Empirically derived guidelines for interpreting the effectiveness of exercise therapy for tendinopathies: A meta-analysis.

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Abstract

Objective To quantify and describe effect size distributions from exercise therapies across a range of tendinopathies and outcome domains to inform future research and clinical practice.

Design An extensive search of the literature with meta-analysis exploring moderating effects and context specific small, medium, and large thresholds.

Eligibility criteria Randomised and quasi-randomised controlled trials involving any persons with a diagnosis of rotator cuff, lateral elbow, patellar, Achilles or gluteal tendinopathy of any severity or duration.

Methods Standardised mean difference (SMD_{pre}) effect sizes were used with Bayesian hierarchical meta-analysis and meta-regression models to calculate the 0.25- (small), 0.5- (medium), and 0.75-quantiles (large) and compare pooled means across potential moderators.

Results Data were analysed from 114 studies (171 treatment arms 4104 participants). SMD_{pre} effect sizes and credible intervals (CrI) across all tendinopathies and outcome domains demonstrated sizeable values for small (0.34 [95%CrI:0.31-0.37]), medium (0.73 [95%CrI:0.70-0.77]), and large (1.21 [95%CrI:1.17-1.27]) thresholds. Values were similar across tendinopathies but varied substantially across outcome domains with greater threshold values obtained for self-reported measures of pain, disability and function (small~0.6, medium~1.0, large~1.6), and the lowest values obtained for quality of life and objective measures of physical function (small~0.15, medium~0.4, large~0.70). Potential moderating effects of assessment duration, exercise supervision and symptom duration were also identified, with greater pooled mean effect sizes estimated for longer assessment durations, supervised therapies, and studies comprising patients with shorter symptom durations.

Conclusion

Effect sizes vary for different outcomes but are similar across tendinopathies, with research and clinical outcomes needing to be judged accordingly. Mean treatment effects are expected to be influenced by a range of factors with the most consistent evidence obtained for assessment duration and exercise supervision. The outcomes of new interventions should be assessed against domain- and time-specific effect sizes to be correctly interpreted. Threshold values presented here should be used to guide interpretation.

Background

Tendinopathy is a common musculoskeletal condition associated with degenerative changes and characterised by a combination of pain impaired movement and reduced function that typically requires extended periods for recovery.[1-5] Tendinopathy can affect any muscle-tendon unit in the body, however, it is most frequently reported in the Achilles, patellar, lateral elbow, rotator cuff, and hip tendons.[6] Surveys of prevalence of lower extremity tendinopathy in the general population have reported rates of 11.8 and 10.5 per 1000 person-years,[7] whilst prevalence for upper limb tendinopathies have been estimated between 1.3% to 21.0%.[8-10] Costs to the individual, the health service and economy (due to absenteeism and loss of productivity) are substantial such that identifying effective interventions is a priority.

Exercise therapy is the mainstay of conservative management of tendinopathy and has focused largely on resistance training, and in many instances eccentric strengthening techniques.[11] The rationale of exercise therapy is to improve load tolerance and possibly structural adaptation of the musculotendinous unit to restore function.[12,13] In the early phase of rehabilitation, flexibility exercises are often initiated and incorporated into strengthening regimes to facilitate improvements in mobility.[11] Effective exercise therapy may also require targeting a range of contributing factors, which not only include muscle weakness and decreased flexibility, but also corticospinal and neuromuscular adaptations resulting from persistent pain.[14] As such, proprioceptive exercise interventions have been used to retrain normal patterns of muscle recruitment in the rehabilitation of shoulder-related tendinopathies including impingement.[14-17] The time course of tendinopathy recovery is usually slow, the degree of recovery may be incomplete, and there may be differences between tendinopathies and across outcome domains. For example, quality of life may improve less quickly for people with rotator cuff tendinopathy compared to those with Achilles tendinopathy, whereas recovery may be faster for pain and the relative magnitudes of these improvements may not be equivalent. Quantifying any tendinopathy or domain-specific differences in expected improvements would help guide efforts to develop consensus concerning optimal management by enabling better intervention comparisons.

A recent scoping review identified a lack of effective tools to draw general conclusions across the large tendinopathy and exercise therapy research base (~ 450 primary studies) which featured a wide range of interventions across different tendinopathies, populations and outcome domains.[18] At present, one of the main tools to synthesise information and therein draw general conclusions include the use of meta-analyses. Most previous meta-analyses have attempted to

quantify the effectiveness of interventions using standardised mean difference effect sizes and Cohen's standard benchmarks (small = 0.2; medium = 0.5; and large = 0.8) irrespective of the tendinopathy location, population or outcome domain.[19-25,27,28] Despite Cohen's recommendations that these general benchmarks should only be used where more relevant context specific information is unavailable,[29] use of these standard benchmarks is ubiquitous through behavioural, social and health sciences. However, recent attempts have been made across a range of disciplines to use empirically derived effect size distributions to generate context specific benchmarks providing better means of establishing the effectiveness of different interventions and drawing general conclusions.[30-36] Results have frequently demonstrated substantive differences between Cohen's benchmarks and those derived empirically, with examples of both under- and over-estimation. In addition, research has shown that even within a single discipline, substantive differences in effect size distributions can exist across sub-domains.[30] Given the range of tendinopathies and outcome domains commonly investigated, there is potential that the distribution and subsequent appropriate interpretation of therapy effects will be diverse and could benefit from the generation of context specific benchmarks. Therefore, the purpose of this meta-analysis was to perform a large synthesis of the available research creating empirically derived thresholds to benchmark the effectiveness of exercise therapies and explore potential differences across tendinopathies and outcome domains. The analysis also investigated the potential for moderating effects of commonly reported features including assessment duration of outcomes, therapy supervision (supervised vs. unsupervised) and symptom duration of patients. The results of this analysis will provide clinicians and researchers with tendinopathy- and domain- specific indicators of effect sizes with which to better interpret intervention outcomes.

Methods

This meta-analysis is part of a project funded by the National Institute for Health Research (NIHR); Health Technology Assessment (HTA) 129388 Exercise therapy for the treatment of tendinopathies. The inclusion criteria were influenced by the project aims, the results of our initial scoping review mapping the exercise and tendinopathy literature, as well as stakeholder workshops. The meta-analysis was registered in the PROSPERO database (CRD42020168187) and a full protocol made publicly available prior to any analyses.[37]

Inclusion criteria

Participants

This meta-analysis included people of any age or gender with a diagnosis of rotator cuff related shoulder pain (RCRSP), lateral elbow, patellar, Achilles or gluteal tendinopathy of any severity or duration. Studies that included participants with tendinopathy in the absence of full thickness or large tears were included. We accepted trial authors' diagnoses where a clearly verifiable group of clinical features is reported including: pathognomonic location of pain; a symptom altering response to applied load and/or stretch, with there being a specific test for most tendinopathies; strategies to rule out differential diagnoses; ultrasound or magnetic resonance imaging confirmation of structural change. We included studies with mixed groups where there was clear reporting of the tendinopathic group, or those participants comprised > 90% of the investigated cohort.

Intervention

The intervention being assessed is exercise therapy comprising five different therapy classes: 1) resistance; 2) plyometric; 3) vibration; 4) flexibility and 5) proprioception. Definitions for each therapy class are presented in the supplementary files (SF-1). Interventions combining exercise with other active therapies (e.g. laser, shockwave, manual therapy or injection) were not included. We included exercise therapies delivered in a range of settings and delivered by a range of health, exercise professionals or support workers. We also included both supervised and unsupervised exercise therapies. As part of the inclusion criteria, we required studies to report sufficient information regarding the exercise intervention to enable appropriate identification of treatment duration, therapy class and exercise dose. In clinical settings, it has been recommended that exercise dose is determined by duration, frequency, and intensity. To be included in the review we required studies to provide sufficient information

to describe at least two of the three exercise dose parameters. Where sufficient information was not presented in the main text of a study, a search was made of the publishers' website to check for supplementary files that may include relevant information.

Comparator

No comparators were included, with effect sizes used to quantify the intervention effectiveness of exercise only therapies based on change relative to baseline.

Outcomes

Based on the results of our initial scoping review and subsequent stakeholder workshops,[18] we included outcomes that assessed six domains: 1) disability; 2) physical function capacity; 3) function; 4) pain (on loading/activity, over a specified time or without further specification; 5) quality of life; and 6) range of motion (shoulder joint only). Definitions of each domain and example tools are presented in the supplementary files (SF-2).

Types of studies

We included randomised controlled trials and non-randomised controlled trials where at least one intervention arm comprised an exercise therapy that could be categorised according to the therapy classes outlined.

