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REVIEW ARTICLE (META-ANALYSIS)

Prevalence of Myofascial Trigger Points in Spinal Disorders: A Systematic Review and Meta-Analysis

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Abstract

Objective: To retrieve, appraise, and synthesize the results of studies on the prevalence of active and latent myofascial trigger points (MTrPs) in subjects with spinal pain disorders.

Data Sources: The databases PubMed, Embase, and CINAHL were searched, with no date or language restrictions. Search terms included controlled and free-text terms for spinal disorders and MTrPs. Further searches were conducted in Google Scholar and by contacting 3 experts in the field. Citation tracking of eligible studies was performed.

Study Selection: Two reviewers independently selected observational studies assessing the prevalence of active and/or latent MTrPs in at least 1 group of adults with a spinal disorder. Twelve studies met the eligibility criteria.

Data Extraction: Methodologic quality was assessed by 2 reviewers independently using a modified version of the Downs and Black checklist. Two reviewers also used a customized form to extract studies and subjects' characteristics and the proportions of subjects with active and/or latent MTrPs in each muscle assessed.

Data Synthesis: A meta-analysis was performed when there was sufficient clinical homogeneity in at least 2 studies for the same spinal disorder. The Grading of Recommendations Assessment, Development and Evaluation approach was used to rate the body of evidence in each meta-analysis. A qualitative description of the results of single studies was provided. Low-quality evidence underpinned pooled estimates of MTrPs in the upper-body muscles of subjects with chronic neck pain. The point prevalence of MTrPs in different muscles of other disorders (eg, whiplash-associated disorders, nonspecific low back pain) was extracted from single studies with low methodologic quality and small samples. Active MTrPs were found to be present in all assessed muscles of subjects diagnosed with different spinal pain disorders. Latent MTrPs were not consistently more prevalent in subjects with a spinal disorder than in healthy controls.

Conclusions: The MTrPs point prevalence estimates in this review should be viewed with caution because future studies with large samples and high methodologic quality are likely to change them substantially.

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Spinal disorders are among the leading causes of years lived with disability, with low back pain (LBP) ranking first and neck pain (NP) ranking fourth worldwide.[1] The same disorders are also majorly responsible for disability-adjusted life years.[2] The mean lifetime activity-limiting prevalence of LBP is estimated to be approximately 39% and that of NP is 23%, and the point prevalence is approximately 18% and 14%, respectively.[3,4] Cost-of-illness studies have highlighted that costs associated with these disorders

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represent a significant burden to society.[5,6] Considering all these factors together, it is apparent that research to increase our understanding of the etiology of these disorders is critical.

A clinical sign in subjects with spinal disorders is the presence of myofascial trigger points (MTrPs).[7-9] Expert-based definitions of MTrPs identify these as hypersensitive spots within a taut band of skeletal muscle that are painful on compression and which can evoke referred pain.[10] From a clinical perspective, MTrPs can be differentiated by manual assessment into active and latent.[10] Active MTrPs elicit local and referred pain that reproduce the symptoms that the patient suffered from and are recognized as a familiar complaint, whereas latent MTrPs reproduce local and referred pain that does not reproduce any spontaneous symptoms perceived by the patient.[10]

The clinical distinction between active and latent MTrPs is supported by histochemical findings showing that active MTrPs contain higher levels of algogenic substances and chemical mediators (eg, bradykinin, substance P, serotonin) than latent MTrPs and body areas without MTrPs.[11,12] Both active and latent MTrPs can be involved in pain sensitization processes involving the central nervous system,[13,14] and these processes have been shown to be altered in subjects diagnosed with different spinal disorders.[15-18] Further, latent MTrPs can be contributors to musculoskeletal signs and symptoms (eg, muscle imbalance, muscle weakness, fatigability), as reported by recent studies.[19-21]

The presence of active MTrPs in a subject can lead to the diagnosis of myofascial pain syndrome, which is considered to be a major cause of musculoskeletal pain, and its prevalence in adult subjects is reported to be high.[22] Several studies have reported the prevalence of manually assessed active and latent MTrPs in different muscles of subjects diagnosed with spinal disorders. To our knowledge, however, no systematic reviews to date have attempted to retrieve all of these studies to assess their methodologic quality and summarize their findings.

The objective of our study was therefore to conduct a systematic review of the literature with a meta-analysis to synthesize the evidence on the prevalence of active and latent MTrPs in subjects with spinal disorders. The body of evidence on the prevalence of MTrPs was considered and analyzed separately for each spinal pain disorder following diagnoses and definitions used by the authors of the original studies (eg, LBP, NP, whiplash-associated disorder [WAD]). Three specific aims were defined for each disorder: (1) to estimate the prevalence of active MTrPs in all evaluated muscles; (2) to compare the prevalence of latent MTrPs in subjects diagnosed with different spinal disorders (eg, NP vs WAD); and (3) to compare the prevalence of latent MTrPs in both subjects diagnosed with a spinal disorder and healthy controls. We did not aim to compare the prevalence of active MTrPs between subjects diagnosed with different spinal disorders or between subjects with a spinal disorder and healthy controls because, by definition, active MTrPs cannot be present in healthy subjects.[7-10]

List of abbreviations:

CI	**confidence interval**
CR	**cervical radiculopathy**
LBP	**low back pain**
MTrP	**myofascial trigger point**
NP	**neck pain**
NSLBP	**nonspecific low back pain**
OR	**odds ratio**
WAD	**whiplash-associated disorder**

Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement guidelines.[23] A protocol was written a priori and is available in appendices 1 through 3.

Study retrieval and screening

On October 15, 2014, we conducted a comprehensive systematic search of the following bibliographic databases: MEDLINE (via PubMed), Embase (via Embase.com), and CINAHL (via EBSCOhost). Search terms included controlled terms (ie, Medical Subject Headings in PubMed, Emtree in Embase, subject headings in CINAHL) and free-text terms. Each database was searched separately, and the search strategy had the same structure in all databases. The complete search strategies for all databases can be found in appendices 1 through 3. No restrictions were applied on the language of the articles. An additional search with the keyword *trigger point* was conducted in the search engine Google Scholar. The first 200 hits were screened because it is not feasible to screen all results obtained with a simple search in Google Scholar (ie, >2 million for *trigger point*) and because this engine automatically lists references with regard to their relevance and the number of citations on the topic searched. All hits obtained with the search strategies were exported in EndNote[a] where duplicates were removed.

The titles and abstracts of the resulting studies were screened by 2 reviewers independently (A.C., M.B.) to assess their eligibility. The full texts of potentially eligible studies were retrieved and assessed against the inclusion criteria by the same 2 reviewers independently. Controversies between reviewers regarding the eligibility of titles/abstracts or full texts were solved in a consensus meeting. When consensus could not be reached, a third reviewer (R.C.) was asked to make the final decision.

Forward citation tracking of the eligible studies was conducted in Web of Science (via Web of Knowledge) by 1 reviewer (A.C.). Backward citation tracking of the reference lists of included studies was also conducted by 1 reviewer (A.C.). When other potentially eligible studies were detected, 2 reviewers (A.C., M.B.) checked independently against the inclusion criteria. At the end of this process, 3 authors with a large number of publications in the field of MTrPs were contacted by e-mail and asked to identify whether to their knowledge any study was missing and whether any other unpublished studies were ongoing.

Eligibility criteria

The following types of study were included in this review: (1) full-text articles published in a peer-reviewed scientific journal; (2) observational designs aimed at assessing the prevalence of active and/or latent MTrPs in at least 1 group of adult subjects (ie, >18y old) with a spinal disorder; (3) inclusion of manual assessment of MTrPs in at least 1 specific muscle; and (4) articles written in English, Italian, French, or Spanish. All medical diagnoses indicating the presence of a spinal pain disorder (eg, nonspecific low back pain [NSLBP], idiopathic NP, WAD, spinal stenosis, herniated disk)[24] were accepted and included in this review. Studies conducted in subjects with underlying medical conditions (eg, rheumatoid arthritis, tumor, infection) were not included, and studies conducted in subjects with fibromyalgia were also excluded. Articles published in languages other than the aforementioned ones were included only if an English version was available.

