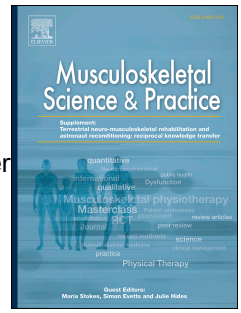
Accepted Manuscript



Evolution of the methodological quality of controlled clinical trials for myofascial trigger point treatments for the period 1978–2015: A systematic review

Rahel Stoop, Ron Clijsen, Diego Leoni, Emiliano Soldini, Greta Castellini, Valentina Redaelli, Marco Barbero

PII: S2468-7812(17)30072-3

DOI: 10.1016/j.msksp.2017.04.009

Reference: MSKSP 79

To appear in: *Musculoskeletal Science and Practice*

Received Date: 20 January 2017

Revised Date: 28 March 2017

Accepted Date: 17 April 2017

Please cite this article as: Stoop, R., Clijsen, R., Leoni, D., Soldini, E., Castellini, G., Redaelli, V., Barbero, M., Evolution of the methodological quality of controlled clinical trials for myofascial trigger point treatments for the period 1978–2015: A systematic review, *Musculoskeletal Science and Practice* (2017), doi: 10.1016/j.msksp.2017.04.009.

Title

Evolution of the methodological quality of controlled clinical trials for myofascial trigger point treatments for the period 1978-2015: a systematic review.

Author names and affiliations

Rahel Stoop[a], Ron Clijsen[a,b,c], Diego Leoni[a], Emiliano Soldini[a], Greta Castellini[d,e], Valentina Redaelli[f], Marco Barbero[a]

[a]Rehabilitation Research Laboratory 2rLab, Department of Business Economics, Health and Social Care, University of Applied Sciences and Arts of Southern Switzerland, Landquart/Manno, Switzerland;
[b]University College Physiotherapy "Thim van der Laan", Landquart, Switzerland;
[c]Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Brussels, Belgium;
[d]Department of Biomedical Sciences for Health, University of Milan, Milan, Italy;
[e]Unit of Clinical Epidemiology, I.R.C.C.S. Orthopedic Institute Galeazzi, Milan, Italy;
[f]Neurorehabilitative department of Casa di Cura Privata del Policlinico, Milan, Italy

Corresponding author

Rahel Stoop

Department of Business Economics, Health and Social Care

University of Applied Sciences and Arts of Southern Switzerland

Switzerland

Phone: +41813000175

Email: rahel.stoop@supsi.ch

ABSTRACT

Background: The methodological quality of controlled clinical trials (CCTs) of physiotherapeutic treatment modalities for myofascial trigger points (MTrP) has not been investigated yet.

Objectives: To detect the methodological quality of CCTs for physiotherapy treatments of MTrPs and demonstrating the possible increase over time.

Design: Systematic review.

Methods: A systematic search was conducted in two databases, Physiotherapy Evidence Database (PEDro) and Medicine Medical Literature Analysis and Retrieval System online (MEDLINE), using the same keywords and selection procedure corresponding to pre-defined inclusion criteria. The methodological quality, assessed by the 11-item PEDro scale, served as outcome measure. The CCTs had to compare at least two interventions, where one intervention had to lay within the scope of physiotherapy. Participants had to be diagnosed with myofascial pain syndrome or trigger points (active or latent).

Results: A total of n = 230 studies was analysed. The cervico-thoracic region was the most frequently treated body part (n = 143). Electrophysical agent applications was the most frequent intervention. The average methodological quality reached 5.5 on the PEDro scale. A total of n = 6 studies scored the value of 9. The average PEDro score increased by 0.7 points per decade between 1978-2015.

Conclusions: The average PEDro score of CCTs for MTrP treatments does not reach the cut-off of 6 proposed for moderate to high methodological quality. Nevertheless, a promising trend towards an increase of the average methodological quality of CCTs for

MTrPs was recorded. More high-quality CCT studies with thorough research procedures are recommended to enhance methodological quality.

Keywords: Methodological quality, Myofascial pain, Myofascial pain syndrome, Myofascial trigger points, Trigger points

Title

Evolution of the methodological quality of controlled clinical trials for myofascial trigger point treatments for the period 1978-2015: a systematic review.

ABSTRACT

Background: The methodological quality of controlled clinical trials (CCTs) of physiotherapeutic treatment modalities for myofascial trigger points (MTrP) has not been investigated yet.

Objectives: To detect the methodological quality of CCTs for physiotherapy treatments of MTrPs and demonstrating the possible increase over time.

Design: Systematic review.

Methods: A systematic search was conducted in two databases, Physiotherapy Evidence Database (PEDro) and Medicine Medical Literature Analysis and Retrieval System online (MEDLINE), using the same keywords and selection procedure corresponding to pre-defined inclusion criteria. The methodological quality, assessed by the 11-item PEDro scale, served as outcome measure. The CCTs had to compare at least two interventions, where one intervention had to lay within the scope of physiotherapy. Participants had to be diagnosed with myofascial pain syndrome or trigger points (active or latent).

Results: A total of n = 230 studies was analysed. The cervico-thoracic region was the most frequently treated body part (n = 143). Electrophysical agent applications was the most frequent intervention. The average methodological quality reached 5.5 on the PEDro scale. A total of n = 6 studies scored the value of 9. The average PEDro score increased by 0.7 points per decade between 1978-2015.

Conclusions: The average PEDro score of CCTs for MTrP treatments does not reach the cut-off of 6 proposed for moderate to high methodological quality. Nevertheless, a promising trend towards an increase of the average methodological quality of CCTs for

MTrPs was recorded. More high-quality CCT studies with thorough research procedures are recommended to enhance methodological quality.

Keywords: Methodological quality, Myofascial pain, Myofascial pain syndrome, Myofascial trigger points, Trigger points

INTRODUCTION

In 1983 Travell and Simons defined myofascial pain syndrome as a regional pain characterized by the presence of one or more active myofascial trigger points (MTrPs). An active MTrP is a distinctive clinical characteristic of this painful syndrome and is specified as a hyperirritable palpable nodule contained in the skeletal muscle fibres. It can produce referred pain, either on digital compression or spontaneously (Travell and Simons, 1983). MTrPs can be classified as active or latent. A latent MTrP does not cause spontaneous pain but may restrict movement (Trampas et al., 2010; Aguilera et al., 2009) or cause muscle weakness (Ge et al., 2012). Conversely, an active trigger point is frequently responsible for the presenting complaint. Despite the criticisms regarding MTrP theory (Quintner et al., 2014; Cohen and Quinter, 2008) and the poor reliability of MTrP manual palpation procedures (Lucas et al., 2009; Myburgh et al., 2008) many health professionals are currently educated in the treatment of myofascial pain syndrome (MPS) and the MPS diagnosis is accepted by the International Association for the Study of Pain (Harden et al., 2000).