Context

The context included primary care, secondary care or community locations in nations defined as very high or high on the Human Development Index (top 62 countries at the time of protocol development) for the findings to be relevant to the UK context.[38]

Search strategy

The search strategy used for this study was part of a larger search conducted to scope the entire tendinopathy and exercise therapy research base.[18] The search comprised three steps; Firstly, a limited search of MEDLINE and CINAHL using initial keywords was conducted to develop a full search strategy. Secondly, the full search strategy was adapted to each database and applied systematically to: MEDLINE, CINAHL, AMED, EMBase, SPORTDiscus, Cochrane library (Controlled trials, Systematic reviews), JBI Evidence Synthesis, PEDRo, and Epistemonikos (search terms for each database are presented in the supplementary files (SF-3). The following trial registries were also searched: ClinicalTrials.gov, ISRCTN Registry, The

Research Registry, EU-CTR (European Union Clinical trials Registry), ANZCTR (Australia and New Zealand Clinical trials Registry). Finally, the third step involved conducting a search of cited and citing articles using Scopus and hand-searching a total of 130 systematic reviews that were identified to include information relevant to exercise therapy and tendinopathy. No limit was placed on language, with research studies published in languages other than English translated via Google Translate or via international collaborations of the review team members. Searches were initiated from 1998 as (i) the heavy load eccentric calf-training protocol for Achilles tendinosis by Alfredsson et al was published in 1998 and may be considered seminal work in the field of tendinopathy,[39] and (ii) there has been a proliferation of research on exercise interventions for tendinopathies post 1998. The final date of the search was 18/01/21.

Study selection

Proquest® Refworks was used to manage references and remove duplicates before importing to Covidence (Melbourne, Australia) to facilitate screening and initiate a second deduplication process. Titles/abstracts were reviewed, independently, by two members of the research team. Full-text copies of all studies included at title/abstract screening stage were retrieved and also reviewed, independently, by two members of the research team. Conflicts were resolved by discussion or by input from a third reviewer.

Data extraction

Data were extracted independently by eight members of the review team (PS/KC/LA/RM/LG/EP/JS/AP) into pre-piloted excel sheets. Data were independently coded as described in the accompanying extraction codebook (SF-4), with all entries double checked by a different member of the review team. Where pre-post intervention data were not presented in text but in figures, data were extracted using digitsation software (PlotDigitizer 2.6.8 Windows).

Statistical analysis overview

In general, meta-analyses attempt to pool data across studies quantifying effectiveness by focusing on a weighted mean value. Due to the use of different outcome domains and different tests within a specific outcome domain, pooling of data requires initial standardisation. The most common metric used to standardise effectiveness is the standardised mean difference (SMD_{pre}) effect size, which divides the group change by the pre-intervention standard deviation. Meta-analyses seek to describe the underlying population effect size based on a normal distribution with the mean representing the most likely value across studies, and the standard deviation representing

the dispersion that can be expected across individual studies. However, a focus on a single central value provides limited description of the overall distribution that can be expected. By providing estimates of the 0.25-quantile (the value which 25% of observed results are expected to be below), the 0.5-quantile and the 0.75-quantile, a more detailed description is obtained. In addition, these estimates can be used to provide benchmarks to interpret the effectiveness of future interventions, with the traditional qualitative labels of "small" (0.25-quantile), "medium" (0.5-quantile) and "large" (0.75-quantile) used to provide a simple scale.

Most meta-analyses are conducted within a frequentist framework where a focus is placed on the mean value and hypothesis testing with confidence intervals to identify whether they overlap a zero effect. In contrast, analyses performed within a Bayesian framework are more flexible enabling for example quantile-values to be estimated and can be interpreted intuitively through reporting of subjective probabilities.[40] Given the purpose of the present meta-analysis to describe the overall distribution of effect sizes and explore differences among potentially relevant factors (e.g. tendinopathy location and outcome domains), a Bayesian framework was selected. Finally, many meta-analyses only extract a single outcome from each study per-analysis to avoid complexities due to relationships within data. However, more precise estimates of effects may be obtained by including all relevant data but accounting for covariances of multiple study outcomes within the meta-analysis model. A recommended approach to account for hierarchical structures (e.g. multiple measurements from the same study, multiple measurements made from difference outcomes within the same study, and multiple measurements made from the same outcome in the same study) is to apply multi-level meta-analysis models, which were included for the present study.

Statistical analysis details

Standardised mean difference (SMD_{pre}) effect sizes were calculated by dividing the relevant mean difference by the pre-intervention standard deviation and including a small sample bias correction.[41] Where required, SMD_{pre} values were reflected by multiplying by –1 to ensure that positive values represented an improved clinical effect. Where outcomes were assessed at multiple time-points following baseline measurement, all possible SMD_{pre} values were calculated and included in the meta-analysis models. Where means and standard deviations were not presented but included combinations of the median, range or interquartile range, values were estimated by the calculations presented by Wan et al (2014).[42] Where sufficient information was not available to estimate standard deviations, these were imputed through simple linear regression of the

log transformed standard deviations and means obtained from all other studies.[43] Separate regressions were performed for pre- and post-intervention data.

All meta-analyses were conducted using a nested four-level model.[44] The series of nestings included the individual study (level 4), the outcome (level 3), the measurement occasion (level 2) and the sampling variance (level 1). Standard distributional assumptions were used to calculate the sampling variance of SMD_{pre} values.[41] However, the calculation requires an estimate of the pre-post correlation which is rarely reported in studies. To account for uncertainty in the sampling variance, values within the model were allowed to vary and were estimated by including an informative Gaussian prior approximating correlation values centred on 0.7 and ranging from 0.5 to 0.9.[44] The relative contributions of variance sources were described by variance partition coefficients (VPCs) which were calculated by dividing each estimated variance level by the total sum. Therefore, the higher the VPC for the outcome and measurement levels the greater the covariances within the data. Inferences from all analyses were performed on posterior samples generated using the Hamiltonian Markov Chain Monte Carlo method. Interpretations were based on the median value ($SMD_{pre0.5}$: 0.5-quantile), credible intervals (CrIs) and calculation of probabilities using the posterior sample. Analyses were only completed where a minimum of 50 effect sizes were available to appropriately describe distributions. It was determined a priori to assess the influence of tendinopathy location, outcome domain, assessment duration, symptom duration and supervised versus non-supervised exercise on effect sizes. This was achieved by subset analysis for tendinopathy location and outcome domain, and meta-regressions for assessment duration, symptom duration and supervision. Meta-regressions were presented by selecting one level of the factor as a reference to make comparisons with the median and 95% CrI ($\beta_{Reference:Comparison}$ = Median [95%CrI: lower bound to upper bound], such that $\beta>0$ indicates an increased effect of the comparison relative to the reference). The importance of removing outliers to obtain accurate estimates of meta-analysis parameters was identified in a previous and similar large meta-analysis of exercise SMD_{pre} values.[45] Outlier SMD_{pre} values were identified by adjusting the empirical distribution by a Tukey g-and-h distribution and obtaining the 0.0125- and 0.9875-quantiles, with values beyond these points removed prior to further analysis.[45,46] Meta-analyses were conducted using the R wrapper package brms interfaced with Stan to perform sampling.[40,47]Convergence of parameter estimates were obtained for all models with Gelman-Rubin R-hat values below 1.1.[48]

Results

Study selection

The search strategy identified a total of 9246 potential studies, with 4635 remaining following removal of duplicates. After title and abstract screening 4210 studies were removed leaving 425 studies obtained for full text screening. Of these studies, a further 311 were excluded based primarily on insufficient description of the exercise stimulus (116 studies) and not including exercise-only treatment arms (75 studies). In total, data from 114 studies comprising 171 treatment arms and 4104 participants were included in the meta-analyses (SF-5: Table of included studies). Descriptions of the study characteristics, tendinopathy location and outcome domains are presented in Table 1. Outcomes obtained from studies investigating gluteal tendons were not included in the analysis based on the number of effect sizes falling below the a priori threshold set to generate accurate estimates of the population effect size distribution.

Description of effect size distributions

From the initial 1454 outcomes extracted, a total of 38 outliers were removed from the analysis with a lower bound threshold of –0.82 (6 effect sizes below) and an upper bound threshold of 7.0 (32 effect sizes above). Across all outcomes and tendinopathy locations, direct calculation of the 0.25- (small), 0.5- (medium), and 0.75-quantiles (large) from the complete empirical data returned the following SMD_{pre} values: 0.37, 0.77 and 1.31, respectively. Application of the meta-analysis model across the data with borrowing of information across studies resulted in similar but shrunken estimates ($0.25\text{-quantile}_{0.5} = 0.34$ [95%CrI: 0.31 to 0.37]; $0.5\text{-quantile}_{0.5} = 0.73$ [95%CrI: 0.70 to 0.77]; and $0.75\text{-quantile}_{0.5} = 1.21$ [95%CrI: 1.17 to 1.27]).