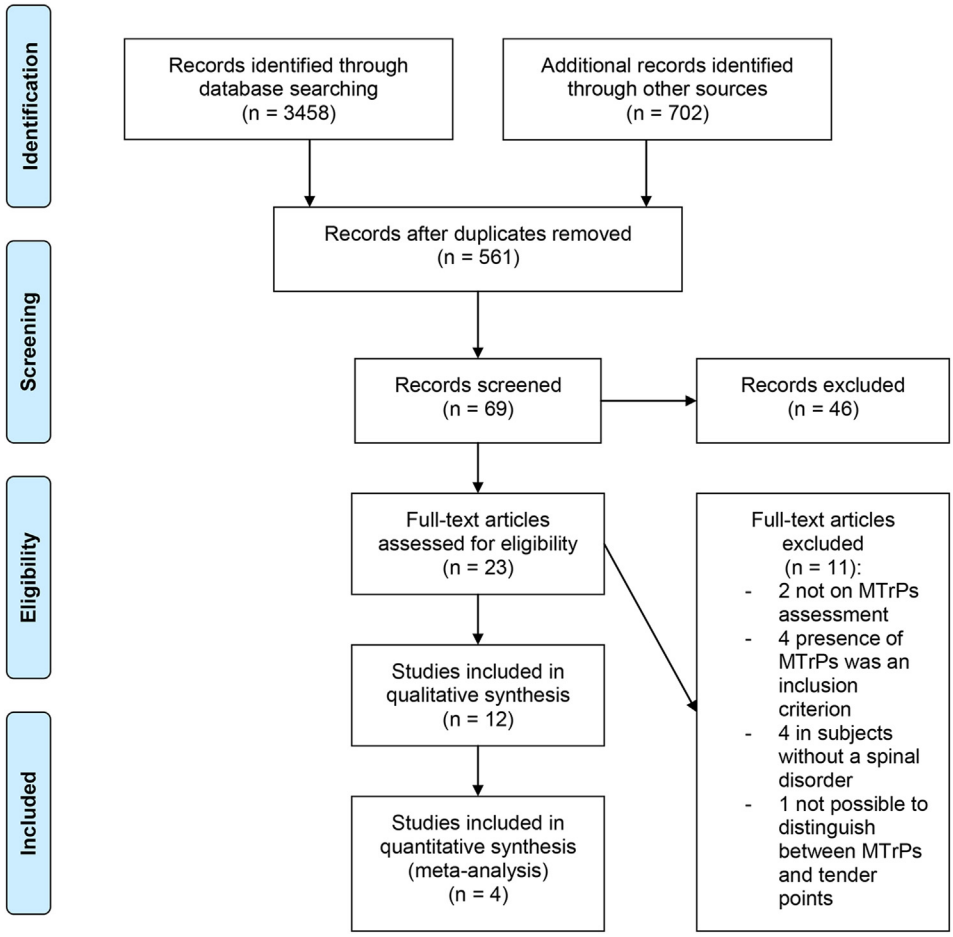

Fig 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart of study retrieval, screening, and eligibility.

Methodologic quality assessment

A 16-item modified version of the Downs and Black checklist[25] was used to assess the methodologic quality of the studies. The version used in this review (see appendices 1—3) was drawn by excluding items 4, 8, 9, 13, 14, 17, 19, 23, 24, 25, and 26 of the original version because they were not compatible with observational studies on the prevalence of MTrPs. This checklist was chosen because there is no consensus regarding the optimal tool to assess the methodologic quality of observational studies[26] and because a modified version of the same checklist has been used in other systematic reviews of observational studies.[27,28] Quality assessment was performed by 2 reviewers (A.C., M.B.) independently, and when disagreements could not be resolved, a third reviewer was asked to make a decision (R.C.). One of the authors of this review (C.F.-d.-l.-P.) has published several studies on the prevalence of MTrPs and was not involved in the quality assessment. To be considered as having high methodologic quality, a study had to meet >50% of the applicable items on the checklist; studies meeting ≤50% of the criteria were considered of low methodologic quality. This cutoff threshold was used because it has been recommended for systematic reviews by the Cochrane Back Review Group[29] and has been widely adopted in systematic reviews of observational and experimental studies for spinal pain disorders.[30-34]

Data extraction

A customized form was created and used to extract the following data about the study characteristics: the medical diagnosis under investigation; inclusion and exclusion criteria; criteria used to detect the presence of active and/or latent MTrPs; assessed muscles; sample size; country; setting; years of experience of the examiners; participants' age and sex; and participants' other characteristics (eg, duration of symptoms, pain intensity). For each study, the proportion of subjects with active and/or latent MTrPs in each assessed muscle was extracted. Data were extracted by 1 reviewer (A.C.) and double-checked for accuracy by a second reviewer (R.C.).

Data analysis

A meta-analysis was performed when at least 2 studies assessed the prevalence of active or latent MTrPs on the same muscle for the same spinal disorder. Sufficient clinical homogeneity regarding the diagnosis of a spinal disorder, subjects' characteristics, and methods of MTrPs assessment had to be present to pool the data. Studies not making a distinction between active and latent MTrPs were not included in the meta-analyses. DerSimonian and Laird random effect models were used in light of expected between-study errors.[35] Pooled estimates of the prevalence of active MTrPs were calculated along with 95% confidence

Table 1 Characteristics of eligible studies

Study	Spinal Disorder(s)	Healthy Controls Group	Diagnostic Criteria Active MTrPs	Diagnostic Criteria Latent MTrPs	Assessed Muscles	Country, Setting
Castaldo et al[40]	WAD NP	No	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation (5) Local and referred pain evoked symptoms familiar to the patient	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation	Bilaterally: Suboccipitals Upper trapezius Levator scapulae Temporalis Supraspinatus Infraspinatus Sternocleidomastoid Deltoid	Italy, outpatient clinic
Chen et al[41]	CBP	No	No distinction between active and latent MTrPs. No clear distinction between the presence of MPS and MTrPs was made. MPS was diagnosed on the presence of: (1) MTrP (2) Reproducible pain (3) Referred pain (4) Jump sign		Trapezius Supraspinatus Rhomboid Sternocleidomastoid Subscapularis Scalene Levator scapulae Infraspinatus Latissimus dorsi Thoracic paravertebrals Piriformis Gluteus medius Gluteus minimus Quadratus lumborum Gluteus maximus	Malaysia, pain management hospital unit
De-la-Llave Rincon et al[42]	NP	Yes	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation (5) Local and referred pain evoked symptoms familiar to the patient	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation	Bilaterally: Masseter Temporalis	Spain, outpatient clinic
Ettlin et al[43]	WAD NP	Yes	No distinction between active and latent MTrPs was made. A MTrP was diagnosed if any 3 of these criteria were met: (1) Palpable hardening (trigger point and/or taut band) in the muscle belly (2) Pressure pain in the MTrP or taut band (3) Referred pain while manipulating the MTrP in the taut band (4) Recognition of the elicited pain as the patient's known and familiar pain		Bilaterally: Semispinalis capitis Upper trapezius Levator scapulae scalenus medius Sternocleidomastoid Masseter	Switzerland, rehabilitation center

(*continued on next page*)

Table 1 (*continued*)

Study	Spinal Disorder(s)	Healthy Controls Group	Diagnostic Criteria Active MTrPs	Diagnostic Criteria Latent MTrPs	Assessed Muscles	Country, Setting
Fernandez-de-las-Penas et al[44]	NP	Yes	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation (5) Local and referred pain evoked symptoms familiar to the patient	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation	Bilaterally: Upper trapezius Levator scapulae Sternocleidomastoid Suboccipitals	Spain, outpatient clinic
Fernández-Pérez et al[45]	WAD	Yes	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation (5) Local and referred pain evoked symptoms familiar to the patient	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation	Bilaterally: Temporalis Masseter Upper trapezius Levator scapulae Sternocleidomastoid scalene Suboccipitals	Spain, outpatient clinic
Hua et al[46]	NSLBP	Yes	No clear distinction between active and latent MTrPs was made. Several criteria were assessed, but only localized tenderness and jump sign or recognition were used for the diagnosis of MTrP.		Bilaterally: Quadratus lumborum Gluteus medius	The Netherlands, health centers and private practices
Iglesias-González et al[47]	NSLBP	Yes	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Referred pain elicited by palpation (4) Local and referred pain evoked symptoms familiar to the patient	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Referred pain elicited by palpation	Bilaterally: Quadratus lumborum Iliocostalis lumborum Psoas Piriformis Gluteus minimus Gluteus medius	Spain, outpatient clinic
Jaeger[48]	CH	No	No distinction between active and latent MTrPs was made. Diagnosis of MTrPs was done if palpation of tender spots in tight bands of muscle resulted in referred symptoms. Patients were asked whether the referred symptoms were similar to their CH, but it was not clear if this criterion was used for the diagnosis of MTrPs.		Bilaterally: Masseter Temporalis Sternocleidomastoid Splenius capitis Semispinalis capitis Upper trapezius Scalenus medius	United States, pain management center and other institution

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Table 1 (*continued*)

Study	Spinal Disorder(s)	Healthy Controls Group	Diagnostic Criteria Active MTrPs	Diagnostic Criteria Latent MTrPs	Assessed Muscles	Country, Setting
Muñoz-Muñoz et al[49]	NP	Yes	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation (5) Local and referred pain evoked symptoms familiar to the patient	(1) Palpable taut band (2) Hyperirritable tender spot within the taut band (3) Local twitch response (4) Referred pain elicited by palpation	Bilaterally: Upper trapezius Sternocleidomastoid splenius capitis Semispinalis capitis Levator scapulae Scalene	Spain, outpatient clinic
Samuel et al[50]	LDH	No	(1) Palpable taut band (2) Exquisite spot tenderness of a nodule in the taut band (3) Recognition of current pain complaint by pressure on the tender nodule (4) Painful limit to full stretch range of motion	Not assessed	Tibialis anterior Tibialis posterior Extensor digitorum longus Extensor digitorum hallucis Gluteus maximus Gluteus minimus Hamstrings Gastrocnemius Quadriceps	India, outpatient and inpatient orthopedic hospital department
Sari et al[51]	CR	Yes	(1) Palpable taut band (2) Hypersensible tender spot in the taut band (3) Local twitch response (4) Reproduction of typical referred pain pattern (5) Spontaneous presence of typical referred pain pattern and/or patient recognition of the pain	(1) Palpable taut band (2) Hypersensible tender spot in the taut band (3) Local twitch response (4) Reproduction of typical referred pain pattern	Upper trapezius Levator scapulae Multifidus Splenius capitis Rhomboid major Rhomboid minor	Turkey, outpatient clinic

Abbreviations: CH, cervicogenic headache; CBP, chronic back pain; CR, cervical radiculopathy; LDH, lumbar disk herniation; MPS, myofascial pain syndrome.

intervals (CIs) by transforming proportions into logits because these are preferred over mean proportions.[36] For ease of interpretation, all final results were backconverted into pooled proportions. Pooled estimates for the comparison of latent MTrPs between groups were calculated using odds ratios (ORs) along with their 95% CIs. Statistical heterogeneity was detected with the Q statistic, and the I^2 statistic was used to estimate its amount. No subgroup or sensitivity analyses were preplanned for meta-analyses. Analyses were performed using the software Comprehensive Meta-Analysis 2.0.[b]

A qualitative description of the results of all of the studies not included in the meta-analyses was provided. ORs with 95% CIs were calculated for the comparison of latent MTrPs between groups in each single study, when this information was not provided in the original article. If a distinction between the diagnosis of active and latent MTrPs could not be extrapolated from a study, the results are not presented because they were considered poorly informative.