Over the past few decades, a considerable number of studies on efficacy of invasive and non-invasive interventions for myofascial pain syndrome have been conducted. Moreover, several systematic reviews on MTrP treatments have been completed, especially for dry needling (Cagnie et al., 2015). A risk of bias analysis revealed some concerns for the RCTs of the above mentioned systematic reviews. The methodological flaws addressed by the authors prompted caution in the interpretation of the results and highlighted the need for high-quality MTrP clinical studies. According to Moseley et al. (2011) a total PEDro score of at least 7 (in the case of self-reported outcomes) or 8 (in the case of outcomes measured by a blinded assessor) out of 10 points is desirable for

all clinical trials for physiotherapy interventions (Moseley et al., 2011). Further, they observed an increase in the methodological quality of randomized controlled trials for physiotherapy interventions over the last decades, with an increasing total PEDro score of about 0.6 points in each decade (Moseley et al., 2011). To the authors knowledge, no comprehensive investigation has appraised the methodological quality of CCTs for MTrP treatments within the scope of physiotherapy.

Therefore, the research questions of the present systematic review were:

1. What is the methodological quality of CCTs for physiotherapy treatments directed towards MTrPs?
2. Does the reported methodological quality of CCTs for physiotherapy treatments directed towards MTrPs increase over time?

METHODS

Search strategy and study selection

Two separate electronic systematic literature searches were performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA statement) (Knobloch et al., 2011). The first search was executed on the PEDro database on January 31th, 2016, followed by a second search on the MEDLINE database (PubMed) on February 10th, 2016. The listed keywords were used, attributing to the PubMed MeSH database, and were combined with the Boolean formula "OR"/"AND": myofascial pain, myofascial pain syndrome, myofascial trigger point, myofascial trigger points, trigger point, trigger points (see Appendix A). A pre-defined search strategy suitable for both search engines was developed to identify published CCTs meeting the inclusion criteria reported in Box 1.

Box 1. Inclusion criteria

Title and Abstract
- English language

Full paper
- Published in peer-reviewed journal

Participants
- Confirmed diagnosis of myofascial pain syndrome or trigger point (active or latent)

Interventions
- Comparison of at least two interventions including no-treatment or sham-treatment
- At least one intervention within the scope of physiotherapy

Allocation
- Random or intended-to-random

A few additional adaptations were made for the MEDLINE database search strategy with the addition of the filters "RCT's", "clinical trials", "English language", "humans" and "full text". Three researchers (DL, RS, RC) independently screened the title and the abstract of the retrieved studies for their eligibility. Cases of disagreement were

resolved in a consensus meeting with a forth researcher (MB). The flow chart of the study selection is represented in Figure 1.

*insert Figure 1 somewhere here, 2-column fitting image

Data extraction

Data extraction from the included studies was performed independently by three authors (DL, RS, RC). Hits identified with the PEDro search queries (see Appendix A) were selected and emailed to the authors (DL and MB) using the email service of the PEDro website. Following this, each email was saved as text file and copied onto a spreadsheet using a custom software able to identify the following variables: article title, journal name, year of publication, ratings for each of the 11-items of the PEDro scale, and total PEDro score. A similar procedure was applied for the records identified with the PubMed search. The retrieved records were downloaded and converted into an excel spreadsheet (RS), the variables were set. Duplicates were removed by using filters. The rating of each of the 11-items of the PEDro scale was manually performed. The stratification was done identically as described above. Additional subcategories were applied as shown in Box 2. Further item details are explained in Appendix B.

Box 2. Data extraction

Year of publication

Regions of treatment

- Lumbo-pelvic region
- Cervico-thoracic region
- Lower limb
- Upper limb
- Cranio-mandibular region
- Not specified

Interventions

- Electrophysical therapies
- Manual therapies
- Active exercise
- Stretching
- Acupuncture
- Injections
- Dry needling
- Relaxation techniques
- Biofeedback
- Counselling/education
- Oral drugs
- Splint/odontoiatric therapy
- Taping
- Others
- Presence of placebo group or sham treatment

PEDro score and items

Assessment of reported methodological quality

For assessing the methodological quality as an outcome, the PEDro score was considered by employing the PEDro scale (see Box 3). For further detail on the PEDro scoring system and procedure see Appendix C. In the event that the PEDro score was not available, two researchers (RS, RC) calculated the total PEDro value by using the above presented PEDro 11-item scale. Cases of disagreement were solved in a consensus meeting with a third researcher (MB), who served as a PEDro rater.

Box 3. The PEDro 11-item scale (from PEDro database, www.pedro.org.au)

1.	eligibility criteria were specified	no	yes	where:
2.	subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	no	yes	where:
3.	allocation was concealed	no	yes	where:
4.	the groups were similar at baseline regarding the most important prognostic indicators	no	yes	where:
5.	there was blinding of all subjects	no	yes	where:
6.	there was blinding of all therapists who administered the therapy	no	yes	where:
7.	there was blinding of all assessors who measured at least one key outcome	no	yes	where:
8.	measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	no	yes	where:
9.	all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	no	yes	where:
10.	the results of between-group statistical comparisons are reported for at least one key outcome	no	yes	where:
11.	the study provides both point measures and measures of variability for at least one key outcome	no	yes	where:

Olivo et al. (2008) reported that the PEDro 11-item scale appears to be a promising tool to assess the methodological quality of physical therapy trials (Olivo et al., 2008). The PEDro scale has been described as valid and reliable (Yamato et al., 2016) in the investigation of internal validity of RCTs (Bhogal et al., 2005) and shows sufficient reliability for use in systematic reviews of physical therapy RCTs (Maher et al., 2003). Each item which meets the criteria (except for item 1 illustrating external validity) contributes one point to the total PEDro score (10 points maximum) and is ranked hierarchically without redundancy (de Morton, 2009).

Statistical analysis

All data were analyzed using the statistical software Stata version 14.1 (StataCorp LP, Texas, USA). Descriptive statistics were applied to summarize the data extracted from the CCTs. The relationship between the cumulative number of CCTs and the year of publication was illustrated using a line chart. Bar charts were designed to show: (1) the relative frequency of body regions where the MTrP treatments were directed, (2) the relative frequency of the proposed interventions, (3) the distribution of the total PEDro scores for the selected clinical trials, (4) the percentage of clinical trials using physiotherapy treatment for MTrPs that met the criteria for each item on the PEDro scale.

A bubble plot of the total PEDro score versus time (i.e. year of publication) was used to describe the evolution of the quality of the studies over time. The diameter of the bubble was proportional to the square root of the number of trials with the same PEDro total score for each year. A linear regression model was applied to assess the relationship between the total PEDro score (i.e. the dependent variable) and time (i.e. the independent variable). The time variable was a continuous measure of the time, in years, starting from 1978 (i.e. the reference year, which is also the first available reference point). To ensure robustness of the estimates, standard errors were adjusted employing the Huber-White sandwich method (White, 1980).

RESULTS

A total of n = 230 studies were included in the final analysis, of which n = 222 (96%) studies were found by the PEDro search. The MEDLINE database search revealed n = 8 studies matching the selection criteria which were not indexed in the PEDro database.

