any disclosures
Participants	Diagnosis: myofascial pain (RDC/TMD Axis I) with TMD pain over the previous week of at least a 3 on a 0–10 NRS Duration since presenting condition began: (inclusion criteria required participants having had TMD symptoms for at least 6 months) – group A: median 10 years (IQR 12.5); group B: median 10 years (IQR 11) Age at baseline (years): group A – mean 31 (range 13–76); group B: mean 30 (range 15–72) Sex: group A – 15% male; group B – 24% male Number randomised: 41 (group A: 20; group B: 21) Number evaluated: 41 (group A: 20; group B: 21) – ITT used (multiple imputation for the missing outcomes)

Interventions	Comparison: Splint versus no splint for TMD
	
	All patients received TMD self-care programme: similar to usual recommendations given to patients with TMD. Conservative and reversible strategies requiring the dentist or dental care co-ordinator to review TMD with the participant; explain to them the current understanding of prognosis; and provide standardised treatment checklist identifying recommendations for care (e.g. jaw relaxation, reduction of parafunctional behaviours, use of thermal packs, use of over-the-counter pain medications, passive jaw-opening stretches and suggestions about stress reduction)
	
	• Group A
	  ○ Splint type: custom-reversible interocclusal splint therapy (RIST)
	  ○ Upper jaw
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full

Attribute	Study details
	○ Details of impression-taking: maxillary and mandibular vinyl polysiloxane impressions made, then interocclusal records were made using a fast-setting vinyl polysiloxane bite registration material and an intraoral metal tray ○ Instructions to patients: wear at night and for at least 2 hours during the day ○ Monitoring of patients: none • Group B: no other treatment • Group C: Activator Method Chiropractic Technique (not eligible for inclusion in this review) • Group D: sham Activator Method Chiropractic Technique (not eligible for inclusion in this review) Duration of treatment: 2 months
Outcomes	Assessed at 2 and 6 months: we used these data in our 0–3 month and 3–6 month analyses, respectively Primary: • Pain – ○ current pain intensity using a 0 (no pain) to 10 (worst pain) NRS; reported as change score (unable to combine change score in primary meta-analysis using SMD; used in sensitivity analyses of studies reporting current pain intensity on VAS/NRS at 0–3 months and 3–6 months) Secondary: • Quality of life (including physical and emotional function) – OHIP-14: contains two questions about each of seven dimensions, indicating how often the participant had experienced each difficulty in the previous month; possible responses range from 0 (never) to 4 (very often). The OHIP score is obtained by summing the 14 ratings; reported as change score (unable to combine change score in primary meta-analysis using SMD; used in sensitivity analyses of studies reporting current pain intensity on VAS/NRS at 0–3 months) • Patient satisfaction: using a 0 (not at all satisfied) to 10 (extremely satisfied) NRS (no usable data at 6 months: no SD/SE/CI or *p*-value)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'We allocated participants via a randomization algorithm stored in the Web-based system, with future allocations concealed' • Comment: appropriate method
Allocation concealment (selection bias): • Low risk of bias	• 'We allocated participants via a randomization algorithm stored in the Web-based system, with future allocations concealed' • Comment: probably done as a separate data co-ordinating centre was used (The office of Data Management and Biostatistics at the Palmer Centre for Chiropractic Research)
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessed by the patients

Attribute	Study details
Incomplete outcome data (attrition bias):	ITT used (multiple imputation for the missing outcomes)
• Low risk of bias	
Selective reporting (reporting bias):	No evidence of selective reporting
• Low risk of bias	
Other bias:	No other apparent bias
• Low risk of bias	
Ekberg 1998[35] *Characteristics*	
Study details	Trial design: parallel (two arms)
	Location: Department of Stomatognathic Physiology, Lund University, Sweden
	Number of centres: one
	Recruitment period: over 3 years
	Sample size calculation: yes (met)
	Funding: public (supported by the Faculty of Odontology at Lund University and the Swedish Dental Society)
	Declarations/conflicts of interest: not reported
Participants	Diagnosis: TMD of arthrogeneous origin – pain localised to the TMJ region and lateral and/or posterior tenderness to palpation of the TMJ combined with self-assessed TMJ pain of ≥ 40 mm on a 100 mm VAS
	Duration since presenting condition began: TMJ pain (months) – group A: median 24 (range 3–360); group B: median 14 (range 2–120)
	Age at baseline (years): group A – mean 31 (range 13–76); group B – mean 30 (range 15–72)
	Sex: group A – 13% male; group B – 3% male
	Number randomised: 60 (group A: 30; group B: 30)
	Number evaluated: 60 (group A: 30; group B: 30)
Interventions	Comparison: splint vs. control splint for TMD
	Group A • Splint type: custom occlusal stabilisation splint • Upper jaw • Material: not reported • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear at night • Monitoring of patients: a second adjustment was made after 2 weeks but no further adjustment was performed during the following 8 weeks except for single patients as a result of comfort
	Group B • Splint type: custom non-occlusal palatal splint • Upper jaw • Material: not reported

Attribute	Study details
	• Teeth coverage: palatal coverage with clasps on the maxillary teeth (did not interpose between the occluding teeth and therefore did not alter the intermaxillary relationship) • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 10 weeks

Outcomes	Assessed at 10 weeks: grouped under 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ current pain intensity and worst pain experienced assessed separately using a 0 (no pain) to 100 (worst pain) mm VAS (only reported as incidence of 50% reduction of worst pain on VAS)
	  ○ current pain intensity assessed using a five-point verbal scale: 0 = no pain, 1 = slight pain, 2 = moderate pain, 3 = severe pain, 4 = very severe pain (we dichotomised as incidence of moderate to very severe pain)
	  ○ pain frequency assessed using a nine-point verbal scale: 0 = never, 1 = rarely, 2 = once a month, 3 = once every second week, 4 = once a week, 5 = twice a week, 6 = three or four times a week, 7 = daily, 8 = constantly (we dichotomised as incidence of once a week or more)
	  ○ pain duration assessed as follows: 0 = no pain, 1 = a couple of minutes, 2 = some hours, 3 = a full day, 4 = constant (not reported)
	  ○ reported pain both at rest and during mandibular movements (yes/no) (only reported as incidence of a decrease)
	  ○ pain during non-guided mandibular movements (we dichotomised as incidence of pain during 2–4 movements)
	  ○ number of painful masticatory muscles on palpation (we dichotomised as incidence of ≥ 4 sites)
	  ○ degree of tenderness of masticatory muscles on palpation assessed using a four-point scale: 0 = no tenderness, 1 = tenderness reported by the patient, 2 = tenderness with a palpebral reflex, 3 = tenderness with a defence reaction (we dichotomised as incidence of scores 2 or 3)
	
	Secondary
	
	• TMJ clicking – incidence of reciprocal clicking
	• Change in restricted mouth-opening: reported as incidence of those with opening < 40 mm

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'The randomization was carried out by one independent person, using 10 series of consecutively numbered sealed opaque envelopes' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'The randomization was carried out by one independent person, using 10 series of consecutively numbered sealed opaque envelopes' • Comment: the next assignment was adequately concealed from the person randomising patients
Blinding of participants and personnel (performance bias): • High risk of bias	The person delivering and adjusting the splints was not blinded
Blinding of outcome assessment (detection bias): • Unclear risk of bias	Examiner was blinded. Many of the outcomes were patient-reported and it was not clear if the patients were aware of their group assignment

Attribute	Study details
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised participants were included in analysis
Selective reporting (reporting bias): • High risk of bias	Some outcomes measured but not reported fully (current pain VAS and maximum mouth-opening mean and SD)
Other bias: • Low risk of bias	No other apparent bias
Ekberg 2003[36] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Stomatognathic Physiology, Malmö University, Sweden Number of centres: one Recruitment period: over approximately 2 years Sample size calculation: not reported Funding: public (grants from the Faculty of Odontology at Lund University and the Swedish Dental Society) Declarations/conflicts of interest: not reported
Participants	Diagnosis: myofascial pain with or without limited opening according to RDC/TMD; self-assessed myofascial pain of at least 40 mm on a 100 mm VAS Duration since presenting condition began: myofascial pain (months) – group A: median 36 (range 4–420); group B: median 24 (range 1–120) Age at baseline (years): group A – mean 31 (range 14–54); group B: mean 28 (range 14–56) Sex: group A – 17% male; group B – 10% male Number randomised: 60 (group A: 30; group B: 30) Number evaluated: 60 (group A: 30; group B: 30)
Interventions	Comparison: splint vs. control splint for TMD Group A • Splint type: custom occlusal stabilisation splint • Upper jaw • Material: not reported • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear at night • Monitoring of patients: a second adjustment was made after 2 weeks but no further adjustment was performed during the following 8 weeks except for single patients as a result of comfort Group B • Splint type: custom non-occlusal palatal splint • Upper jaw • Material: not reported

Attribute	Study details
	• Teeth coverage: palatal coverage with clasps to attach to one molar on each side (appliance did not cover occlusal surfaces) • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 10 weeks

Outcomes	Assessed at 10 weeks: grouped under 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ current pain intensity and worst pain experienced assessed separately using a 0 (no pain) to 100 (worst pain) mm VAS (only worst pain means were reported with SD, so the current pain means were not usable – we used worst pain in the meta-analysis)
	  ○ current pain intensity assessed using a five-point verbal scale: 0 = no pain, 1 = slight pain, 2 = moderate pain, 3 = severe pain, 4 = very severe pain (we dichotomised as incidence of moderate to very severe pain)
	  ○ pain frequency assessed using a nine-point verbal scale: 0 = never, 1 = rarely, 2 = once a month, 3 = once every second week, 4 = once a week, 5 = twice a week, 6 = 3 or 4 times a week, 7 = daily, 8 = constantly (we dichotomised as incidence of once a week or more)
	  ○ reported pain both at rest and during mandibular movements (yes/no)
	  ○ pain during non-guided mandibular movements (we dichotomised as incidence of pain during 2–4 movements)
	  ○ number of painful masticatory muscles on palpation (we dichotomised as incidence of ≥ 4 sites)
	  ○ degree of tenderness of masticatory muscles on palpation assessed using a four-point scale: 0 = no tenderness, 1 = tenderness reported by the patient, 2 = tenderness with a palpebral reflex, 3 = tenderness with a defence reaction (we dichotomised as incidence of scores 2 or 3)
	
	Secondary:
	
	• TMJ clicking – incidence of reciprocal clicking
	• Change in restricted mouth-opening – reported as incidence of those with opening of < 40 mm
	• Patient satisfaction – satisfied with their treatment (yes/no)
	• Adherence to treatment – 0 = every night, 1 = several nights a week, 2 = when necessary, 3 = not at all (we dichotomised as incidence of use every night or several nights a week)

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'One independent person carried out the randomization by using 10 series of consecutively numbered, sealed, opaque envelopes' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'One independent person carried out the randomization by using 10 series of consecutively numbered, sealed, opaque envelopes' • Comment: the next assignment was adequately concealed from the person randomising patients
Blinding of participants and personnel (performance bias): • High risk of bias	The person delivering and adjusting the splints was not blinded

Attribute	Study details
Blinding of outcome assessment (detection bias): • Unclear risk of bias	Examiner was blinded. Many of the outcomes were patient-reported and it was not clear if the patients were aware of their group assignment
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised participants were included in analysis
Selective reporting (reporting bias): • High risk of bias	Some outcomes measured but not reported fully (current pain VAS and maximum mouth-opening mean and SD)
Other bias: • Low risk of bias	No other apparent bias
Elsharkawy 1995[58] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Oral Surgery Department, Cairo University, Egypt Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported
Participants	Diagnosis: based on presence of two or more of TMJ pain and tenderness when palpated both laterally in the preauricular area and via the external auditory meatus, masticatory muscle tenderness, clicking and jaw locking, and trismus (patients with disc displacement were excluded) Duration since presenting condition began: not reported Age at baseline (years): not reported Sex: not reported Number randomised: 50 (group A: 25; group B: 25) Number evaluated: 46 (group A: 23; group B: 23)

Interventions	Comparison: splint vs. no splint for TMD
	All patients in groups A and B received acuhealth therapy: acuhealth unit detects energy acupuncture points and performs stimulation/treatment without penetrating the skin; weekly sessions for 8 weeks
	• Group A
	  ○ Splint type: custom occlusal splint
	  ○ Lower jaw
	  ○ Material: soft (polyvinyl)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear at night
	  ○ Monitoring of patients: not reported

Attribute	Study details
	• Group B: no other treatment • Group C*: above-mentioned splint alone (no acuhealth therapy) • Group D*: placebo acuhealth therapy (machine switched off) *Groups C and D are excluded from this review as it was not possible to make any eligible pairwise comparisons using them Duration of treatment: 8 weeks
Outcomes	Assessed at 3 months: grouped under 0–3 month analysis (also assessed at 6 and 12 months but patients had crossed over and were no longer analysed according to the group they were originally randomised to, so the data were not eligible for inclusion) Primary: • Pain – (a) current pain intensity 0 (no pain) to 100 (worst pain) mm VAS (no data reported) (b) subjective dysfunction score: 1 = no pain, 2 = mild pain, 3 = moderate pain, 4 = severe pain, 5 = very severe pain (no data reported) ○ the results for pain outcomes a and b above were individually assessed according to the following scale: impaired, unchanged, improved, symptom free (we dichotomised this as incidence of improved and symptom free)
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly divided' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly divided' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective pain outcomes assessment by patients
Incomplete outcome data (attrition bias): • High risk of bias	We were unable to use data at 6 and 12 months as some patients were no longer analysed according to the group they were originally randomised to
Selective reporting (reporting bias): • High risk of bias	Incomplete reporting of pain data
Other bias: • Low risk of bias	No other apparent bias
Ficnar 2013[61] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Department of Prosthetic Dentistry and Biomaterials and the Department of Orthodontics of the Center for Dental, Oral and Maxillofacial Diseases of Münster University Hospital, Germany

Attribute	Study details
	Number of centres: one Recruitment period: 2009–10 Sample size calculation: not reported Funding: industry ('The expenses for this study were payed by Jaxeurope [Taunusstein, Germany]') Declarations/conflicts of interest: 'The authors declare that they have no competing interests'
Participants	Diagnosis: RDC/TMD Ia or Ib (myofascial pain) also in combination with arthralgia (IIIa) and/or disk displacement with reduction (IIa) and a maximum 'von Korff' pain grade of I (functional pain with low levels of intensity) to II (functional pain with high levels of intensity) Duration since presenting condition began: not reported Age at baseline (years): median 35 (not reported by group) Sex: 21% male (not reported by group) Number randomised: 63 (group A: 21; group B: 21; group C: 21) Number evaluated: 58 (group A: 18; group B: 21; group C: 19)
Interventions	**Comparison:** splint vs. no splint for TMD – prefabricated splint vs. custom-made splint for TMD All patients received conservative therapy: self-exercises (muscle exercise form according to Professor Schulte, self-massage techniques, mouth-opening exercises), medication-based therapy using NSAID, muscle relaxants as well as manual therapy Group A • Splint type: custom occlusal stabilisation splint • Upper jaw/lower jaw: not reported • Material: not reported • Teeth coverage: full • Details of impression-taking: a bite registration was taken using wax • Instructions to patients: wear every night and for 2 hours during the day • Monitoring of patients: not reported Group B • Splint type: prefabricated, semi-finished occlusal splint (SOLUBrux) • Upper jaw • Material: soft (malleable thermoplastic) • Teeth coverage: full • Details of impression-taking: no impression needed • Instructions to patients: as above • Monitoring of patients: not reported Group C • No other treatment Duration of treatment: 2.5 months

Attribute	Study details
Outcomes	Assessed at 2 weeks and 2.5 months: we would have used the 2.5 month data for our 0–3 month analysis Primary: • Pain – reduction in the number of of pressure-sensitive areas on palpation of (1) masticatory muscles and (2) TMJ (no usable data – medians presented) Secondary: • Change in restricted mouth-opening – unassisted pain-free maximum jaw opening – incisal edge distance in mm (no usable data – medians presented)
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomisation' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomisation' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective pain outcome ('change in restricted mouth-opening' was more objective but unclear whether or not it was measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	Low (8%) overall attrition and fairly equally distributed
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No other apparent bias
Giannakopoulos 2016[62] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: University clinic, Heidelberg, Germany Number of centres: one Recruitment period: 2009–11 Sample size calculation: no (only post hoc to estimate sample size required for future trials) Funding: not reported Declarations/conflicts of interest: 'The authors report no conflicts of interest' Authors provided unpublished data

Attribute	Study details
Participants	Diagnosis: painful non-chronic (i.e. non-dysfunctional) TMD-related pain, diagnosed by use of the RDC/TMD – patients with a GCPS value of 3 or 4, indicative of disabling chronic pain, were not eligible for the study Duration since presenting condition began: pain duration mean 42.98 weeks (SD 51.33 weeks) Age at baseline (years): overall mean 41.58 (SD 16.68) – not reported by group Sex: group A – 50% male; group B – 33.3% male; group C – 8.3% male Number randomised: 36 (group A: 12; group B: 12; group C: 12) Number evaluated: 36 (group A: 12; group B: 12; group C: 12)
Interventions	Comparison: (1) splint vs. no splint for TMD; (2) custom-made splint vs. prefabricated splint for TMD All patients received counselling: their disease and its multifactorial aetiology were explained, and they were given advice on how to reduce stress on their masticatory system by avoiding extreme movements of the jaw (e.g. yawning) and by avoiding chewing hard food or chewing gum. All patients in extreme pain were allowed to use common over-the-counter analgesics, the type, amount and frequency of which were to be reported on recall Group A • Splint type: custom vacuum-formed oral splint fabricated on the patient's study casts in a dental laboratory • Upper jaw/lower jaw: not reported • Material: soft (1.5-mm-thick co-polyester film) • Teeth coverage: full • Details of impression-taking: 'custom alginate impressions of both dental arches and bite registrations were obtained from all patients' • Instructions to patients: as above • Monitoring of patients: as above Group B • Splint type: prefabricated oral splint with water-filled elastic pads (Aqualizer) • Upper jaw/lower jaw: not reported • Material: soft (water-filled elastic pads) • Teeth coverage: full • Details of impression-taking: not used for this group • Instructions to patients: wear splint during sleep and for at least 6 hours per day • Monitoring of patients: none as intervention was used for only 2 weeks Group C • Waiting-list group, received normal counselling (described above) followed by a Michigan-type hard acrylic oral splint after 2 weeks (i.e. after the study finished) Duration of treatment: 2 weeks

Attribute	Study details
Outcomes	Assessed at 2 weeks: grouped under 0 to 3 month analysis Primary: • Pain – current pain intensity using a 0 (no pain) to 10 (worst pain) NRS; we converted this to a 0–100 scale as reported in the majority of other studies Secondary: • Change in restricted mouth-opening – unassisted maximum jaw-opening (mm) (only reported mean and SD for overall sample – author provided data for opening with no pain, with pain and assisted opening; we used opening with no pain)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'A statistician not involved in the study had provided consecutively numbered sealed envelopes with one random assignment in each' • Comment: probably done considering allocation concealment was done properly
Allocation concealment (selection bias): • Low risk of bias	• 'A statistician not involved in the study had provided consecutively numbered sealed envelopes with one random assignment in each. The envelopes were opened in sequence by the principal investigator after an eligible patient had given his/her written informed consent to participation in the study and had been examined' • Comment: the next assignment was adequately concealed from the person randomising patients
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective pain outcome assessment by patients (but 'change in restricted mouth-opening' was objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • Low risk of bias	Pain outcome fully reported and author provided mean and SD for each group for the outcome of maximum mouth-opening
Other bias: • Low risk of bias	No apparent other bias
Gomes 2014[32] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Nove de Julho University, São Paulo, Brazil Number of centres: one Recruitment period: June 2011 to December 2012 Sample size calculation: yes (met – not powered on any of the relevant outcomes from our review) Funding: 'This study had no financial support' Declarations/conflicts of interest: 'The authors declare that they have no competing interests'

Attribute	Study details
Participants	Diagnosis: severe TMD and sleep bruxism – (1) the Fonseca Patient History Index was used to diagnose the presence and intensity of TMD; (2) those with incisal and/or occlusal tooth wear and clinical signs in the buccal mucosa and tongue of clenching or grinding were diagnosed with bruxism based on the criteria of the American Academy of Sleep Medicine and a positive self-report of awake bruxism Duration since presenting condition began: at least 1 year Age at baseline (years): (inclusion was 18–40 years) group A – mean 26 (SD 3); group B – mean 29 (SD 4) Sex: group A – 7% male; group B – 13% male Number randomised: 30 (group A: 15; group B: 15) Number evaluated: 30 (group A: 15; group B: 15)

Interventions	Comparison: splint vs. no splint for TMD and bruxism
	
	All patients in groups A and B received massage: three weekly 30-minute sessions of massage therapy performed by a physiotherapist who had undergone a training exercise for the administration of sliding and kneading manoeuvres of the masseter and anterior temporal muscles, bilaterally, over 4 consecutive weeks (total: 12 sessions)
	
	• Group A
	  ○ Splint type: custom Michigan-type occlusal splint
	  ○ Upper jaw
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: the upper arch of each volunteer was moulded with irreversible hydrocolloid
	  ○ Instructions to patients: wear the splint while sleeping
	  ○ Monitoring of patients: adjustments made after 2 weeks by the same dentist in charge of the evaluation and splint fabrication
	
	• Group B: no other treatment
	• Group C*: custom Michigan-type occlusal splint (not combined with massage)
	• Group D*: custom silicone occlusal splint (not combined with massage)
	
	*Groups C and D are excluded from this review as it was not possible to make any eligible pairwise comparisons using them
	
	Duration of treatment: 4 weeks

Outcomes	The outcomes measured at 4 weeks (electromyographic analysis of the masseter and anterior temporal muscles, reported as median frequency, and the Fonseca Patient History Index) were not outcomes of this review and therefore there were no usable data in this study
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Block randomization was employed and opaque envelopes were used to conceal the allocation' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'Block randomization was employed and opaque envelopes were used to conceal the allocation' • Comment: probably done
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients

Attribute	Study details
Blinding of outcome assessment (detection bias): • Low risk of bias	Irrelevant as there are no outcomes of use for this review
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients appear to have been included in the analyses (from correspondence with authors)
Selective reporting (reporting bias): • High risk of bias	We would expect to see pain reported in the assessment of TMD patients
Other bias: • Low risk of bias	No apparent other bias
Gomes 2015[33] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Nove de Julho University, São Paulo, Brazil Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported
Participants	Diagnosis: sleep bruxism diagnosed by experienced dentist based on criteria of the International Classification for Sleep Disorders of the American Academy of Sleep Medicine, self-reported awake bruxism, and a minimum pain intensity score of 3 on an 11-point NRS Duration since presenting condition began (months): group A – mean 18.16 (SD 9.33); group B – mean 23.19 (SD 4.84); group C – mean 27.55 (SD 9.41); group D – mean 22.94 (SD 5.02) Age at baseline (years): (inclusion was 18–40 years) group A – mean 24.40 (SD 4.10); group B – mean 25.72 (SD 6.20); group C – mean 28.60 (SD 4.20); group D – mean 24.40 (SD 4.10) Sex: all female Number randomised: 100 (group A: 25; group B: 25; group C: 25; group D: 25) Number evaluated: 78 (group A: 19; group B: 19; group C: 23; group D: 17)
Interventions	Comparison: splint vs. no splint for bruxism We split the four groups/arms into two pairwise comparisons of A vs. B and C vs. D Group A • Splint type: custom Michigan-type occlusal splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: the upper arch of each volunteer was moulded with irreversible hydrocolloid • Instructions to patients: wear splint while sleeping • Monitoring of patients: adjustments made after 2 weeks by the same dentist in charge of the evaluation and splint fabrication