Evidence synthesis

Where a meta-analysis was performed, the overall quality of the evidence was rated using the Grading of Recommendations Assessment, Development and Evaluation approach,[37] as suggested by the *Cochrane Handbook for Systematic Reviews of Interventions*[38] and as implemented by the Cochrane Back Review Group.[29] Factors that could reduce the quality of the evidence were low methodologic quality, inconsistency of results, indirectness, lack of precision, and publication bias.[29] The quality of the evidence was initially considered high for each meta-analysis and then reduced by $\geq$1 level according to the performance of the studies against the 5 aforementioned factors.[29] The overall quality could be downgraded from 1 to 3 levels, becoming moderate, low, or very low.[29,37] Downgrading for low methodologic quality was applied when at least half of the included studies did not meet at least 50% of the checklist criteria.[29] Likewise, evidence quality was downgraded for inconsistency when there was substantial heterogeneity (ie, $I^2 \geq 60\%$)[38] and for lack of precision when <400 subjects were included in a meta-analysis.[39] Indirectness was considered present when there was a lack of ability to generalize MTrPs assessment and subject characteristics[29]; publication bias was investigated only if at least 10 studies were included in a meta-analysis.[38]

Results

Figure 1 is a flowchart of study retrieval, screening, and eligibility. The 3 experts in the field we contacted did not identify any additional studies besides those retrieved from the database searches and citation tracking. Twelve studies met the eligibility criteria and were included in this review[40-51]; 4 of these studies[40,42,44,49] were included in the meta-analyses. All studies were cross-sectional and assessed the point prevalence of MTrPs. The characteristics of these studies (ie, spinal disorders involved, diagnostic criteria, muscles assessed, country, setting) are summarized in table 1. One study compared the point prevalence of MTrPs in subjects with NP and WAD,[40] 8 compared the prevalence of MTrPs in $\geq$1 group of subjects with a spinal disorder and healthy controls,[42-47,49,51] and the remaining 3 assessed the prevalence of MTrPs only in a group of subjects with a spinal disorder.[41,48,50] Five studies were conducted in subjects with NP[40,42-44,49]; 3 included subjects with WAD[40,43,45]; 1 included a mixed population of subjects with spinal pain[41]; 2 included subjects with NSLBP[46,47]; 1 included subjects with cervicogenic headache[48]; 1 included subjects with lumbar disk herniation[50]; and 1 included subjects with cervical radiculopathy (CR).[51] Sample size, sex age, and other characteristics of the subjects included in the studies are shown in table 2.

Diagnostic criteria for MTrPs varied widely across the studies. Six studies[40,42,44,45,49,51] adopted expert-based definitions for active and latent MTrPs[10]; Iglesias-González et al[47] adopted the same criteria but with the exclusion of local twitch response as a diagnostic criterion; Samuel et al[50] used different criteria for active MTrPs; and the other 4 studies[41,43,46,48] did not make a clear distinction between active and latent MTrPs (see table 1).

Methodologic quality assessment

Table 3 presents the methodologic quality assessment of the 12 included studies. Because 1 reviewer (A.C.) was an author of an eligible study, he was not involved in the quality assessment of that study, which was assessed by the third reviewer (R.C.). Overall, the studies presented low methodologic quality, with only 2 meeting >50% of the applicable criteria of the checklist.[40,42] Seven criteria were not applicable to 3 studies because they included only 1 group of subjects.[41,48,50] All but 1 study[41] had a clear description of the hypothesis/aim/objective (ie, item 1), and all but 2 studies[41,43] clearly presented the inclusion and exclusion criteria of the subjects included (ie, item 3). Item 8 regarding the description of the sampling method for the recruitment of subjects from the source population was not met by any study, likewise for item 13 on the accuracy of the main outcome measures (ie, MTrPs diagnosis) and item 16 on the sample size calculation. Only Hua et al[46] reported on the proportion of recruited subjects who agreed to participate (ie, item 9). Items 14 and 15 on selection bias regarding the recruitment of subjects and controls from the same population and over the same time period were met by a small minority of the studies (see table 3). The distribution of principal confounders in each study group (ie, item 4) was met by De-la-Llave-Rincon et al,[42] but the other studies did not report on some key potential confounders (ie, body mass index, anxiety, depression, pain hypersensitivity).

Neck pain

Among the 5 studies that reported on the point prevalence of MTrPs in subjects with NP, 4 studies included subjects with chronic NP; of these, 2 studies[40,42] had high methodologic quality and the other 2 studies[44,49] had low quality (see table 3). Ettlin et al[43] did not report the inclusion criteria or clinical characteristics of the included subjects with NP, had low methodologic quality, did not make a distinction between active and latent MTrPs, and did not make a distinction between the diagnosis of myofascial pain syndrome and MTrPs. For these reasons, this study was excluded from the meta-analyses, and its results are not presented here because they were poorly informative.

There was low-quality evidence that the point prevalence of active MTrPs in 91 subjects with chronic NP is 38.5% (95% CI, 29.1−48.9) on the right upper trapezius, 29.8% (95% CI, 21.3−40.0) on the left trapezius, 16.9% (95% CI, 10.4−26.2) on the right levator scapulae, 14.8% (95% CI, 7.7−26.7) on the left levator scapulae, 22.0% (95% CI, 14.5−32.1) on the right

Table 2 Characteristics of the subjects included in the studies

	Patients					Healthy Controls			
Study	Spinal Disorder(s)	Sample, n	Sex, % Female	Age (y), Mean ± SD	Other Characteristics, Mean ± SD or %	Sample, n	Sex, % Female	Age (y), Mean ± SD	Other Characteristics, Mean ± SD or %
Castaldo et al[40]	WAD grade II or III MNP >3mo	49 56	57.1 58.9	41.6±1.7 45.2±1.8	PD: 57.1±14.1mo Current VAS: 5.6±0.4 PD: 109.4±20.9mo Current VAS: 4.7±0.4	Not applicable			
Chen et al[41]	CBP >6mo	126	61.1	48.5±15.0	PD: 15.1%: <1y 64.3%: 1 to <3y 20.6%: >3y BMI: 39.7%: <24.9 34.1%: 25.0 to <29.9 26.2%: >30.0	Not applicable			
De-la-Llave Rincon et al[42]	MNP >6mo	20	60.0	27.0±6.0	PD: 9.0±4.0mo Current NRS: 3.8±1.2 NDI: 18.0±3.0 BDI: 7.0±2.0 STAI: 22.0±3.0	20	?	27.0±5.0	BDI: 3.0±4.0 STAI: 8.6±8.0
Ettlin et al[43]	WAD >6mo NP	47 17	74.5 35.3	38.6±10.2 46.2±8.6	PD: 1.5±1.8y ?	24	45.8	37.4±11.4	Not reported
Fernandez-de-las-Penas et al[44]	MNP >4mo	20	65.0	28.0±7.0	PD: 9.3±3.0mo Current VAS: 2.5±0.7	20	50.0	29.0±9.0	Not reported
Fernández-Pérez et al[45]	WAD grade II <1mo	20	50.0	28.7±12.4	PD: 26.6±3.8d Current NRS: 6.2±2.6 Worst NRS: 8.0±2.0 Lowest NRS: 3.3±2.9 NDI: 68.5±8.7	20	?	29.1±12.2	Not reported
Hua et al[46]	NSLBP <2mo	61	44.2	36.2±9.8	Not reported	63	50.7	38.1±9.9	Not reported
Iglesias-González et al[47]	NSLBP >3y	42	50.0	45.0±8.0	PD: 9.1 (6.8—11.3y)* BMI: 24.5±3.2 Current NRS: 6.2 (5.3—6.9)* Worst NRS: 7.8 (7.2—8.4)* Lowest NRS: 4.6 (4.1—5.3)* RMDQ: 12.9±2.5 PSQI: 12.4± 3.3	42	50	45.0±9.0	BMI: 24.9±3.4 RMDQ: 0.8±0.2 PSQI: 3.5±2.3
Jaeger[48]	CH	11	90.9	33.8±6.3	PD: 8.9 (1—20y)†	Not applicable			

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Table 2 (*continued*)