Distribution of scientific literature

The CCT time distribution ranged from the years 1978 to 2015. Until the year 2002 not more than n = 1 to 7 studies per year were published in peer-reviewed journals. Over the last decades, the number of published studies on the topic has increased with a peak of n = 23 studies in 2010. Out of all analysed studies, n = 219 (95%) received a PEDro score for the allocated item, whereas n = 11 (4.8%) were rated as CCTs due to the usage of quasi-random allocation.

Relative frequency of body region MTrPs localisation

The most frequently treated body region was the cervico-thoracic area with 62% followed by the cranio-mandibular region (22%). The frequency of locations of MTrP treatments for the lower (7%) and upper (8%) limbs was similar. Combined pelvic and lumbar regions represented a total of 11%. In 6% of the reported studies, the body region treated was not specified.

Relative frequency of the interventions

The various interventions utilised and their comparators are expressed as a percentage of the included studies are illustrated in Figure 2. Of the studies analysed,

electrophysical agent applications reached the highest relative frequency (43%), followed by manual therapy and dry needling.

*insert Figure 2 somewhere here, single column fitting image

The methodological quality

The methodological quality spectrum of the included studies ranged from 1 to 9 out of 10 maximum points on the PEDro scale. None of the retrieved studies attained the maximum score of 10. The highest frequency distribution of total PEDro scores of the n = 230 studies selected was between 5 to 6/10 and accounted for n = 53 (23.0%) and n = 54 studies (23.5%), respectively. Exactly half of the analysed studies (n = 115) scored equal to or higher than 6 on the total PEDro scale. The maximal obtained total PEDro score was 9/10 points, achieved by n = 6 studies (2.6%) (see Figure 3).

*insert Figure 3 somewhere here, single column fitting image

Analysis of the PEDro score by single items referring to internal validity showed 95% and 94% for random allocation and between-group comparisons, respectively. Lower relative frequency scores were attained for the items eligibility criteria and baseline comparability, followed by adequate follow-up and blinding of the assessors. Of the selected studies, the investigators blinded their subjects (32%), concealed allocation and intention-to-treat analysis attained lower percentages (25%, 17%, respectively). Therapists were blinded in 5% of the trials (see Figure 4).

*insert Figure 4 somewhere here, single column fitting image

The bubble plot shows the proportion of CCTs that share the same PEDro score over time, green for scores greater than or equal to a total PEDro of 6, red for those with lower scores than 6 (see Figure 5). The cut-off value suggested by PEDro, rates PEDro scores equal to or higher than 6 as being of moderate to high methodological quality (www.pedro.org.au). The regression line for the total PEDro score versus time is shown in black. The weighted linear regression accounted for 9.7% of the variance using the equation: total PEDro score = 3.469 + (0.0705 x year). The plot displays an increase in the methodological quality and number of trials with scores equal to or higher than 6 during the last 10 years. The slope of the weighted linear regression indicates an average increase in the total PEDro score by 0.7 points each decade.

*insert Figure 5 somewhere here, single column fitting image, please use colours for bubbles

DISCUSSION

Primarily, the aim of this review was to assess the methodological quality of CCTs including physiotherapeutic treatments directed at MTrPs by considering the PEDro score. A secondary aim was to assess whether there was an increase in the methodological quality of the selected trials over time.

The choice of appropriate databases for the electronic search was supported by the statement of Moseley et al. (2009). They reported that the PEDro database indexes the greatest number of records (279/281), 99% in rehabilitation field (Moseley et al., 2009). Additionally, out of these 281, only one record (<1%) was indexed on a single database, which was PEDro (Moseley et al., 2009). Although the CENTRAL database covers 98% of a pool of 281 reports of RCTs (MEDLINE 91%), the authors chose the latter as CENTRAL also indexes grey literature (Moseley et al., 2009).

The average methodological quality of the studies included in the present review was 5.5 on the PEDro scale. This value is in agreement with existing literature (Moseley et al., 2011; Yamato et al., 2016). Yamato et al. (2016) reported an average score of 5.6 in a random sample of 200 trials indexed in the PEDro database (Yamato et al., 2016), whereas Moseley et al. (2011) mentioned an average score of physiotherapeutic trials published in 2008 of 5.3 points (Moseley et al., 2011). Further, they stated that studies within the field of physiotherapy could theoretically reach at least 7 to 8 on the PEDro scale, since only blinding of the assessor, therapist and / or patient could be a problematic issue in physiotherapeutic applications (Moseley et al., 2011). From the analysed studies in this review just 23.9% reached the rating of 7 or 8 on the PEDro scale.

In accordance with the PEDro database, PEDro scores reporting a total of greater or

equal to 6 are rated as being of a moderate to high quality. This value attained 47.4% of the analysed studies in this review. Therefore, the authors conclude the included studies to be of a fairly moderate methodological quality. Non-debatable, the studies could have reached higher scores.

The attained poor relative frequency of the last four PEDro items (blinding of subjects, concealed allocation, intention-to-treat analysis, blinding of therapists), the reported weaknesses of the MTrP theory (Quinter et al., 2014, Cohen and Quinter, 2008), as well as the poor reliability of the MTrP manual palpation procedures (Lucas et al., 2009; Myburgh et al., 2008) raise the issue of the limited external validity of MTrP clinical studies. Blinding of the assessors could be utilised to a much higher degree than the observed 59% since he or she is not actively involved in the intervention. The therapists were blinded in 5% of the included studies. Furthermore, intention-to-treat analysis could have easily been performed in all studies (Moseley et al., 2011). The relatively low values in concealed allocation (25%) may be a result of ethical constraints, where the implementation of non-effective treatments is questionable. Our results are comparable to those of Maher et al. (2008), assuming that all trials conducted within the scope of physiotherapy encounter the same challenges (Maher et al., 2008).

The item of random allocation was used in 95% of the analysed studies. From the perspective of quality, this result should be interpreted carefully as an article receives one score for this item just by mentioning random allocation performance without further specification required. Only quasi-random allocation procedures are not rated as fulfilled criterion (de Morton, 2009). Apart from this item, clear identification and specification of the criteria have to be provided within the text, otherwise no point can be given and the total PEDro score decreases although the study would have otherwise

fulfilled the criterion. Therefore, researchers should consider their protocol carefully according to PEDro guidelines in order to achieve the highest methodological quality. Furthermore, a proper reporting of the methods used can increase the total PEDro score of clinical trials. For both of the above, the Consolidated Standards of Reporting Trials (CONSORT) statement provides useful guidelines (www.consort-statement.org). It should be remembered that the PEDro scale cannot be used to measure the validity of the study's outcome, as a high total PEDro score does not automatically correspond with the clinical evidence of the treatment effect (www.pedro.org.au).

The high prevalence of painful syndromes in the neck and upper trapezius region in the working population (Sterud et al., 2014) might explain the high number of studies evaluating physiotherapeutic treatment of trigger points and myofascial pain in the cervico-thoracic region. Additionally, the large number of trials focussing on the treatment of MTrPs may be contributed to the high prevalence of active or latent MTrPs in the neck and shoulder (Chiarotto et al., 2015) and their ease of accessibility.