Attribute	Study details
	Group B: no treatment Group C: combined (splint + massage) – as groups A and D Group D: massage – three weekly 30-minute sessions of massage of the muscles of mastication over 4 consecutive weeks (total: 12 sessions). Massage therapy performed by a physiotherapist who had undergone a training exercise for the administration of the protocol, involving sliding and kneading manoeuvres on the masseter and temporal muscles Duration of treatment: 4 weeks
Outcomes	Assessed at 4 weeks Primary: • Pain – current pain intensity using a 0 (no pain) to 10 (worst pain) NRS Secondary: • Quality of life (including physical and emotional function) – SF-36: questionnaire with 36 items distributed across eight subscales: physical functioning (10 items), role physical (4 items), bodily pain (2 items), general health state (5 items), vitality (4 items), role social (2 items), role emotional (3 items) and mental health (5 items) – each reported separately apart from 'bodily pain', which was not assessed or reported (0–100, higher = better health) (data not usable – no SD/SE/*p*-values)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Randomization was performed using opaque envelopes containing information stipulating to which group each participant belonged' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'Randomization was performed using opaque envelopes containing information stipulating to which group each participant belonged' • Comment: probably done
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients
Incomplete outcome data (attrition bias): • High risk of bias	Overall attrition was 22% and also differed by group (group A: 24%; group B: 24%; group C: 8%; group D: 32%). High attrition for such a short-term study
Selective reporting (reporting bias): • High risk of bias	No typical bruxism outcomes measured or reported
Other bias: • Low risk of bias	No apparent other bias

Attribute	Study details
Haketa 2010[66] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: TMJ Clinic of the Tokyo Medical and Dental University, Japan Number of centres: one Recruitment period: January to December 2006 Trials registry ID: NCT00936338 Sample size calculation: yes (not met) Funding: public (supported by the Dental Hospital and the Department of Temporomandibular joint and Occlusion of Tokyo Medical and Dental University) Declarations/conflicts of interest: not reported We emailed authors for data but none provided so far
Participants	Diagnosis: anterior disc displacement without reduction – confirmed by MRI; must have mouth-opening pain on TMJ-affected side and maximum mouth-opening of < 40 mm Duration since presenting condition began: > 2 weeks Age at baseline (years): group A – mean 38.6 (SD 13.8); group B – mean 38.8 (SD 15.2) Sex: group A – 16% male; group B – 0% male Number randomised: 52 (group A: 28; group B: 24) Number evaluated: 44 (group A: 25; group B: 19)

Interventions	Comparison: splint vs. minimal treatment (exercise) for TMD
	
	Instructions to all participants in both groups: all participants received a verbal explanation of the pathological conditions based on X-ray and MRI findings, and a general self-care protocol such as good posture, soft diet, teeth apart, etc. All participants were prescribed a NSAID three times every day
	
	• Group A
	  ○ Splint type: custom occlusal stabilisation splint
	  ○ Upper jaw
	  ○ Material: hard (1.5-mm-thick, hard clear acrylic sheet)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: vacuum-adapted to the maxillary cast
	  ○ Instructions to patients: information as above; splint was worn at night
	  ○ Monitoring of patients: not reported
	
	• Group B: exercise intervention: manual jaw-opening exercises performed by the participants as follows: as a warm-up, the individual placed their fingertips on the edge of the mandibular anterior teeth and slowly pulled the mandible down until pain occurred on the TMJ-affected side. This mouth-opening position was held for 30 seconds. Three cycles of this stretching movement were defined as a single set. The participants performed four sets per day, one after each meal and one after bathing
	
	Duration of treatment: 8 weeks

Attribute	Study details
Outcomes	Assessed at 4 and 8 weeks: we used the 8-week data for our 0–3 month analysis Primary: • Pain – current maximum daily pain intensity using a 0 (no pain) to 100 (worst pain) mm VAS (no description of how measured) • Harms/adverse effects – reported narratively ('No significant adverse effect was reported resulting from either treatment') Secondary: • Change in restricted mouth-opening – maximum mouth-opening range (distance between the incisal edges of the upper and lower central incisors in mm) was reported separately with and without pain (we used opening without pain) • Quality of life (including physical and emotional function) – pain-related limitation of daily functions assessed using the 'Limitation of Daily Functions for the TMD Questionnaire' – 10 questions scored using a 5-level NRS from (1) no problem at all to (5) extremely difficult. The summary score of the 10 questions ranges from 10 to 50 (data not used – median and IQR)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'The assignment was made by a table of random sampling numbers' and 'a clinician drew a sealed envelope from a series of envelopes, each containing a card indicating either of two treatments for that individual' • Comment: appropriate method
Allocation concealment (selection bias): • Low risk of bias	• 'a clinician drew a sealed envelope from a series of envelopes, each containing a card indicating either of two treatments for that individual' and 'One examiner who was completely independent of the treatment of participants prepared this procedure' • Comment: these methods should ensure that the next assignment was adequately concealed from the person randomising patients
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening' which was objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	Overall attrition was 22% (group A: 11%; group B: 21%) – probably not sufficient to cause serious bias
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No apparent other bias
Hasanoglu 2017[52] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Oral Surgery, Gazi University, Turkey Number of centres: one

Attribute	Study details
	Recruitment period: January to June 2014 Sample size calculation: yes (met) Funding: 'The authors have no support or funding to report' Declarations/conflicts of interest: 'The authors have stated explicitly that there are no conflict of interests in connection with this article'
Participants	Diagnosis: myofascial pain (RDC/TMD Group I: pain or ache in the jaw, temples, face, pre-auricular area or inside the ear at rest or during function and pain in response to palpation of ≥ 3 of the specified 20 muscle sites. In addition, at least one site must be ipsilateral to the site of pain complaint) Duration since presenting condition began: group A – mean 3.49 years (SD 2.75 years); group B – mean 1.16 years (SD 1.36 years) Age at baseline (years): (inclusion was ≥ 18 years) group A – mean 24.6 years (SD 9.2 years); group B – mean 32.25 years (SD 11.97 years) Sex: group A – 20% male; group B – 15% male Number randomised: 40 (group A: 20; group B: 20) Number evaluated: 40 (group A: 20; group B: 20)

Interventions	Comparison: splint vs. no splint for TMD
	
	Both groups received first line therapy for facial pain: guidance, assurance, counselling and behavioural changes (no further description given)
	
	• Group A
	  ○ Splint type: custom NTI-tss
	  ○ Upper jaw/lower jaw: not reported
	  ○ Material: (hard) 'For its adjustment, the thermoplastic material provided in the box with the splint is melted in hot water, filled into the concave region of the splint and adapted to lower or upper incisor teeth. The material re-polymerises again, becomes rigid, fits to the anterior teeth and avoids contact of canines and molars'
	  ○ Teeth coverage: partial
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear device overnight
	  ○ Monitoring of patients: not reported
	
	• Group B: no other treatment
	
	Duration of treatment: 6 weeks

Outcomes	Assessed at 3 and 6 weeks: we used the 6-week data for our 0–3 month analysis Primary: • Pain – current pain intensity 0 (no pain) to 100 (worst pain) mm VAS Secondary: • Change in restricted mouth-opening – self-assessment of functional limitation of jaw using 0 (no limitation) to 100 (severe limitation) mm VAS
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Patients were randomly divided into two groups' • Comment: insufficient information

Attribute	Study details
Allocation concealment (selection bias): • Unclear risk of bias	• 'Patients were randomly divided into two groups' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No apparent other bias
Johansson 1991[37] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Department of Stomatognathic Physiology, University of Gothenberg, Sweden Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported
Participants	Diagnosis: CMD – a history including signs and symptoms of CMD; complaints of headache and/or facial pain; clinical examination demonstrating tenderness to palpation in the masticatory muscles; exclusion of individuals with psychologic/psychogenic factors, trauma, surgery, or systemic joint, muscle, or skin diseases influencing the symptoms; exclusion of pathologic conditions in TMJs, facial skeleton, or teeth using radiographs Duration since presenting condition began: not reported Age at baseline (years): not reported Sex: not reported Number randomised: 30 (group A: 15; group B: 15) Number evaluated: 30 (group A: 15; group B: 15)

Attribute	Study details

Interventions	Comparison: splint vs. no splint for TMD
	
	• Group A
	  ○ Splint type: custom occlusal splint
	  ○ Upper jaw
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: not reported
	  ○ Monitoring of patients: additional adjustments to splints were made after 2 weeks
	
	• Group B: no treatment
	• Group C: acupuncture (not eligible for this review)
	
	Duration of treatment: splint group were examined at '3 months after treatment', but it is unclear if the treatment period lasted 3 months

Outcomes	Group A assessed at 3 months, group B assessed at 2 months
	
	Primary:
	
	• Pain –
	  ○ 0 (no pain) to 100 (worst pain) mm VAS (presented graphically with no SD – unable to use data)
	  ○ subjective dysfunction score on five-point scale: 1 = no pain; 2 = mild pain; 3 = moderate pain; 4 = severe pain; 5 = very severe pain (no usable data – reported as incidence of different score changes)
	  ○ changes in facial pain and headache: reported as incidence of impaired, unchanged, improved, symptom free (we dichotomised the data to report the incidence of improved and symptom free)

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Patients meeting the above criteria were randomly divided into three groups' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Patients meeting the above criteria were randomly divided into three groups' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • Low risk of bias	Poor reporting but probably not done selectively
Other bias: • High risk of bias	Outcomes were assessed at 3 months for the splint group but at 2 months for the control group

Attribute	Study details
Karakis 2014[53] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Prosthodontics, Gazi University, Ankara, Turkey Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public (Cumhuriyet University, Foundation of Scientific Research Projection) Declarations/conflicts of interest: not reported
Participants	Diagnosis: sleep bruxism according to the following criteria – history of frequent tooth grinding occurring at least 3 nights per week for the preceding 6 months, as confirmed by a sleep partner; clinical presence of tooth wear; masseter muscle hypertrophy; report of jaw muscle fatigue or tenderness in the morning Duration since presenting condition began: at least 6 months Age at baseline (years): ranging from 18 to 27 (not reported by treatment group) Sex: not reported Number randomised: 12 (group A: 6; group B: 6) Number evaluated: not reported
Interventions	Comparison: custom-made splint vs. prefabricated splint for bruxism Group A • Splint type: custom occlusal stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: not to take any medications, such as muscle relaxants, sleeping pills, tranquilizers and antidepressants during treatment; to be worn during sleep (at least 8 hours) • Monitoring of patients: not reported Group B • Splint type: prefabricated occlusal splint (Bruxogard) • Upper jaw • Material: soft • Teeth coverage: full • Details of impression-taking: no impression. Placed in boiling water for 30 seconds, fitted to patient's mouth, removed and placed in cold water for 20 seconds • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 6 weeks
Outcomes	The outcomes assessed at 3 and 6 weeks (Craniomandibular Index and occlusal force) were not outcomes of this review; therefore, there were no usable data in this study

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Participants were randomly assigned to either of two splint groups' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Participants were randomly assigned to either of two splint groups' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • Low risk of bias	Irrelevant as there are no outcomes of use for this review
Incomplete outcome data (attrition bias): • Unclear risk of bias	Numbers of participants analysed is not reported
Selective reporting (reporting bias): • High risk of bias	There are no useful bruxism outcomes
Other bias: • Low risk of bias	No apparent other bias
Katyayan 2014[56] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Prosthetic Dentistry, Government Dental College and Hospital, Ahmedabad, India Number of centres: one Recruitment period: not reported ('over a period of one year') Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported
Participants	Diagnosis: TMD (RDC/TMD axis I) Duration since presenting condition began: at least 6 months Age at baseline (years): mean 34.4 (range 20–56) – not reported by group Sex: 22.5% male – not reported by group Number randomised: 80 (group A: 40; group B: 40) Number evaluated: 80 (group A: 40; group B: 40)

Attribute	Study details

Interventions	Comparison: splint vs. no splint for TMD
	
	All patients received counselling and masticatory muscle exercises: mandible held in the maximal position for a few seconds on each movement (laterotrusive and protrusive), then with resistance from the patient's fingers. After jaw exercised, the patients were suggested to open the jaw wide stretching it with their fingers a few times for 10–20 seconds. Movements were repeated 7–10 times per training session and sessions were performed two or three times per day. Patients received written instructions and the movements were demonstrated by the dentist before treatment and after, if necessary
	
	• Group A
	  ○ Splint type: custom occlusal stabilisation splint
	  ○ Upper jaw
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear at night while sleeping for a minimum of 12 hours. The appliance was adjusted at regular intervals and, after 10 weeks, the patients were advised to gradually reduce wear of the appliance to a minimum of 8 hours per day
	  ○ Monitoring of patients: adjustments at 1-, 7-, 15-, 30-, 90-, 150- and 180-day intervals for follow-up
	
	• Group B: no other treatment
	
	Duration of treatment: 6 months

Outcomes	Assessed at 6 months: grouped under 3 to 6 months analysis
	
	Primary:
	
	• Pain –
	  ○ current pain intensity on 0 (no pain) to 100 (worst pain) mm VAS (authors confirmed that these scores were accidentally reported in cm – we converted them to mm)
	  ○ number of painful muscle sites on palpation (out of 20 sites); 2 lb of pressure for extraoral muscles, 1 lb of pressure on the joints and intraoral muscles
	
	Secondary:
	
	• Change in restricted mouth-opening – maximum mouth-opening in mm – the sum of unassisted maximal interincisal opening and the vertical incisal overlap

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'The assignment was made by a table of random sampling numbers' • Comment: appropriate method
Allocation concealment (selection bias): • Low risk of bias	• 'a clinician drew a sealed envelope from a series of envelopes, each containing a card indicating either of two treatments for that individual' and 'This allocation was done by a clinician who was independent of the trial and unaware of patient diagnosis, and was not involved at any stage in the clinical treatment phase' • Comment: these methods should ensure that the next assignment was adequately concealed from the person randomising patients

Attribute	Study details
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening', which was objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No apparent other bias
Leeson 2007[63] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Eastman Dental Hospital, London, UK Number of centres: one Recruitment period: unclear but appears to be 1995–97 Sample size calculation: yes (met) Funding: public and pharmaceutical (medication donated by Lilly Pharmaceutical Company and the project was funded by a Department of Health and Social Care grant and locally organised research funding) Declarations/conflicts of interest: not reported
Participants	Diagnosis: chronic TMD of recent onset (of > 3 months duration, hence exposed to minimal treatment intervention) – pain in one or both TMJs with or without (1) clicking, (2) limited mouth-opening, (3) muscle tenderness Duration since presenting condition began: at least 3 months Age at baseline (years): group A – mean 34.1 (SD 9.99), range 16–55; group B – mean 29.8 (SD 7.99), range 16–55 Sex: group A – 21.0% male; group B – 23.8% male Number randomised: 125 (group A: 62; group B: 63) Number evaluated: 125 (group A: 62; group B: 63) imputational analysis used (last score brought forward)
Interventions	Comparison: splint vs. no splint for TMD All patients in groups A and B received medication: SSRI fluoxetine, Prozac. Initial 20 mg daily, then doubled to 40 mg at the 2-month review. After 3 months, patients who improved on medical therapy and wished to continue on treatment, remained on medication, usually at the 40 mg dosage. If pain had failed to respond, or worsened, patients were reassessed and, in some cases, withdrawn from continuation in the study. Further data were collected from these patients to include in the ITT analysis. All patients requested to only embark on minimal essential dental treatment and refrain from alternative pain therapies during treatment

Attribute	Study details

	• Group A
	  ○ Splint type: custom occlusal stabilisation splint (Michigan splint)
	  ○ Upper jaw
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: an appointment was arranged for impressions, wax bite and face bow recordings with the restorative lecturer. The work was then sent to Kurban Dental Laboratory (London, UK) for construction of splint
	  ○ Instructions to patients: not reported
	  ○ Monitoring of patients: reviewed after 2 weeks for further adjustment and then minor alterations at monthly intervals up to 3 months
	• Group B: no other treatment
	• Group C*: splint alone (no medication)
	• Group D*: placebo medication
	
	*Groups C and D are excluded from this review as it was not possible to make any eligible pairwise comparisons using them
	
	Duration of treatment: 3 months

Outcomes	Assessed at 1, 2 and 3 months: we used the 3-month data for our 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ current pain intensity on 0 (no pain) to 10 (worst pain) cm VAS (we converted this to mm in order to combine with data from other studies); this was also reported as incidence of both 25% and 50% reduction in VAS pain score at 3 months (we used the 50% reduction data as this enabled pooling with other data)
	  ○ current pain intensity reported categorically as follows: none, mild, moderate, severe (we used only the VAS data)
	  ○ pain frequency reported categorically as follows: never, occasionally, often, always (we used only the VAS data)
	  ○ pain response reported categorically as follows: worse, in pain, improved, pain free (we used only the VAS data)
	  ○ pain interference with life reported as yes or no (we used only the VAS data)
	
	Secondary:
	
	• Change in restricted mouth-opening – maximum unassisted pain-free mouth-opening in mm (interincisal)
	• Quality of life (including physical and emotional function) – (1) Multidimensional Pain Inventory severity; (2) McGill Short Pain Questionnaire; (3) Kellner Illness Attitude Scale; (4) BDI scores (no usable data – median and IQR)

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Patients were randomly allocated to one of four groups, using the method of block randomisation' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'Randomisation was undertaken by a third party, namely a member of the administration or dental nursing staff. A sealed envelope was opened indicating group participation and recorded in a locked register' • Comment: these methods should ensure that the next assignment was adequately concealed from the person randomising patients

Attribute	Study details
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening', which was objective but unclear whether or not it was measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	Inputational analysis used (last score brought forward) so that all randomised patients were included in the analyses
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No apparent other bias
List 1992[38] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Department of Stomatognathic Physiology, University of Gothenberg, Sweden Number of centres: one Recruitment period: April 1987 to March 1989 Sample size calculation: not reported Funding: public (Jonkoping County Council and Swedish Medical Research Council, project 55) Declarations/conflicts of interest: not reported
Participants	Diagnosis: craniomandibular disorder (CMD): signs and symptoms of CMD of primarily muscular origin; pain for > 6 months; clinical dysfunction index of Di II or more according to Helkimo[74] Duration since presenting condition began: pain for > 6 months – median duration in years (range) – group A: 3.0 (14.5); group B: 4.3 (24.5) Age at baseline (years): group A – mean 39 (SD 11); group B – mean 48 (SD 13) Sex: group A – 35% male; group B – 3% male Number randomised: 70 (group A: 40; group B: 30) Number evaluated: 56 (group A: 34; group B: 22)

Interventions	Comparison: splint vs. no splint for TMD
	• Group A
	  ○ Splint type: custom occlusal stabilisation splints
	  ○ Upper jaw (only applied in the mandible area for patients with loss of molar support; $n = 3$)
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: used at night until evaluation 7–8 weeks later
	  ○ Monitoring of patients: splints were checked and adjusted after 1 week

Attribute	Study details
	Group B: no treatment (3-month wait list) Group C: acupuncture (not eligible for this review) Duration of treatment: group A – 6–8 weeks (but preceded by 1-month pre-treatment period); group B – on waiting list for 3 months

Outcomes	Group A assessed at 2 months, group B assessed at 3 months: grouped under 0–3 months' analysis There were also 6-month and 12-month assessments but they are not reported
	
	Primary:
	
	• Pain –
	  ○ 0 (no pain) to 100 (worst pain) mm VAS; recorded three times daily (morning, noon, evening) in a pain diary, with the average calculated on a weekly basis (appears to be presented in the study report as cm – we converted this to a mm scale)
	  ○ frequency of pain: number of occasions during a week with a VAS pain score of > 0, so the number of recordings during the week (3 × 7) could vary in the range 0–21 (we used only the VAS data above)

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Unable to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients
Incomplete outcome data (attrition bias): • Low risk of bias	Overall attrition 20% (group A: 15%; group B: 27%). There were no dropouts in the study but only pain diaries in which > 70% of the required recordings had been completed were included in the analysis. Unlikely to change the results much
Selective reporting (reporting bias): • High risk of bias	The assessments at 6 and 12 months are reported in a separate study report, but only for groups A and C
Other bias: • High risk of bias	• (1) Outcomes were assessed at 6–8 weeks for the splint group but at 3 months for the control group • (2) Substantial sex imbalance between groups (potentially indicating that the randomisation process was inadequate or did not work)
Lundh 1985[39] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Department of Stomatology, University of Lund, Sweden Number of centres: one Recruitment period: January 1982 to March 1984 Sample size calculation: not reported

Attribute	Study details
	Funding: public and industry, that is private health-care company (financial support from University of Lund, and Praktikertjanst AB, Sweden; study supported by Magnus Bergvalls Foundation, Torsten and Ragnar Soderbergs Foundations, and Swedish Medical Research Council) Declarations/conflicts of interest: not reported
Participants	Diagnosis: '1704 patients referred for pain and dysfunction of the masticatory system', every third patient given an appointment ($n = 568$). These were then subdivided into those with reciprocal clicking (clicking on opening and closing) ($n = 88$) these were then subdivided again into those that could eliminate clicking by beginning mandibular movements in a position anterior to intercuspal position (centric occlusion), but not as far as edge to edge incisal potion and only these added to the trial ($n = 78$). Those that could not eliminate clicking unless mandibular movements were started from edge to edge incisal position, these were excluded from the trial ($n = 10$) Duration since presenting condition began: not reported Age at baseline (years): median 30, range 10–69 (not reported by group) Sex: 31% male (not reported by group) Number randomised: 70 (group A: 24; group B: 23; group C: 23) Number evaluated: 70 (group A: 24; group B: 23; group C: 23)
Interventions	Comparison: splint vs. no splint for TMD Group A • Splint type: custom anterior repositioning splint • Upper jaw • Material: hard • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear 24 hours per day for 6 weeks then reduce over following 2 weeks starting with taking it out for 2 hours between meals • Monitoring of patients: 6, 17 and 52 weeks Group B • Splint type: custom flat occlusal splint • Upper jaw • Material: hard • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear only at night for 6 weeks then reduce over following 2 weeks • Monitoring of patients: as above Group C • No treatment Duration of treatment: 6 weeks (but followed by 2 weeks of reduction in use and unclear thereafter)

Attribute	Study details

Outcomes	Assessed at 6, 17 and 52 weeks: we used these in our 0–3 month, 3–6 month and 6–12 month analyses, respectively
	
	Primary:
	
	• Pain –
	  ○ pain at rest, chewing and on protrusion assessed separately on 0–10 cm worsening VAS at each follow-up examination (if bilateral click then only the most painful side was scored) (no usable data – no means or SD)
	  ○ palpation pain of muscles of mastication (data not used – incidence reported separately for four different sites but was not equal at baseline)
	