Analysis of effect size distributions across the different tendinopathy locations are illustrated in Figure 1 with numerical values presented in Table 2. Analysis of the modelled small, medium, and large thresholds showed considerable overlap in small and medium thresholds across all tendinopathy locations ($0.25\text{-quantile}_{0.5}$ ranged from 0.28 to 0.38; $0.5\text{-quantile}_{0.5}$ ranged from 0.70 to 0.82). However, greater divergence was identified for large threshold estimates, with the greatest values estimated for the elbow ($0.75\text{-quantile}_{0.5}$ ranged from 1.18 to 1.49).

Analysis of effect size distributions across outcome domains are presented in Figure 2 with numerical values presented in Table 3. A clear split was identified between the domains of quality

of life and the objective measures of physical function capacity and ROM, versus the subjective measures of function, disability and pain. The lowest threshold values were estimated for quality of life, physical function capacity and ROM, with the small threshold for quality of life estimated to be below zero (0.25-quantile$_{0.5}$ = -0.21 [95%CrI: -0.32 to -0.09]). In contrast, the greatest effect sizes values were obtained for outcomes measuring disability, pain and function with the reduced amount of data for function resulting in wider credible intervals. Central estimates indicated that small threshold estimates for domains with the greatest effect sizes were situated between the medium and large threshold estimates for domains with the lowest effect sizes (Figure 2).

Moderator analyses

Moderator analyses investigating potential changes in the mean effect size across all outcomes and tendinopathies are presented in Table 4. Evidence of a moderator effect was identified for assessment duration (short: ≤12 weeks; medium: 13-52 weeks; long duration: >52 weeks), with results showing a hierarchy and greater mean estimate with increased time from baseline assessment ($\beta_{Short:Medium0.5}$ = 0.28 [95%:CrI: 0.23 to 0.33], p>0.999; $\beta_{Short:Long0.5}$ = 0.37 [95%:CrI: 0.27 to 0.47], p>0.999). These estimates remained consistent after meta-regressions were controlled for tendinopathy location and outcome domain ($\beta_{Short:Medium0.5}$ = 0.28 [95%:CrI: 0.23 to 0.33], p>0.999; $\beta_{Short:Long0.5}$ = 0.38 [95%:CrI: 0.27 to 0.48], p>0.999). Consistent evidence of a moderating effect was also obtained for exercise supervision, with a greater mean estimate for supervised exercise therapies ($\beta_{Unupervised:Supervised0.5}$ = 0.38 [95%CrI: 0.05 to 0.71], p=0.989), which increased in estimate after controlling for tendinopathy location and outcome domain ($\beta_{Unupervised:Supervised0.5}$ = 0.66 [95%CrI: 0.35 to 0.98], p>0.999). Finally, some evidence was obtained indicating a hierarchy of effects with regards to symptom duration and greater mean estimates with patients reporting shorter symptom durations ($\beta_{Medium:Short0.5}$ = 0.33 [95%:CrI: -0.12 to 0.81], p=0.920; $\beta_{Long:Short0.5}$ = 0.51 [95%:CrI: 0.08 to 0.96], p=0.989). However, differences between the symptom duration levels were close to zero after controlling for tendinopathy location and outcome domain ($\beta_{Medium:Short0.5}$ = -0.05 [95%:CrI: -0.44 to 0.36], p=0.411; $\beta_{Long:Short0.5}$ = 0.06 [95%:CrI: -0.34 to 0.47], p=0.619).

Discussion

The present analysis represents the largest quantitative synthesis of exercise therapy interventions for the management of tendinopathies to date. Data from a total of 115 studies were included, with results demonstrating that substantive improvements in outcomes from baseline are generally obtained. With important clinical relevance, the meta-analyses identified clear differences in the distribution of effects sizes across outcome domains. The greatest values were generally obtained for subjective patient reported outcomes including disability and pain-related outcomes, with considerably lower values obtained for measures of quality of life and objective measures including physical function capacity and range of motion. Considerable overlap in effect size distributions were identified across the different tendinopathy location investigated, indicating that similar substantive improvements can be obtained with exercise therapies. Moderator analyses provided consistent evidence of increased improvement in outcomes as time increased from baseline assessment and with supervised compared to non-supervised exercise therapies. Some evidence was obtained for greater improvements with patients reporting symptoms for shorter durations, however, differences did not remain after controlling for outcome domain and tendinopathy location.

Of the 114 studies included in the analysis, 100 (88%) were randomised controlled trials and 14 (12%) were quasi-experimental trials. Therapies predominantly focussed on resistance exercise, with 70% of outcomes obtained from a treatment arm where this was the dominant class. Tendinopathy has been clinically defined as persistent pain and loss of function related to mechanical loading on a degenerative tendon.[49] Therefore, resistance exercise that focuses on restoration of loading ability is established as the mainstay of rehabilitation, particularly for lower limb tendinopathies, and is in keeping with current guidance.[50] Across the included studies flexibility and proprioceptive training were frequently combined with resistance exercise. However, these alternative therapy classes were rarely the dominant exercise class, and where they were, this tended to be restricted to management of RCRSP which accounted for over 50% of outcomes measured in the studies. Given the focus on resistance exercise and the desire to change the mechanical properties of the tendon, the standard duration of exercise therapies featured in the included studies is potentially a major limitation. Whilst clear reporting of therapy duration only occurred in 49% of studies, where it was reported, the median duration was only 8 weeks and over 90% of studies included durations of 12 weeks or shorter. Tendon healing is known to be a complex and lengthy process, with remodelling only beginning 1-2 months post-injury and

extending beyond 1-year, suggesting that longer duration exercise interventions are required, which is in keeping with guidelines recommending a minimum 12-weeks duration.[51] It is also relevant to note that in clinical practice, education and exercise programmes are frequently provided for patients to continue therapy after the initial intervention which may also contribute to the findings observed here including evidence of greater improvements with increased time from baseline assessment.

Review of previous meta-analyses and individual studies investigating the effectiveness of exercise therapy for tendinopathy shows that Cohen's standard benchmarks are most frequently used to interpret effectiveness.[19-28] The results of the present study show that across most outcomes Cohen's standard benchmarks of 0.2 (small), 0.5 (medium), and 0.8 (large) would tend to result in an overestimation of effectiveness and for quality of life may result in an underestimation.[29] Based on the analyses performed in the present meta-analysis, more appropriate thresholds include ~0.4 (small), ~0.8 (medium), and ~1.3 (large), highlighting a systematic shift by one category (e.g. what would have been referred to as a medium/large effect is more representative of a small/medium effect). However, the results of the analyses clearly show that effect size distributions are strongly dependent on the outcome domain, with more subjective patient reported outcomes (e.g. pains scales and patient-rated levels of function and disability) producing substantively larger effects compared with more objective assessments (e.g. range of motion and quantitative measures of physical function capacity). A wide range of outcome measures are used for tendinopathies, with little consensus in the literature to date,[18] although this should improve in future with work ongoing to identify core outcome sets for specific tendinopathies. International consensus reported that nine outcome domains should be considered core for tendinopathy.[52] The majority (8/9) of the consensus domains are patient-reported, with only physical function capacity being objectively measured in the clinical setting (e.g. number of hops/squats, dynamometry). The results of this study highlight that when using patient-centred self-reported outcomes, substantial changes should be expected from most exercise therapies.

The lowest effect sizes were obtained for quality of life outcomes with the small threshold indicating that over 25% of exercise therapies represented by those investigated will result in in patients' reporting a poorer quality of life. However, it is possible that the generic nature of quality of life instruments (e.g. EQ-5D) insufficiently reflects tendinopathy-specific symptoms or

that potential limitations such as ceiling effects limit the usefulness of these instruments. Tendinopathy may be acute but is typically due to chronic overuse and degeneration, exacerbated by overloading; therefore, patients may have developed specific coping strategies over time. Concern was raised when developing core domains that there is no tendon-specific quality of life measure,[52] but that the overall well-being of patients was important to assess. Further research is required to better understand the factors that influence quality of life assessments when manging tendinopathies and the best measurement tool to use.

Considerable overlap in the effect size thresholds across the five tendinopathies assessed suggests that exercise therapies commonly used to manage the different tendinopathies result in similar profiles of improvement. This contrasts previous perspectives that responses to interventions are variable across tendons and even within tendon sites.[53] It is likely that the interactions between a single exercise therapy, the tendinopathy and the outcome domain are complex and when better understood can improve patient care. However, the results of the present analysis demonstrate that exercise therapies commonly used to manage RCRSP, Achilles, patellar, and lateral elbow tendinopathies generally result in overall similar responses with most causing relatively large changes in relation to baseline standard deviations.