For the analysis of physiotherapeutic interventions directed at MTrPs, the authors rated all electrotherapy applications and thermo-therapeutic interventions as electrophysical agents as proposed by the ISEAPT (International Society for Electrophysical Agents in Physical Therapy). This may explain the high relative frequency of these treatment strategies. Physiotherapists frequently use electrophysical agent applications in the treatment of musculoskeletal disorders, although only few of them have been proven to be effective so far (Robertson and Baker, 2001; Awotidebe et al., 2015).

The moderate relative frequencies of acupuncture and dry needling treatments (13%, 20%, respectively) may be explained by the demanding continuing education process, the legal requirements for their application, or the patients' acceptance of such

treatments. Nevertheless, Caramagno et al. (2015) showed that dry needling, when performed by physical therapists, would be safe and effective (Caramagno et al., 2015). It also appears that these invasive modalities are a relatively recent addition to the treatment options for MTrPs. Apart from four studies conducted before 2002, all other related studies have been published since 2006. If dry needling and acupuncture treatments were united to one single treatment modality as suggested by Dunning et al. (2014) or Liu et al. (2015) (Dunning et al., 2014; Liu et al., 2015), the cumulative relative frequency would achieve 33%.

Studies investigating the effect of drug injections (5%) are rare when compared to studies using dry needling or acupuncture (33%) as a treatment strategy. On the one hand, the inclusion criteria that at least one intervention falls within the scope of physiotherapy practice may have restricted hits including injections, on the other hand, it may reflect that the trigger point treatments performed by physicians as injections are not a treatment modality used by physical therapists. Further, the low percentage seen is in line with the results of Cumming and White (2001) who reported that the treatment of MTrPs using wet injections was not superior to dry needling (Cummings and White, 2001).

The increase in the number of published papers in peer-reviewed journals over the last 15 years, could possibly be explained by the growing use of best evidence practice and applied research in physiotherapy. The bubble plot illustrates a promising tendency towards a high number of good quality trials. Nevertheless, the average PEDro score of CCTs for MTrPs treatments does not reach the cut-off of 6 proposed for moderate to high methodological quality and a few recent outliers with surprisingly low methodological quality have been reported.

A limitation of this review could be the restrictive inclusion criteria of English language publications which may have led to missing data.

CONCLUSIONS

The average PEDro score of CCTs for MTrP treatments does not reach the cut-off of 6 proposed for moderate to high methodological quality. Nevertheless, a promising trend towards an increase of the average methodological quality of CCTs for MTrPs was recorded. More high-quality CCT studies with thorough research procedures are recommended to enhance methodological quality. For future research, a distribution analysis of the total PEDro score for each achieved item with regard to treatment modality and its restriction would contribute to the existing knowledge. Further, the correlation between total PEDro score, the composition of the achieved items and the study's treatment effect may be of interest.

Author's contributions

All authors had a decisive and important role in this review. The research conception and study design were performed by RC, ES and MB. Data analysis was done by DL, GC, VR and RS. The statistical analysis was performed by ES. All authors added their expertise to the drafting, revision of this article, read and approved the final version of the manuscript.

Conflicts of interest

None.

REFERENCES

Aguilera, J. M., Martin, D. P., Masanet, R. A., Botella, A. C., Soler, L. B., & Morell, F. B. (2009). Immediate effect of ultrasound and ischemic compression techniques for the treatment of trapezius latent myofascial trigger points in healthy subjects: a randomized controlled study. *Journal of Manipulative and Physiological Therapeutics*, *32*(7), 515–520.

Awotidebe, A. W., Inglis-jassiem, G., & Young, T. (2015). Low-level laser therapy and exercise for patients with shoulder disorders in physiotherapy practice: a systematic review protocol. *Systematic Reviews*, *4*(60), 2–7.

Bhogal, S. K., Teasell, R. W., Foley, N. C., & Speechley, M. R. (2005). The PEDro scale provides a more comprehensive measure of methodological quality than the Jadad scale in stroke rehabilitation literature. *Journal of Clinical Epidemiology*, *58*(7), 668–673.

Cagnie, B., Castelein, B., Pollie, F., Steelant, L., Verhoeyen, H., & Cools, A. (2015). Evidence for the use of ischemic compression and dry needling in the management of trigger points of the upper trapezius in patients with neck pain. *Am J Phys Med Rehabil*, *94*, 573–583.

Caramagno, J., Adrian, L., Mueller, L., & Purl, J. (2015). Analysis of competencies for dry needling by physical therapists, (33), 1–14.

Chiarotto, A., Clijsen, R., Fernandez-de-las-Penas, C., & Barbero, M. (2015). The Prevalence of Myofascial Trigger Points in Spinal Disorders: a Systematic Review and Meta-Analysis. *Archives of Physical Medicine and Rehabilitation*, (February 2016).

Cohen, M., & Quinter, J. (2008). The Horse Is Dead: Let myofascial pain syndrome rest in peace. *Pain Medicine*, *9*(4), 0–1.

CONSORT, Transparent report of trials (2017). Retrieved January 19th 2017, from https://www.consort-statement.org

Cummings, T. M., & White, A. R. (2001). Needling therapies in the management of myofascial trigger point pain: a systematic review. *Archives of Physical Medicine and Rehabilitation*, *82*(7), 986–992.

de Morton, N. A. (2009). The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. *Australian Journal of Physiotherapy*, *55*(2), 129–133.

Dunning, J., Butts, R., Mourad, F., Young, I., Flannagan, S., & Perreault, T. (2014). Dry needling: a literature review with implications for clinical practice guidelines 1.

Ge, H.-Y., Arendt-Nielsen, L., & Madeleine, P. (2012). Accelerated muscle fatigability of latent myofascial trigger points in humans. *Pain Medicine*, *13*, 957–964.

Harden, R., Bruehl, S., Gass, S., Niemiec, C., & Barbick, B. (2000). Signs and symptoms of the myofascial pain syndrome: a national survey of pain management providers. *Clinical Journal of Pain*, *16*(1), 64–72.

Knobloch, K., Yoon, U., & Vogt, P. M. (2011). Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias. *Journal of Cranio-Maxillofacial Surgery*, *39*(2), 91–92.

Liu, L., Huang, Q., Liu, Q., Ye, G., Bo, C., Chen, M., & Li, P. (2015). Effectiveness of dry needling for myofascial trigger points associated with neck and shoulder pain: a systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation*, *96*(5), 944–955.

Lucas, N., Macaskill, P., Irwig, L., Moran, R., & Bogduk, N. (2009). Reliability of physical examination for diagnosis of myofascial triggerpoints: a systematic review of the literature identification of studies. *Clinical Journal of Pain*, *25*(1).

Maher, C. G., Moseley, A. M., Elkins, M. R., Herbert, R. D., Maher, C. G., Moseley, A. M., Herbert, R. D. (2008). Perspective a description of the trials, reviews, and practice guidelines indexed in the PEDro database, *88*(9), 1068–1077.