	Patients					Healthy Controls			
Study	Spinal Disorder(s)	Sample, n	Sex, % Female	Age (y), Mean ± SD	Other Characteristics, Mean ± SD or %	Sample, n	Sex, % Female	Age (y), Mean ± SD	Other Characteristics, Mean ± SD or %
Muñoz-Muñoz et al[49]	MNP	15	80.0	39.0±8.0	PD: 3.3 (2.5—4.1y)* BMI: 25.7±4.4 Current NRS: 5.3 (2.5—4.1)* Worst NRS: 6.1(5.0—7.1)* Lowest NRS: 4.7(3.5—5.8)* NDI: 25.7± 15.1 PSQI: 9.7±5.1	12	75.0	40.0±7.0	BMI: 24.6±3.9 NDI: 3.8±1.1 PSQI: 3.7±2.9
Samuel et al[50]	LDH diagnosed with MRI and severe pain	60	26.7	22—61†	PD: 1—36mo†	Not applicable			
Sari et al[51]	CR with disk herniation diagnosed with history, MRI and clinical findings	244	52.5	44.6±10.3	BMI: 26.3±5.3	122	?	43.8±9.8	Not reported

Abbreviations: BDI, Beck Depression Inventory; BMI, body mass index; CBP, chronic back pain; CH, cervicogenic headache; CR, cervical radiculopathy; LDH, lumbar disk herniation; MNP, mechanical neck pain; MRI, magnetic resonance imaging; NDI, Neck Disability Index; NRS, Numerical Rating Scale; PD, pain duration; PSQI, Pittsburgh Sleep Quality Index; RMDQ, Roland Morris Disability Questionnaire; STAI, State Trait Anxiety Inventory; VAS, visual analog scale; ?, information not available.

* 95% CI.

† Range.

Table 3 Methodologic quality assessment of eligible studies

Study	Reporting Bias							External Validity		Internal Validity Bias					Power	Low vs High
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Quality
Castaldo et al[40]	✓	✓	✓	x	✓	x	✓	?	?	✓	✓	✓	?	✓	?	x	High quality
Chen et al[41]	x	x	x	NA	x	NA	NA	?	?	?	?	NA	?	NA	NA	NA	Low quality
De-la-Llave Rincon et al[42]	✓	✓	✓	✓	✓	✓	✓	?	?	✓	✓	✓	?	?	?	x	High quality
Ettlin et al[43]	✓	x	x	x	x	x	x	?	?	✓	✓	✓	?	?	?	x	Low quality
Fernandez-de-las-Penas et al[44]	✓	✓	✓	x	✓	x	x	?	?	✓	✓	✓	?	?	✓	x	Low quality
Fernández-Pérez et al[45]	✓	✓	✓	x	✓	x	✓	?	?	✓	✓	✓	?	?	?	x	Low quality
Hua et al[46]	✓	x	✓	x	✓	x	x	?	✓	x	x	✓	x	✓	✓	x	Low quality
Iglesias-González et al[47]	✓	✓	✓	x	✓	x	✓	?	?	✓	✓	✓	?	x	?	x	Low quality
Jaeger[48]	✓	x	✓	NA	x	NA	NA	?	?	?	?	NA	?	NA	NA	NA	Low quality
Muñoz-Muñoz et al[49]	✓	✓	✓	x	✓	x	x	?	?	✓	✓	✓	?	x	?	x	Low quality
Samuel et al[50]	✓	x	✓	NA	x	NA	NA	?	?	✓	✓	NA	?	NA	NA	NA	Low quality
Sari et al[51]	✓	✓	✓	x	✓	x	✓	?	?	?	✓	✓	?	?	?	x	Low quality

Abbreviations: NA, not applicable; ✓, yes; x, no; ?, unable to determine.

sternocleidomastoid, and 19.8% (95% CI, 12.6−29.6) on the left sternocleidomastoid (fig 2). Downgrading of the quality of evidence was caused by low methodologic quality and imprecision. Low-quality evidence (because of inconsistency and lack of precision) was also found on the point prevalence of active MTrPs on the temporalis muscle of 76 subjects with chronic NP, resulting in pooled estimates of 11.9% (95% CI, 1.0−63.6) on the right side and 11.2% (95% CI, 1.2−56.9) on the left side (fig 3). The point prevalence for active MTrPs on other muscles is summarized in table 4, where it can also be seen that all results were extracted from studies with small samples.

ORs with 95% CIs were calculated for a high-quality study[40] that compared the presence of latent MTrPs in subjects with chronic NP and chronic WAD (table 5). A significant difference was found for the left sternocleidomastoid, indicating that subjects with chronic NP had lower odds than those with WAD to display a latent MTrP on this muscle. For all other muscles, no significant differences were found regarding the presence of latent MTrPs between subjects with NP and those with WAD (see table 5).

There was low-quality evidence showing that pooled ORs for the presence of latent MTrPs on both sides of the upper trapezius and levator scapulae were not statistically different between subjects with chronic NP and healthy controls (fig 4). Reasons for downgrading evidence quality were low methodologic quality and small sample sizes. The same level of evidence was found for pooled ORs showing that subjects with chronic NP have significantly higher odds than healthy controls to have latent MTrPs on both sides of the sternocleidomastoid (see fig 4).

One study[40] of high methodologic quality found that subjects with chronic NP had significantly higher odds than healthy controls to have latent MTrPs on the masseter and temporalis muscles (see table 5). Muñoz-Muñoz et al[49] (low quality) did not find a significant difference for latent MTrPs on other muscles between subjects with chronic NP and healthy subjects (see table 5). All of these results were extracted from studies with small samples (see table 2).

Whiplash-associated disorder

One study[40] of high quality and 1 study[43] of low quality reported on the point prevalence of MTrPs in subjects with chronic WAD; another study[45] with low quality assessed subjects with acute WAD. The results of Ettlin et al[43] are not presented here because they made no distinction between active and latent MTrPs and the diagnosis of myofascial pain syndrome and MTrPs. Statistical pooling of the other 2 studies[40,45] was not feasible because of ample heterogeneity in the symptom duration of subjects with WAD (see table 2).

ORs with 95% CIs were calculated for the comparisons of active MTrPs in subjects with chronic WAD and chronic NP and the comparisons of latent MTrPs in subjects with acute WAD and healthy controls (table 6). The point prevalence of active MTrPs in subjects with WAD is also shown in table 6. Table 5 presents the ORs with 95% CIs for the study[40] that compared the presence of latent MTrPs between subjects with chronic NP and chronic WAD. Fernández-Pérez et al,[45] in a study of low quality and small sample size, showed significantly greater odds of displaying latent MTrPs on the right upper trapezius, right sternocleidomastoid, and right scalene in subjects with WAD than in healthy controls (see table 6).

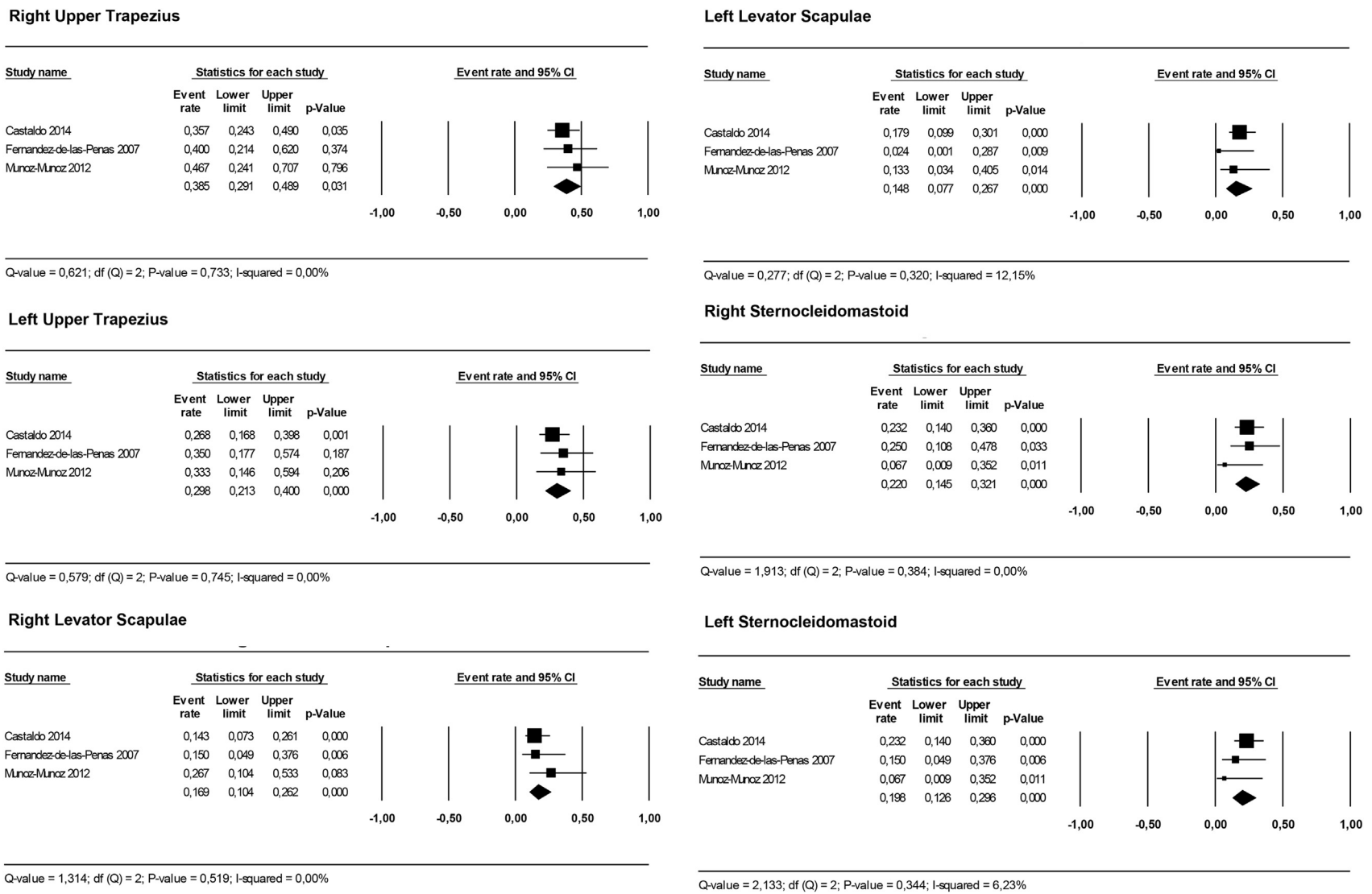

Fig 2 Meta-analyses on point prevalence of active MTrPs on the upper trapezius, levator scapulae, and sternocleidomastoid in subjects with chronic NP.