Despite almost all exercise therapies being of short duration (≤12 weeks), a substantial proportion of outcomes were measured beyond the intervention at a medium duration (13-52 weeks), and a relatively small number of instances of longer-term follow-up (>52 weeks). Moderator analysis demonstrated an ordered effect with the smallest mean pooled effect size obtained for short durations (1.0 [95%CrI: 0.87 to 1.1]), and evidence of greater pooled means for medium (1.3 [95%CrI: 1.1 to 1.4]; p>0.999) and long durations (1.4 [95%CrI: 1.2 to 1.6] p>0.999). Whilst the absolute magnitude of the differences were relatively small (~0.2 to 0.4 increase) and there were only two studies that included long term observations, the finding are in keeping with previous research,[54] and provide support for longer duration interventions as well as follow-up periods in studies. Moderator analyses also provided evidence of a greater mean pooled effect with supervised compared to unsupervised exercise therapies ($\beta_{Unupervised:Supervised0.5}$ = 0.70 [95%CrI: 0.39 to 1.0], p = 0.797). Previous systematic reviews specifically investigating supervised versus unsupervised exercise therapy for the rotator cuff have suggested that both approaches are likely to lead to similar improvements.[55,56] Whilst previous reviews employed greater control and focussed on more homogenous comparisons and considerably smaller number of outcomes, the findings in the present analysis and the consistency of results after controlling for tendinopathy

location and outcome, demonstrate that in general supervised exercise therapies are likely to provide clinically meaningful improvements beyond unsupervised exercise therapies. Finally, limited evidence was obtained to indicate that greater improvements may be obtained with patients reporting shorter symptom durations. However, differences in pooled mean estimates were close to zero after controlling for tendinopathy location and outcome domains, indicating the need for further research, and highlighting limitations of large modelling studies such as those included here, where systematic differences in a range of potential moderating factors can bias results and generate spurious associations.

Effect sizes vary for different outcomes but are similar across tendinopathies, with research and clinical outcomes needing to be judged accordingly. Mean treatment effects are expected to be influenced by a range of factors with the most consistent evidence obtained for assessment duration and exercise supervision. The outcomes of new interventions should be assessed against domain- and time-specific effect sizes to be correctly interpreted. Threshold values presented here should be used to guide interpretation

In conclusion, the results from this large meta-analysis show that **r**elative to baseline assessment, a reasonably wide distribution of changes and in general, improvements, should be expected following exercise therapy to manage tendinopathy. The magnitude of improvements appears somewhat independent of the location of the tendinopathy, but are strongly influenced by the outcome domain, with the greatest improvements measured in subjective patient-reported outcomes (e.g., disability, function, pain) and the smallest improvements measured in quality of life and more objective outcomes (e.g., PFC and ROM). When interpreting the effectiveness of exercise therapies for the management of tendinopathies, clinicians and researchers should be aware of these factors and use the context specific information presented here as a guide.

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Conflicts of interest

The authors declare no conflict of interest.

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Table 1: Distribution (percentiles) of study characteristics, tendinopathy locations and outcome domains calculated across treatment arms.

Study Characteristic	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
Participants per group	5	10	13	16	19	20	24	28	31	44	70
Mean age	22.5	29.5	39.8	42.6	44.0	46.0	47.9	48.7	49.9	51.9	62.1
Mean symptom duration (Months)	0.85	4.4	6.0	7.8	11.6	17.5	19.5	24.1	29.7	37.4	98.5
Publication Year	1998	2005	2007	2009	2012	2014	2015	2017	2017	2019	2020
Intervention length (Weeks)	2	4	4	4	6	8	12	12	12	12	21
Measurement duration (Weeks)	0.7	3	4	4	5	6	6	9	12	13	104

Tendinopathy location	**Number of TA (%)**	**Number of effects (%)**
Rotator cuff	77 (45.0)	817 (56.2)
Achilles	45 (26.3)	321 (22.1)
Lateral elbow	29 (17.0)	227 (15.6)
Patellar	20 (11.7)	89 (6.1)

Dominant therapy class	**Number of TA (%)**	**Number of effects (%)**
Resistance	124 (72.5)	1014 (69.7)
Flexibility	25 (14.6)	215 (14.8)
Proprioception	21 (12.3)	223 (15.3)
Vibration	1 (0.6)	2 (0.1)

Outcome Domain	**Number of TA (%)**	**Number of effects (%)**
Disability	142 (83.0)	447 (30.7)
Pain	122 (71.3)	406 (27.9)
PFC	59 (34.5)	320 (22.0)
ROM	30 (17.5)	159 (10.9)
Function	29 (17.0)	68 (4.7)
QoL	12 (7.0)	54 (3.7)

TA: Treatment arms Pain loading: Pain on loading; Pain: Pain without further specification; PFC: Physical function capacity; Pain time: Pain over a specified time; ROM: Range of motion for rotator cuff tendinopathy only; QoL: Quality of life.

Table 2: Meta-analysis results for all outcomes pooled across different tendinopathy locations.

Tendinopathy Location	Small [95%CrI]	Medium [95%CrI]	Large [95%CrI]	Study VPC [75%CrI]	Outcome VPC [75%CrI]	Measurement VPC [75%CrI]
All	0.34 [0.31 to 0.37]	0.73 [0.70 to 0.77]	1.21 [1.17 to 1.27]	0.73 [0.68 to 0.77]	0.27 [0.22 to 0.32]	0.01 [0.00 to 0.02]
RCRSP	0.38 [0.34 to 0.42]	0.74 [0.70 to 0.78]	1.18 [1.13 to 1.24]	0.55 [0.48 to 0.62]	0.45 [0.37 to 0.52]	0.01 [0.00 to 0.02]
Achilles	0.32 [0.25 to 0.38]	0.70 [0.62 to 0.78]	1.22 [1.10 to 1.34]	0.71 [0.59 to 0.81]	0.27 [0.18 to 0.39]	0.01 [0.00 to 0.03]
Elbow	0.28 [0.17 to 0.39]	0.82 [0.72 to 0.92]	1.49 [1.31 to 1.68]	0.90 [0.84 to 0.94]	0.10 [0.06 to 0.15]	0.01 [0.00 to 0.02]
Patellar	0.33 [0.19 to 0.46]	0.69 [0.55 to 0.84]	1.21 [1.00 to 1.43]	0.46 [0.13 to 0.69]	0.52 [0.29 to 0.85]	0.01 [0.00 to 0.05]

Small: 0.25-quantile; Medium: 0.5-quantile; Large: 0.75-quantile. RCRSP: Rotator cuff related shoulder pain. VPC: Variance partition coefficient. CrI: Credible interval.

Table 3: Meta-analysis results for all tendinopathy locations pooled across different outcome domains

Outcome Domain	Small [95%CrI]	Medium [95%CrI]	Large [95%CrI]	Study VPC [75%CrI]	Outcome VPC [75%CrI]	Measurement VPC [75%CrI]
All	0.34 [0.31 to 0.37]	0.73 [0.70 to 0.77]	1.21 [1.17 to 1.27]	0.73 [0.68 to 0.77]	0.27 [0.22 to 0.32]	0.01 [0.00 to 0.02]
Function	0.62 [0.45 to 0.77]	1.05 [0.88 to 1.23]	1.78 [1.53 to 2.09]	0.43 [0.03 to 0.81]	0.55 [0.17 to 0.94]	0.01 [0.00 to 0.04]
Disability	0.61 [0.55 to 0.68]	1.04 [0.98 to 1.11]	1.51 [1.43 to 1.60]	0.78 [0.68 to 0.88]	0.15 [0.08 to 0.24]	0.05 [0.00 to 0.13]
Pain	0.53 [0.45 to 0.61]	0.94 [0.87 to 1.02]	1.45 [1.32 to 1.58]	0.26 [0.06 to 0.46]	0.71 [0.51 to 0.90]	0.02 [0.00 to 0.07]
ROM	0.21 [0.14 to 0.27]	0.42 [0.36 to 0.48]	0.65 [0.58 to 0.73]	0.86 [0.76 to 0.93]	0.11 [0.05 to 0.20]	0.01 [0.00 to 0.06]
PFC	0.16 [0.11 to 0.21]	0.38 [0.34 to 0.43]	0.64 [0.59 to 0.71]	0.73 [0.61 to 0.82]	0.27 [0.18 to 0.38]	0.01 [0.00 to 0.02]
QoL	-0.21 [-0.32 to -0.09]	0.25 [0.12 to 0.38]	0.68 [0.48 to 0.93]	0.84 [0.65 to 0.93]	0.14 [0.05 to 0.33]	0.01 [0.00 to 0.04]