Maher, C. G., Sherrington, C., Herbert, R. D., Moseley, A. M., & Elkins, M. (2003). Reliability of the PEDro scale for rating quality of randomized controlled trials. *Physical Therapy*, *83*(8), 713–721.

Moseley, A. M., Herbert, R. D., Maher, C. G., Sherrington, C., & Elkins, M. R. (2011). Reported quality of randomized controlled trials of physiotherapy interventions has improved over time. *Journal of Clinical Epidemiology*, *64*(6), 594–601.

Moseley, A. M., Sherrington, C., Elkins, M. R., Herbert, R. D., & Maher, C. G. (2009). Indexing of randomised controlled trials of physiotherapy interventions: a comparison of AMED, CENTRAL, CINAHL, EMBASE, Hooked on Evidence, PEDro, PsycINFO and PubMed. *Physiotherapy*, *95*(3), 151–156.

Myburgh, C., Larsen, A., & Hartvigsen, J. (2008). A systematic, critical review of manual palpation for identifying myofascial trigger points: evidence and clinical significance. *Archives of Physical Medicine and Rehabilitation*, *89*(6), 1169–76.

Olivo, S. A., Macedo, L. G., Gadotti, I. C., Fuentes, J., Stanton, T., & Magee, D. J. (2008). Scales to Assess the Quality of Randomized Controlled Trials: A Systematic Review. *Physical Therapy*, *88*(2), 156–175.

PEDro Physiotherapy evidence database (2017). Retrieved January 19th 2017, from https://www.pedro.org.au

Quintner, J. L., Bove, G. M., & Cohen, M. L. (2014). A critical evaluation of the trigger point phenomenon. *Rheumatology*, 1–8.

Robertson, V. J., & Baker, K. G. (2001). A review of therapeutic ultrasound: effectiveness studies. *Physical Therapy*, *81*(7), 1339–1350.

Sterud, T., Johannessen, H. A., & Tynes, T. (2014). Work-related psychosocial and mechanical risk factors for neck/shoulder pain: A 3-year follow-up study of the general working population in Norway. *International Archives of Occupational and Environmental Health*, *87*(5), 471–481.

Trampas, A., Kitsios, A., Sykaras, E., Symeonidis, S., & Lazarou, L. (2010). Physical therapy in sport clinical massage and modified proprioceptive neuromuscular facilitation stretching in males with latent myofascial trigger points. *Physical Therapy in Sport*, *11*(3), 91–98.

Travell, J. G., & Simons, D. G. (1983). *Myofascial Pain and Dysfunction: The Trigger Point Manual*. Williams & Wilkins.

White, H. (1980). A heteroskedasticity-consistent Covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, *48*(4), 817–38.

Yamato, T. P., Maher, C. G., Saragiotto, B. T., Hoffmann, T. C., & Moseley, A. M. (2016). How completely are physiotherapy interventions described in reports of randomised trials? *Physiotherapy*, *PublishAh*(2), 121–126.

Captions to illustrations

Figure 1: Flow chart of study selection.

Figure 2: Relative frequency of the interventions for MTrPs as reported in the n = 230 selected studies.

Figure 3: Frequency distribution of the total PEDro scores of the 230 studies n = 230 studies selected.

Figure 4: Percentage of CCTs on physiotherapy interventions for MTrPs indexed in the PEDro and MEDLINE databases that met the criteria for each item on the PEDro scale.

Figure 5: Bubble plot of the PEDro scores for the n = 230 studies selected versus time, representing the relationship between the quality and the publication year. The size of each bubble represents the proportion of CCTs that share the same PEDro score. Green bubbles are those with a PEDro score greater than or equal to 6. Red bubbles are those with a PEDro score lower than 6. In black, the regression line for the total Pedro score versus time.

Appendix A. Search strategy

PEDro database

#1, Search "trigger points" and "clinical trial",151,21:32

#2, Search "trigger point" and "clinical trial",100,21:37

#3, Search "myofascial pain" and "clinical trial",135,21:42

#4, Search "myofascial trigger point" and "clinical trial",37,21:44

#5, Search "myofascial trigger points" and "clinical trial",62,21:48

#6, Search "myofascial pain syndrome" and "clinical trial",63,21:51

MEDLINE database

The search of MEDLINE database was optimized by using MeSH keywords and the additional filters "randomized controlled trials, clinical trials, English language, humans, full text".

#1, Search "trigger point" OR "trigger points" OR "myofascial trigger point" OR "myofascial trigger points" OR "myofascial pain" OR "myofascial pain syndrome",3127,02:38:22

#2, Search "trigger point" OR "trigger points" OR "myofascial trigger point" OR "myofascial trigger points" OR "myofascial pain" OR "myofascial pain syndrome" Filters: Clinical Trial",484,02:39:26

#3, Search "trigger point" OR "trigger points" OR "myofascial trigger point" OR "myofascial trigger points" OR "myofascial pain" OR "myofascial pain syndrome" Filters: Clinical Trial Randomized Controlled Trial",484,02:39:54

#4, Search "trigger point" OR "trigger points" OR "myofascial trigger point" OR "myofascial trigger points" OR "myofascial pain" OR "myofascial pain syndrome" Filters: Clinical Trial Randomized Controlled Trial Humans",484,03:37:58

#5, Search "trigger point" OR "trigger points" OR "myofascial trigger point" OR "myofascial trigger points" OR "myofascial pain" OR "myofascial pain syndrome" Filters: Clinical Trial Randomized Controlled Trial Humans English language full text",373,03:40:36

Appendix B. Clarification of body region definitions and intervention contents

Definitions of body regions

Lumbo-pelvic region:	Lumbar spine, pelvis
Cervico-thoracic region:	Cervical spine, thoracic spine, rib cage, shoulder girdle
Lower limb:	Hip, thigh, knee, leg, ankle, foot
Upper limb:	Shoulder, arm, forearm, wrist, hand
Cranio-mandibular region:	Temporo-mandibular, jaw muscles

Interventions

Electrophysical therapies:	Electrotherapy modalities, thermotherapy
Manual therapies:	Passive treatment such as joint mobilisation and manipulation, massage, soft tissue techniques, muscle elongation
Active exercise:	Any kind of actively performed cardio-vascular training or strength training
Stretching:	Including any sort of active stretching techniques
Acupuncture:	Alternative medicine technique where thin needles were inserted into the body
Injections:	Applications with or without agent with a syringe and hollow needle
Dry needling:	Trigger point treatment technique using sterile acupuncture needles to penetrate the muscle tissue

Relaxation techniques:	Meditation, yoga
Biofeedback:	Any use of sensors or gadgets to make body reactions visible to the patient
Counselling/education:	Any kind of written or spoken information i.e. brochures, video tapes
Oral drugs:	Any kind of orally taken medicaments
Splint/odontoiatric therapy:	Any kind of passive support to immobilise or create distance of anatomical sites
Taping:	Any kind of rigid or flexible taping techniques
Others:	Psychotherapy, conservative therapy not further specified