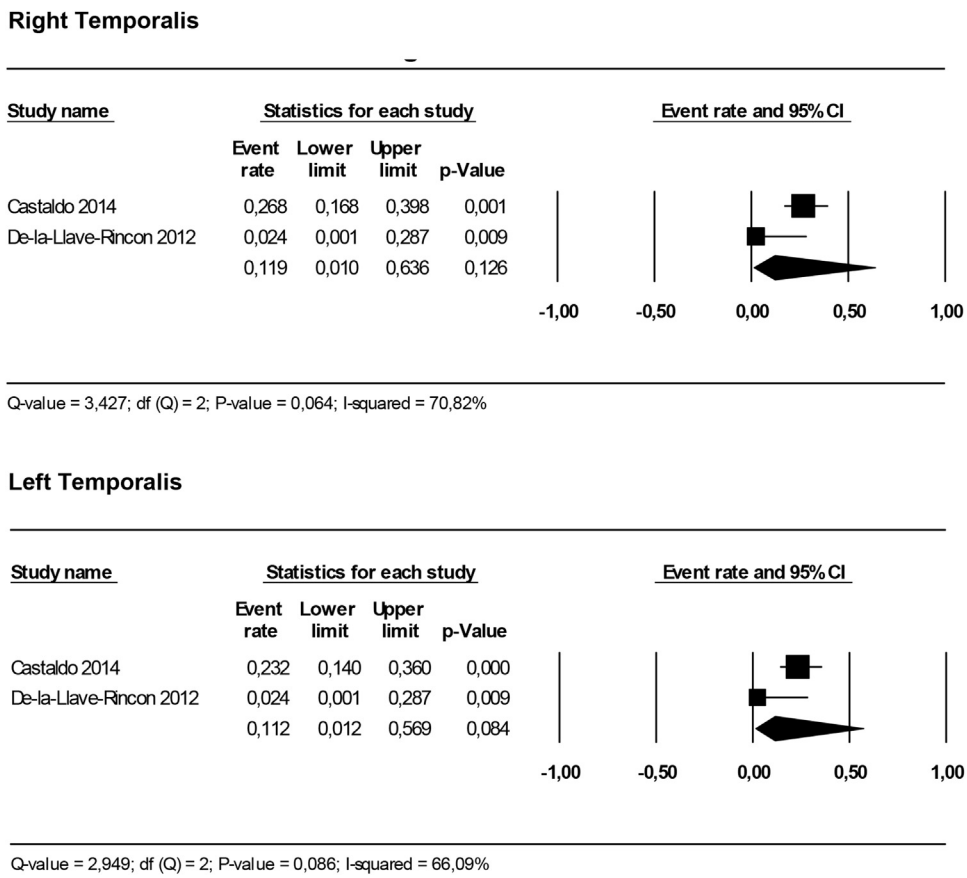

Fig 3 Meta-analyses on point prevalence of Active MTrPs on the temporalis muscle in subjects with chronic NP.

Cervicogenic headache

One study[48] with low methodologic quality reported on the prevalence of MTrPs in 11 subjects with cervicogenic headache. This study did not make a distinction between active and latent MTrPs, and it was not possible to extract this difference from the article because it was not clear whether symptom recognition was used for the diagnosis of MTrPs. For this reason, the results of this study are not presented here.

Cervical radiculopathy

Sari et al[51] reported on the prevalence of MTrPs in 244 subjects with CR compared with 122 healthy controls. This study was low quality and did not make a distinction between right/left or symptomatic/asymptomatic muscle sides. Point prevalences for active MTrPs were as follows: 51.2% on the total sample, 16.3% on the levator scapulae, 14.7% on the splenius capitis, 14.3% on the rhomboid minor, 13.5% on the upper trapezius, 10.2% on the rhomboid major, and 8.6% on the multifidus. No significant differences between subjects with CR and controls were found for latent MTrPs on the levator scapulae (OR = .80; 95% CI, .52−1.26), splenius capitis (OR = 1.02; 95% CI, .58−1.83), rhomboid minor (OR = 1.15; 95% CI, .69−1.92), upper trapezius (OR = .83; 95% CI, 0.55−1.25), and rhomboid major (OR = 1.37; 95% CI, 0.59−3.18). Subjects with CR displayed significantly lower odds than controls with latent MTrPs on the multifidus (OR = .48; 95% CI, .25−.91).

Nonspecific low back pain

Two studies[46,47] with low methodologic quality reported on the prevalence of MTrPs in subjects with NSLBP: one included only subjects with chronic NSLBP,[47] and the other included only acute and subacute NSLBP.[46] The results of the latter are not presented because a distinction between active and latent MTrPs could not be established from the diagnostic criteria used (see table 1). The point prevalences of active MTrPs from the study of Iglesias-González[47] in 42 subjects with chronic NSLBP are shown in table 7. No ORs were calculated for latent MTrPs in subjects with NSLBP and healthy controls because of the differences in assessing more/less painful or dominant/nondominant muscle sides. Overall, latent MTrPs tended to be more prevalent in subjects with chronic NSLBP than in healthy subjects (see table 7).

Lumbar disk herniation

Samuel[50] (low methodologic quality) assessed the point prevalence of active MTrPs in 60 subjects diagnosed with lumbar disk herniation. In this study, no distinction between right/left or symptomatic/asymptomatic muscle sides was made, and some criteria used in other studies for the diagnosis of active MTrPs were not used (see table 1). Point prevalences were as follows: 50.0% tibialis anterior, 67.7% extensor hallucis longus, 3.3% extensor digitorum longus, 81.7% gluteus maximus, 13.3%

Table 4 Point prevalence of active MTrPs in subjects with chronic NP

Muscle	Castaldo et al[40] (N = 56)	De-la-Llave Rincon et al[42] (N = 20)	Fernandez-de-las-Penas et al[44] (N = 20)	Muñoz-Muñoz et al[49] (N = 15)
Right suboccipitals	37.5		50.0*	
Left suboccipitals	35.7			
Right masseter		0.0		
Left masseter		0.0		
Right semispinalis capitis				6.7
Left semispinalis capitis				6.7
Right splenius capitis				6.7
Left splenius capitis				13.3
Right supraspinatus	12.5			
Left supraspinatus	7.1			
Right infraspinatus	10.7			
Left infraspinatus	10.7			
Right deltoid	14.3			
Left deltoid	7.1			
Right scalene				6.7
Left scalene				6.7

NOTE. Values are presented as percents.
* No distinction between right and left side of this muscle was made.

Table 5 ORs on the presence of latent MTrPs in subjects with chronic NP compared with subjects with chronic WAD and HC

Muscle	Castaldo et al[40] (NP: n = 56; WAD: n = 49)	De-la-Llave Rincon et al[42] (NP: n = 20; HC: n = 20)	Fernandez-de-las-Penas et al[44] (NP: n = 20; HC: n = 20)	Muñoz-Muñoz et al[49] (NP: n = 15; HC: n = 12)
	NP vs WAD	NP vs HC	NP vs HC	NP vs HC
Right suboccipitals	0.68 (0.28—1.66)		2.00 (0.52—7.72)*	
Left suboccipitals	0.62 (0.26—1.47)			
Right upper trapezius	1.13 (0.51—2.51)			
Left upper trapezius	0.57 (0.26—1.24)			
Right sternocleidomastoid	0.43 (0.17—1.11)			
Left sternocleidomastoid	0.33 (0.11—0.96)			
Right levator scapulae	0.49 (0.17—1.39)			
Left levator scapulae	0.37 (0.13—1.08)			
Right masseter		36.00 (5.80—223.55)		
Left masseter		17.00 (3.46—83.44)		
Right temporalis	1.40 (0.52—3.76)	32.11 (5.66—182.18)		
Left temporalis	1.09 (0.41—2.89)	32.11 (5.66—182.18)		
Right semispinalis capitis				0.81 (0.01—43.60)
Left semispinalis capitis				0.79 (0.04—14.03)
Right splenius capitis				0.81 (0.01—43.60)
Left splenius capitis				0.25 (0.01—6.64)
Right scalene				5.50 (0.55—55.50)
Left scalene				2.75 (0.25—30.51)
Right supraspinatus	0.66 (0.25—1.76)			
Left supraspinatus	1.19 (0.38—3.72)			
Right infraspinatus	0.41 (0.14—1.22)			
Left infraspinatus	0.59 (0.17—1.99)			
Right deltoid	0.38 (0.12—1.21)			
Left deltoid	0.62 (0.20—1.92)			

NOTE. Values are presented as OR (95% CI).
Abbreviation: HC, healthy controls.
* No distinction between right and left side of this muscle was made.