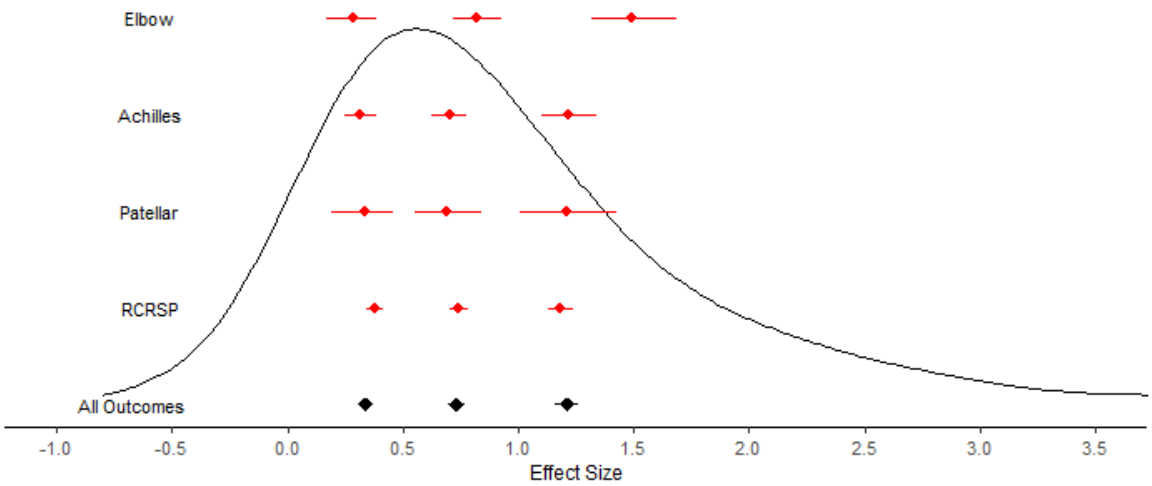
Small: 0.25-quantile; Medium: 0.5-quantile; Large: 0.75-quantile. ROM: Range of motion (shoulder only); PFC: Physical function capacity; QoL: Quality of life. VPC: Variance partition coefficient. CrI: Credible interval.

Table 4: Meta-analysis results for moderator analyses pooling all outcomes across all tendinopathies

	Moderator	Estimate of mean [95%CrI]	Probabilities	Study VPC [75%CrI]	Outcome VPC [75%CrI]	Measurement VPC [75%CrI]
Assessment duration	**Short** (≤12 weeks) 923 outcomes from 144 trials	0.97 [0.85 to 1.1]	*p*(Medium>Short) > 0.999	0.71 [0.66 to 0.75]	0.27 [0.23 to 0.32]	0.02 [0 to 0.04]
	Medium (13-52 weeks) 442 outcomes from 23 trials	1.2 [1.1 to 1.4]	*p*(Long>Medium) = 0.980			
	Long (>52 weeks) 51 outcomes from 2 trials	1.4 [1.2 to 1.6]	*p*(Long>Short) > 0.999			
Symptom duration	**One year or less** 308 outcomes from 44 trials	1.4 [1.1 to 1.7]	*p*(1yr>2yr) = 0.920	0.81 [0.76 to 0.84]	0.17 [0.14 to 0.21]	0.03 [0.00 to 005]
	Two years or less 258 outcomes from 30 trials	1.1 [0.74 to 1.4]	*p*(2yr>+2yr) = 0.772			
	Over two years 381 outcomes from 33 trials	0.88 [0.56 to 1.2]	*p*(1yr>+2yr) = 0.989			
Supervision	**Supervised** 354 outcomes from 35 trials	1.4 [1.1 to 1.7]	*p*(Supervised > Unsupervised) = 0.989	0.77 [0.73 to 0.81]	0.20 [0.17 to 0.24]	0.03 [0.00 to 0.05]
	Unsupervised 914 outcomes from 112 trials	0.99 [0.83 to 1.2]				

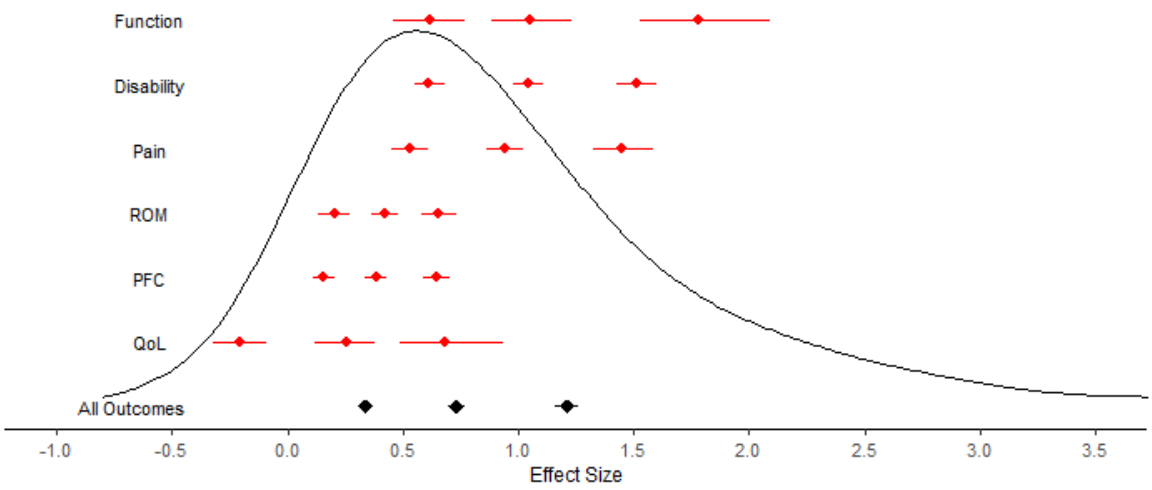
VPC: Variance partition coefficient; CrI: Credible interval. *p* : Subjective Bayesian probability.

Figure 1: Effect size distributions across tendinopathy locations with identification of small, medium and large thresholds



Black curve represents density plot of empirical effect size distribution. Diamonds with intervals represent small, medium and large thresholds with credible intervals (black: all outcomes; red: tendinopathy specific).

Figure 2: Effect size distributions across outcome domains with identification of small, medium and large thresholds



Black curve represents density plot of empirical effect size distribution. Diamonds with intervals represent small, medium and large thresholds with credible intervals (black: all outcomes; red: outcome domain specific).

Supplementary File 1: Exercise therapy definitions

Therapy Class	Definition	Therapy Treatment	Definition
Resistance	Exercise designed primarily to increase strength of muscles by causing them to produce substantive force against an applied resistance which can take several forms including the mass of the body or its segments, isoinertial resistance, elastic resistance, or strength training equipment such as isokinetic devices. In tendinopathy, the stimulus may also be intended to provoke tendon remodelling, reduce pain and improve function.	Concentric Only	Includes movements where force produced overcomes the resistance such that muscle shortening occurs.
		Eccentric Only	Includes movements where force produced is less than the resistance such that controlled muscle lengthening occurs.
		Concentric and eccentric	Includes movements where force produced exceeds the resistance in one phase and is less than the resistance in another such that controlled muscle lengthening and shortening occurs.
		Isokinetic	Uses specialised exercise equipment such that the resistance is adjusted in real-time to ensure joint angular velocity remains constant.
		Isometric	Includes muscular actions against a resistance such that joint angle remains constant.
Flexibility	Exercise designed to increase joint range of motion and extensibility of muscles and/or associated tissues. Also referred to as range-of-motion exercises or stretching.	Static	Joint range of motion actions where the movement is held at or near the end range of motion.
		Dynamic	Joint range of motion actions where the movement is performed continuously into and out of the end range of motion.
		PNF	Proprioceptive neuromuscular facilitation is a technique combining passive stretching and isometric action to achieve maximum range of motion.
		Ballistic	Uses the momentum of a moving body or a limb to increase joint range of motion, bouncing into (or