Appendix C. PEDro 11-item scale and its scoring procedure system

(from www.pedro.org.au, last amended June 21st, 1999)

PEDro scale

1.	eligibility criteria were specified	no ❑ yes ❑ where:
2.	subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	no ❑ yes ❑ where:
3.	allocation was concealed	no ❑ yes ❑ where:
4.	the groups were similar at baseline regarding the most important prognostic indicators	no ❑ yes ❑ where:
5.	there was blinding of all subjects	no ❑ yes ❑ where:
6.	there was blinding of all therapists who administered the therapy	no ❑ yes ❑ where:
7.	there was blinding of all assessors who measured at least one key outcome	no ❑ yes ❑ where:
8.	measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	no ❑ yes ❑ where:
9.	all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	no ❑ yes ❑ where:
10.	the results of between-group statistical comparisons are reported for at least one key outcome	no ❑ yes ❑ where:
11.	the study provides both point measures and measures of variability for at least one key outcome	no ❑ yes ❑ where:

The PEDro scale is based on the Delphi list developed by Verhagen and colleagues at the Department of Epidemiology, University of Maastricht (*Verhagen AP et al (1998). The Delphi list: a criteria list for quality assessment of randomised clinical trials for conducting systematic reviews developed by Delphi consensus. Journal of Clinical Epidemiology, 51(12):1235-41*). The list is based on "expert consensus" not, for the most part, on empirical data. Two additional items not on the Delphi list (PEDro scale items 8 and 10) have been included in the PEDro scale. As more empirical data comes to hand it may become possible to "weight" scale items so that the PEDro score reflects the importance of individual scale items.

The purpose of the PEDro scale is to help the users of the PEDro database rapidly identify which of the known or suspected randomised clinical trials (ie RCTs or CCTs) archived on the PEDro database are likely to be internally valid (criteria 2-9), and could have sufficient statistical information to make their results interpretable (criteria 10-11). An additional criterion (criterion 1) that relates to the external validity (or "generalisability" or "applicability" of the trial) has been retained so that the Delphi list is complete, but this criterion will not be used to calculate the PEDro score reported on the PEDro web site.

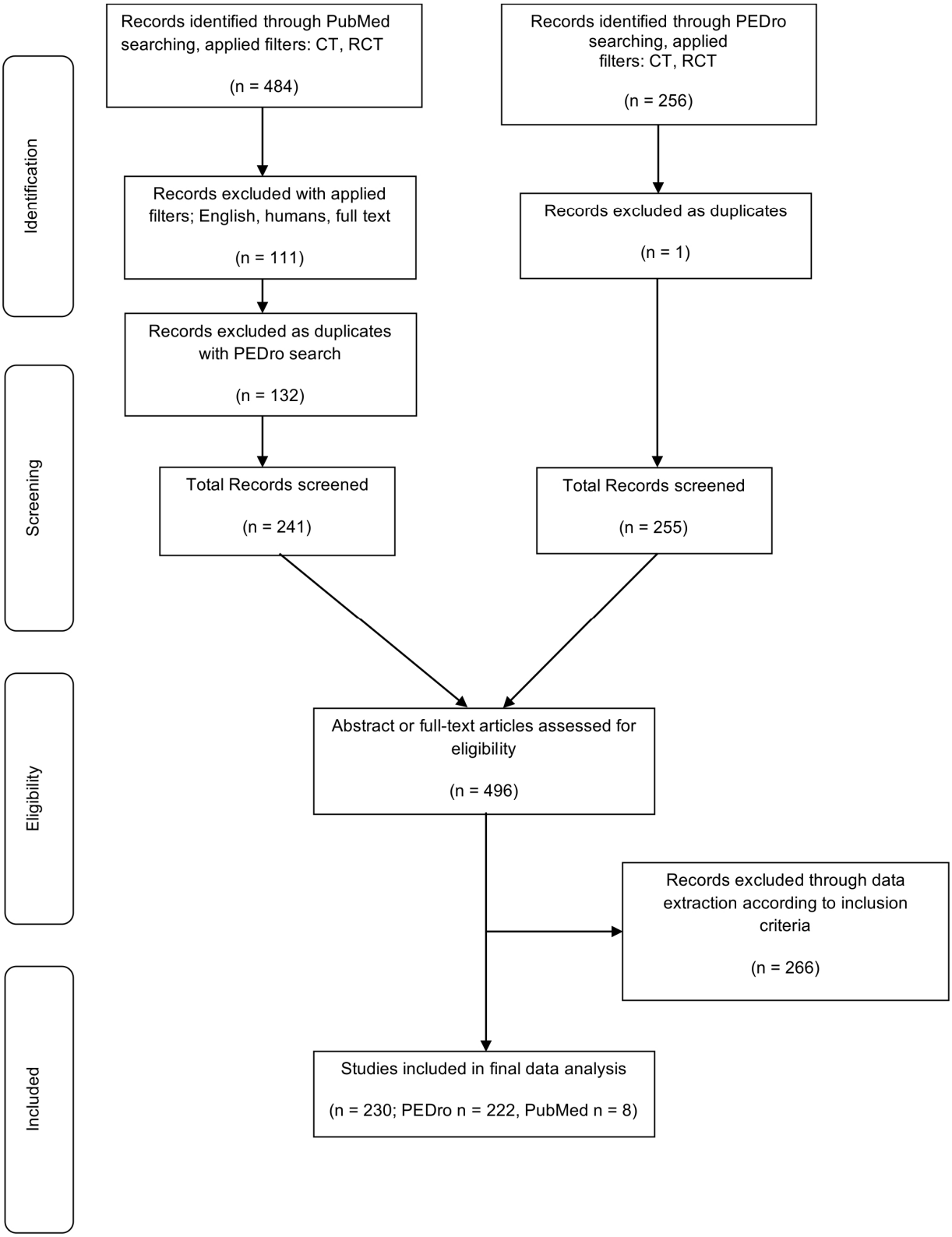
The PEDro scale should not be used as a measure of the "validity" of a study's conclusions. In particular, we caution users of the PEDro scale that studies which show significant treatment effects and which score highly on the PEDro scale do not necessarily provide evidence that the treatment is clinically useful. Additional considerations include whether the treatment effect was big enough to be clinically worthwhile, whether the positive effects of the treatment outweigh its negative effects, and the cost-effectiveness of the treatment. The scale should not be used to compare the "quality" of trials performed in different areas of therapy, primarily because it is not possible to satisfy all scale items in some areas of physiotherapy practice.