	Secondary:
	
	• TMJ clicking: reciprocal clicking assessed using a stethoscope

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessed by patient (except for clicking – but blinding was not mentioned)
Incomplete outcome data (attrition bias): • Low risk of bias	There did not appear to be any dropouts
Selective reporting (reporting bias): • High risk of bias	No data reported for the VAS pain outcomes
Other bias: • Low risk of bias	No other bias apparent
Lundh 1988[40] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: (1) Department of Stomatology, School of Dentistry, Malmö, Sweden and (2) Department of Oral Surgery, University Hospital, Lund, Sweden Number of centres: two Recruitment period: not reported Sample size calculation: not reported

Attribute	Study details
	Funding: public and industry, that is both private health-care company and pharmaceutical company (supported by Magnus Bergvalls Foundation, University of Lund, Praktikertjanst AB, Sweden, Swedish Medical Research Council, Torsten and Ragnar Soderbergs Foundations, and the Ake Wiberg Foundation; Nycomed AB, Sweden provided contrast medium used for arthrography) Declarations/conflicts of interest: not reported
Participants	Diagnosis: disk displacement with reduction: *902 consecutive patients referred for treatment of masticatory muscle or temporomandibular joint pain and dysfunction were clinically examined. 212 patients demonstrated temporomandibular joint reciprocal clicking defined as clicking during opening that did not occur unless it was preceded by clicking during closing. 149 of the 212 patients were excluded from the study. 105 of these had minor subjective complaints (graded as less than 5 on a visual analog scale with 0 and 10 as end points), 27 patients were not willing to participate in a scientific study, 11 patients needed mandibular protrusion anterior to the edge-to-edge incisal relationship to eliminate the clicking, 5 patients showed arthrographic evidence of disk displacement without reduction, and 1 patient was arthrographically normal. The study was therefore based on the remaining 63 patients* – confirmed by arthrography Duration since presenting condition began: not reported Age at baseline (years): median 24, range 13–74 (not reported by group) Sex: 14% male (not reported by group) Number randomised: 43 (group A: 21; group B: 22) Number evaluated: 43 (group A: 21; group B: 22)

Interventions	Comparison: splint vs. no splint for TMD
	
	All patients were informed about basic anatomy and function of the TMJ, the mechanisms of clicking and locking, and the possible caused of pain
	
	• Group A
	  ○ Splint type: flat occlusal splint
	  ○ Upper jaw
	  ○ Material: hard
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: no information
	  ○ Instructions to patients: wear at night
	  ○ Monitoring of patients: not reported
	
	• Group B: no other treatment
	• Group C: disk-repositioning onlays (not eligible for this review)
	
	Duration of treatment: 6 months

Outcomes	Assessed at 6 months: grouped under 3–6 month analysis
	
	Primary:
	
	• Pain –
	  ○ pain at rest, chewing and on protrusion assessed separately on 0 to 10 cm worsening VAS at each follow-up examination (if bilateral click then only the most painful side was scored) (no usable data – no means or SD)
	  ○ palpation pain of muscles of mastication as described by Krogh-Poulsen 1979 (data not used – incidence reported separately for five sites but was not equal at baseline)

Attribute	Study details
	Secondary: • TMJ clicking: reciprocal clicking assessed using a stethoscope and/or palpation
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessed by patient (except for clicking – but blinding was only done for around half of the assessments)
Incomplete outcome data (attrition bias): • Low risk of bias	There did not appear to be any dropouts
Selective reporting (reporting bias): • High risk of bias	Pain at rest was not reported
Other bias: • Low risk of bias	No other bias apparent
Lundh 1992[41] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Stomatology, University of Lund, Malmö, Sweden Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public and industry, that is private health-care company (supported by grants from Praktikertjanst AB, Sweden and by the Torsten and Ragnar Soderbergs Foundations) Declarations/conflicts of interest: not reported
Participants	Diagnosis: pain on chewing (> 50 on a 0–100 mm VAS) with arthographically documented disc displacement without reduction in one or both TMJs Duration since presenting condition began: not reported Age at baseline (years): mean 29, range 14–61 (not reported by group) Sex: 10% male (not reported by group) Number randomised: 51 (group A: 25; group B: 26) Number evaluated: 51 (group A: 25; group B: 26)

Attribute	Study details

Interventions	Comparison: splint vs. no splint for TMD
	
	• Group A
	  ○ Splint type: flat occlusal splint
	  ○ Upper jaw
	  ○ Material: hard
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear at night
	  ○ Monitoring of patients: 1 week for further adjustments and then follow-up at 6 and 12 months
	
	• Group B: no treatment
	
	Duration of treatment: 12 months

Outcomes	Assessed at 12 months: grouped under 6–12 month analysis
	
	Primary:
	
	• Pain –
	  ○ pain at rest, during chewing and on protrusion assessed using a 0–100 mm worsening VAS; reported categorically as pain free, improved (at least 50% reduction), unchanged or worse (we dichotomised the data as incidence of pain free and improved vs. unchanged and worse)
	  ○ changes in palpatory tenderness of masseter muscle reported as better vs. unchanged or worse (data not used – those with no tenderness at start and end of study were not included)

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomised' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomised' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessed by patient
Incomplete outcome data (attrition bias): • Low risk of bias	There did not appear to be any dropouts
Selective reporting (reporting bias): • High risk of bias	Only outcomes with statistically significant differences were reported
Other bias: • Low risk of bias	No other bias apparent

Attribute	Study details
Magnusson 1999[42] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Stomatognathic Physiology, The Institute for Postgraduate Dental Education, Jonkoping, Sweden Number of centres: one Recruitment period: November 1993 to September 1996 Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported
Participants	Diagnosis: TMD of mainly muscular origin: patients referred to specialist clinic with main subjective symptom of tension-type headache and/ orofacial pain of non-neurogenic or non-dental origin Duration since presenting condition began: pain history of at least 1 year Age at baseline (years): group A – mean 32 (range 17–49); group B – mean 37 (range 16–67) Sex: not reported Number randomised: 26 (group A: 14; group B: 12) Number evaluated: 18 (group A: 9; group B: 9)
Interventions	Comparison: splint vs. minimal treatment for TMD Group A • Splint type: interocclusal stabilisation splint (Michigan style) • Upper jaw • Material: hard • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear at night • Monitoring of patients: only reports that adjustments and follow-ups were made by a dentist Group B • Jaw exercise programme – based on different jaw movements to achieve reciprocal inhibition, proprioceptive neuromuscular facilitation, and stretching – performed at least three times per day with each session lasting at least 2–3 minutes; dental assistant delivered the instructions to patients and also decided on length of time between, as well as number of, follow-ups (she also modified patients' individual programmes when necessary by adding or removing specific exercises) Patients with significant symptoms after 3 months of treatment were offered complementary treatment with the other treatment modality. Those receiving combined treatment were analysed separately (group not included in this review) Duration of treatment: 6 months

Attribute	Study details

Outcomes	Assessed at 3 and 6 months: we used these in our 0–3 month and 3–6 month analyses, respectively
	
	Primary:
	
	• Pain –
	  ○ categorised as none, mild and severe; reported separately for TMJ pain, muscle pain and pain on movement as part of clinical dysfunction index Di (Helkim[74]) (we dichotmised as incidence of being pain free)
	  ○ incidence of both pain when opening the mouth and pain in the face or jaws as part of a 'subjective' anamnestic dysfunction index Ai (Helkimo[74]) (not used as too similar to other pain outcomes)
	  ○ Behaviour Rating scale for pain 1 (no pain) to 6 (very strong pain, totally handicapped, cannot do anything) (no usable data – graphs with no SD)
	
	Secondary:
	
	• TMJ clicking: incidence of joint sounds during functional examination
	• Change in restricted mouth-opening: maximum jaw opening in mm (no usable data – no SD); also reported as incidence of having difficulty in opening the mouth wide

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessed by patient (except for clicking – but the outcome assessor was not blinded)
Incomplete outcome data (attrition bias): • Low risk of bias	Overall attrition 31% (group A: 36%; group B: 25%) – reasons mostly the same
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No other bias apparent
Michelotti 2012[64] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Clinic for Temporomandibular Disorders and Orofacial Pain, University of Naples Federico II, Italy Number of centres: one Recruitment period: 9 months (dates not reported) Sample size calculation: no (post hoc only)

Attribute	Study details
	Funding: not reported Declarations/conflicts of interest: 'None of the authors reported any disclosures'
Participants	Diagnosis: myogenous pain according to RDC/TMD categories Ia and Ib; also objective evidence of joint pathology or dysfunction; spontaneous muscle pain > 30 mm on 100 mm VAS Duration since presenting condition began: recurrent or constant myogenous pain for > 3 months Age at baseline (years): group A – mean 30 (range 20–53); group B – mean 30 (range 18–49) Sex: group A – 29% male; group B – 17% male Number randomised: 44 (group A: 21; group B: 23) Number evaluated: 41 (group A: 18; group B: 23)
Interventions	Comparison: splint vs. minimal treatment for TMD Group A • Splint type: custom occlusal stabilisation splint (Michigan) • Upper jaw • Material: hard • Teeth coverage: full • Details of impression-taking: alginate impressions of both arches and an interocclusal record with a wax wafer • Instructions to patients: wear only while sleeping • Monitoring of patients: both groups seen every 3 weeks for 15 minutes (assessments carried out, motivation reinforced, and splint group had any necessary adjustments) Group B • Education – explanation of the aetiology and of the good prognosis for TMD, as well as information about self-care for the jaw musculature Duration of treatment: 3 months
Outcomes	Assessed at 3 months: grouped under 0–3 month analysis Primary: • Pain – current pain intensity (spontaneous muscle pain) using 0 mm (no pain) to 100 mm (worst pain) VAS; reported as change from baseline score (unable to combine change score in primary meta-analysis using SMD; used in sensitivity analyses of studies reporting current pain intensity on VAS/NRS at 0 to 3 months) Secondary: • Change in restricted mouth-opening: maximal unassisted pain-free opening (mm) – distance between the maxillary and mandibular incisal edges and added the overbite measurement. 'Pain free' defined as the maximum distance the participant could open their mouth without experiencing any additional pain and discomfort; reported as change score

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'We assigned the patients to two treatment groups by means of a balanced block randomization' • Comment: probably done
Allocation concealment (selection bias): • Unclear risk of bias	• 'We assigned the patients to two treatment groups by means of a balanced block randomization' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening' which was objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	Overall attrition 7% (group A: 14%; group B: 0%) – only 3 participants dropped out in group A so probably not enough to bias the results in a meaningful way
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No other bias apparent
Nagata 2015[67] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Nippon Dental University, Niigata Hospital, Niigata, Japan Number of centres: one Recruitment period: June 2009 to July 2013 Sample size calculation: yes (met) Funding: none Declarations/conflicts of interest: 'None of the authors received support from a corporation or any funding for this study'
Participants	Diagnosis: TMD (RDC/TMD axis I); RDC/TMD axis II was excluded Duration since presenting condition began (months): group A – median 24 (range 3–360); group B – median 24 (range 4–72) Age at baseline (years): group A – mean 41 (SD 19); group B – mean 43 (SD 18) Sex: group A – 31% male; group B – 39% male Number randomised: 201 (group A: 103; group B: 98) Number evaluated: 181 (group A: 96; group B: 85)

Attribute	Study details

Interventions	Comparison: splint vs. no treatment for TMD
	
	All patients in both groups received multimodal therapy: self-exercise of the jaw (pulled down on bilateral lower last molars with secondary fingers while opening jaw to the greatest possible extent – performed with 20 repetitions three times per day), CBT (guidance about clenching control during waking hours and coping with pain and stress) and received education about TMD self-management (i.e. a diet of soft foods, avoiding gum chewing and correcting bad posture). Participants with mouth-opening of < 35 mm also underwent jaw manipulation
	
	• Group A:
	  ○ Splint type: custom stabilisation splint
	  ○ Upper jaw
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear while sleeping, but daytime use was not required
	  ○ Monitoring of patients: if no change of symptoms was achieved by this treatment, the splint was altered to the bruxism-controlled type to disturb the eccentric movements of the mandible with a steep obstacle located at the anterior teeth
	• Group B: no other treatment
	
	Duration of treatment: 10 weeks

Outcomes	Assessed at 2, 4, 6, 8 and 10 weeks: we used the 10-week data for our 0–3 month analysis Primary: • Pain – current orofacial pain using a 0–10 worsening NRS (we converted to a 0 –100 scale) Secondary: • TMJ clicking – measured using a 0–10 worsening NRS • Change in restricted mouth-opening – between upper and lower teeth in mm (not reported which teeth); asked to open mouth as wide as possible unassisted, even if they felt pain
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Participants were randomly assigned to the non-splint multimodal therapy group (NS) or to the multimodal therapy plus splint group (NS+S) with block randomisation' • Comment: probably done
Allocation concealment (selection bias): • Unclear risk of bias	• 'Participants were randomly assigned to the non-splint multimodal therapy group (NS) or to the multimodal therapy plus splint group (NS+S) with block randomisation' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective pain outcome assessment by patients (except for 'change in restricted mouth-opening' and clicking which were objective – described as single blind so probably the assessors for these outcomes)
Incomplete outcome data (attrition bias): • Low risk of bias	Overall attrition 10% (group A: 7%; group B: 13%) – low attrition and similar reasons stated

Attribute	Study details
Selective reporting (reporting bias): • Low risk of bias	No evidence of selective reporting
Other bias: • Low risk of bias	No other bias apparent
Niemelä 2012[71] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Oral and Maxillofacial Department, Oulu University Hospital, Finland Number of centres: one Recruitment period: March 2008 to September 2009 Sample size calculation: yes (not met) Funding: public (supported by the Finnish Dental Society, Apollonia and the Academy of Finland) Declarations/conflicts of interest: 'No conflict of interests are declared'
Participants	Diagnosis: TMD (RDC/TMD) – the patients were referred to the Oral and Maxillofacial Department, Oulu University Hospital, for treatment of TMD and had thus been suffering from relatively chronic and severe TMD Duration since presenting condition began: not reported Age at baseline (years): (inclusion = at least 20) group A – mean 43 (SD 13); group B – mean 44 (SD 13) Sex: group A – 18% male; group B – 27% male Number randomised: 80 (group A: 39; group B: 41) Number evaluated: 1 month: 76 (group A: 39; group B: 37); 1 year: 78 (group A: 37; group B: 41) – ITT *(Two patients dropped out of the trial from the splint group; one did not attend any of the check-ups and the other was offered other treatment, that is orthognathic surgery. In addition, during the 1-year follow-up, altogether 16 patients interrupted their attendance to the trial or did not show up for their appointed follow-up. Sixteen controls were transferred from the control group to the splint group because of their symptoms and need of treatment. Thirteen patients (10 patients in the splint group and three in the control group) were treated with arthrocentesis of the TMJ during the study. All the patients in the total sample were defined as belonging to the 'intention-to-treat' (ITT) population except for the two who were excluded at the beginning of the trial. Thus, the ITT also included those who switched groups or those who in whichever group received other treatment than initially planned based on the group criteria)*
Interventions	Comparison: splint vs. no treatment for TMD All patients in both groups received counselling and instructions for masticatory muscle exercises – at the beginning of the training programme, active mouth-openings, laterotrusive movements and protrusive movements were performed. The mandible was held in the maximal positions for a few seconds on each movement. Thereafter, these movements were made towards resistance (using patient's own fingers). After jaw exercises, the patients were suggested to open the jaw wide, stretching it with fingers a few times for 10–20 seconds. These movements were repeated 7–10 times per training sessions, and the

Attribute	Study details

	sessions were performed two or three times per day. The patients received written instructions, and the movements were also demonstrated by the dentist before the treatment and reprised if necessary
	
	• Group A:
	  ○ Splint type: custom occlusal stabilisation splint
	  ○ Upper jaw/lower jaw: not reported
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: 'occlusion of the splint was defined in the centric relation occlusion using wax'
	  ○ Instructions to patients: use every night during study
	  ○ Monitoring of patients: not reported
	
	• Group B: no other treatment
	
	Duration of treatment: 1 year

Outcomes	Assessed at 1, 3, 6 months and 1 year (mouth-opening only assessed at 1 month) VAS pain only reported as median at 3 and 6 months so data not used
	
	Primary:
	
	• Pain –
	  ○ current facial pain intensity using 0 (no pain) to 10 (worse pain) cm VAS (we converted this to mm in order to combine with data from other studies)
	  ○ number of painful masticatory muscle sites on palpation (out of 20 sites) (only VAS data used – baseline scores for this outcome were not comparable)
	  ○ incidence of TMJ pain on lateral or posterior palpation of one or both TMJs (only VAS data used – baseline scores for this outcome were not comparable)
	
	Secondary:
	
	• Change in restricted mouth-opening: unassisted maximal opening (exact location not reported; whether with/without/until pain not reported)
	• Quality of life (including physical and emotional function): 14-item Oral Health Impact Profile (OHIP-14) – responses were as follows: 0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often and 4 = very often. The OHIP severity score was calculated by summing the ordinal values for 14 items (range 0 to 56)

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Patients were assigned randomly using computer generated random number' • Comment: appropriate method
Allocation concealment (selection bias): • Unclear risk of bias	• 'Patients were assigned randomly using computer generated random number' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective pain outcomes assessed by patients (except for 'change in restricted mouth-opening', which was objective and measured by a blinded assessor)

Attribute	Study details
Incomplete outcome data (attrition bias): • Low risk of bias	Low attrition and ITT was used at 1 year for pain on VAS (but quality-of-life data have very high attrition at all assessment points and should be considered at high risk of bias)
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No other apparent bias
Nilner 2008[73] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: (1) Department of Stomatognathic Physiology, Malmö University, Sweden; (2) Department of Stomatognathic Physiology, Turku University, Finland Number of centres: two Recruitment period: study performed from February 2005 to August 2007 Sample size calculation: yes (met) – equivalence Funding: public (supported by the Finnish Dental Society, Apollonia and Finska Lakaresallskapet) Declarations/conflicts of interest: 'The authors report no conflicts of interest' E-mailed authors for data but none provided so far
Participants	Diagnosis: pain of muscular origin with or without limited opening, according to the RDC/TMD; myofascial pain of at least 4 on a 0–10 NRS Duration since presenting condition began (months): myofascial pain – group A: median 36 (range 6–240); group B: median 36 (range 3–480) Age at baseline (years): (inclusion = at least 18) group A – mean 36 (range 18–71); group B – mean 37 (range 20–63) Sex: group A – 6% male; group B – 16% male Number randomised: 65 (group A: 33; group B: 32) Number evaluated: 10 weeks: 65 (group A: 33; group B: 32); 6 months: 52 (group A: 24; group B: 28); 12 months: 49 (group A: 22; group B: 27)
Interventions	Comparison: custom-made splint vs. prefabricated splint for TMD All patients in both groups were informed about the lack of a clear-cut cause of their myofascial pain and about contributing factors. They were reassured and informed about the nature of TMD and the relationship between muscle fatigue, muscle pain, the psychophysiologic aspects of stress and how to self-monitor TMD symptoms Group A • Splint type: custom occlusal stabilisation splint • Upper jaw • Material: hard (methylmethacrylate) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: use at night • Monitoring of patients: comfort, patient acceptance and function of both appliances were checked within 2 weeks, by the general practitioner, and the same procedure was repeated at all follow-up points

Attribute	Study details
	Group B • Splint type: prefabricated occlusal splint (Relax) • Upper jaw • Material: hard ('made of polymethylmetacrylate . . . The appliance is individually fitted with a silicon self-curing material, polyvinylsiloxane') • Teeth coverage: partial • Details of impression-taking: not done • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 12 months

Outcomes	Assessed at 6 and 10 weeks, 6 months and 12 months: we used the 10-week, 6-month and 12-month data for our 0–3 month, 3–6 month, and 6–12 month analyses, respectively
	
	Primary:
	
	• Pain –
	  ○ daily pain intensity at rest, on mouth-opening and during chewing using a 0–100 VAS (higher = more pain) in the week prior to each assessment point; reported graphically as mean (only at 6 and 10 weeks) and reported as both 30% and 50% reduction in worst reported pain at all follow-up points (no usable data for VAS means – e-mailed authors for VAS means and SDs)
	  ○ frequency of myofascial pain on a nine-point scale: 0 = never; 1 = rarely; 2 = once a month; 3 = once every second week; 4 = once a week; 5 = twice a week; 6 = three to four times a week; 7 = daily; 8 = constantly; reported only at 6 and 10 weeks (data not reported)
	  ○ GCPS reported by incidence of grades 0 to IV, which is included in the RDC/TMD Axis II questionnaire. Divided into two parts: (1) assessment of pain intensity (0–100 worsening scale) and (2) assessment of pain-related disability/limitations in physical functioning (0–6 worsening scale). GCPS grade 0: no TMD pain in past 6 months; grade I: low disability (< 3) and low-intensity pain (< 50); grade II: low disability (< 3) and high-intensity pain (> 50); grade III: high disability that was moderately limiting (3 to 4 regardless of pain score); grade IV: high disability that was severely limiting (5 to 6 regardless of pain score) (we dichotomised as incidence of grade III or IV)
	
	• Harms/adverse effects – reported as changes in the occlusion – vertical overbite assessed to nearest 0.5 mm (only reported at 6 and 12 months)
	
	Secondary:
	
	• Change in restricted mouth-opening: mentioned in separate paper (Doepel 2011[124] – linked under this study ID) – maximum opening without pain, both unassisted and assisted but not fully reported (no usable data)
	• Frequency of headaches (secondary to pain-related TMD): during the preceding 6 months on a verbal scale, as follows: no headache; rarely; once a month; once a week; at least 15 times a month; continuous (we dichotomised this as once per week or more)
	• Quality of life (including physical and emotional function): SCL-90-R instrument in the RDC/TMD Axis II questionnaire – 20 questions for depression and 12 questions for non-specific physical symptoms (NSPhS). The total score was calculated (0–4); reported at 6 and 12 months
	• Adherence to treatment: reported as incidence of use of appliance every night, several nights per week or when necessary (we dichotomised as use of appliance for several nights per week or more – data only available at 10 weeks)

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'One independent person (D2) at each clinic carried out the randomization by using 10 series of consecutively numbered, sealed, opaque envelopes. Each envelope contained a treatment specification. The last series included 6 envelopes (3 for each treatment modality). This randomization procedure was repeated until 66 patients were included in the study' • Comment: method of sequence generation not described but probably done
Allocation concealment (selection bias): • Low risk of bias	• 'Treatment assignment was concealed from the examiner in sealed envelopes' • Comment: the next assignment was adequately concealed from the person randomising patients
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'harms/adverse effects' – vertical overbite)
Incomplete outcome data (attrition bias): • High risk of bias	20% attrition (group A: 27%; group B: 13%) at 6 months; this rose to 25% (group A: 33%; group B: 16%) at 6 months and 36% (group A: 30%; group B: 43%) at 12 months; unequal between groups
Selective reporting (reporting bias): • High risk of bias	Some outcomes measured but not reported fully (i.e. with SDs or *p*-values for between-group differences), or not reported at all at some time points (e.g. VAS pain)
Other bias: • Low risk of bias	No other apparent bias
Nilsson 2009[43] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Stomatognathic Physiology, University of Malmö, Sweden Number of centres: one Recruitment period: April 2000 to April 2003 Sample size calculation: yes (met at 10 weeks but not 6 or 12 months) Funding: public (study was supported by the Swedish Dental Society and Malmö University) Declarations/conflicts of interest: not reported
Participants	Diagnosis: mixed TMDs according to RDC/TMD; worst self-assessed TMD pain at least 40 mm on 100 mm VAS Duration since presenting condition began (months): group A – median 24 (range 3–360); group B – median 24 (range 4–72) Age at baseline (years): group A – mean 35 (range 14–67); group B – mean 33 (range 13–68) Sex: group A – 25% male; group B – 11% male Number randomised: 80 (group A: 40; group B: 40)