Therapy Class	Definition	Therapy Treatment	Definition
			out of) a stretched position.
Proprioception	Exercise designed to enhance the sensation of the joint relative to body position and movement, sense of force, and to encourage muscular stabilisation of the joint in the absence of external stabilising devices e.g. ankle brace.	Sense of joint position and force	Exercise aimed at enhancing the ability to perceive joint position and force with minimal external cues.
		Balance	Includes exercise that require the person to keep or return the displacement of centre of gravity over the base of support through various environmental conditions and changes in body position.
		Movement pattern retraining	Exercise aimed at re-education of motor control and movement patterns that may involve specific retraining of under- or over-active muscles and alteration of kinematic rotation +- translation timing between body segments. May also be termed motor control or stabilisation.
Plyometric	Exercise where a resistance is overcome by a muscle rapidly stretching then shortening	Plyometric	Exercise where a resistance is overcome by a muscle rapidly stretching then shortening.
Vibration	Exercise where body segments are held stationary or actively displaced as per definitions for other treatment classes whilst applying a rapid oscillating resistance	Vibration	Exercise where body segments are held stationary or actively displaced as per definitions for other treatment classes whilst applying a rapid oscillating resistance

Supplementary File 2: Outcome domain definitions and example tools

Domain	ICON Definition	Example Tools
Disability	Composite scores of a mix of patient-rated pain & disability due to the pain, usually relating to tendon-specific activities/tasks	VISA scales; DASH; quick DASH; SPADI; Patient-rated tennis-elbow evaluation questionnaire; Constant Murley Score; WORC (Western Ontario Rotator Cuff Index); AOFAS (American Orthopaedic Foot & Ankle Society); Roles and Maudsley score; ASES (American Shoulder & Elbow Surgeons Index; Tegner activity score; Lysholm knee scale; Pain free function questionnaire; Ankle activity score; Subjective elbow Value (SEV); Placzek score; Shoulder disability questionnaire; International Knee Documentation Committee form (IKDC); Penn Shoulder score (university of Pennsylvania shoulder score) (PSS); Brief pain inventory (BPI); UCLA Shoulder Rating Scale; FILLA - functional index of leg and lower limb; Neer Shoulder Score; Nirschl phase rating scale; American Shoulder and Elbow Surgeon's (MASES) questionnaire; Mayo Elbow Performance Score (MEPS); Shoulder rating questionnaire (SRQ)
Function:	Participant/patient rated level of function (and not referring to the intensity of their pain; eg, Patient Specific Function Scale on a VAS or NRS).	Patient-specific functional scale
Pain: Pain on loading/activity	Patient reported intensity of pain performing a task that loads the tendon	VAS; NRS; Pain experience scale
Pain: Pain over a specified time	Patient-reported pain intensity over period of time e.g. morning/night/24-hours/1-week	VAS; NRS Painful days in 3 months
Pain: Pain without further specification	Patient asked about pain levels without reference to activity or timeframe	VAS; NRS; Borg CR10 Scale; Pain status
Physical function capacity	Quantitative measures of physical tasks (e.g. hops, times walk, single leg squat) includes muscle strength	Counter movement jump; One-leg triple hop; Single-leg decline squat; Muscle strength measured by dynamometry (hand-held, isokinetic); Repetition maximum; Manual muscle testing.
Quality of Life	General wellbeing	EQ5D; EQ3D; SF-36 or SF-12; Assessment of Quality of Life (AQoL); Nottingham Health Profile; Gothenburg QoL Instrument

Domain	ICON Definition	Example Tools
Range of Motion (Shoulder only)	Active or passive range of motion in specified plane, measured in degrees.	Hand-held goniometer; inclinometer

Supplementary File 3: Search databases and terms

Search last updated 19/01/2021

Embase (Ovid)	(exercise OR exercise*.mp OR "isometric exercise" OR kinesiotherapy OR Eccentric.mp OR concentric.mp OR "heavy slow resistance".mp OR "isokinetic exercise" OR plyometrics OR "muscle stretching" OR "muscle training") AND (tendinitis OR Tendinopathy.mp OR "tendon injury" OR "shoulder injury" OR "rotator cuff injury" OR "tennis elbow" OR tendin.mp OR tendon.mp OR bursitis OR "shoulder impingement syndrome" OR 2posterior tibial tendon dysfunction" OR "Greater trochanteric pain syndrome".mp)
CINAHL (EBSCO-host)	(MH Exercise OR AB exercise* OR MH "muscle strengthening" OR MH "rehabilitation" OR MH "eccentric contraction" OR TX "heavy slow resistance exercis*" OR AB eccentric OR AB concentric OR AB isokinetic OR MH "therapeutic exercise") AND (MH tendinopathy OR MH "arm injuries" OR "tendon injuries" OR MH tendons OR TX tendin* OR TX tendon* OR AB bursitis OR MH Bursitis OR MH "Posterior tibial tendon dysfunction" OR MH "shoulder impingement syndrome" OR AB "Greater trochanteric pain syndrome")
Medline (EBSCO-host)	(MH exercise OR AB exercise* OR MH "isometric contraction" OR MH rehabilitation OR TX eccentric OR TX concentric OR TX "heavy slow resistance" OR TX isokinetic) AND (MH tendinopathy OR MH "shoulder injuries" OR MH tendons OR MH "tendon injuries OR TX tendin* OR tendon* OR MH bursitis OR AB bursitis OR MH "posterior tibial tendon dysfunction" OR MH "shoulder impingement syndrome" OR AB "greater trochanteric pain syndrome")
SPORTDiscus (EBSCO-host)	(DE exercise OR DE "exercise therapy" OR AB exercise* OR TX eccentric OR TX concentric OR TX "heavy slow resistance" OR DE "isokinetic exercise" OR DE plyometrics OR DE "strength training" OR DE "stretch (physiology)" OR DE "isometric exercise" OR DE rehabilitation) AND (DE tendinitis OR DE tendinosis OR AB tendinopathy OR DE "tendon injuries" OR "shoulder injuries" OR DE "tennis elbow" OR AB tendin* OR AB tendon* OR DE bursitis OR AB "shoulder impingement syndrome" OR AB "posterior tibial tendon dysfunction" OR AB "greater trochanteric pain syndrome")
Amed (EBSCO-host)	(ZU exercise OR ZU "exercise therapy" OR AB exercise OR ZU "muscle stretching exercises" OR ZU "isometric contraction" OR ZU rehabilitation OR TZ eccentric OR TZ concentric OR TX "heavy slow resistance" OR TX isokinetic OR AB plyometric) AND (ZU tendinopathy OR ZU "tendon injuries" OR ZU tendons OR ZU "shoulder injuries" OR ZU "tennis elbow" OR TX tendin* OR TX tendon* OR ZU bursitis OR AB bursitis OR ZU "shoulder impingement syndrome" OR ZU "posterior tibial tendon dysfunction" OR AB "greater trochanteric pain syndrome")
Open Grey	Tendinopathy AND exercise

	Tendin* AND exercise Tendon AND exercise
Mednar	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
New York Academy Grey Literature Report	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
EThOS	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
Google Scholar	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
JBI Evidence Synthesis	Tendinopathy AND exercise
Cochrane Library	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
PEDro	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
Epistemonikos	(tendinopathy OR tendon* OR tendin*) AND exercise
CORE	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
Clinicialtrials.gov	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
ISRCTN	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
EU CTR	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise
ANZCTR	Tendinopathy AND exercise Tendin* AND exercise Tendon AND exercise

ISRCTN – the Research Registry; EU CTN – European Clinical Trials Registry; ANZCTR – Australia and New Zealand Clinical Trials Registry

Supplementary File 4: Extraction codebook

	Column	Heading	Description
Study Details	A	Initials Reviewer	Identification of individual extracting information
	B	Covidence Identifier	Reference number for Covidence
	C	Author	First author surname *et al.,*
	D	Year	Year of publication
	E	Title	Study title
	F	Country	Country where study was conducted
	G	Journal	Journal name
	H	Aims/Purpose	Study aims/purpose
	I	Tendinopathy type	1=Achilles; 2= Lateral elbow (tennis); 3 = Patellar; 4 = Rotator cuff (SI)
	J	Study Design	RCT = 1; Quasi-experimental = 2
	K	Age Mean	Mean age of study sample as a whole
	L	Age SD	Standard deviation age of study sample as a whole
	M	Baseline Total N	Total sample across all interventions measured at baseline
	N	Training Status Description	Brief description of training status of study sample as a whole
	O	Training Status Code	1 = Performance; 2 = Sporting; 3 = Other
	P	Sex	Percentage female of study sample as a whole
	Q	BMI Mean	Mean BMI of study sample as a whole
	R	BMI SD	Standard deviation of BMI of study sample as a whole
	S	Symptom Severity Mean	Mean severity measure at baseline of study sample as a whole
	T	Symptom Severity SD	Standard deviation of severity measure at baseline of study sample as a whole
	U	Symptom Duration Mean (Months)	Mean symptom duration reported in months
	V	Symptom Duration SD (Months)	Standard deviation symptom duration reported in months
	W	Population Comments	Any additional information relevant to the participants investigated including diagnostic criteria
Outcomes	X	Outcome Category	1 = Disability; 2 = Pain on loading/activity; 3 = Pain over a specified time; 4 = Pain without further specification; 5 = Physical function capacity
	Y	Outcome Tool	Description of outcome tool
	Z	Reflection	1 = Increase in outcome indicates positive treatment; -1 = Decrease in outcome indicates positive treatment
	AA	Measurement Time (Weeks)	Time of measurement in weeks