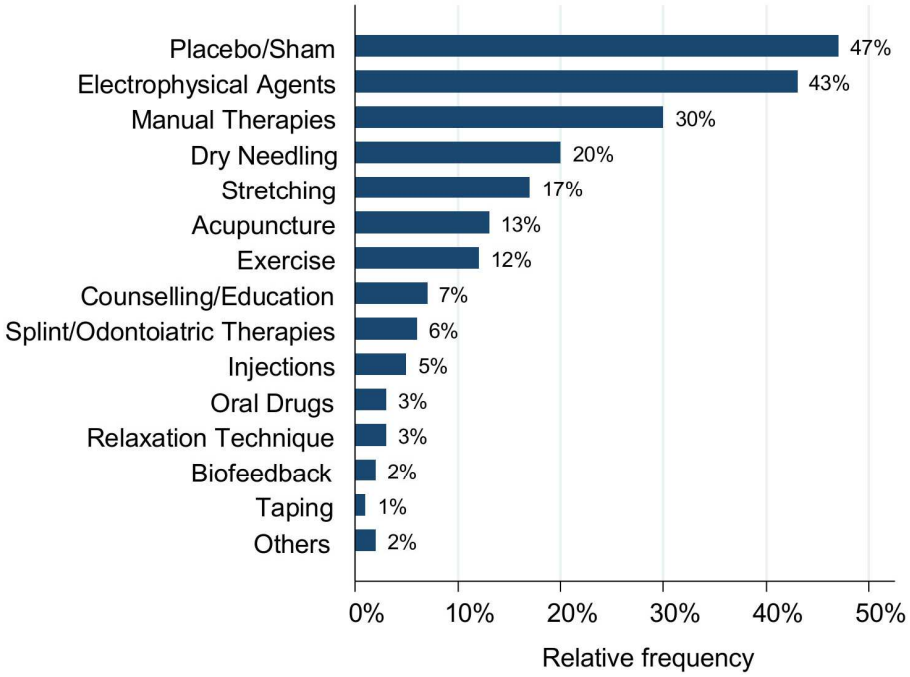
Notes on administration of the PEDro scale:

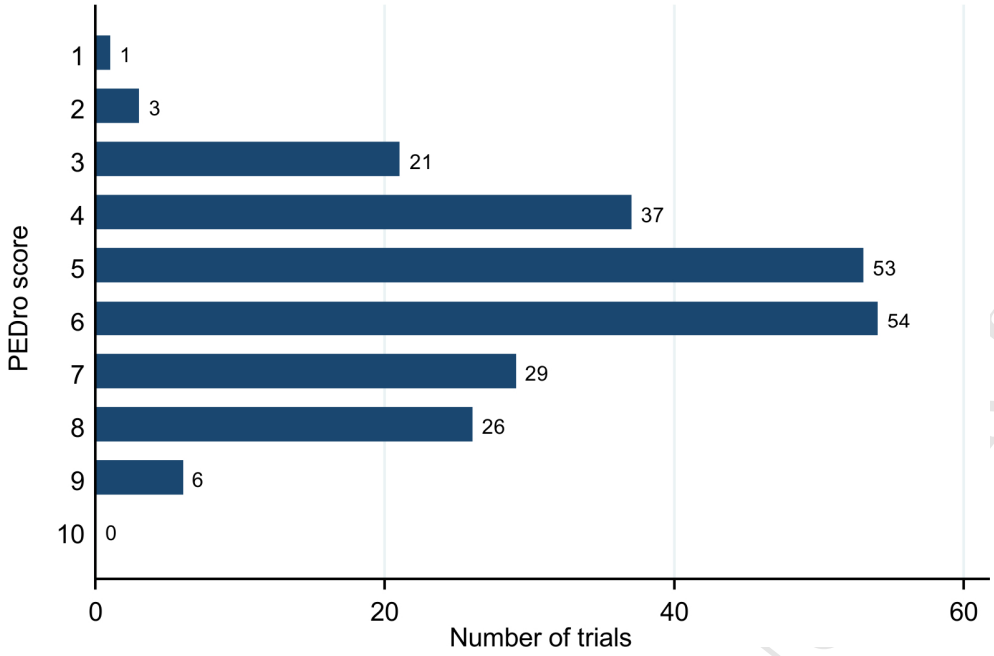
All criteria	**Points are only awarded when a criterion is clearly satisfied**. If on a literal reading of the trial report it is possible that a criterion was not satisfied, a point should not be awarded for that criterion.
Criterion 1	This criterion is satisfied if the report describes the source of subjects and a list of criteria used to determine who was eligible to participate in the study.
Criterion 2	A study is considered to have used random allocation if the report states that allocation was random. The precise method of randomisation need not be specified. Procedures such as coin-tossing and dice-rolling should be considered random. Quasi-randomisation allocation procedures such as allocation by hospital record number or birth date, or alternation, do not satisfy this criterion.
Criterion 3	*Concealed allocation* means that the person who determined if a subject was eligible for inclusion in the trial was unaware, when this decision was made, of which group the subject would be allocated to. A point is awarded for this criteria, even if it is not stated that allocation was concealed, when the report states that allocation was by sealed opaque envelopes or that allocation involved contacting the holder of the allocation schedule who was "off-site".
Criterion 4	At a minimum, in studies of therapeutic interventions, the report must describe at least one measure of the severity of the condition being treated and at least one (different) key outcome measure at baseline. The rater must be satisfied that the groups' outcomes would not be expected to differ, on the basis of baseline differences in prognostic variables alone, by a clinically significant amount. This criterion is satisfied even if only baseline data of study completers are presented.
Criteria 4, 7-11	*Key outcomes* are those outcomes which provide the primary measure of the effectiveness (or lack of effectiveness) of the therapy. In most studies, more than one variable is used as an outcome measure.
Criterion 5-7	*Blinding* means the person in question (subject, therapist or assessor) did not know which group the subject had been allocated to. In addition, subjects and therapists are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the treatments applied to different groups. In trials in which key outcomes are self-reported (eg, visual analogue scale, pain diary), the assessor is considered to be blind if the subject was blind.
Criterion 8	This criterion is only satisfied if the report explicitly states *both* the number of subjects initially allocated to groups *and* the number of subjects from whom key outcome measures were obtained. In trials in which outcomes are measured at several points in time, a key outcome must have been measured in more than 85% of subjects at one of those points in time.
Criterion 9	An *intention to treat* analysis means that, where subjects did not receive treatment (or the control condition) as allocated, and where measures of outcomes were available, the analysis was performed as if subjects received the treatment (or control condition) they were allocated to. This criterion is satisfied, even if there is no mention of analysis by intention to treat, if the report explicitly states that all subjects received treatment or control conditions as allocated.
Criterion 10	A *between-group* statistical comparison involves statistical comparison of one group with another. Depending on the design of the study, this may involve comparison of two or more treatments, or comparison of treatment with a control condition. The analysis may be a simple comparison of outcomes measured after the treatment was administered, or a comparison of the change in one group with the change in another (when a factorial analysis of variance has been used to analyse the data, the latter is often reported as a group × time interaction). The comparison may be in the form hypothesis testing (which provides a "p" value, describing the probability that the groups differed only by chance) or in the form of an estimate (for example, the mean or median difference, or a difference in proportions, or number needed to treat, or a relative risk or hazard ratio) and its confidence interval.
Criterion 11	A *point measure* is a measure of the size of the treatment effect. The treatment effect may be described as a difference in group outcomes, or as the outcome in (each of) all groups. *Measures of variability* include standard deviations, standard errors, confidence intervals, interquartile ranges (or other quantile ranges), and ranges. Point measures and/or measures of variability may be provided graphically (for example, SDs may be given as error bars in a Figure) as long as it is clear what is being graphed (for example, as long as it is clear whether error bars represent SDs or SEs). Where outcomes are categorical, this criterion is considered to have been met if the number of subjects in each category is given for each group.