Attribute	Study details
	Number evaluated: 68 (group A: 35; group B: 33) at 10 weeks but ITT results reported for outcome of 30% reduction in worst pain; 57 (group A: 32; group B: 25) at 6 months; 51 (group A: 28; group B: 23) at 12 months
Interventions	Comparison: splint vs. control splint for TMD Group A: • Splint type: custom occlusal splint • Upper jaw • Material: soft [4-mm-thick Bioplast® (Scheu Dental GmbH, Iserlohn, Germany) clear-transparent film] • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear at night • Monitoring of patients: checked within 2 weeks and adjusted if necessary; no further adjustments made in the following 4 weeks except for comfort reasons; thereafter 'Another TMD specialist who was not involved in the evaluation delivered, adjusted and checked the use, wear and durability of appliances' Group B: • Splint type: custom non-occlusal palatal splint • Upper jaw • Material: hard • Teeth coverage: palatal coverage with clasps to attach to one molar on each side (appliance did not cover occlusal surfaces) • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 12 months

Outcomes	Assessed at 6 and 10 weeks, 6 and 12 months: we used the 10-week, 6-month and 12-month data for our 0–3 month, 3–6 month, and 6–12 month analyses, respectively
	
	Primary:
	
	• Pain –
	  ○ worst pain on 0 mm (no pain) to 100 mm (worst pain) VAS (10-week data not usable – no SD/*p*-value); also reported as incidence of 30% reduction (only for 10 weeks and 12 months)
	  ○ characteristic pain intensity 0 to 100 worsening scale: mean of three scales – current pain, worst and average in previous 6 months (10-week data not usable – presented graphically but unclear what error bars represent); also reported as incidence of 30% reduction (only for 10 weeks and 12 months)
	  ○ frequency of pain reported categorically: we dichotomised the data as incidence of recurrent or persistent (vs. never/one-time experience)
	
	Secondary:
	
	• Frequency of headaches (secondary to pain-related TMD): reported categorically at 6 and 12 months: we dichotomised the data as incidence of recurrent or persistent (vs. never/one-time experience)
	• Quality of life (including physical and emotional function): depression (20 questions) and somatisation (12 questions) from subscales of the SCL-90-R – each reported as incidence of normal, moderate or severe; we dichotmised as incidence of moderate to severe (reported only for 6 and 12 months)
	• Adherence to treatment: splint wear reported categorically (dichotomised as every night/most nights vs. when needed/not at all)

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'patients were randomized to treatment . . . in blocks of 10' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'independent dental assistant . . . allocated the patients . . . Each block included five concealed sheets with the text 'resilient appliance' and five with the text 'control appliance' • Comment: probably done
Blinding of participants and personnel (performance bias): • Unclear risk of bias	A TMD specialist not involved in the study fitted and made all adjustments. However, not clear if the patients were aware of their group assignment. If they were aware, this might affect behaviours and introduce performance bias
Blinding of outcome assessment (detection bias): • Unclear risk of bias	• 'Both examiners were blinded to group assignment' • Comment: however, the outcomes were patient-reported and it was not clear if the patients were aware of their group assignment
Incomplete outcome data (attrition bias): • High risk of bias	15% attrition (group A: 13%; group B: 18%) at 10 weeks but this rose to 29% (group A: 20%; group B: 38%) at 6 months and 36% (group A: 30%; group B: 43%) at 12 months
Selective reporting (reporting bias): • Low risk of bias	TMD pain VAS at 10 weeks reported with no SD or a *p*-value for the difference between the groups. However, this was reported fully for the longer-term outcomes at 6 and 12 months
Other bias: • Low risk of bias	No other apparent bias
Nitecka-Buchta 2014[70] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Department of Orthodontics and TMJ Dysfunction, Medical University of Silesia Katowice, Zabrze, Poland Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public (study was funded by the Medical University of Silesia Katowice, Poland) Declarations/conflicts of interest: 'The authors have no conflict of interest regarding this commentary'
Participants	Diagnosis: RDC/TMD examination for group Ia (myofascial pain) and Ib (myofascial pain with limited opening) Duration since presenting condition began: not reported Age at baseline (years): overall mean 47 (range 44–70) Sex: group A – 29% male; group B – 30% male Number randomised: 72 (group A: 36; group B: 36) Number evaluated: 65 (group A: 35; group B: 30)
Interventions	Comparison: splint vs. no splint for TMD

Attribute	Study details

	• Group A
	  ○ Splint type: custom occlusal splint
	  ○ Upper jaw/lower jaw: not reported
	  ○ Material: not reported
	  ○ Teeth coverage: not reported
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: not reported
	  ○ Monitoring of patients: not reported
	• Group B: no treatment
	Duration of treatment: 30 days

Outcomes	Assessed at 30 days: grouped under 0–3 month analysis Primary: • Pain – current pain intensity on 0 (no pain) to 10 (worst pain) cm VAS (we converted this to mm) • Harms/adverse effects – reported narratively ('no complications or any unintended effects in either group')
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Randomised … allocated into one of two groups (by picking a colour card from an envelope)' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'One person enrolled participants in the study, and another dental practitioner assigned them to the interventions' • Comment: attempted to conceal allocation
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective pain outcome assessment by patients
Incomplete outcome data (attrition bias): • High risk of bias	10% attrition (group A: 3%; group B: 17%), which differed by group and may feasibly have biased results
Selective reporting (reporting bias): • Low risk of bias	Pain reported clearly
Other bias: • Low risk of bias	No other apparent bias
Pierce 1988[46] *Characteristics*	
Study details	Trial design: parallel (five arms) Location: School of Dental Medicine, State University of New York, Buffalo, USA Number of centres: one Recruitment period: not reported Sample size calculation: not reported

Attribute	Study details
	Funding: public (study was supported in part by research grants DE-05344 and DE-04358 from the National Institutes of Health, USA) Declarations/conflicts of interest: not reported
Participants	Diagnosis: (1) self-reported history of bruxism; or (2) currently bruxing and someone else had heard them bruxing; or (3) tooth wear indicating bruxism. This was then confirmed by EMG activity and patients were included only if they had a baseline of mean bruxing episodes per hour of > 1.0 Duration since presenting condition began: not reported Age at baseline (years): overall mean 38 (range 18–72) Sex: 35% male Number randomised: 40 (group A: 20; group B: 20) Number evaluated: not reported

Interventions	Comparison: splint vs. no splint for bruxism
	
	• Group A
	  ○ Splint type: flat-plane occlusal splint with cuspid rise
	  ○ Upper jaw
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear at night
	  ○ Monitoring of patients: asked to return during first week of treatment for splint adjustment, or any other time if discomfort or lack of fit was experienced
	
	• Group B: no treatment
	• Group C: 'massed negative practice': individually tailored; six blocks of clenching per day consisting of five clench/relax cycles varying between 5 seconds and 1 minute; each clench continued to the point of discomfort, not pain, and then discontinued (not used due to more appropriate control group consisting of no treatment)
	• Group D: nocturnal biofeedback (not eligible for this review)
	• Group E: diurnal biofeedback (not eligible for this review)
	
	EMG monitoring of all patients while sleeping (at their home i.e. not in a sleep clinic); use of EMG monitored at regular appointments
	
	Duration of treatment: 2 weeks

Outcomes	Outcomes assessed at 2 weeks (for 2-week treatment phase) and at 6 months (EMG monitoring carried out for a 2-week period and to calculate the means for the bruxism outcomes) Primary: • Tooth wear (bruxism only): not reported Secondary: • Bruxism severity: duration of bruxing per hour (no usable data – no SD/SE/CI or *p*-values) • Bruxism frequency: episodes per hour (no usable data – no SD/SE/CI or *p*-values)

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'each subject was randomly assigned to one of the five experimental groups' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'each subject was randomly assigned to one of the five experimental groups' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Not possible to blind
Blinding of outcome assessment (detection bias): • Low risk of bias	Objective assessment using EMG monitoring while participants were asleep
Incomplete outcome data (attrition bias): • Unclear risk of bias	The numbers analysed per group at each assessment were not reported
Selective reporting (reporting bias): • High risk of bias	Poor reporting of outcomes
Other bias: • Low risk of bias	No other apparent bias
Rampello 2013[65] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Clinical Gnathology Service, Umberto I Polyclinic, Sapienza University, Rome, Italy Number of centres: one Recruitment period: January to May 2011 Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: 'all authors report no conflict of interest relevant to this article' – however, one of the authors designed and patented the splint [Universal Neuromuscular Immediate Relaxing Appliance (UNIRA)] used in the study E-mailed authors for information and data but none provided so far
Participants	Diagnosis: muscular, articular and headache/migraine VAS scores all > 30; non-reducing dislocations of the articular disc in acute cases of miocene; parafunctions associated with muscular and/or articular pain; limited mouth-opening of muscular origin; abstract mentions 'according to the RDC-TMD (SPEC) criteria' Duration since presenting condition began: not reported Age at baseline (years): group A – mean 30.9, SD 7.9 (range 20–46); group B – mean 30.2, SD 7.3 (range 20–45) Sex: group A – 20% male; group B – 12% male Number randomised: 50 (group A: 25; group B: 25) Number evaluated: 50 (group A: 25; group B: 25)

Attribute	Study details
Interventions	Comparison: splint vs. no splint for TMD Group A • Splint type: UNIRA (Universal Neuromuscular Immediate Relaxing Appliance) 'ready-to-use' occlusal splint • Upper jaw/lower jaw: not reported • Material: (soft) polyvinyl (polypropylene) • Teeth coverage: not reported • Details of impression-taking: not reported • Instructions to patients: 'applied for a minimum of 1 night, followed by rest to a maximum of 12 h/day (including night and rest) for patients with intense pain'; no other form of therapy permitted • Monitoring of patients: not reported Group B • No treatment Duration of treatment: maximum of 3 months
Outcomes	Assessed at 3 months for splint group but 4 months for control: we would have grouped under 0–3 month analysis Primary: • Pain – 0 to 100 VAS, separate ratings for (1) muscular, (2) migraine, (3) cervical, (4) TMJ, reported only graphically with mean and SE but unable to accurately use; also reported for numbers cured/improved of above pains 1 to 4 (however, only some of the patients in each group had the specified pain type at baseline, and very poorly reported – not usable) Secondary: • Change in restricted mouth-opening: only reported for splint group and for those who started with restricted mouth-opening (data not usable)
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Divided randomly' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Divided randomly' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective pain outcome assessment by patients
Incomplete outcome data (attrition bias): • Low risk of bias	Does not appear to have been any attrition
Selective reporting (reporting bias): • Low risk of bias	Although there are no usable data, this is not related to selective reporting
Other bias: • High risk of bias	The splint group outcomes were assessed at 3 months (end of treatment) whereas the 'no treatment' control group were assessed at 4 months

Attribute	Study details
Raphael 2001[47] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Oral Medicine Clinic, University of Medicine and Dentistry of New Jersey, USA Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public (study supported by National Institute of Dental and Craniofacial Research grants DE11714 and DE13486) Declarations/conflicts of interest: not reported Author provided some clarification regarding measurement of pain and quality of life
Participants	Diagnosis: myofascial face pain according to RDC/TMD (facial pain complaint was associated with localised tenderness in response to palpation at 3 or more of 20 muscle sites); patients meeting criteria for other TMDs (e.g. TMJ osteoarthritis) also included but only if primary complaint was pain (rather than clicking or restricted mouth-opening) Duration since presenting condition began: mean duration of pain = 5 years (30% reported duration of $\leq$ 1 year; 19% reported duration of $\geq$ 10 years) Age at baseline (years): mean 33.7 (SD 10.9) Sex: all female Number randomised: 68 (group A: 35; group B: 33) Number evaluated: 63 (group A: 32; group B: 31)
Interventions	Comparison: splint vs. control splint for TMD Group A • Splint type: flat-plane 'active splint' • Upper jaw • Material: hard (acrylic) • Teeth coverage: full ('covered the hard palate'; also covered the occlusal surfaces) • Details of impression-taking: not reported • Instructions to patients: at baseline patients were instructed to eat a soft diet; at 2-week appointment patients were instructed to add moist heat/massage; at 4-week appointment patients were instructed to add exercises • Monitoring of patients: after fitting the splints there were assessments at 2 and 4 weeks during which adjustments were made to the splints if needed

Attribute	Study details
	Group B • Splint type: palatal-only splint that did not interfere with occlusion • Upper jaw • Material: hard (acrylic) • Teeth coverage: partial ('did not cover the occlusal surfaces or interfere with occlusion in any way' and 'the palatal splint was designed to only partially cover the palate') • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 6 weeks

Outcomes	Some outcomes measured at 2, 4 and 6 weeks – in all cases, we used only the 6-week data, which were grouped under 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ mean pain and mean value of worst pain, both assessed using 0 (no pain) to 10 (worst pain) NRS; we used the mean pain score in the main meta-analysis (we converted to a 0–100 scale) and recorded the mean value of worst pain in the additional table (author informed us error bars in graphs are probably SE, and that pain was probably recorded daily and these measurements represent 2-week retrospective measures of average and worst pain)
	  ○ pain on palpation using 2 lb of pressure: mean number of painful facial muscles (unclear how many were muscles were palpated)
	
	Secondary:
	
	• Quality of life (including physical and emotional function) –
	  ○ average mood assessed using a 0 (best possible mood) to 10 (worst possible mood) scale
	  ○ psychological distress assessed using self-reported depression symptom scale from the SCL-90 (higher score = worse depression) (length of scale not reported but is 0 to 4 in other included studies)
	  ○ how much the facial pain interfered with daily activities in the last 2 weeks on 0 (no interference) to 10 (unable to carry on any activities) scale (mentioned in methods but not actually reported)
	
	• Adherence to treatment: dichotomised as every night/more than half the time vs. less than half the time/not at all

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned to treatment' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned to treatment' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • Unclear risk of bias	Unclear if the personnel fitting and adjusting the splints were involved in the study. Also unclear if the patients were aware of their group assignment. If they were aware, this might affect behaviours and introduce performance bias
Blinding of outcome assessment (detection bias): • Unclear risk of bias	Personnel carrying out the RDC examinations were blinded. However, other outcomes were patient-reported and it was not clear if the patients were aware of their group assignment

Attribute	Study details
Incomplete outcome data (attrition bias): • Low risk of bias	7% attrition (group A: 9%; group B: 6%): low attrition, similar between groups and reasons stated
Selective reporting (reporting bias): • Low risk of bias	Although details around some outcomes are poorly reported, there is no evidence of selective reporting
Other bias: • Low risk of bias	No other apparent bias
Rubinoff 1987[48] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: School of Dental Medicine, State University of New York, Buffalo, NY, USA Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported
Participants	Diagnosis: myofascial pain dysfunction based on complaint of facial pain plus one or more of the following: limited opening, joint sounds, deviation on opening, tenderness to muscle palpation. Also required to have absence of organic pathologic condition of the TMJ assessed clinically and radiographically Duration since presenting condition began: not reported Age at baseline (years): mean 33.7 (range 18–62) Sex: group A – 20% male; group B – 8% male Number randomised: 28 (group A: 15; group B: 13) Number evaluated: 25 (group A: 14; group B: 11) for patient-reported pain; 26 (group A: 15; group B: 11) for all other outcomes
Interventions	Comparison: splint vs. control splint for TMD Group A • Splint type: custom 'conventional' occlusal stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: upper and lower alginate impressions made for all patients and master casts poured from these impressions • Instructions to patients: wear splints 24 hours per day, removed only for cleaning and eating; advised to apply moist heat to painful areas of face/neck; instructed to place lips together with teeth apart and keep jaws relaxed as a 2-minute daily home exercise, and to repeat whenever possible • Monitoring of patients: examined and appliances adjusted weekly (or until no further alterations required at two consecutive appointments)

Attribute	Study details
	Group B • Splint type: 'experimental' non-occluding stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: partial (palatal) • Details of impression-taking: as above • Instructions to patients: as above • Monitoring of patients: as above (with mock adjustments) Duration of treatment: 6 weeks

Outcomes	Assessed at 6 weeks: grouped under 0–3 month analysis
	
	Primary:
	
	• Pain –
	  ○ patient-reported pain assessed three times daily in pain diary using 0 (no pain) to 5 (worst pain; incapacitating; unable to carry on with normal activities) ordinal categorical scale (individual patient data reported – not used as would not contribute to main meta-analysis)
	  ○ tenderness on palpation scored 0 (no response) to 3 (retreat of head in anticipation and report of considerable pain upon contact) on multiple regions and scores summed to obtain a palpation score (length of scale unclear) – we used change scores presented in the text of the study report
	
	Secondary:
	
	• TMJ clicking: presence of joint sounds
	• Change in restricted mouth-opening: maximal interincisal distance in mm – we used change scores presented in the text of the study report

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • Unclear risk of bias	'Two dentists participated in this study, one as an examiner and one as a therapist. Neither the examiner nor the patient knew which type of appliance the patient wore. Moreover, the therapist was unaware of the data collected by the examiner during the six weeks of active treatment' Comment: unclear if therapist was aware of the purpose of the study. Patients did not know which type of splint they had
Blinding of outcome assessment (detection bias): • Low risk of bias	See above quote Comment: patients and outcome assessors did not know which type of splint they had
Incomplete outcome data (attrition bias): • Low risk of bias	Only one patient missing from group A and two from group B for patient-reported pain
Selective reporting (reporting bias): • Low risk of bias	Individual patient data all reported
Other bias: • Low risk of bias	No other bias apparent

Attribute	Study details
Sharma 2016[49] *Characteristics*	
Study details	Trial design: parallel (three arms)
	Location: School of Dental Medicine, State University of New York, Buffalo, USA
	Number of centres: one
	Recruitment period: not reported
	Sample size calculation: no (post hoc only)
	Funding: not reported
	Declarations/conflicts of interest: not reported
Participants	Diagnosis: bilateral masseter myalgia according Diagnostic Criteria for TMDs (DC/TMD); pain intensity of 5 or more on a 0 (no pain) to 10 (worst pain) scale; morning symptoms of jaw pain and stiffness
	Duration since presenting condition began: not reported
	Age at baseline (years): (overall range 24 to 62) group A: mean 42.6 (SD 9.6); group B: mean 35 (SD 9.5)
	Sex: group A – 0% male; group B – 17% male
	Number randomised: 13 (group A: 7; group B: 6)
	Number evaluated: 13 (group A: 7; group B: 6) – two dropouts but not reported by group A, B or C, and not clear if ITT used
Interventions	Comparison: splint vs. no splint for TMD
	In groups A and B, if indicated, ethyl chloride vapocoolant spray was used during spray and stretch physical therapy sessions once per week for a total of four treatment sessions

	• Group A:
	  ○ Splint type: custom occlusal flat plane splint
	  ○ Upper jaw
	  ○ Material: hard/soft dual laminate material [a compound material made up of hard polycarbonate (PC) base material and a soft thermoplastic (TPU) material]; a translucent 2.5 mm (1.2 mm PC/1.3 mm TPU) dura-soft sheet was used
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: not reported
	  ○ Monitoring of patients: patients see weekly and splint checked and polished (followed by spray and stretch, as described above, if indicated)

	• Group B: no other treatment • Group C: above splint alone (this group was not included in the review as it was not possible to include it in an eligible pairwise comparison)
	Duration of treatment: 5 weeks
Outcomes	Assessed at 5 weeks: grouped under 0–3 month analysis
	Primary:
	• Pain – CPI – patients scored: (1) current pain, (2) worst pain, (3) average pain each on 0 (no pain) to 10 (worst pain) scale – scores 1 to 3 were summed together, divided by 3 and then multiplied by 100 to get a score on a 0–100 scale; reported as change score

Attribute	Study details
	Secondary: • Change in restricted mouth-opening – (1) pain-free opening (mm); (2) maximum unassisted opening (mm); (3) maximum assisted opening (mm) (we used pain-free opening data); reported as change score • Quality of life (including physical and emotional function) – assessed using Axis II questionnaires: (1) Patient Health Questionnaire-9; (2) Patient Health Questionnaire-15; (3) Generalised Anxiety Disorder-7 scale (scales not described – unclear direction of benefit – data not used)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'A computer generated spreadsheet was utilized to randomly assign each subject before recruiting any subjects, a block randomization process was performed to evenly distribute every participant into one of the three treatment arms' • Comment: probably done
Allocation concealment (selection bias): • Unclear risk of bias	No mention of allocation concealment
Blinding of participants and personnel (performance bias): • High risk of bias	Not possible to blind patients
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening' which was objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Unclear risk of bias	Two dropouts but not reported which group and not clear if ITT used in analyses
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No other bias apparent
Tatli 2017[54] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: TMD clinic, Cukurova University Dental Hospital, Adana, Turkey Number of centres: one Recruitment period: not reported Sample size calculation: yes (achieved) Funding: none Declarations/conflicts of interest: 'nothing to declare'
Participants	Diagnosis: unilateral TMJ disc displacement without reduction diagnosis based on clinical DC/TMD (history of reduction in mouth-opening, TMJ pain during palpation and/or function, TMJ clicking) and MRI Duration since presenting condition began: not reported

Attribute	Study details
	Age at baseline (years): group A – mean 38.9 (SD 11.3); group B – mean 35.2 (SD 9.4) Sex: group A – 2.5% male; group B – 12.5% male Number randomised: 80 (group A: 40; group B: 40) Number evaluated: 80 (group A: 40; group B: 40)

Interventions	Comparison: splint vs. no splint for TMD
	
	All patients in groups A and B were treated with arthrocentesis plus sodium hyaluronate at the start of the study
	
	• Group A:
	  ○ Splint type: occlusal stabilisation splint
	  ○ Upper jaw/lower jaw: not reported
	  ○ Material: hard (acrylic)
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear at night and also for 1 or 2 hours during the day; patients in all groups instructed to use ibuprofen (600 mg) when needed
	  ○ Monitoring of patients: not reported
	
	• Group B: no other treatment
	• Group C: stabilisation splint alone (i.e. no arthrocentesis and sodium hyaluronate) – excluded from the review as not comparable with other groups
	
	Duration of treatment: 6 months

Outcomes	Assessed as 1, 3 and 6 months: we used the 3- and 6-month data in our 0–3 month and 3–6 month analyses, respectively
	
	Primary:
	