Intervention	AB	Dominant Treatment Class	**Only one dominant theme to be selected** 1 = Resistance; 2 = Plyometric; 3 = Vibration; 4 = Flexibility; 5 = Movement pattern retraining
	AC	Total Treatment class	**Multiple themes to be selected as required** 1 = Resistance; 2 = Plyometric; 3 = Vibration; 4 = Flexibility; 5 = Movement pattern retraining
	AD	Intervention N	Intervention sample size at specified time
	AE	Intervention Total Duration	Total duration of exercise intervention in weeks
	AF	Intervention Adherence %	Reporting of adherence to exercise (reported as a percentage) if applicable
	AG	Intervention Location	Location exercise was performed 1 = Home; 2 = Clinic; 3 = Fitness facility; 4 = NR; 5 = NA
	AH	Intervention Volume	Numerical value describing volume
	AI	Intervention Volume Category	1 = Duration of session (mins); 2 = sets * repetitions; 3 = number of repetitions; 4 = number of sets
	AJ	Intervention Volume Comments	Any additional information relevant.
	AK	Intervention Intensity	Numerical value describing intensity
	AL	Intervention Intensity Category	1 = Absolute; 2 = Relative
	AM	Intervention Frequency	Number of sessions per week. Where there is progression, average value is to be entered.
	AN	Intervention Frequency Comments	Any additional information relevant.
	AO	Intervention Progression	**Multiple themes to be selected as required** 1 = No progression; 2 = NR; 3 = Progression volume; 4 = Progression intensity; 5 = Progression frequency; 6 = Progression specificity; 7 = Progression capacity; 8 = Other
	AP	Intervention Progression Comments	Any additional information relevant.
Control	AQ	Control Comparator	1 = Placebo; 2 = No treatment
	AR	Control Comparator Comments	Any additional information relevant.
Data	AS	Intervention Baseline Mean	Baseline mean for exercise therapy
	AT	Intervention Baseline SD	Baseline standard deviation for exercise therapy
	AU	Intervention Measurement Mean	Mean of outcome for exercise therapy at stated time point
	AV	Intervention Measurement SD	Standard deviation of outcome for exercise therapy at stated time point
	AW	Control Baseline Mean	Baseline mean for control
	AX	Control Baseline SD	Baseline standard deviation for control

AY	Control Measurement Mean	Mean of outcome for control at stated time point
AZ	Control Measurement SD	Standard deviation of outcome for control at stated time point
BA	Measurement Comments	State if a different value has been entered for means (e.g. median), a different value for standard deviations (e.g. standard error, IQR, percentiles, distance from mean to upper bound). Provide the relevant statistic (width of CI's, width of percentiles). Also state if data has been extracted by digitization

*** Outcome Specific**

Supplementary File 5: Table of included studies

Study (first author, year, country)	Design	Tendinopathy Location	Participants (number (n); sex (%female); mean (sd) age; mean (sd) symptom duration in months)	Exercise Treatment arms	Exercise Treatment classes	Findings
Aceituno-Gómez 2019 Spain[1]	Quasi-experimental	Rotator cuff - subacromial impingement	N=43 % female 60.9 Age 59 (8.9) Symptoms NR Training status Other	1	(Flexibility, Resistance)	High-intensity laser therapy plus exercise did not give greater improvements in pain and functionality in patients with subacromial syndrome than exercise alone.
Akkaya 2016 Turkey[2]	RCT	Rotator cuff - subacromial impingement	N=34 % female 67.6 Age 41.7 (8.9) Symptoms 6.9 (4.1) Training status Other	2	2*(Flexibility)	Weighted and un-weighted solo pendulum exercises achieved significant clinical improvements but showed no differences in ultrasonographic acrohumeral distance measurements between groups.
Alfredson 1998 Sweden[3]	Quasi-experimental	Achilles	N= 30 % female 20.0 Age 44.0 (7.0) Symptoms 25.9 (3-100)** Training status Recreational	1	(Resistance)	Our treatment model with heavy-load eccentric calf muscle training has a very good short-term effect on athletes in their early forties.
Alfredson 1999 Sweden[4]	Quasi-experimental	Achilles	N= 24 % female 14.3 Age 42.6 (9.0) Symptoms 23.7 (3-100)** Training status Recreational	1	(Resistance)	Heavy-loaded, eccentric calf-muscle training seems to be a good treatment mode for chronic Achilles tendinosis.
Arias-Buría 2017 Spain[5]	RCT	Rotator cuff - subacromial impingement	N= 50 % female 26.0 Age 48.5 (5.5) Symptoms 71.9 (21.6)	1	(Resistance)	This study found that the inclusion of 2 sessions of TrP-DN into an exercise program was effective for improving shoulder pain-related disability at short-, medium-, and long-term;

			Training status Other			however, no greater improvement in shoulder pain was observed.
Arias--Buría 2015 Spain[6]	RCT	Rotator cuff - subacromial impingement	N= 36 % female 75.0 Age 57.5 (6.4) Symptoms 10.9 (2.6) Training status Other	1	(Resistance)	Ultrasound-guided percutaneous electrolysis combined with eccentric exercises resulted in better short-term outcomes compared to eccentric exercises alone.
Bae 2011 Korea (Republic of)[7]	Quasi-experimental	Rotator cuff - subacromial impingement	N=35 % female 65.7 Age 49.1 (4.9) Symptoms Training status Other	1	(Proprioception, Resistance)	The motor control and strengthening programme improved pain, function, strength and ROM.
Bahr 2006 Norway[8]	RCT	Patellar	N= 40 % female 12.5 Age 30.5 (7.9) Symptoms 34 (28.7) Training status Other	1	(Resistance)	No added benefit was observed for surgical treatment to eccentric strength training. Eccentric training should be offered for 12 weeks before tenotomy is considered for the treatment of patellar tendinopathy.
Balius 2016 Spain[9]	RCT	Achilles	N=37 % female 20.4 Age 41.4 (11.7) Symptoms NR Training status Other	6	4*(Resistance);2*(Flexibility)	Findings confirmed the therapeutic potential of eccentric exercise at reactive and degenerative stages of tendinopathy. MCVC supplementation decreased pain more than eccentric exercise alone (reactive tendinopathy) Personalized stretching regime supplemented with MCVC may be appropriate for some patients
Bang 2000 United States[10]	RCT	Rotator cuff - subacromial impingement	N=50 % female 42.3 Age 43 (9.1) Symptoms 5 (3.3) Training status Other	1	(Flexibility, Resistance)	Manual physical therapy applied by experienced physical therapists combined with supervised exercise in a brief clinical trial is better than exercise alone for increasing strength, decreasing pain, and improving function in patients with shoulder impingement syndrome
Başkurt 2011 Turkey[11]	Quasi-experimental	Rotator cuff - subacromial impingement	N= 40 % female 67.5 Age 51.4 (10.0)	2	1*(Flexibility, Resistance);1*(Flexibility, Proprioception)	Scapular stabilisation combine with stretching and strengthening exercises can be more effective in the short-term for SIS.

			Symptoms NR Training status Other			
Beyer 2015 Denmark[12]	RCT	Achilles	N= 58 % female 31.9 Age 48.0 (2.0) Symptoms 18.1 (4.3) Training status Other	2	2*(Resistance)	Both traditional eccentric exercise and HSR yield positive, equally good and lasting clinical results in patients with Achilles tendinopathy. HSR is associated with greater patient satisfaction after 12 weeks but not after 52 weeks.
Blume 2015 United States[13]	RCT	Rotator cuff - subacromial impingement	N= 34 % female 58.0 Age 49.4 (15.6) Symptoms 22.7 (24.3) Training status Other	2	2*(Flexibility, Resistance)	Both eccentric and concentric PRE programs resulted in improved function, AROM, and strength in patients with SAIS. However, no difference was found between the two exercise modes, suggesting that therapists may use exercises that utilize either exercise mode in their treatment of SAIS.
Boudreau 2019 Canada[14]	RCT	Rotator cuff - subacromial impingement	N= 42 % female 52.4 Age 42.9 (12.0) Symptoms 43.0 (46.6) Training status Other	2	2*(Resistance)	No additional benefit was found to adding coactivation to regular rotator cuff strengthening exercises at 6-weeks.
Breda 2020 Netherlands[15]	RCT	Patellar	N= 76 % female 23.7 Age 24 (3.9) Symptoms 98.5 (NR) Training status Performance	2	1*(Plyometric, Resistance);1*(Flexibility, Resistance)	In patients with patellar tendinopathy, progressive tendon-loading exercises resulted in a significantly better clinical outcome after 24 weeks than eccentric exercise therapy. Progressive tendon-loading exercises are superior to eccentric exercise therapy and are therefore recommended as initial conservative treatment for patellar tendinopathy.
Brox 1999 Norway[16]	RCT	Rotator cuff - subacromial impingement	N= 125 % female 44.0 Age 47.6 (23-66)** Symptoms NR Training status Other	1	(Proprioception, Resistance)	At 2.5 years follow-up, both arthroscopic surgery and supervised exercises are better treatments than placebo with no significant difference between the 2 active treatments.