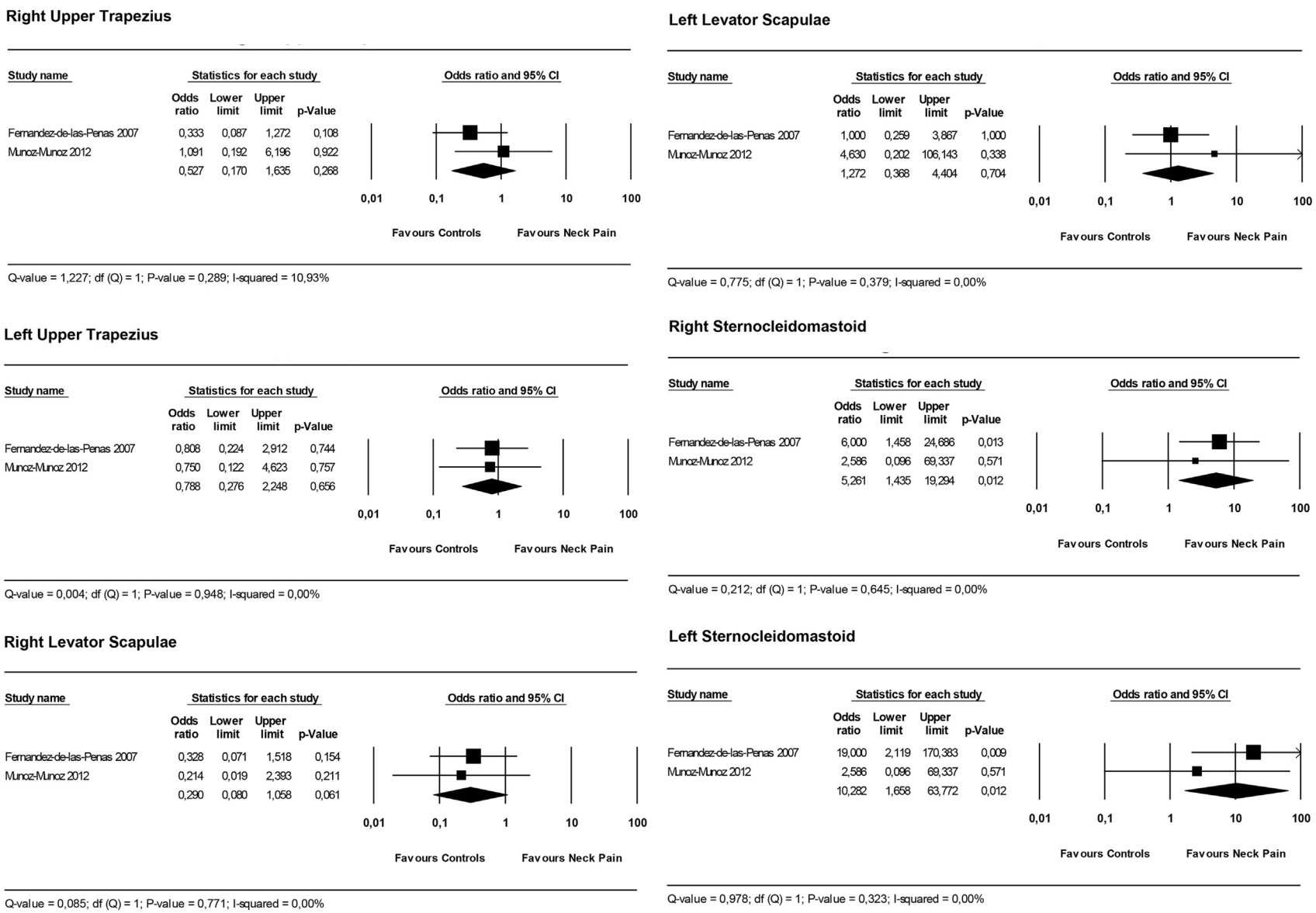

Fig 4 Meta-analyses of ORs for latent MTrPs on the upper trapezius, levator scapulae, and sternocleidomastoid in subjects with chronic NP and healthy controls.

Table 6 Prevalence of active MTrPs in subjects with WAD and ORs for latent MTrPs in subjects with WAD compared with HC

	Castaldo et al[40] (N=49)	Fernández-Pérez et al[45] (n=20)	Fernández-Pérez et al[45] (n=20 vs n=20)
Diagnosis	Chronic WAD vs NP	Acute WAD	Acute WAD vs HC
MTrPs assessed	Active MTrPs	Active MTrPs	Latent MTrPs
Right suboccipitals	2.07 (1.07–3.99)		
Left suboccipitals	1.60 (0.80–3.19)		
Right upper trapezius	2.11 (1.09–4.11)	35.0	6.00 (1.08–33.28)
Left upper trapezius	1.52 (0.70–3.30)	30.0	2.43 (0.51–11.51)
Right sternocleidomastoid	1.93 (0.88–4.24)	5.0	6.00 (1.46–24.69)
Left sternocleidomastoid	1.85 (0.84–4.07)	30.0	2.45 (0.64–9.39)
Right scalene		20.0	7.36 (1.34–40.55)
Left scalene		30.0	4.00 (0.98–16.27)
Right levator scapulae	2.14 (0.84–5.48)	65.0	0.53 (0.11–2.60)
Left levator scapulae	1.71 (0.71–4.16)	55.0	1.00 (0.21–4.71)
Right temporalis	1.83 (0.86–3.87)	10.0	4.75 (0.48–46.91)
Left temporalis	1.41 (0.62–3.21)	20.0	8.20 (0.40–169.91)
Right masseter		0.0	8.14 (0.88–75.48)
Left masseter		10.0	3.35 (0.32–35.37)
Right supraspinatus	2.45 (0.92–6.50)		
Left supraspinatus	4.00 (1.23–12.95)		
Right infraspinatus	3.43 (1.26–9.32)		
Left infraspinatus	3.24 (1.18–8.86)		
Right deltoid	2.00 (0.77–5.17)		
Left deltoid	4.29 (1.33–13.78)		

NOTE. Values are OR (95% CI), %, or as otherwise indicated.
Abbreviation: HC, healthy controls.

gluteus minimus, 48.3% hamstring, 80.0% gastrocnemius, and 1.7% quadriceps.

Mixed population of spinal disorders

One study[41] of low quality assessed the presence of MTrPs in a mixed sample of subjects with chronic spinal pain. In this study no distinction between active and latent MTrPs was made, and its results are not presented here.

Discussion

In this systematic review we aimed to synthesize the evidence on the prevalence of active and latent MTrPs in spinal disorders by including 12 cross-sectional studies assessing point prevalence in 6 different spinal pain disorders. Low-quality evidence was found for the pooled point prevalence of active MTrPs of different muscles in subjects with chronic NP. Point prevalences of active MTrPs in subjects with WAD and NSLBP were

Table 7 Point prevalence of active and latent MTrPs in subjects with NSLBP and healthy controls from De-la-Llave-Rincon et al[42]

	Active MTrPs	Latent MTrPs	Latent MTrPs
Group	Chronic NSLBP	Chronic NSLBP	Healthy Controls
Sample size	42	42	42
Quadratus lumborum > painful side*	54.8	14.3	0.0
Quadratus lumborum < painful side†	45.2	16.7	9.5
Iliocostalis lumborum > painful side*	38.1	19.0	0.0
Iliocostalis lumborum < painful side†	33.3	19.0	4.8
Psoas > painful side*	9.5	26.2	19.0
Psoas < painful side†	4.8	35.7	26.2
Piriformis > painful side*	35.7	21.4	0.0
Piriformis < painful side†	28.6	35.7	7.1
Gluteus minimus > painful side*	11.9	7.1	11.9
Gluteus minimus < painful side†	4.8	11.9	9.6
Gluteus medius > painful side*	35.7	11.9	4.8
Gluteus medius < painful side†	38.1	16.7	4.8

NOTE. Values are percentages.
* Dominant side for healthy controls.
† Nondominant side for healthy controls.

extracted from single studies that had low quality and/or very small samples. In 1 study of high methodologic quality,[40] no significant differences were found in the prevalence of latent MTrPs between subjects with chronic NP and those with chronic WAD. There was low-quality evidence that subjects with chronic NP had higher odds than healthy controls to display latent MTrPs on the sternocleidomastoid, but not on upper trapezius and levator scapulae. Small sample sizes and/or low methodologic quality were a constant characteristic of the findings on latent MTrPs taken from individual studies on different spinal disorders (ie, NP, WAD, NSLBP, CR). Future studies of high methodologic quality and with larger samples are very likely to substantially change the point prevalence estimates of MTrPs presented here.