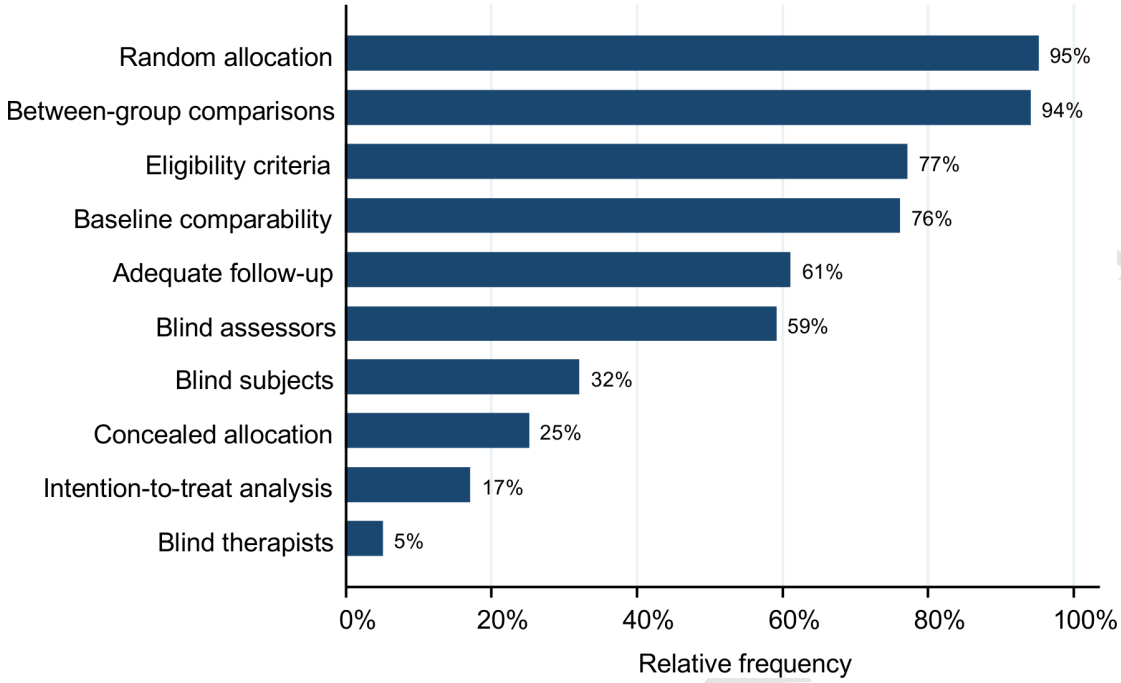
ACKNOWLEDGEMENTS

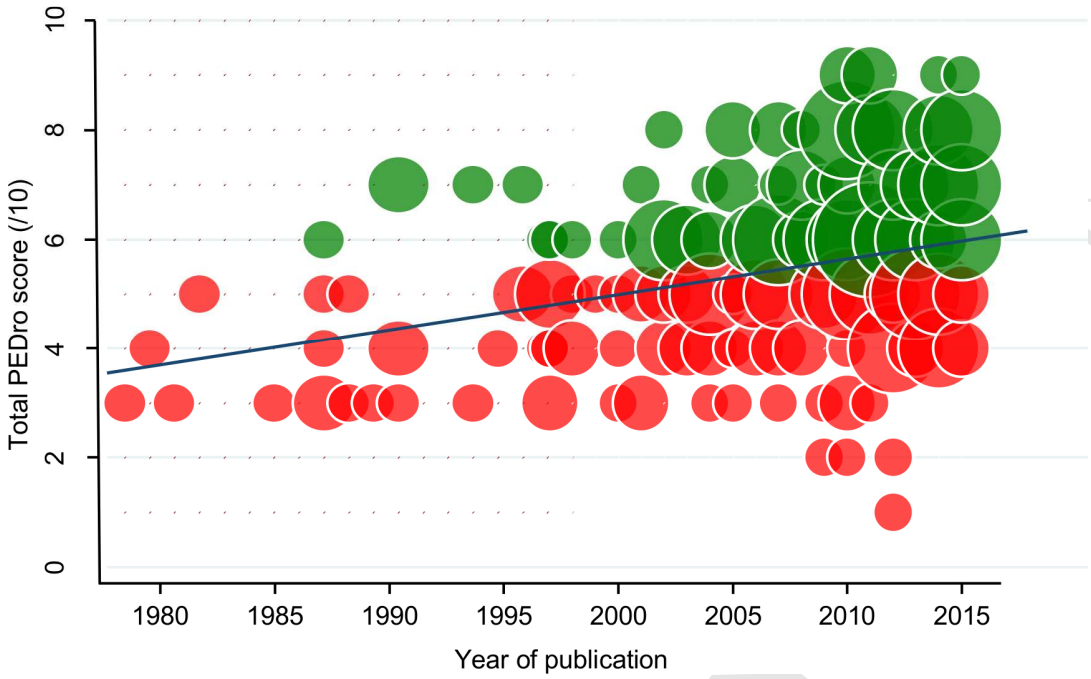
The authors like to thank the “Thim van der Laan” foundation and Mrs. Lindsay Melcher-Kunz for providing language help and proof reading.


Identification
Screening
Eligibility
Included
Records identified through PubMed searching, applied filters: CT, RCT
(n = 484)
Records identified through PEDro searching, applied filters: CT, RCT
(n = 256)
Records excluded with applied filters; English, humans, full text
(n = 111)
Records excluded as duplicates
(n = 1)
Records excluded as duplicates with PEDro search
(n = 132)
Total Records screened
(n = 241)
Total Records screened
(n = 255)
Abstract or full-text articles assessed for eligibility
(n = 496)
Records excluded through data extraction according to inclusion criteria
(n = 266)
Studies included in final data analysis
(n = 230; PEDro n = 222, PubMed n = 8)


Placebo/Sham
Electrophysical Agents
Manual Therapies
Dry Needling
Stretching
Acupuncture
Exercise
Counselling/Education
Splint/Odontoiatric Therapies
Injections
Oral Drugs
Relaxation Technique
Biofeedback
Taping
Others
47%
43%
30%
20%
17%
13%
12%
7%
6%
5%
3%
3%
2%
1%
2%
0%
10%
20%
30%
40%
50%
Relative frequency







Highlights:

- The CCT time distribution of all studies ranged from the years 1978 to 2015.
- The most frequently treated body part was the cervico-thoracic region with 62%.
- The most frequently used intervention was electrophysical agent application (43%).
- The average methodological quality reached 5.5/10 on the PEDro scale.
- An average increase in the PEDro score by 0.7 points each decade was revealed.