	• Pain –
	  ○ current pain intensity 0 to 10 cm VAS (we converted this to mm in order to combine with data from other studies)
	  ○ CPI – patients scored: (1) current pain, (2) worst pain, (3) average pain each on 0 (no pain) to 10 (worst pain) scale – scores 1 to 3 were summed together, divided by 3 and then multiplied by 100 to get a score on a 0–100 scale
	
	• Harms/adverse effects – reported but they were all due to arthrocentesis
	
	Secondary:
	
	• Change in restricted mouth-opening: maximum mouth-opening measured between the edges of the upper and lower central incisors in mm (unclear if with/without pain or assisted/unassisted)
	• Quality of life (including physical and emotional function): pain-related disability (0 to 100 worsening scale) and psychological status (0 to 4 worsening scale) both separately assessed using RDC/TMD Axis II biobehavioural questionnaire

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Assigned randomly to the treatment groups using randomization software' • Comment: appropriate method
Allocation concealment (selection bias): • Unclear risk of bias	• 'Assigned randomly to the treatment groups using randomization software' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening', which was objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No other bias apparent
Tavera 2012[23] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: Mexican Institute for Clinical Research, Mexico Number of centres: one Recruitment period: May to September 2008 Trials registry ID: NCT00815776 Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported We e-mailed authors for data but none provided so far
Participants	Diagnosis: RDC/TMD diagnosis of myofascial pain, arthralgia, and/or disc displacement with reduction, and a VAS pain score of > 4 (0–10 worsening scale) Duration since presenting condition began: not reported Age at baseline (years): group A – mean 38 (SD 11); group B – mean 36.3 (SD 13) Sex: group A – 17% male; group B – 11% male Number randomised: 108 (group A: 71; group B: 37) Number evaluated: 78 (group A: 56; group B: 22)

Attribute	Study details
Interventions	Comparison: splint vs. minimal treatment for TMD Group A: • Splint type: flat-planed occlusal stabilisation splint • Upper jaw/lower jaw (not reported) • Material: hard (plastic) • Teeth coverage: full ('full coverage' and 'fits over the occlusal one-third surfaces of the dentition') • Details of impression-taking: not reported • Instructions to patients: wear at night • Monitoring of patients: not reported Group B • Jaw exercise: patients instructed to open jaw as wide as possible without pain and hold the position for 5 seconds. Patients then closed their jaw and rested for 10 seconds. This was performed 10 times in a row. Also advised to apply warm compress to the jaw area after the exercises for 10 minutes Group C • TMD*es* (a novel, non-invasive and reversible custom-fit ear insert worn in the outer third of both ear canals; small, hollow and constructed from rigid, medical grade plastics used in hearing devices) (not used because more appropriate control group consisting of jaw exercise) Duration of treatment: 3 months
Outcomes	Assessed at 1, 2 and 3 months: we would have used the 3-month data in our 0–3 month analyses Primary: • Pain – 0 (no pain) to 10 (worst pain) VAS (mean and SD not reported for each group – data not usable) • Harms/adverse effects: incidence of the following treatment-related adverse events: discomfort or pain, increased TMD symptoms, diminished hearing acuity, headache, dizziness or nausea, other (jaw muscle/gum-related for group A) Secondary: • Patient satisfaction: only reported for groups A and C so not usable • Adherence to treatment: assessed using a daily diary and average usage reported as hours per day for group A and C, and average exercise repetitions for group B; therefore, data not comparable and not used
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding was not possible

Attribute	Study details
Blinding of outcome assessment (detection bias): • High risk of bias	Neither patients nor study personnel were blinded
Incomplete outcome data (attrition bias): • High risk of bias	Overall attrition was 28% (group A: 20%; group B: 43% at 2 months; very similar at 3 months). Attrition was notably higher in group B
Selective reporting (reporting bias): • High risk of bias	Very poor reporting of outcomes – focuses on TMD*es* group (group C)
Other bias: • Low risk of bias	No other bias apparent
Truelove 2006[50] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Orofacial Pain Clinic, Department of Oral Medicine, University of Washington, Seattle, USA Number of centres: one Recruitment period: not reported Sample size calculation: yes (not met) Funding: public (study supported by National Institute of Dental and Craniofacial Research grant P01 DE-08773) Declarations/conflicts of interest: not reported
Participants	Diagnosis: RDC/TMD Axis I diagnosis of myofascial pain (group Ia or Ib) with or without a concurrent diagnosis of arthralgia (Group IIIa) or disk displacement with reduction (Group IIa), as well as a RDC/TMD Axis II Graded Chronic Pain score of grade I (low pain) or grade II (high pain), both of which had no or minimal pain-related psychosocial interference. Any other RDC/TMD Axis I diagnosis (e.g. arthritis, disk displacement without reduction) was excluded Duration since presenting condition began: years with facial pain: group A – mean 6 (SD 9); group B – mean 5 (SD 6); group C – mean 5 (SD 5) Age at baseline (years): group A – mean 36 (SD 11); group B – mean 35 (SD 12); group C – mean 36 (SD 11) Sex: group A – 13% male; group B – 10% male; group C – 19% male Number randomised: 200 (group A: 68; group B: 68; group C: 64) Number evaluated: 3 months: 164 (group A: 54; group B: 56)
Interventions	Comparison: (1) splint vs. no splint for TMD; (2) custom-made splint vs. prefabricated splint for TMD All groups received usual treatment: dentist-prescribed, conservative and reversible self-care strategies that required the dentist to follow a standardised treatment checklist that identifies all treatment recommendations (jaw relaxation, reduction of parafunction, thermal packs, NSAIDs, passive opening stretches and suggestions about stress reduction); treatments such as narcotic analgesics, antidepressant medications and use of a non-study prescribed splint were discouraged

Attribute	Study details
	Group A • Splint type: custom flat-plane hard splint adjusted to centric occlusion • Upper jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: not reported • Instructions to patients: wear at night plus 2 hours during the day; discontinue if problems developed • Monitoring of patients: patients in all three groups followed up at 3, 6 and 12 months (nothing mentioned regarding adjustment/monitoring of the actual splints) Group B: • Splint type: (prefabricated) soft thermoplastic athletic mouthguard splint (with the dentist supervising and directing the patient in splint fabrication) • Upper jaw • Material: soft (vinyl) • Teeth coverage: full • Details of impression-taking: 'we took a bite registration using dental wax to provide an oral procedure of comparable duration' • Instructions to patients: as above • Monitoring of patients: as above Group C • No other treatment Duration of treatment: 12 months

Outcomes	Assessments at 3, 6* and 12 months: we used the 3- and 12-month data in our 0–3 month and 6–12 months analyses, respectively
	
	*Data at 6 months not reported because 'we typically found six-month data to be intermediate or equivalent to 12-month data'
	
	Primary:
	
	• Pain –
	  ○ CPI 0–10 scale (the mean of present, average and worst TMD-related pain in the previous 2 months) (we converted to 0–100 scale; range of SDs reported – we used median value; unclear which group the single SD in the graph belongs to)
	  ○ pain duration (both hours/day and days/month) (no usable data – reported narratively)
	  ○ pain on palpation assessed as number of extraoral muscle sites (0–16), intraoral muscle sites (0–4) and TMJ sites (0–4)
	
	• Harms/adverse effects – 'no subjects reported an adverse effect with any of the treatments'
	
	Secondary:
	
	• TMJ clicking – on opening, closing or both; patient-assessed and clinician-assessed, reported as incidence (we used clinician-assessed in line with other studies, and also because they were blinded)
	• Change in restricted mouth-opening – vertical jaw opening in mm, reported both as unassisted without pain and assisted (no usable data – no SD reported)
	• Adherence to treatment – reported for custom-made splint vs. prefabricated splint (not clear what level of compliance e.g. using splint all the time/majority of the time, etc)

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'We generated randomization assignments using randomly selected block sizes of six, nine or 12 and stratified them by provider' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'We concealed randomization to all study personnel until after we obtained the subjects' consent' • Comment: randomly permuted block size, probably done adequately
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding was not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening' and 'TMJ clicking', which were objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • High risk of bias	Overall attrition 18% (group A: 21%; group B: 18%; group C: 16%) at 3 months; overall attrition 16% (group A: 4%; group B: 19%; group C: 25%) at 12 months. There was a large difference between group A and the other groups at 12 months
Selective reporting (reporting bias): • Low risk of bias	Although we were unable to use some of the data, this does not appear to be because of selective reporting
Other bias: • Low risk of bias	No other bias apparent
van der Zaag 2005[69] *Characteristics*	
Study details	Trial design: parallel (two arms) Location: Clinic for Oral Kinesiology at Academic Centre for Dentistry Amsterdam (ACTA), the Netherlands Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: public (study supported by The Netherlands Institute of Dental Sciences) Declarations/conflicts of interest: not reported
Participants	Diagnosis: recent history of tooth-grinding sounds for at least 3 nights per week during the previous 6 months, confirmed by patient or their partner; tooth wear to at least the degree of exposed dentine (grade 2); presence of bruxism was clinically established by means of an inspection of the soft and hard intraoral tissues; patients with a TMD pain diagnosis were excluded (this was examined using the RDC/TMD); if the participant was eligible to enrol in the study protocol, they underwent a first polysomnographic recording at the hospital's sleep laboratory (i.e. does not seem to be part of eligibility/diagnosis) Duration since presenting condition began: at least 6 months Age at baseline (years): (had to be aged ≥ 18 years as part of eligibility) group A – mean 34.2 (SD 13.1; range 21–68); group B – mean 34.9 (SD 11.2; range 18–55)

Attribute	Study details
	Sex: group A – 36% male; group B – 10% male Number randomised: 27 (not reported by group) Number evaluated: 21 (group A: 11; group B: 10)
Interventions	Comparison: splint vs. control splint for bruxism Group A • Splint type: occlusal stabilisation splint • Upper jaw • Material: hard (acrylic) • Teeth coverage: full coverage of the occlusal surfaces • Details of impression-taking: not reported • Instructions to patients: wear 24 hours per day, except during eating • Monitoring of patients: not reported (probably none as a result of short treatment time) Group B • Splint type: palatal splint • Upper jaw • Material: hard (same acrylic as above) • Teeth coverage: partial (palatal coverage only) • Details of impression-taking: not reported • Instructions to patients: as above • Monitoring of patients: as above • Polysomnographic recording was carried out at the end of treatment at the hospital's sleep laboratory (quiet, dark, single room) using a Biosaca sleep-recording unit (Ortivus AB, Danderyd, Sweden) Duration of treatment: 4 weeks
Outcomes	Assessed at 4 weeks: grouped under 0–3 month analysis Primary: • Tooth wear (bruxism only) – not reported Secondary: • Bruxism severity – reported as bruxism time index (percentage of total sleep time spent bruxing) • Bruxism frequency – reported as both episodes per hour and bursts per hour (we used episodes per hour because bursts per hour was not properly described)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'Participants were randomly assigned using the block randomization method' • Comment: probably done
Allocation concealment (selection bias): • Unclear risk of bias	• 'Participants were randomly assigned using the block randomization method' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	• 'A second experienced dentist (FL) inserted the splints, without mentioning the type of splint and its expected mechanism' • Comment: although attempts were made to blind patients to splint type, the clinician giving the treatment could not be blinded (and was involved in the study)

Attribute	Study details
Blinding of outcome assessment (detection bias): • Low risk of bias	Objective measurements carried out by a machine. Furthermore, the data were analysed by an investigator blinded to the patients' allocated splint
Incomplete outcome data (attrition bias): • Low risk of bias	Although overall attrition was 22% (not reported by group), none of the reasons were linked to treatment allocation or outcomes
Selective reporting (reporting bias): • Low risk of bias	Data fully reported
Other bias: • Low risk of bias	No other apparent bias
Wahlund 2003[44] *Characteristics*	
Study details	Trial design: parallel (three arms) Location: TMD Unit, Specialist Centre for Oral Rehabilitation, Linkoping, Sweden Number of centres: one Recruitment period: 1996–2000 Sample size calculation: not reported Funding: public (study was supported by the Public Dental Service of Ostergotland – County Council) Declarations/conflicts of interest: not reported
Participants	Diagnosis: TMD pain according to RDC/TMD Duration since presenting condition began: at least 3 months Age at baseline (years): overall range 12–18; group A – mean 15.7 (SD 2.1); group B – mean 14.8 (SD 1.9) Sex: group A – 26% male; group B – 31% male Number randomised: 81 (group A: 42; group B: 39) Number evaluated: 76 (group A: 37; group B: 39)

Interventions	Comparison: splint vs. no splint for TMD
	
	All patients received an individual 30-minute session in which TMD-related anatomy, pain epidemiology, parafunction and stress were discussed
	
	• Group A
	  ○ Splint type: occlusal stabilisation splint
	  ○ Upper jaw
	  ○ Material: not reported
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear every night during treatment phase and then whenever needed until 6-month follow-up point
	  ○ Monitoring of patients: four visits at 2-week intervals (first: brief information described above; second: impression-taking; third: splint fitted and adjusted; fourth: splint checked and readjusted)

Attribute	Study details
	• Group B: no other treatment • Group C: relaxation training – this was not considered to be minimal treatment owing to multiple individual sessions and was therefore excluded from this review
	Duration of treatment: not clear from the text of the study report. There was a treatment period that seems to have been 2 or 4 weeks long, but then there was follow-up at 6 months. From the end of the treatment period to the 6-month follow-up, patients were instructed to wear their splint whenever needed

Outcomes	All outcomes are reported at the end of treatment period (unclear how many weeks), which we included in our 0–3 month analysis, and at 6 months' follow-up, which we included in our 3–6 month analysis
	
	Primary:
	
	• Pain (not clear if all measures were recorded in the daily pain diary or at the two assessment time points) –
	  ○ pain intensity on 0 (no pain) to 10 (worst pain imaginable) cm VAS (unable to use data – not possible to read SDs from graph)
	  ○ pain frequency on five-point scale (never, one or two times a month, once per week, several times per week, daily) (unable to use – reported as median and quartiles)
	  ○ pain index on a 0–50 worsening scale (pain intensity (VAS) multiplied by frequency of pain) (unable to use data – not possible to read SDs from graph)
	  ○ incidence of 50% reduction in pain index (unable to use data – unclear whether data are for the end of treatment or 6-month follow-up)
	  ○ pressure pain threshold measured using a pressure algometer that applied pressure on the skin surface over the TMJ and masticatory muscles (scale/units of measurement not stated but higher score = better outcome)
	
	• Harms/adverse effects: 'None of the patients in any of the treatment modes reported any major adverse effects'
	
	Secondary:
	
	• TMJ clicking – measured but not reported
	• Change in restricted mouth-opening – reported as maximum assisted mandibular opening (mm) without pain
	• Adherence to treatment – reported for splint group but not control group

Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• Quote: 'randomly assigned' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• Quote: 'randomly assigned' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Subjective outcomes assessment by patients (except for 'change in restricted mouth-opening', which was objective and measured by a blinded assessor)
Incomplete outcome data (attrition bias): • High risk of bias	Overall attrition 6% (group A: 12; group B: 0%); 'subjects who dropped out had lower pain scores and less motivation to participate in treatment' – this may have biased the results

Attribute	Study details
Selective reporting (reporting bias): • High risk of bias	Outcomes poorly reported and mostly unusable
Other bias: • Low risk of bias	No other bias apparent
Wassell 2004[22] *Characteristics*	
Study details	Trial design: parallel (two arms) – non-responders from the control group were allowed to cross over after 6 weeks; therefore, we report data up to 6 weeks Location: general dental practices in and around Newcastle, UK Number of centres: 11 (two of these centres did not return their data) Recruitment period: February 1994 to end of July 1996 Sample size calculation: not reported Funding: public (sponsored by British Dental Association Research Foundation through the Shirley Glasstone Hughes Memorial Prize) Declarations/conflicts of interest: not reported
Participants	Diagnosis: pain in TMJ or muscles or both plus one or more of the following: joint sounds; history of jaw locking or limited opening; TMJ or muscle tenderness on palpation Subdiagnosis later assigned using criteria developed in collaboration between the International Headache Society and the American Academy of Craniomandibular Disorders Duration since presenting condition began: > 4 weeks Age at baseline (years): (had to be aged ≥ 18 years) group A – mean 37.9 (SD 12.6); group B – mean 35.9 (SD 10.3) Sex: 12% male (of 78 patients who started treatment – not reported by group) Number randomised: 93 (not reported by group) Number evaluated: 72 (group A: 38; group B: 34)
Interventions	Comparison: splint vs. control splint for TMD Group A • Splint type: occlusal stabilising splint • Lower jaw • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: 'Alginate maxillary and mandibular impressions were recorded along with a wax retruded record at a vertical separation approximating to the thickness of a stabilising splint. Patients' mandibles were manipulated bimanually in an attempt to achieve centric relation. A facebow facilitated mounting on a semi-adjustable articulator. Major undercuts were blocked out before the splints were waxed. To ensure consistency, this approach was used for both the stabilising and the nonoccluding control' • Instructions to patients: wear all the time except meal times • Monitoring of patients: every 3 weeks

Attribute	Study details
	Group B • Splint type: non-occluding control splint • Upper jaw/lower jaw: not reported • Material: hard (acrylic) • Teeth coverage: (unclear) 'essentially a lingual flange of acrylic extending from the occlusal or incisal surfaces into the lingual sulcus' • Details of impression-taking: as above • Instructions to patients: as above • Monitoring of patients: as above Duration of treatment: 6 weeks (treatment continued for longer but non–responders crossed over after 6 weeks)

Outcomes	Assessed at 3 and 6 weeks: we used the 6-week data for our 0–3 month analysis (TMJ-clicking only)
	
	Primary:
	
	• Pain –
	  ○ 0 (no pain) to 10 (unbearable pain) VAS assessed in waiting room prior to follow-up appointments (no usable data – no SD/SE/*p*-value reported)
	  ○ number of tender muscles on palpation (masticatory and cervical) out of a total of 24 regions (no usable data – no SD/SE/*p*-value reported)
	  ○ aggregate joint tenderness (determined by giving a score of one for tenderness laterally or in the external auditory meatus or on movement and adding the scores for both TMJs to give a maximum total of 6) (no usable data – no SD/SE/*p*-value reported)
	
	Secondary:
	
	• TMJ clicking – incidence read from graph
	• Change in restricted mouth-opening: maximum interincisal opening with pain (mm) (no usable data – no SD/SE/*p*-value reported)
	• Frequency of headaches (secondary to pain-related TMD) – number per week (no usable data – no SD/SE/*p*-value reported)

Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'random allocation of splints was predetermined for each GDP using a permuted block of ten' • Comment: probably done
Allocation concealment (selection bias): • Low risk of bias	• 'All dentists were blind to the allocation until the patient was registered into the trial' • Comment: probably done
Blinding of participants and personnel (performance bias): • High risk of bias	The authors state that it was not a blinded study
Blinding of outcome assessment (detection bias): • High risk of bias	Outcome assessment was not blinded
Incomplete outcome data (attrition bias): • Low risk of bias	Overall attrition 23%, but mostly due to general dental practice withdrawal
Selective reporting (reporting bias): • High risk of bias	Very poorly reported with no measures of variability around the means

Attribute	Study details
Other bias:	No other bias apparent
• Low risk of bias	
Wright 1995[51] *Characteristics*	
Study details	Trial design: parallel (three arms)
	Location: TMJ and Craniofacial Pain Clinic, University of Minnesota, MN, USA
	Number of centres: one
	Recruitment period: not reported
	Sample size calculation: not reported
	Funding: not reported
	Declarations/conflicts of interest: not reported
Participants	Diagnosis: orofacial pain with clinical evidence of a masticatory muscle origin (medical history and clinical examination used to rule out other sources of pain such as dental, metabolic and neurological disorders); inclusion criteria included (1) patient's pain aggravated by jaw function (e.g. talking/eating) or parafunctional habits (e.g. clenching or grinding teeth) – based on patient history and (2) pain aggravated/duplicated by palpation of the muscles of mastication – based on clinical examination; TMJ intra-articular sources of pain ruled out by exclusion criteria: (1) pain aggravated by clinical loading of TMJ – based on clinical examination, (2) pain aggravated by TMJ clicking or catching or both – based on patient history and clinical examination
	Duration since presenting condition began: not reported
	Age at baseline (years): (overall range 19–51): group A – mean 34; group B – mean 31
	Sex: not reported
	Number randomised: 20 (group A: 10; group B: 10)
	Number evaluated: 20 (group A: 10; group B: 10)
Interventions	Comparison: splint vs. no splint for TMD

	• Group A
	  ○ Splint type: custom soft splint
	  ○ Lower jaw
	  ○ Material: soft [3.8-mm-thick resilient mouth guard material – Dentiform (JDE Interstate, Amityville, New York, NY, USA)]
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: not reported
	  ○ Instructions to patients: wear all day except when eating meals
	  ○ Monitoring of patients: not reported

	• Group B: no treatment • Group C: palliative treatment (verbal and written instructions on self-care: applying moist heat or ice, eating soft diet, decreasing oral parafunctional habits, decreasing caffeine, modifying sleeping posture, using over-the-counter medication) (not used because more appropriate control group consisting of no treatment)
	Duration of treatment (weeks): group A – mean 6.3; group B – mean 6.7 (range 4–11)
Outcomes	Assessed at end of treatment (roughly 6 weeks): grouped under 0–3 month analysis

Attribute	Study details
	Primary: • Pain – muscle pain threshold assessed with a pressure algometer on the anterior temporal muscle and on the superior and inferior areas of the masseter muscle (psi) • Harms/adverse effects – occlusal contact changes Secondary: • Change in restricted mouth-opening – maximum pain-free opening (from incisor to incisor in mm)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• (1) 'Randomization was made in blocks to maintain equal group sizes' and (2) 'two additional subjects were sequentially added to the study and assigned to the groups in the order that the dropouts were originally assigned' • Comments: (1) probably done, (2) unlikely to affect the results in any meaningful way
Allocation concealment (selection bias): • Unclear risk of bias	• 'Randomization was made in blocks to maintain equal group sizes' • Comments: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	• 'Final evaluations were with the same independent, blinded examiner who performed the initial evaluation' • Comment: although a blinded examiner carried out the pain assessment procedure, the patient was not blinded and this could introduce bias
Incomplete outcome data (attrition bias): • Low risk of bias	Two dropouts but they were replaced (see above)
Selective reporting (reporting bias): • Low risk of bias	Outcomes fully reported
Other bias: • Low risk of bias	No other apparent bias
Yu 2016[59] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Department of Prosthodontics, Shanghai Ninth People's Hospital, Shanghai, China Number of centres: one Recruitment period: February 2013 to March 2015 Sample size calculation: not reported Funding: unclear if public or other (Fund of Construction of Shanghai Key Subject, T0202) Declarations/conflicts of interest: not reported
Participants	Diagnosis: TMJ disc displacement without reduction (RDC/TMD) Duration since presenting condition began: unclear

Attribute	Study details
	Age at baseline (years): mean 32.5 (SD 9.8) (only overall data available) Sex: 11.3% male (only overall data available) Number randomised: 168 (group A: 42; group B: 42; group C: 42; group D: 42) Number evaluated: 168 (group A: 42; group B: 42; group C: 42; group D: 42)

Interventions	Comparison: splint vs. no/minimal treatment for TMD
	
	We split the four groups/arms into two pairwise comparisons of A vs. D and C vs. B
	