Of the 12 studies included in this review, 10 studies[41,43-51] had low methodologic quality (see table 3). Several items were not met by any study, and this emphasizes that future studies on the prevalence of MTrPs in spinal disorders should attempt to meet these criteria. For example, a lack of information on the sampling method used to recruit subjects from the source population, and on the proportion of those recruited agreeing to participate, might strongly limit the generalizability of findings. Information regarding the recruitment of subjects and controls from the same source population should also be reported because a failure to do so might hinder the assessment of selection bias in these studies. The measurement properties of active and latent MTrPs diagnostic criteria were not presented in any of the studies. This lack is even more important if we consider that 2 systematic reviews[52,53] reported limited reliability for MTrPs criteria. However, in line with more recent individual studies,[54,55] these reviews also highlighted that reliability was strongly dependent on the selected muscles and on other variables (eg, examiners' training and experience). Detailed reference to this information should be provided in future studies because this would confirm that researchers are at least aware of this potential limitation of MTrPs assessment.

Future studies comparing the prevalence of latent MTrPs in 2 distinct groups should calculate their sample size beforehand to reduce the chances of finding false significant results as a result of poor statistical power (ie, type I error). Another crucial aspect that should be better addressed by future studies is the reporting of potential key confounders when comparing the prevalence of MTrPs in 2 distinct groups of subjects. In fact, patients' morphologic features or impairments of the nociceptive system may limit the applicability of the diagnostic criteria for MTrPs. Detection of the taut band can be difficult in subjects with a high body mass index because of the presence of subcutaneous fat. Moreover, criteria based on pain provocation (ie, spot tenderness, pain recognition, referred pain) may be affected by general hypersensitivity or the presence of comorbid conditions that may alter the perception or reporting of pain (ie, depression, somatization).[56]

In 4 studies,[41,43,46,48] a clear distinction between active and latent MTrPs was not made, making it difficult to extract meaningful data from these studies. The distinction between active and latent MTrPs, initially made for clinical purposes by experts in the field,[10] has been supported by studies showing that the 2 phases/stages of MTrPs present different histochemical findings.[11,12] Two other studies[50,51] did not present the assessment of MTrPs on each side of each muscle (or did not distinguish between painful sides), making the interpretation of the results more difficult. This variability in the diagnostic criteria for MTrPs is not new[57] and can strongly hinder the synthesis of data from different studies. Such variability is probably the result of lack of data on the criterion validity of MTrPs diagnostic criteria because of the absence of a feasible and accepted reference standard to estimate indices (eg, sensitivity, specificity). In this regard, a future study might focus on reaching an international and multidisciplinary consensus on the diagnostic criteria for MTrPs (eg, Delphi survey), with the goal of standardizing their assessment in clinical practice and research. Overall, good quality studies of the reliability of different sets of criteria are needed to further strengthen or weaken the findings of the available literature.[52-55,57]

Pooled estimates of the point prevalence of active MTrPs in subjects with chronic NP on the upper trapezius, levator scapulae, sternocleidomastoid, and temporalis showed that the highest prevalence was on the upper trapezius (see figs 2 and 3). Despite low-quality evidence, these estimates may be to some extent accurate if we consider the high prevalence of NP and shoulder pain in both the working and general population.[58,59] These painful syndromes are common among office workers, and upper trapezius myalgia is the most frequent neck complaint in occupational groups.[60-62] Results from single studies showed the highest point prevalence for active MTrPs on the suboccipital muscles (see table 4), but all estimates were extracted from studies with very small samples. The significant difference in the prevalence of latent MTrPs on the left sternocleidomastoid between subjects with chronic WAD and chronic NP can be considered a spurious finding, considering that no differences were found for all other muscles and that this study included a small sample.[40] Future studies with larger samples are needed to confirm or refute this peculiar finding for the left sternocleidomastoid. The same applies for meta-analyses or results of individual studies comparing the prevalence of latent MTrPs in subjects with NP and healthy controls (see fig 4 and table 5) because these were extracted from very small samples. Future observational studies should adopt large sample sizes and have a higher methodologic quality to provide more precise estimates of the point prevalence of both active and latent MTrPs in subjects with NP.

Castaldo et al[40] showed that active MTrPs appear to have a higher point prevalence in subjects with chronic WAD than in those with chronic NP (see table 6). If the presence of MTrPs is considered a possible indicator of central sensitization,[13,14] these results could be explained by the enhanced degree of central sensitization of subjects with WAD compared with those with NP.[18,28,63] However, more studies are needed to confirm or reject the findings obtained from the relatively small sample of this study. The same consideration applies to the study of Fernández-Pérez,[45] in which latent MTrPs were compared between subjects with acute WAD and healthy controls; although some differences between groups were found (see table 6), more studies with larger samples are clearly needed.

Several health care providers recognize the clinical relevance of the MTrP concept; however, the validity of this concept is discussed in the scientific community, and controversies still exist.[64-66] To add to this, the aforementioned methodologic limitations of existing studies on spinal disorders strongly influence their findings. For this reason, the apparent and constant presence of the MTrP phenomenon in different spinal disorders emerging from this review (see figs 2–4 and tables 4–7) should be considered with caution at this stage.

All of the elements described here highlight the need to establish the relevance of MTrPs for clinical practice. Nevertheless, we do not know whether MTrPs should be considered an epiphenomenon of the painful conditions or a relevant comorbidity. Clinical guidelines for spinal disorders do not usually consider either MTrP evaluation or MTrP treatment. To improve rehabilitation for spinal disorders, it may be important to establish whether MTrP treatment should be taken into account or not; more specifically, it appears crucial to strengthen the construct validity of the MTrP diagnosis and to reach a consensus on a set of MTrP diagnostic procedures.

Study limitations

We acknowledge as a limitation of this systematic review that the reviewer (A.C.), who was an author of an eligible study, although he was excluded from the quality assessment of that particular study, could have influenced the assessment of the other studies. However, given the circumstances, it was not practical for this review to find a different reviewer from the author originally designed for quality assessment of all of the studies. It should also be considered that the approach of excluding a reviewer only from rating his own study is not new in the literature, and it has been adopted also in Cochrane Reviews on the effectiveness of health interventions.[67,68]

Conclusions

This systematic review shows that active and latent MTrPs can be present in different spinal disorders (eg, NP, WAD, NSLBP). However, these findings are at best underpinned by pooled estimates of point prevalence that are based on low-quality evidence, according to the Grading of Recommendations Assessment, Development and Evaluation approach. Most of the estimates for both active and latent MTrPs are based on individual studies with very small sample sizes and low methodologic quality. Future studies with large samples and high methodologic quality are needed to provide more reliable and precise estimates on the point prevalence of MTrPs in spinal disorders. Moreover, to facilitate comparison of findings and data pooling, there is an urgent need to standardize the assessment of MTrPs across clinical studies.

Suppliers

a. EndNote; Thomson Reuters.
b. Comprehensive Meta-Analysis 2.0; Biostat.

Keywords

Low back pain; Neck pain; Prevalence; Rehabilitation; Trigger points; Whiplash injuries

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Appendix 1 Presence of MTrPs in Different Spinal Health Conditions: Protocol for a Systematic Review

Spinal musculoskeletal disorders are the most common cause of years lived with disability in people from all around the world. More specifically, among the major causes of years lived with disability, LBP and NP ranked first and fourth, respectively. In addition, the same pathologies ranked third and eleventh regarding disability-adjusted life years. Most of these disorders can also be grouped and defined as spinal pain disorders (SPDs) considering that their most common symptom is pain.

One of the most common causes of pain in the musculoskeletal system is considered to be MTrPs. They are defined as hypersensitive spots within a taut band of a skeletal muscle that are painful on compression or stretching and that can evoke a referred pain distant from the spot. From a clinical perspective, MTrPs can be divided into active or latent. Active MTrPs can reproduce local and referred pain that is recognized as familiar by the patient because it corresponds to his or her usual symptoms. Latent MTrPs can reproduce local and referred pain, but this is not correspondent to the patient's usual symptoms. The clinical distinction between active and latent MTrPs is supported by histochemical findings showing that active MTrPs contain higher levels of algogenic substances and chemical mediators (eg, bradykinin, substance P, serotonin) than latent and body areas without MTrPs. Moreover, MTrPs can be morphologically distinguished from muscle portions without them, through the use of ultrasound imaging techniques.

Active MTrPs have been found to be the one of the sources of pain in subjects with different musculoskeletal disorders presenting to different clinical settings. Nevertheless, latent MTrPs can also contribute to musculoskeletal signs or symptoms (eg, abnormal motor recruitment, muscle imbalance, muscle weakness, fatigability). Both active and latent MTrPs can be involved in sensitization processes associated with the central nervous system that are a feature of several musculoskeletal health conditions.

The clinical diagnosis of myofascial pain syndrome is often adopted when active MTrPs are present in a patient. However, in recent years, the presence of MTrPs has been investigated in subjects with different SPDs (eg, NP, WAD, LBP). To our knowledge, to date, no studies have summarized all the available evidence for the presence of active and latent MTrPs in different SPDs.

The purpose of this study is to perform a systematic review of the literature to synthesize the evidence regarding the presence of active and latent MTrPs in subjects with different SPDs labeled by different medical diagnoses. In addition, we aimed to compare the presence of MTrPs between those subjects with a medical diagnosis and those without any diagnosis (ie, healthy subjects). This work could provide valuable information regarding the prevalence of MTrPs for different muscles in different SPDs, providing a clear overview of the existent scientific literature.

Methods Protocol

Inclusion criteria

Inclusion criteria for the studies will be as follows: observational design with at least 1 group of subjects with an SPD; investigation of adult subjects who are men and women (ie, age $\geq$18y); trigger points manually assessed in at least 1 specific muscle (eg, upper trapezius, infraspinatus); and full-text article written in English, Italian, French, or Spanish. Articles published in other languages will be included only if an English version of the article is available. All medical diagnosis representing different SPDs will be included in this review. Case reports will be excluded.

Retrieval of studies

A comprehensive systematic search will be conducted in January 2014 in the following bibliographic databases: PubMed, Embase, and CINAHL. An additional search will be conducted in the engine Google Scholar. Search terms in the databases will include controlled terms (ie, Medical Subject Headings in PubMed, Emtree in Embase, Subject Headings in CINAHL) and free-text terms. Only free-text terms will be used in Google Scholar. The search strategy will follow the same structure of terms in all databases, combining terms expressing musculoskeletal disorders and MTrPs with the Boolean operator "AND". Complete search strategies for all databases will be provided.

Titles and abstracts of the resulting studies from each database will be screened by 2 reviewers independently to assess for their potential eligibility. In this phase, the first 200 titles resulting from Google Scholar will be assessed. After elimination of duplicates among databases, full texts of potentially eligible studies will be retrieved and checked for inclusion in this review by the 2 reviewers independently. In case of controversies between reviewers regarding eligibility of titles/abstracts or full-texts, an agreement will be found through a consensus meeting.

Citation tracking of included studies will be conducted by 1 reviewer in Web of Science to identify other potentially eligible studies. With the same goal, hand searching of the reference lists of included studies will also be conducted by 1 reviewer. When other potentially eligible studies are detected, both reviewers will check for the correspondence with the inclusion criteria. At the end of this process, experts in the field will be contacted through e-mail and provided with the list of include studies to evaluate if relevant studies are missed and if they are aware of other nonpublished studies on the topic.

Methodologic quality assessment

The methodologic quality of the studies will be assessed by 2 reviewers independently, and when disagreement cannot be solved in a discussion meeting, a third reviewer will be contacted. A 16-item checklist was drawn specifically for this review, modifying a 27-item existing version. From the original version, items 4, 8, 9, 13, 14, 17, 19, 23, 24, 25, and 26 will be excluded because of incompatibility with the type of studies included in this review.

We acknowledge that several tools for assessing the methodologic quality of observational studies have been used in the literature and that there is no consensus regarding the optimal tool. A cutoff of 50% of met items will be used to define a study as low or high methodologic quality. The results of quality assessment will also be presented in a table for all the criteria of included studies to allow a more qualitative interpretation of the findings.

Data extraction

Data for each study will be extracted by 1 reviewer using a form that will include information regarding study design, health condition under assessment, population characteristics, methods of assessment of MTrPs, clinical expertise of assessing clinicians, type of MTrPs assessed (ie, active, latent), and muscles assessed for the presence of MTrPs. From each study the number of patients and/or healthy subjects with latent and/or active MTrPs on each side (ie, left, right) of each muscle will be extracted by 1 reviewer. A second reviewer will check for the accuracy of the extracted numbers.

Statistical analysis

Meta-analyses will be performed when at least 2 studies assessing the presence of MTrPs on the same muscle for the same SPD will be included. Clinical homogeneity regarding included SPDs, MTrPs methods of assessment, type of MTrPs, and assessed muscles will be evaluated before pooling. Two primary analyses will be conducted. A first analysis will allow to obtain an optimal estimation of the prevalence of active MTrPs in each side of each muscle of subjects with SPDs. This analysis will be performed by transforming proportions into logits because these are preferred over mean proportions that tend to underestimate the size of the CI and overestimate the degree of heterogeneity across effect sizes. For ease of interpretation, all final results will be backconverted into pooled proportions. Random effect models will be used in light of expected heterogeneity between studies. To examine the heterogeneity of the effect size distribution, the Q statistic will be used, and the I^2 will be used to estimate the amount of heterogeneity. A second analysis will be carried out with data from individual studies that also included healthy subjects, and it will be used to calculate ORs to compare the prevalence of latent MTrPs in each side of each muscle between patients with an SPD and healthy controls and/or between patients with an SPD and patients with another SPD. Random effect models, Q statistic, and I^2 will also be used in these meta-analyses.

Evidence synthesis

The Grading of Recommendations Assessment, Development and Evaluation approach, as recommended by the Cochrane Handbook for Systematic Reviews of Interventions and as implemented by the Cochrane Back Review Group, will be adopted to rate the body of evidence of each meta-analysis. Low methodologic quality, inconsistency of results, indirectness, imprecision, and publication bias will be assessed to determine if the evidence body should be downgraded. The overall quality of the evidence will be scored as high, moderate, low, or very low, depending on how many of the aforementioned factors will be present to downgrade the evidence. A qualitative description will be provided for the results of the studies not included in the meta-analyses.

Appendix 2 Queries for the Bibliographic Databases

PubMed

1#	"disease"[MeSH Terms] OR disease[All Fields] OR disorder[All Fields] OR condition[All Fields] OR "musculoskeletal diseases"[MeSH Terms]
2#	"Trigger Points"[Mesh Terms] OR trigger point[Text Word]
3#	1# AND 2#

Embase

1#	'diseases'/exp AND [embase]/lim
2#	'trigger point'/exp AND [embase]/lim
3#	1# AND 2#

CINAHL

1#	(MH "Musculoskeletal Diseases+" OR MH "Disease+")
2#	(MH "Trigger Point" OR trigger point)
3#	1# AND 2#

Appendix 3 Checklist for Assessing Study Quality, Modified From Downs and Black[25,*,†]

Reporting

1. Is the hypothesis/aim/objective of the study clearly described?

YES 1
NO 0

2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?

If the main outcomes are first mentioned in the Results section, the question should be answered no.

YES 1
NO 0

3. Are the characteristics of the patients included in the study clearly described?

In cohort studies and trials, inclusion and/or exclusion criteria should be given. In case-control studies, a case definition and the source for controls should be given.

YES 1
NO 0

4. Are the distributions of principal confounders in each group of subjects to be compared clearly described?

A list of principal confounders is provided. Possible confounding variables include age, sex, duration of pain, and severity of pain.

YES 1
NO or ONLY PARTIALLY 0

5. Are the main findings of the study clearly described?

Simple outcome data (including denominators and numerators) should be reported for all major findings so that the reader can check the major analyses and conclusions. (This question does not cover statistical tests which are subsequently considered.)

YES 1
NO 0

6. Does the study provide estimates of the random variability in the data for the main outcomes?

In nonnormally distributed data the interquartile range of results should be reported. In normally distributed data the SE, SD, or CIs should be reported. If the distribution of the data is not described, it must be assumed that the estimates used were appropriate and the question should be answered yes.

YES 1
NO 0

7. Have actual probability values been reported (eg, .035 rather than <.05) for the main outcomes except where the probability value is <.001?

YES 1
NO 0

External validity

All the following criteria attempt to address the representativeness of the findings of the study and whether they may be generalized to the population from which the study subjects were derived.

8. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?

The study must identify the source population for patients and describe how the patients were selected. Patients would be representative if they comprised the entire source population, an unselected sample of consecutive patients, or a random sample. Random sampling is only feasible where a list of all members of the relevant population exists. Where a study does not report the proportion of the source population from which the patients are derived, the question should be answered as unable to determine.

YES 1
NO 0
UNABLE TO DETERMINE 0

9. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?

* Original items 4, 8, 13, 14, 17, 19, 23, 24, and 25 were removed; item 27 was modified.
† Original items on losses to follow-up (9 and 26) were removed after selection of eligible studies (all cross-sectional).

The proportion of those asked who agreed should be stated. Validation that the sample was representative would include demonstrating that the distribution of the main confounding factors was the same in the study sample and the source population.

YES 1
NO 0
UNABLE TO DETERMINE 0

Internal validity: bias

10. Was an attempt made to blind those measuring the main outcomes of the intervention?

YES 1
NO 0
UNABLE TO DETERMINE 0

11. If any of the results of the study were based on data dredging, was this made clear?

Any analyses that had not been planned at the outset of the study should be clearly indicated. If no retrospective unplanned subgroup analyses were reported, then answer yes.

YES 1
NO 0
UNABLE TO DETERMINE 0

12. Were the statistical tests used to assess the main outcomes appropriate?

The statistical techniques used must be appropriate to the data. For example, nonparametric methods should be used for small sample sizes. Where little statistical analysis has been undertaken but where there is no evidence of bias, the question should be answered yes. If the distribution of the data (normative or not) is not described, it must be assumed that the estimates used were appropriate, and the question should be answered yes.

YES 1
NO 0
UNABLE TO DETERMINE 0

13. Were the main outcome measures used accurate (valid and reliable)?For studies where the outcome measures are clearly described, the question should be answered yes. For studies which refer to other work or that demonstrates the outcome measures are accurate, the question should be answered as yes.

YES 1
NO 0
UNABLE TO DETERMINE 0

Internal validity: confounding (selection bias)

14. Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?

For example, patients for all comparison groups should be selected from the same hospital. The question should be answered unable to determine for cohort and case-control studies where there is no information concerning the source of patients included in the study.

YES 1
NO 0
UNABLE TO DETERMINE 0

15. Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?

For a study which does not specify the time period over which patients were recruited, the question should be answered as unable to determine.

YES 1
NO 0
UNABLE TO DETERMINE 0

Power

16. Was the sample size calculation done a priori?

YES 1
NO 0
UNABLE TO DETERMINE 0

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