	• Group A
	  ○ Splint type: custom stabilised (Michigan) splint
	  ○ Upper jaw
	  ○ Material: transparent base resin
	  ○ Teeth coverage: full
	  ○ Details of impression-taking: alginate was used to take the impression of both upper and lower dentitions, wax and the 'chin point guided CR position' method were used to record patients' centric relation position
	  ○ Instructions to patients: 20 hours per day usage
	  ○ Monitoring of patients: not reported
	
	• Group B: MPT
	  ○ Manipulative therapy: application of the proprioception neuromuscular promoting technique and joint mobilisation
	  ○ Physical therapy: ultra-short wave therapy and ultrasonic therapy
	
	• Group C: stabilised splint therapy plus MPT (see the above)
	• Group D: control (TMJ related health instructions)
	
	Duration of treatment: 3 months

Outcomes	Assessed at 3 months: grouped under 0–3 month analysis Primary: • Pain – current pain intensity – spontaneous masseter pain, palpation pain and chewing pain were separately measured, using a 0 to 10 VAS card made by the Chinese Medical Association (we used spontaneous masseter pain as it is most comparable with other included studies; we converted the scale to 0 to 100) Secondary: • Change in restricted mouth-opening – pain-free unassisted maximum mouth-opening
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'Patients were randomly allocated to four groups' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'Patients were randomly allocated to four groups' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible

Attribute	Study details
Blinding of outcome assessment (detection bias):	Pain assessed by patients, who were not blinded
• High risk of bias	
Incomplete outcome data (attrition bias):	No dropouts
• Low risk of bias	
Selective reporting (reporting bias):	Outcomes fully reported
• Low risk of bias	
Other bias:	No other apparent bias
• Low risk of bias	
Zhang 2013[60] *Characteristics*	
Study details	Trial design: parallel (two arms)
	Location: Department of Stomatology, AnZhen Hospital, Capital Medical University, Beijing, China
	Number of centres: one
	Recruitment period: not reported
	Sample size calculation: 'The sample size for this study was calculated' – no further details (apparently met)
	Funding: not reported
	Declarations/conflicts of interest: not reported
Participants	Diagnosis: RDC/TMD Axis 1 (myofascial pain)
	Duration since presenting condition began: as part of eligibility criteria, patients had to have chronic TMD pain for > 6 months (longest reported duration was 3 years): group A – mean 8.3 months (SD 6.4); group B – mean 6.5 months (SD 6.4)
	Age at baseline (years): (overall range 16–57) group A – mean 31.4 (SD 9); group B – mean 31.3 (SD 8.3)
	Sex: 33% male (not reported by group)
	Number randomised: 36 (group A: 18; group B: 18)
	Number evaluated: 36 (group A: 18; group B: 18)
Interventions	Comparison: splint vs. control splint for TMD
	Group A
	• Splint type: occlusal stabilisation splint • Upper jaw/lower jaw (not reported) • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: full-mouth impression • Instructions to patients: wear all day • Monitoring of patients: not reported

Attribute	Study details
	Group B • Splint type: placebo (non-occluding palatal) splint • Upper jaw (palatal) • Material: hard (acrylic) • Teeth coverage: full • Details of impression-taking: full-mouth impression • Instructions to patients: wear all day • Monitoring of patients: not reported Duration of treatment: 1 month
Outcomes	Assessed at 1 month: grouped under 0–3 month analysis Primary: • Pain – current pain intensity 0 to 100 mm VAS (higher = worse pain)
Risk of bias	
Random sequence generation (selection bias): • Low risk of bias	• 'A random digit table is used to separate the selected patients into two groups' • Comment: adequate method
Allocation concealment (selection bias): • Unclear risk of bias	• 'A random digit table is used to separate the selected patients into two groups' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • Unclear risk of bias	'double-blind' Comment: only blinding of the examiner was specified
Blinding of outcome assessment (detection bias): • Unclear risk of bias	'double-blind' and 'The second examiner … performed the clinical examination … This examiner was blinded to the type of treatment the patient received' Comment: blinding of the examiner is not relevant to the outcome of pain, and it is not clear if the patients were properly blinded to their treatment
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • High risk of bias	Very poorly reported outcomes. Pain outcome not mentioned in the methods section and the description of the results is vague and does not appear to match the results reported in the table
Other bias: • Low risk of bias	No other apparent bias
Zuim 2006[34] *Characteristics*	
Study details	Trial design: parallel (four arms) Location: Temporomandibular Disorders Diagnostic and Treatment Centre, Aracatuba Dental School, São Paulo State University, Brazil Number of centres: one Recruitment period: not reported Sample size calculation: not reported Funding: not reported Declarations/conflicts of interest: not reported

Attribute	Study details
Participants	Diagnosis: TMD patients with chronic pain, muscle pain on palpation Duration since presenting condition began: at least 6 months Age at baseline (years): 13–47 (not reported by group) Sex: 10% male (not reported by group) Number randomised: 20 (group A: 5; group B: 5; group C: 5; group D: 5) Number evaluated: 20 (group A: 5; group B: 5; group C: 5; group D: 5)
Interventions	Comparison: splint vs. no splint for TMD We split the four groups/arms into two pairwise comparisons of A vs. B and C vs. D: • Groups A and B had MENS on affected muscles using conductive pads or probes; eight applications of 10 minutes each (twice per week over 4 weeks) • Groups C and D had placebo MENS (apparatus was turned off) Group A • Splint type: occlusal splint • Upper jaw • Material: hard (heat cured acrylic resin) • Teeth coverage: full • Details of impression-taking: maxillary and mandibular alginate impressions taken; impressions were poured using special gypsum type IV and the casts were mounted in semi-adjustable articulator • Instructions to patients: not reported • Monitoring of patients: evaluated at weekly intervals for necessary adjustments Group B • No other treatment Group C • Same splint as group A Group D • No other treatment Duration of treatment: 1 month
Outcomes	Assessed at 1 month: we would have grouped under 0–3 month analysis Primary: • Pain – 0 (no pain) to 10 (worst pain) cm VAS (not clear if current/worst/average) (no usable data – individual patient data but only five patients per group)

Attribute	Study details
Risk of bias	
Random sequence generation (selection bias): • Unclear risk of bias	• 'The patients were randomly placed in one of four treatment modalities' • Comment: insufficient information
Allocation concealment (selection bias): • Unclear risk of bias	• 'The patients were randomly placed in one of four treatment modalities' • Comment: insufficient information
Blinding of participants and personnel (performance bias): • High risk of bias	Blinding not possible
Blinding of outcome assessment (detection bias): • High risk of bias	Pain assessed by patients, who were not blinded
Incomplete outcome data (attrition bias): • Low risk of bias	All randomised patients were included in the analyses
Selective reporting (reporting bias): • Low risk of bias	Individual patient data reported
Other bias: • Low risk of bias	No other apparent bias

BDI, Beck Depression Inventory; CAPES, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Improvement of Higher Education Personnel); CBT, cognitive–behavioural therapy; CMD, craniomandibular disorder; EMG, electromyographic; EVA, ethylene-vinyl acetate; HADS, Hospital Anxiety and Depression Scale; IQR, interquartile range; ITT, intention to treat; MENS, microcurrent electrical nerve stimulation; Mod-SSI, Modified Symptom Severity Index; MPT, manipulative and physical therapies; NSAID, non-steroidal anti-inflammatory drug; SE, standard error; SF-36, Short Form questionnaire-36 items; TMJ, temporomandibular joint.

Appendix 4 Forest plots of comparisons for the systematic review

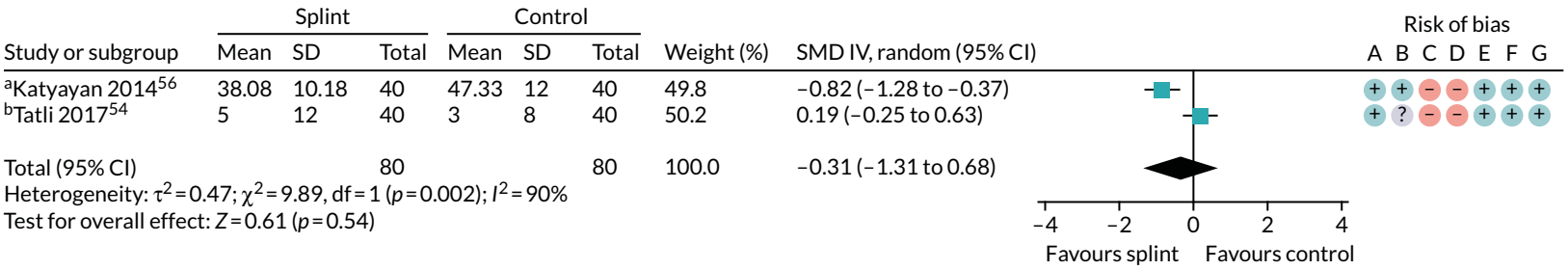

FIGURE 15 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: any combinable scale (higher = more pain), 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Current pain intensity 0 to 100 mm VAS (authors confirmed that scores were accidentally reported in cm – we converted them to mm); b, current pain intensity 0 to 10 cm VAS (we converted this to mm).

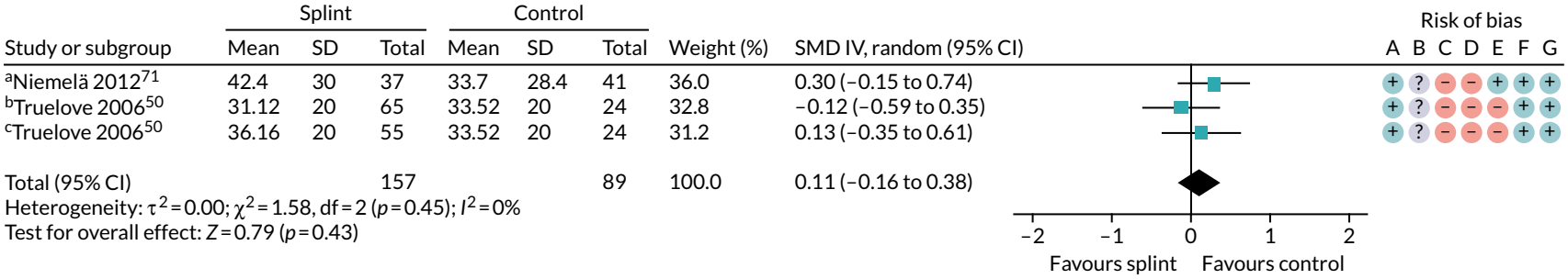

FIGURE 16 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: any combinable scale (higher = more pain), 6–12 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Current facial pain intensity 0 to 10 cm VAS (we converted this to mm); b, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in paper; c, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in paper (custom-made splint vs. control).

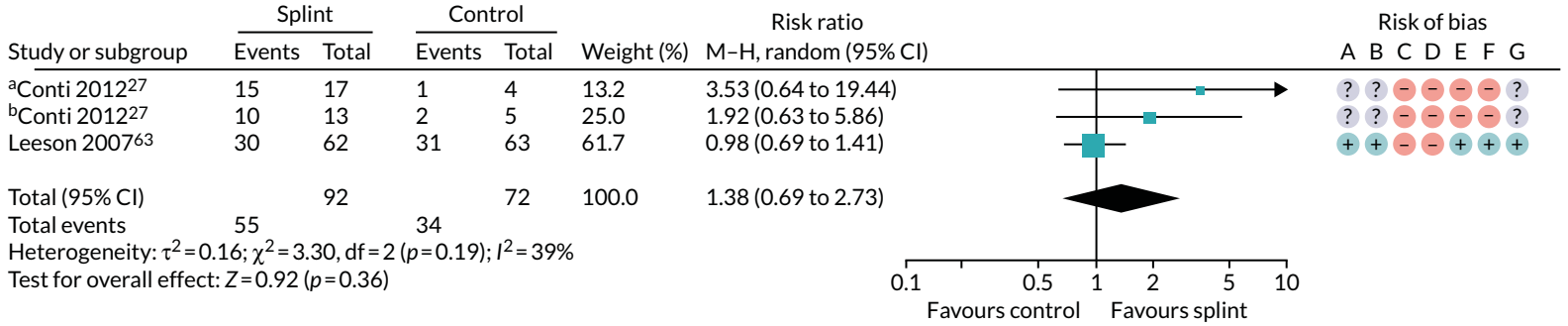

FIGURE 17 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: 50% reduction in VAS pain, 0–3 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Custom stabilisation; b, custom NTI.

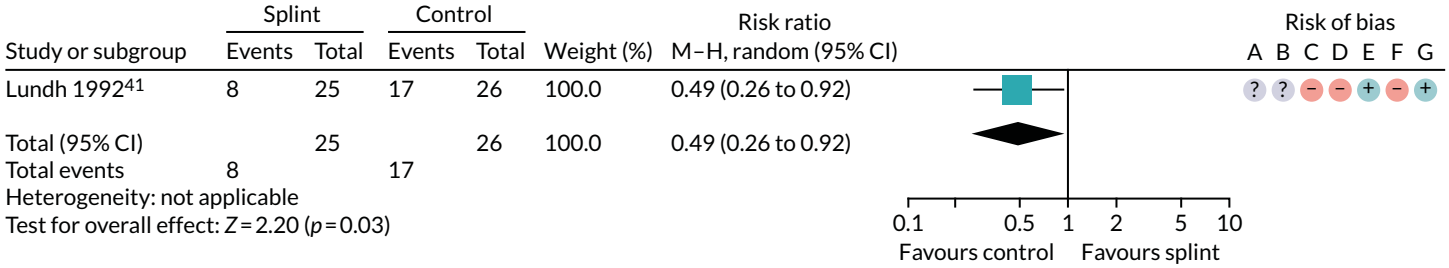

FIGURE 18 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – pain: 50% reduction in VAS pain, 6–12 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

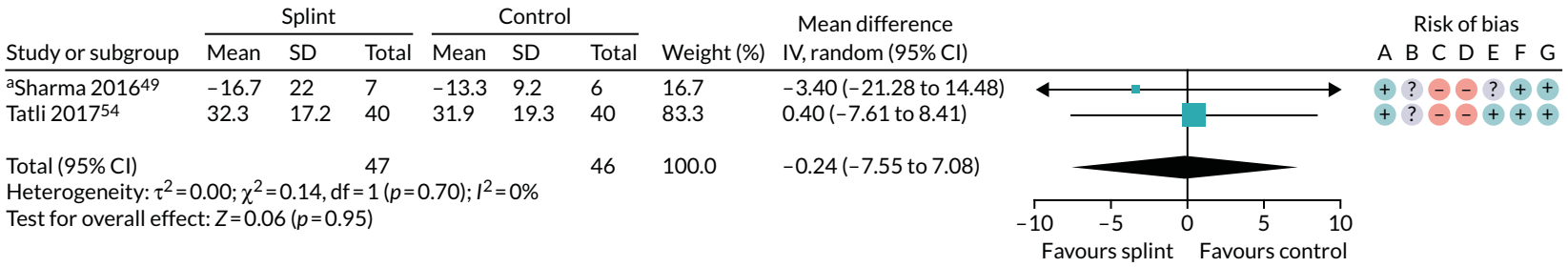

FIGURE 19 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – CPI 0–100 worsening scale, 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Reported as change score (mean decrease in score).

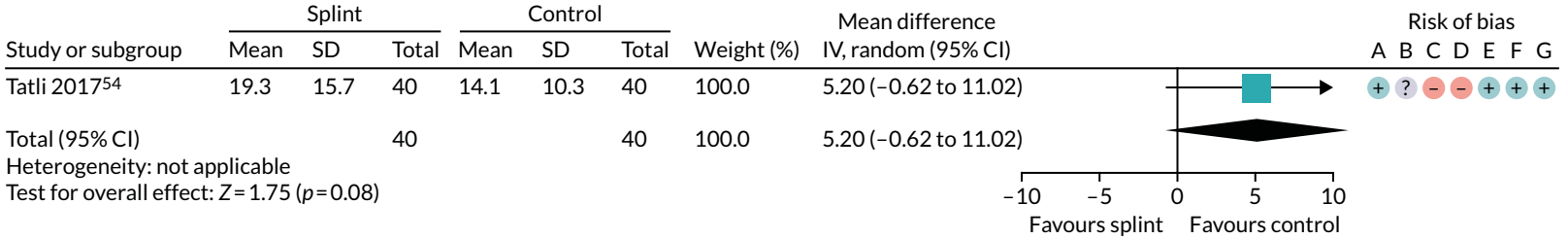

FIGURE 20 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – CPI 0–100 worsening scale, 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

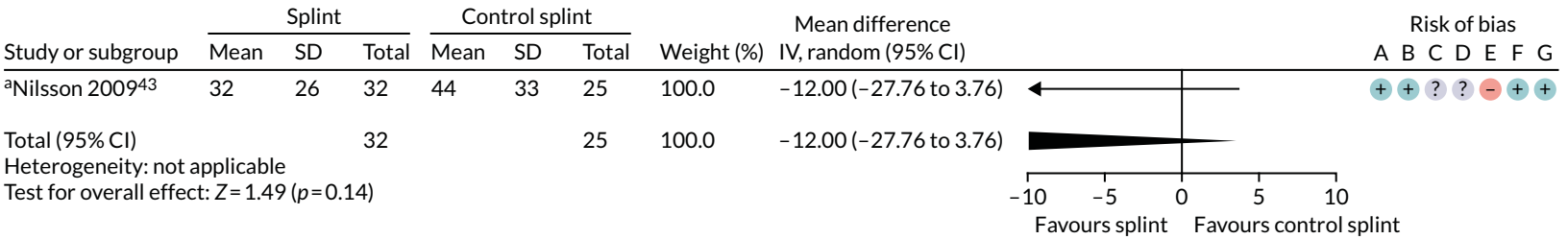

FIGURE 21 Forest plot of comparison: TMD, splint vs. control splint; outcome – pain: any combinable scale (higher = more pain), 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

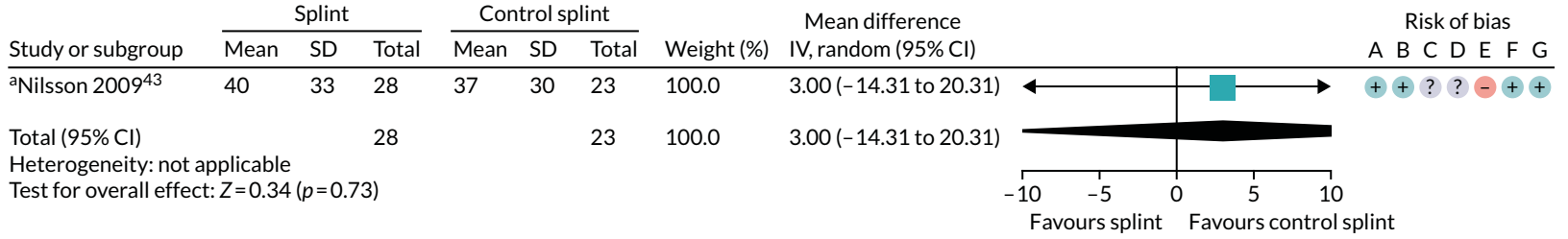

FIGURE 22 Forest plot of comparison: TMD, splint vs. control splint; outcome – pain: any combinable scale (higher = more pain), 6–12 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Worst pain on 0 to 100 VAS.

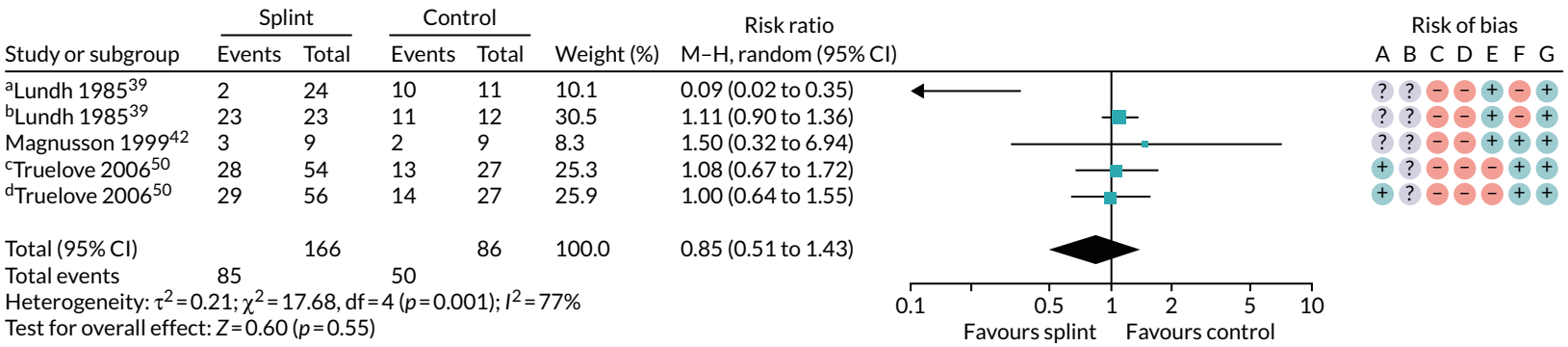

FIGURE 23 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – TMJ clicking: presence of joint noises (detected during TMJ palpation/opening/closing), 0–3 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Anterior repositioning splint; b, flat occlusal splint; c, custom; d, prefabricated.

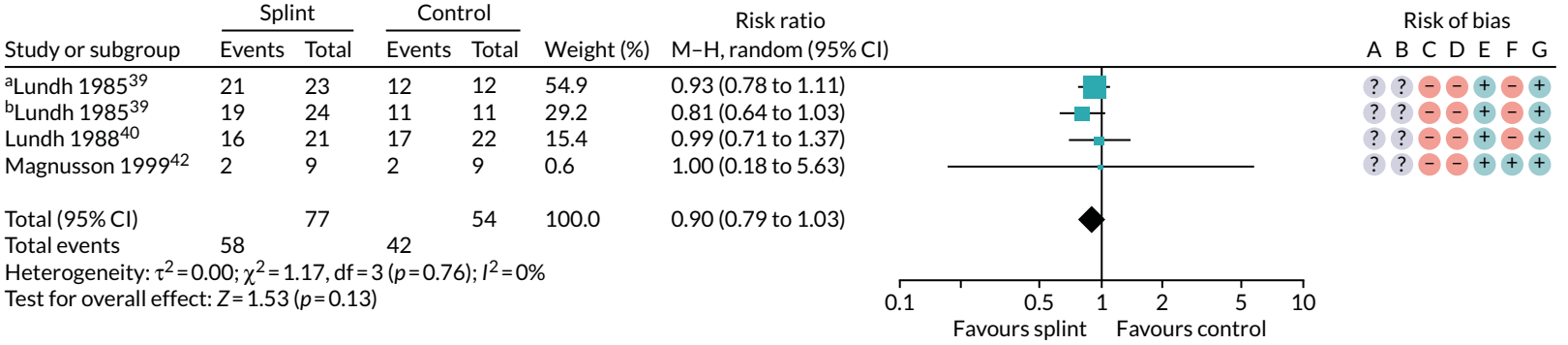

FIGURE 24 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – TMJ clicking: presence of joint noises (detected during TMJ palpation/opening/closing), 3–6 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Flat occlusal splint; b, anterior repositioning splint.

FIGURE 25 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – TMJ clicking: presence of joint noises (detected during TMJ palpation/opening/closing), 6–12 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Flat occlusal splint; b, anterior repositioning splint; c, custom; d, prefabricated.

Study or subgroup	Splint Mean	Splint SD	Splint Total	Control Mean	Control SD	Control Total	Weight (%)	Mean difference IV, random (95% CI)	Risk of bias A B C D E F G
[a]Conti 2015[28]	42.2	6.4	12	39.3	6.1	4	4.2	2.90 (−4.09 to 9.89)	? ? − − − − ?
[b]Conti 2015[28]	41.2	7.2	12	39.3	6.1	5	4.4	1.90 (−4.82 to 8.62)	? ? − − − − ?
[c]de Felício 2010[31]	43.96	8.56	10	46.25	6.77	10	4.3	−2.29 (−9.05 to 4.47)	+ ? − − ? + +
[d]Giannakopoulos 2016[62]	43.18	8.66	12	33.08	9.22	6	3.1	10.10 (1.24 to 18.96)	+ + − − + + +
[e]Giannakopoulos 2016[62]	41.83	13.76	12	33.08	9.22	6	2.3	8.75 (−1.98 to 19.48)	+ + − − + + +
[f]Haketa 2010[66]	31.6	7.6	25	37.8	6.4	19	6.8	−6.20 (−10.34 to −2.06)	+ + − − + + +
[g]Leeson 2007[63]	39.34	10.17	62	39.67	10.18	63	7.4	−0.33 (−3.90 to 3.24)	+ + − − + + +
[h]Michelotti 2012[64]	2.981	0.677	18	4.394	0.619	23	10.1	−1.41 (−1.82 to −1.01)	+ ? − − + + +
[i]Nagata 2015[67]	43.435	6.5492	96	44.005	6.3006	85	9.2	−0.57 (−2.44 to 1.30)	+ ? − − + + +
[j]Niemelä 2012[71]	45.9	8.7	39	46.5	7.8	37	7.2	−0.60 (−4.31 to 3.11)	+ ? − − + + +
[k]Sharma 2016[49]	6.2	7.3	7	7	9.2	6	2.9	−0.80 (−9.93 to 8.33)	+ ? − − ? + +
[l]Tatli 2017[54]	40.8	5.7	40	40.3	4.4	40	8.9	0.50 (−1.73 to 2.73)	+ ? − − + + +
[m]Wahlund 2003[44]	49.3	8.8	37	47.1	7.2	39	7.3	2.20 (−1.43 to 5.83)	? ? − − − − +
[n]Wright 1995[51]	42.4	6.2	10	40	7.1	10	5.1	2.40 (−3.44 to 8.24)	+ ? − + + + +
[o]Yu 2016[59]	34.12	5.63	42	24.78	7.05	42	8.4	9.34 (6.61 to 12.07)	? ? − − + + +
[p]Yu 2016[59]	35.59	6.95	42	33.74	5.69	42	8.4	1.85 (−0.87 to 4.57)	? ? − − + + +
Total (95% CI)			476			437	100.0	1.17 (−0.68 to 3.03)	

Heterogeneity: $\tau^2 = 8.84$; $\chi^2 = 87.16$, df = 15 ($p < 0.0001$); $I^2 = 83\%$

Test for overall effect: $Z = 1.24$ ($p = 0.22$)

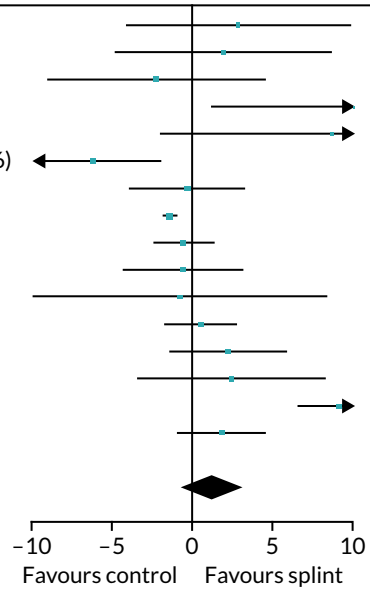

FIGURE 26 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – change in restricted mouth-opening: maximum mouth-opening (mm), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Custom NTI-tss (unassisted opening until pain felt); b, custom anterior repositioning (unassisted opening until pain felt); c, unclear if with/without/until pain or assisted/unassisted; d, custom splint (unassisted opening without pain); e, prefabricated splint (unassisted opening without pain); f, opening without pain; g, unassisted pain-free opening; h, unassisted pain-free opening (reported as change score); i, asked to open mouth as wide as possible, even if they felt pain; j, unassisted (with/without/until pain not reported); k, pain-free opening (reported as change score); l, unclear if with/without/until pain or assisted/unassisted; m, assisted opening without pain; n, pain-free opening; o, pain-free unassisted opening (splint vs. control); p, pain-free unassisted opening (splint + manipulative and physical therapies vs. manipulative and physical therapies).

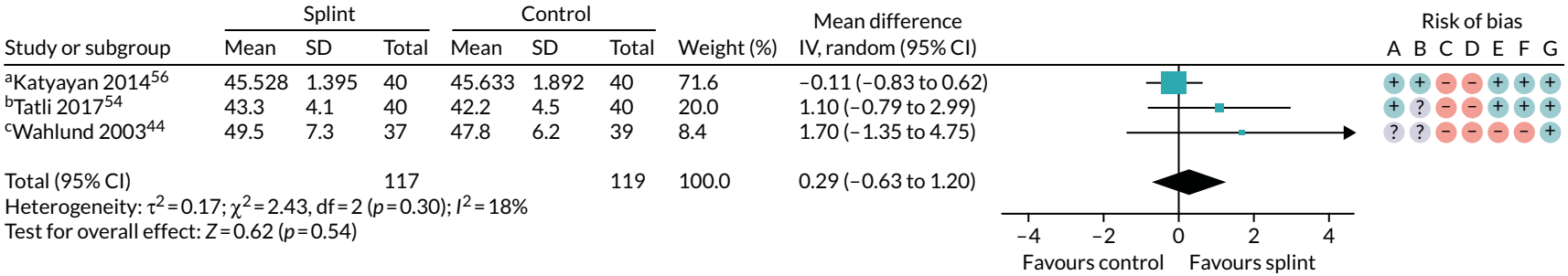

FIGURE 27 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – change in restricted mouth-opening: maximum mouth-opening (mm), 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, The sum of unassisted maximal interincisal opening and the vertical incisal overlap; b, unclear if with/without pain or assisted/unassisted; c, assisted opening without pain.

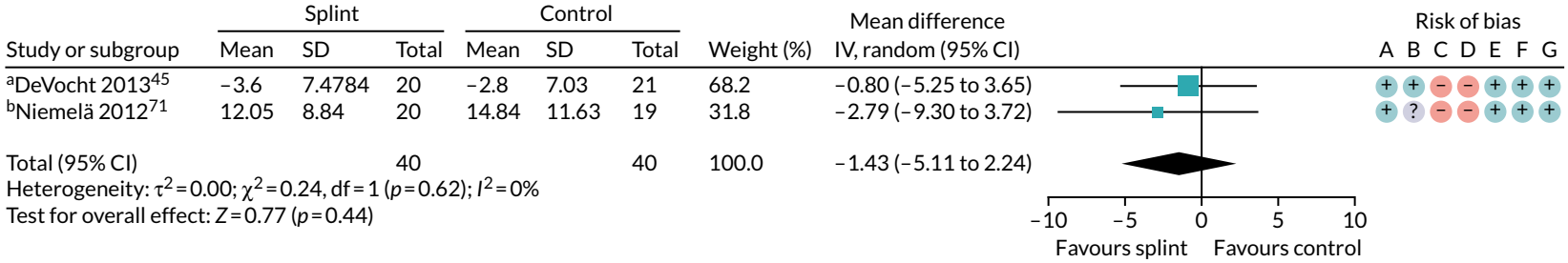

FIGURE 28 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – quality of life: OHIP-14, 0–56 worsening scale, 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Change score reported; b, end score reported.

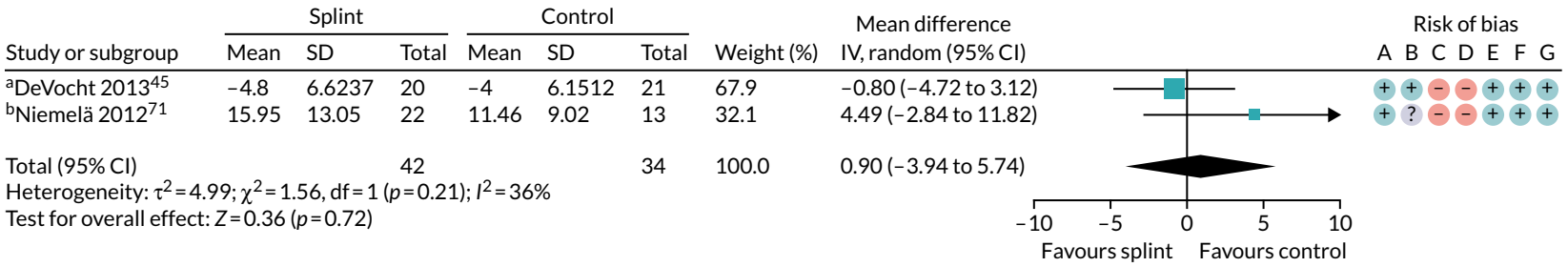

FIGURE 29 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – quality of life: OHIP-14, 0–56 worsening scale, 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Change score reported; b, end score reported.

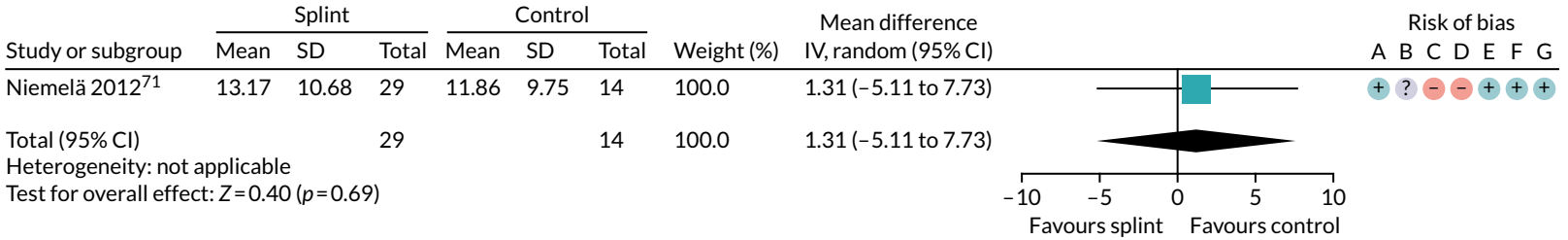

FIGURE 30 Forest plot of comparison: TMD, splint vs. no/minimal treatment; outcome – quality of life: OHIP-14, 0–56 worsening scale, 6–12 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

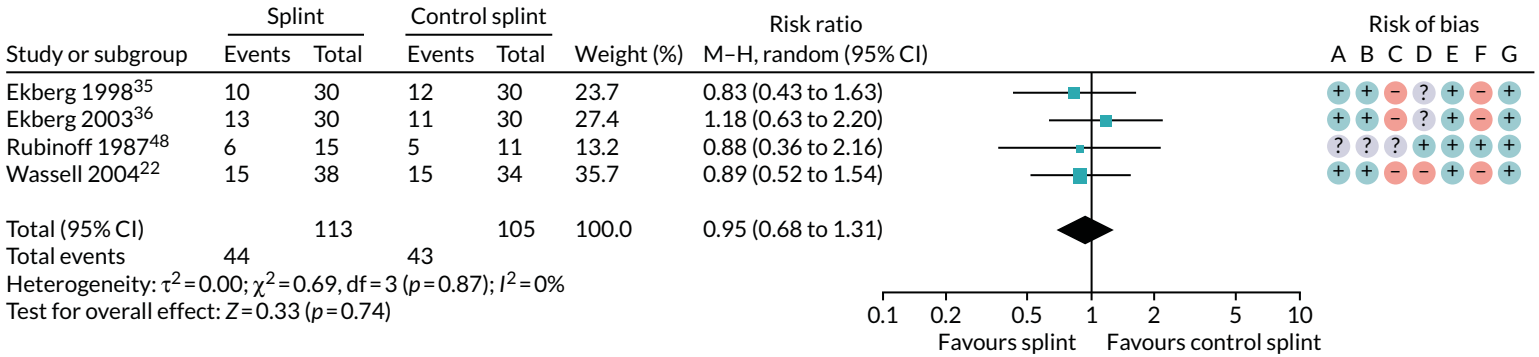

FIGURE 31 Forest plot of comparison: TMD, splint vs. control splint; outcome – TMJ clicking: presence of joint sounds during palpation, 0–3 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

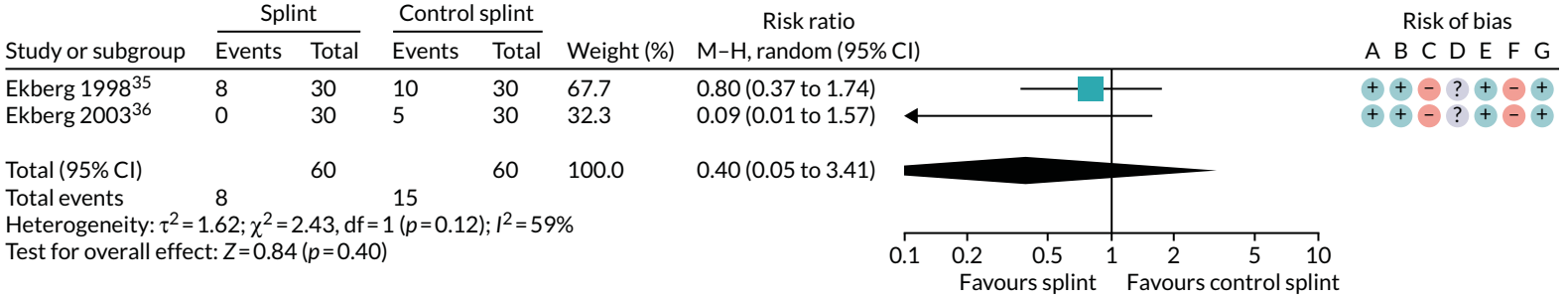

FIGURE 32 Forest plot of comparison: TMD, splint vs. control splint; outcome – change in restricted mouth-opening: opening < 40 mm. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

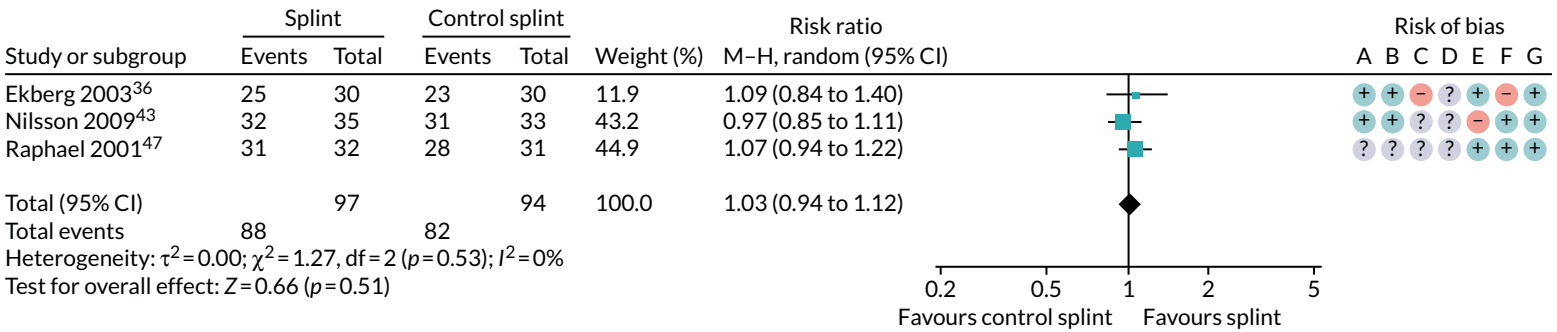

FIGURE 33 Forest plot of comparison: TMD, splint vs. control splint; outcome – compliance: splint worn every night or most nights, 0–3 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

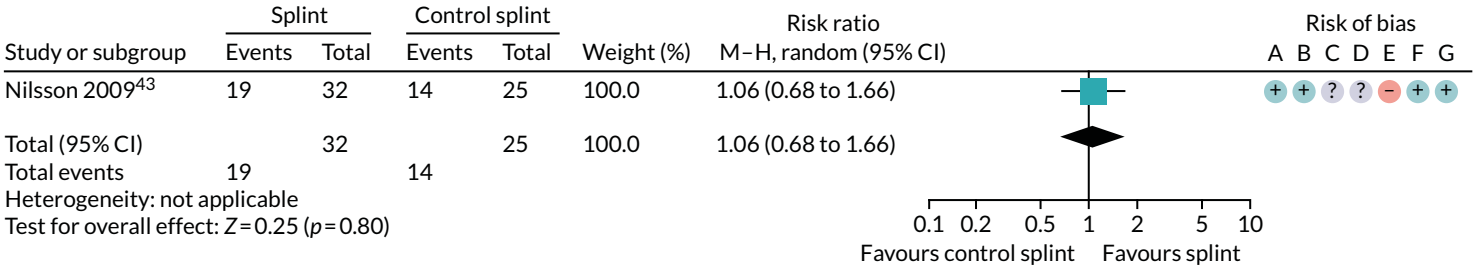

FIGURE 34 Forest plot of comparison: TMD, splint vs. control splint; outcome – compliance: splint worn every night or most nights, 3–6 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

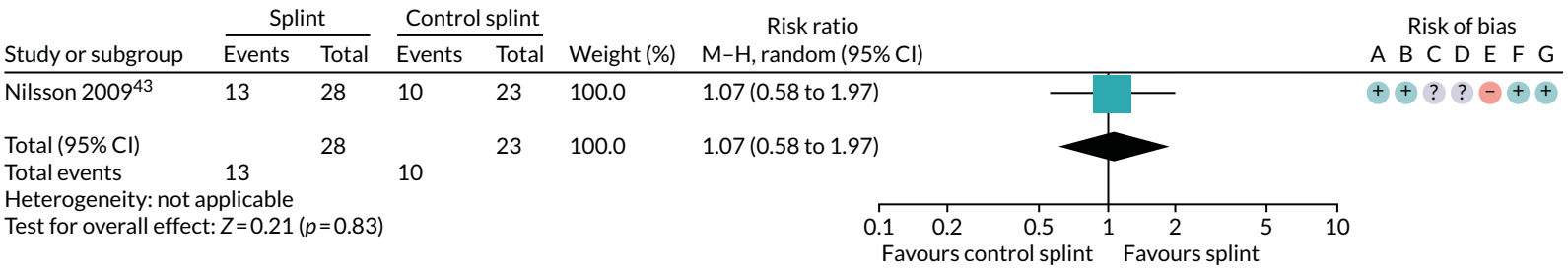

FIGURE 35 Forest plot of comparison: TMD, splint vs. control splint; outcome – compliance: splint worn every night or most nights, 6–12 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

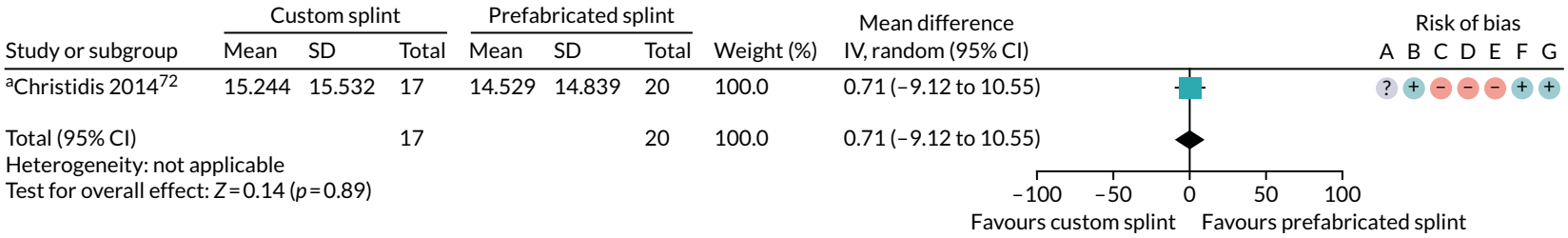

FIGURE 36 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – pain: any combinable scale (higher = more pain), 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Assessed daily in a 1-week pain diary for the week prior to each assessment point using 0 to 100 VAS (pain at rest).

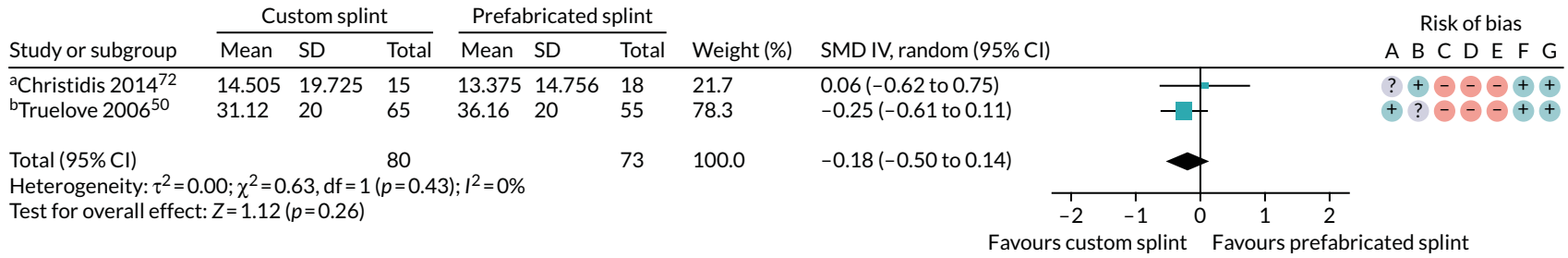

FIGURE 37 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – pain: any combinable scale (higher = more pain), 6–12 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Assessed daily in a 1-week pain diary for the week prior to each assessment point using 0 to 100 VAS (pain at rest); b, CPI 0 to 10 converted to 0 to 100 scale – SD is median value from range of SDs reported in the paper.

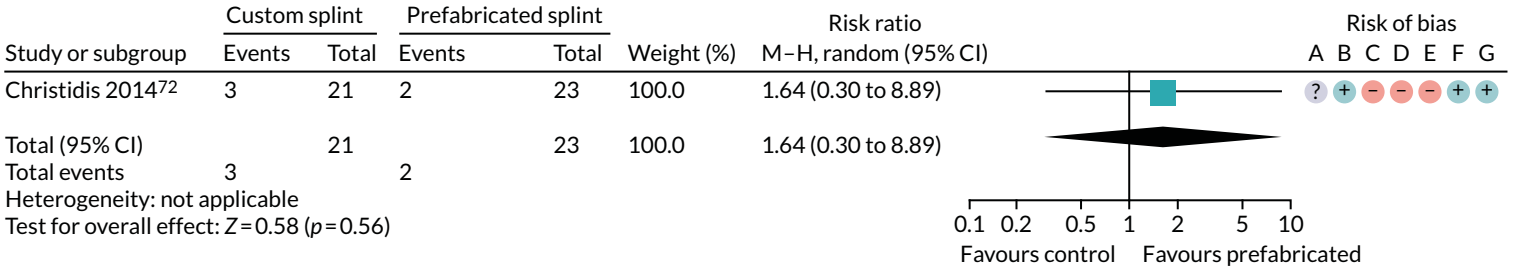

FIGURE 38 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – pain: GCPS (incidence of grade III or IV), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

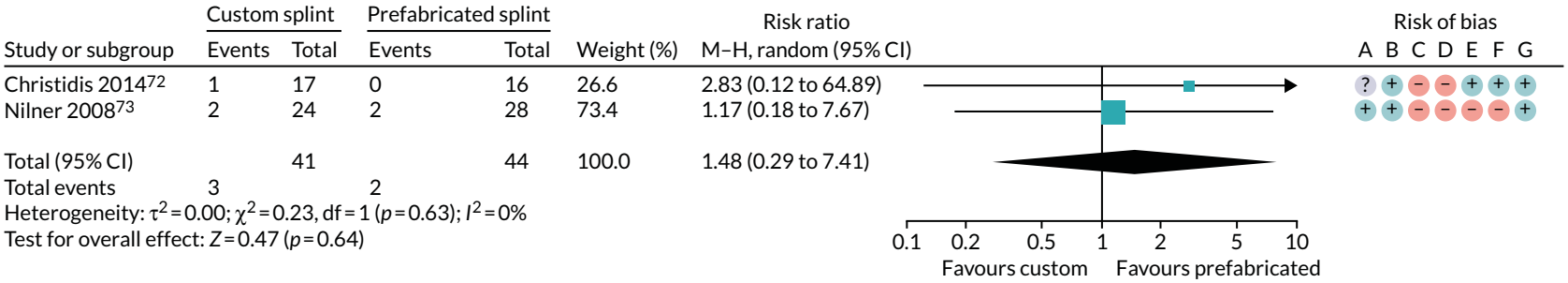

FIGURE 39 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – pain: GCPS (incidence of grade III or IV), 3–6 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

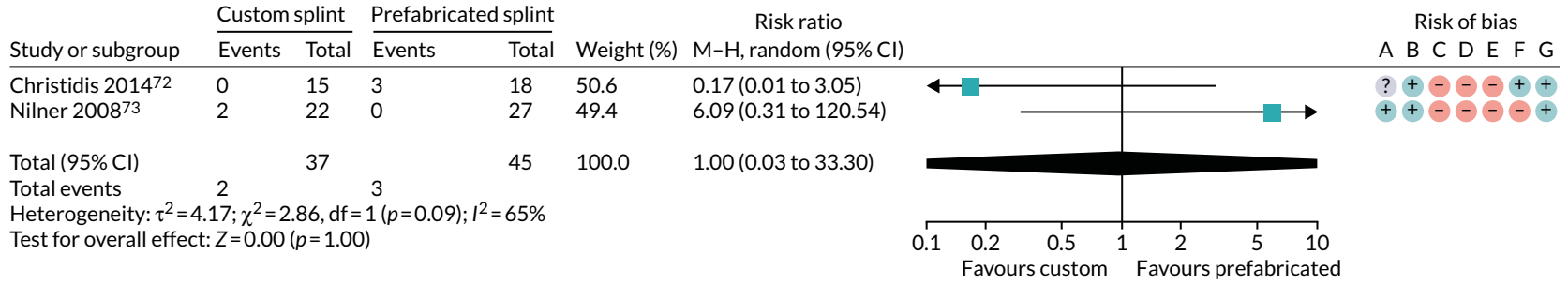

FIGURE 40 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – pain: GCPS (incidence of grade III or IV), 6–12 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

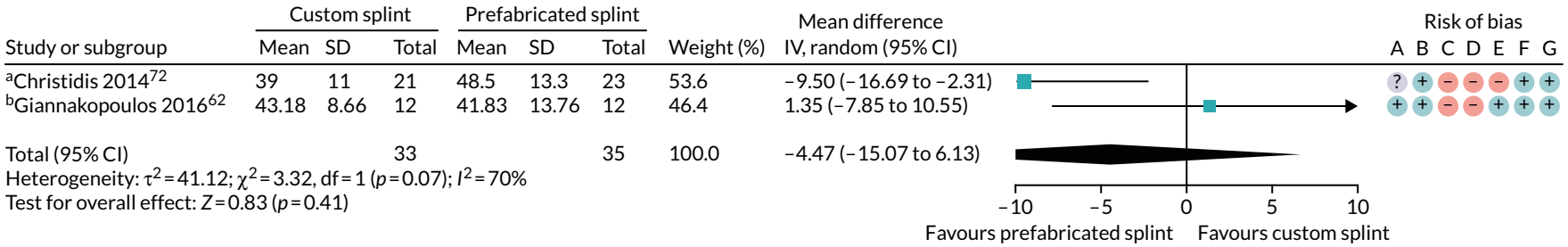

FIGURE 41 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – change in restricted mouth-opening: maximum opening (mm), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Maximum voluntary mouth-opening; b, unassisted opening without pain.

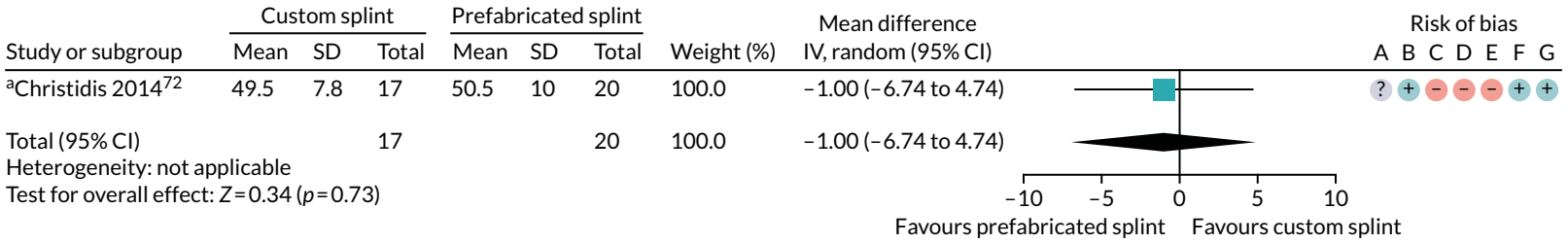

FIGURE 42 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – change in restricted mouth-opening: maximum opening (mm), 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias. a, Maximum voluntary mouth-opening.

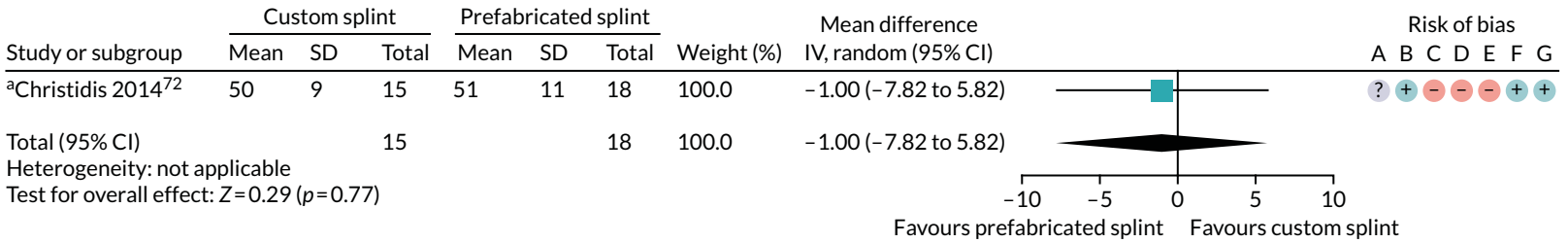

FIGURE 43 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – change in restricted mouth-opening: maximum opening (mm), 6–12 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

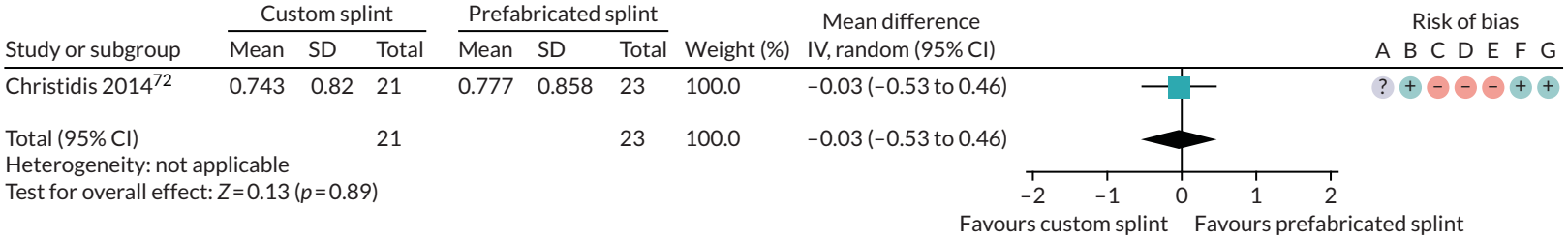

FIGURE 44 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – quality of life: SCL-90-R – depression 0–4 (higher = worse), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

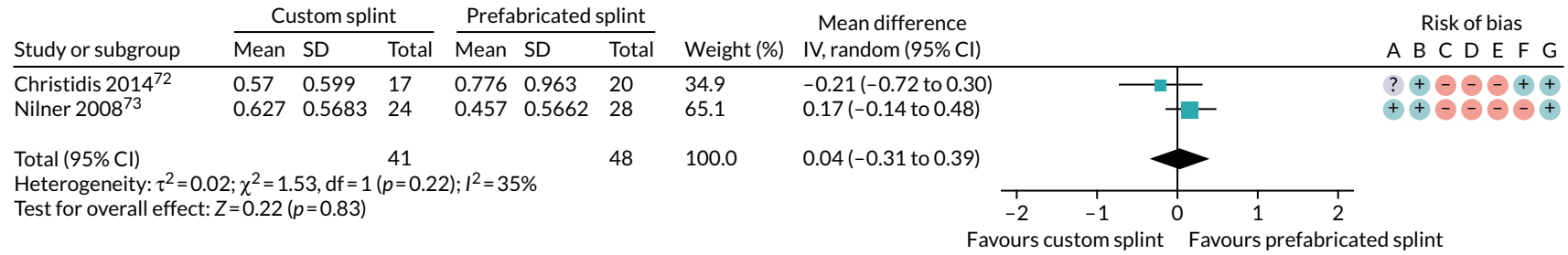

FIGURE 45 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – quality of life: SCL-90-R – depression 0–4 (higher = worse), 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

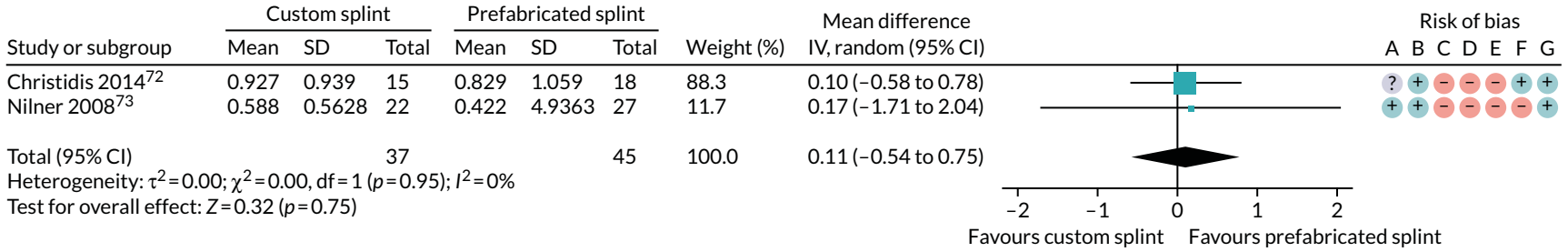

FIGURE 46 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – quality of life: SCL-90-R – depression 0–4 (higher = worse), 6–12 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

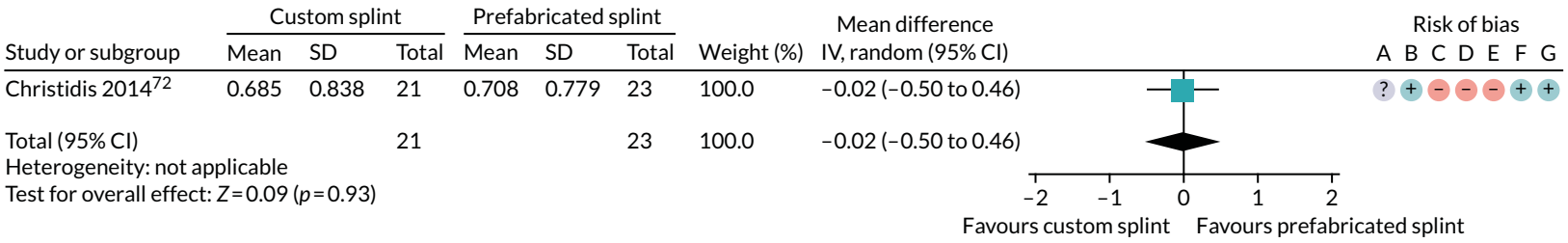

FIGURE 47 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – quality of life: SCL-90-R – non-specific physical symptoms 0–4 (higher = worse), 0–3 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

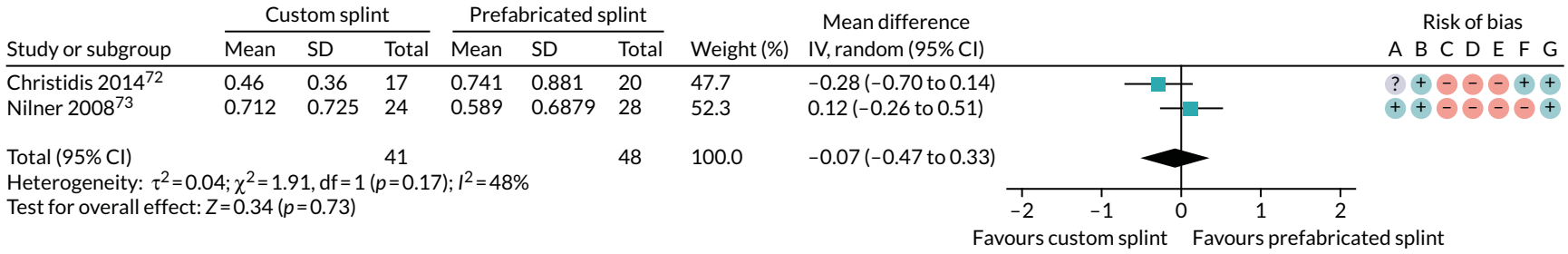

FIGURE 48 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – quality of life: SCL-90-R – non-specific physical symptoms 0–4 (higher = worse), 3–6 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

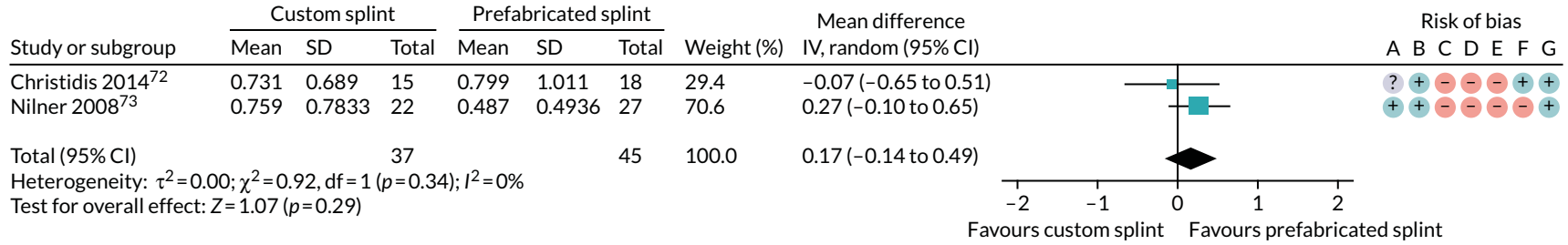

FIGURE 49 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – quality of life: SCL-90-R – non-specific physical symptoms 0–4 (higher = worse), 6–12 months. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

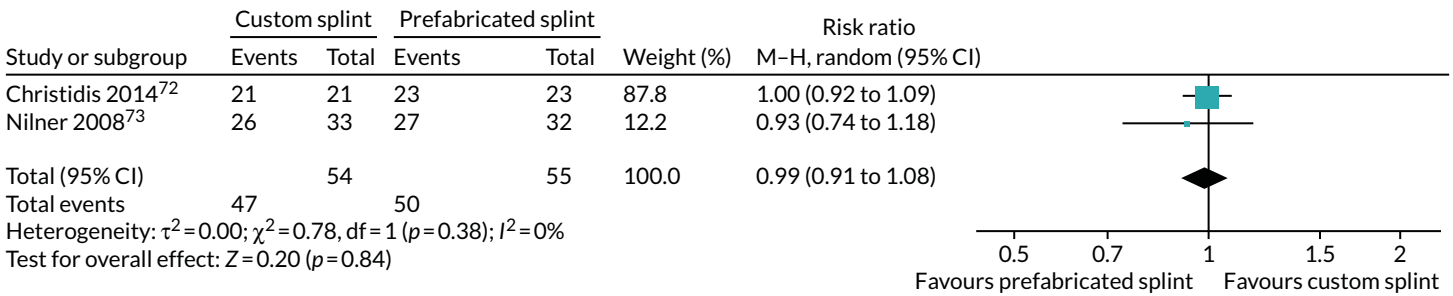

FIGURE 50 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – adherence to treatment: use of appliance for several nights per week or more, 0–3 months. M–H, Mantel–Haenszel.

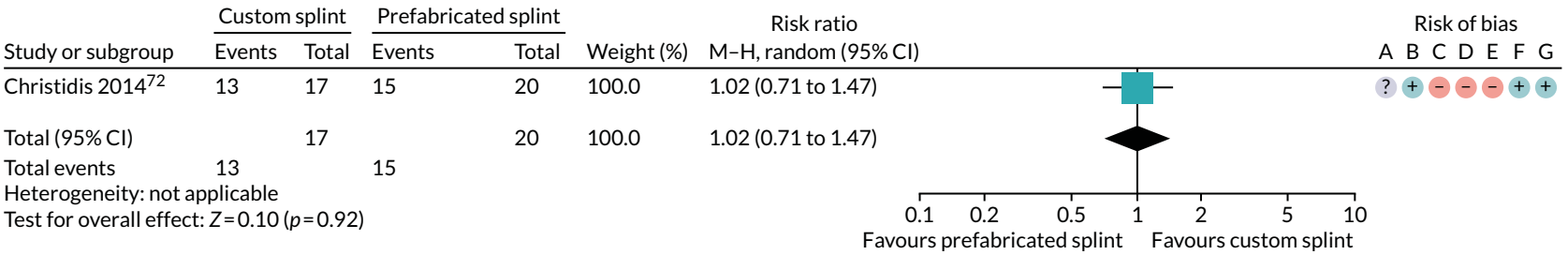

FIGURE 51 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – adherence to treatment: use of appliance for several nights per week or more, 3–6 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

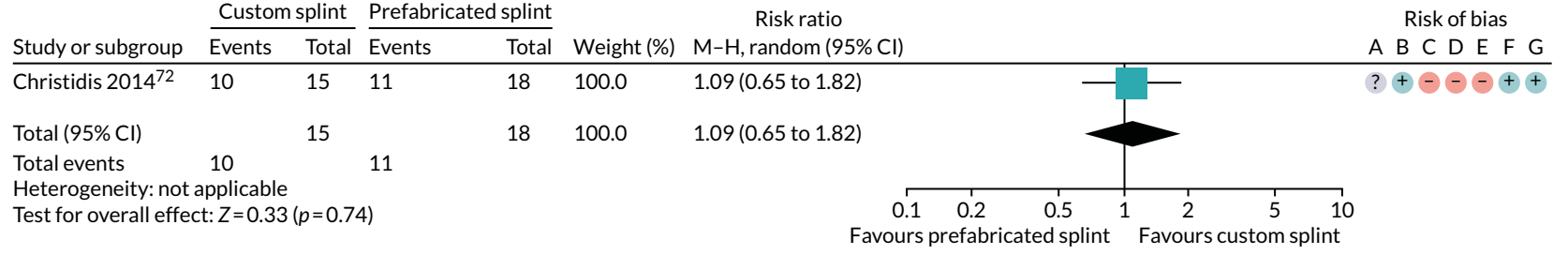

FIGURE 52 Forest plot of comparison: TMD, custom splint vs. prefabricated splint; outcome – adherence to treatment: use of appliance for several nights per week or more, 6–12 months. M–H, Mantel–Haenszel. Risk of bias: A, random sequence generation (selection bias); B, allocation concealment (selection bias); C, blinding of participants and personnel (performance bias); D, blinding of outcome assessment (detection bias); E, incomplete outcome data (attrition bias); F, selective reporting (reporting bias); and G, other bias.

Appendix 5 Draft structure of bruxism model

The proposed model structure in *Figure 53* is based on the severity of tooth wear (defined in Adult and Dental Health Survey Report 2009[125]). Tooth wear was identified as the primary outcome for bruxism patients according to clinical expert opinion (Stephen Davies, School of Dentistry, Manchester, 2018, personal communication).

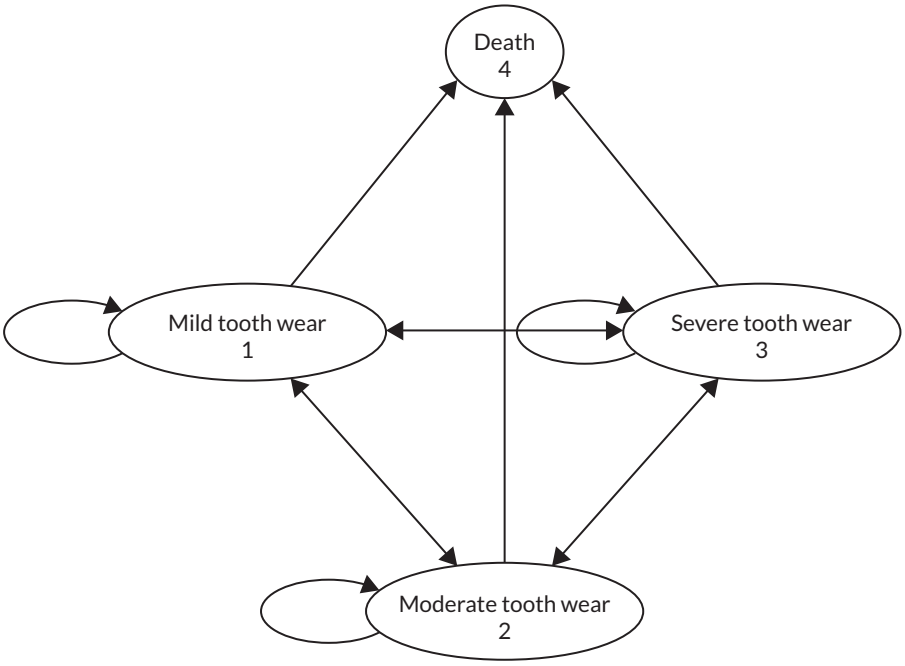

FIGURE 53 Transition state diagram for bruxism.

EME
HS&DR
HTA
PGfAR
PHR

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