Calis 2011 Turkey[17]	RCT	Rotator cuff - subacromial impingement	N= 52 % female 67.3 Age 49.2 (12.6) Symptoms 3.0 (1-24)** Training status Other	1	(Flexibility)	Ultrasound and laser treatments were not superior to each other in the treatment of SIS
Chaconas 2017 United States[18]	RCT	Rotator cuff - subacromial impingement	N=46 % female 41.7 Age 45.9 (17.4) Symptoms 49.1 (80) Training status Other	2	2*(Flexibility, Resistance)	An eccentric program targeting the external rotators was superior to a general exercise program for strength, pain, and function after six months. The findings suggest eccentric training may be efficacious to improve self-report function and strength for those with SAPS.
Cheng 2007 Hong Kong, China (SAR)[19]	RCT	Rotator cuff - subacromial impingement	N=94 % female Age 32.4 (10.2) Symptoms 23.4 Training status Other	2	1*(Flexibility, Proprioception);1*(Resistance, Flexibility)	An eccentric program targeting the external rotators was superior to a general exercise program for strength, pain, and function after six months. The findings suggest eccentric training may be efficacious to improve self-report function and strength for those with subacromial pain syndrome.
Cho 2017 Korea (Republic of)[20]	Quasi-experimental	Patellar	N= 30 % female 46.7 Age 33.1 (29.1) Symptoms 15.1 (16.1) Training status Other	1	(Flexibility, Proprioception, Resistance)	A rehabilitation exercise programme was more effective at improving pain, strength and function in patellar tendinopathy that injection therapy alone.
de Jonge 2008 Netherlands[21]	RCT	Achilles	N= 70 % female NR Age 44.6 (26-59) ** Symptoms 30.7 (2-204) ** Training status Other	1	(Resistance)	Eccentric exercises with or without a night splint improved functional outcome at one year follow-up. At follow-up there was no significant difference in clinical outcome when a night splint was used in addition to an eccentric exercise.
de Oliveira 2020 Canada[22]	RCT	Rotator cuff - subacromial impingement	N= 52 % female 42.3 Age 30.2 (8.3)	1	(Flexibility, Proprioception, Resistance)	Whereas symptoms, functional limitations, ROM, and AHD improved in both groups, the addition of KT did not lead to superior outcomes

			Symptoms 22.6 (26.7) Training status Other			compared with exercise-based treatment alone, in the mid and long term, for individuals with RCRSP.
de Vos 2007 Netherlands[23]	RCT	Achilles	N= 63 % female 41.3 Age 44.6 (8) Symptoms 30.6 (50.6) Training status Recreational	1	(Resistance)	A night splint has no added benefit to eccentric exercises in the treatment of chronic midportion Achilles tendinopathy. There was no significant difference between the two groups in VISA-A score and patient satisfaction.
Dejaco 2017 Netherlands[24]	RCT	Rotator cuff - subacromial impingement	N=36 % female 47.3 Age 49.5 (11.3) Symptoms 19.7 (20.1) Training status Other	2	2*(Flexibility, Resistance)	12-week-isolated eccentric training programme of the RC is beneficial for shoulder function and pain after 26 weeks in patients with RC tendinopathy. However, it is no more beneficial than a conventional exercise programme for the RC and scapular muscles.
Devereaux 2016 Canada[25]	RCT	Rotator cuff - subacromial impingement	N= 100 % female 37.9 Age 48.0 (11.9) Symptoms NR Training status Other	2	1*(Flexibility, Proprioception);1*(Resistance, Flexibility)	The improvements in pain and function observed with an NSAID or precut kinesiology tape as adjuvant treatments were no greater than with rehabilitation exercise alone.
Dimitrios 2013 Cyprus[26]	Quasi-experimental	Patellar	N= 60 % female 36.7 Age 47.57 (5.9) Symptoms 4.5 (NR) Training status Other	2	2*(Flexibility, Resistance)	A specific supervised exercise programme is superior to a specific home exercise programme in reducing pain and improving function in patients with LET at the end of the treatment and at the 3 month follow-up.
Dimitrios 2012 Greece[27]	Quasi-experimental	Patellar	N= 60 % female 36.7 Age 47.6 (5.9) Symptoms 4.5 (NR) Training status Other	2	1*(Flexibility, Resistance);1*(Resistance)	Eccentric training and static stretching exercises is superior to eccentric training alone to reduce pain and improve function in patients with patellar tendinopathy at the end of the treatment and at follow-up.
Dupuis 2018 Canada[28]	RCT	Rotator cuff - subacromial impingement	N=43 % female 55.8 Age 33.3 (11.7) Symptoms 0.9 (0.3)	2	1*(Flexibility);1*(Flexibility, Resistance)	Both groups showed statistically significant improvements on symptoms and function at 2 weeks and 6 weeks but there was no difference between the short-term effect of cryotherapy and a

			Training status Other			gradual reloading exercise programme.
Engebretsen 2009 Norway[29]	RCT	Rotator cuff - subacromial impingement	N= 104 % female 50.0 Age 48.0 (10.6) Symptoms 12.5 (NR) Training status Other	1	(Plyometric, Proprioception, Resistance)	Supervised exercises are superior to ESWT in terms of shoulder pain, disability and some work-related outcomes.
Engebretsen 2011 Norway[30]	RCT	Rotator cuff - subacromial impingement	N= 104 % female 50.0 Age 48.0 (10.6) Symptoms 12.5 (NR) Training status Other	1	(Proprioception)	Both radial ESWT and the supervised exercise regime devised by Bohmer (1998) provided similar benefits in pain and function-related outcomes. However, exercise may be superior for work-related outcomes.
Gatz 2020 Germany[31]	RCT	Achilles	N= 42 % female 35.7 Age 50.0 (12.0) Symptoms 27.5 (23.8) Training status Other	2	2*(Resistance)	No additional clinical benefits of adding ISOs to a basic EE program could be found in this preliminary randomized controlled trial study over a period of 3 months. SWE was able to differentiate between insertional and midportion tendon tissue and localize reported symptoms to sublocations but this did not correlate with better clinical scores (VISA-A) over a 3-month follow-up period.
Giray 2019 Turkey[32]	RCT	Lateral elbow/tennis elbow	N= 30 % female 86.7 Age 44.46 (9.92) Symptoms 1.69 (NR) Training status Other	1	(Flexibility, Resistance)	Kinesiotaping in addition to exercises is more effective than sham taping and exercises alone in improving pain in daily activities and arm disability due to lateral epicondylitis.
Granviken 2015 Norway[33]	RCT	Rotator cuff - subacromial impingement	N=44 % female 48 Age 47.9 (9.9) Symptoms 14.5 Training status Other	2	1*(Flexibility, Proprioception);1*(Resistance, Flexibility)	No significant differences in pain and disability were found between home exercises and supervised exercises of more than the first session of a 6-week exercise regime for people with subacromial impingement.
Hallgren 2014 Sweden[34]	RCT	Rotator cuff - subacromial impingement	N= 50 % female 37.0 Age 52 (30-65)**	2	1*(Resistance);1*(Flexibility)	Specific exercises produced positive short-term improvements at 1-year follow-up and reduces the need for surgery. Full-

			Symptoms 18 (6-186)* Training status Other			thickness tear and a low CMS score appear to be predictors of poor outcome.
Hallgren 2017 Sweden[35]	RCT	Rotator cuff - subacromial impingement	N= 108 % female 34.1 Age 58 (NR) Symptoms NR Training status Other	2	1*(Flexibility, Resistance);1*(Flexibility)	More patients in the specific exercise group managed to avoid surgery compared to the unspecific exercise group at 5-year follow-up supporting it's prescription as an initial treatment for patients with subacromial pain.
Heron 2017 United Kingdom[36]	RCT	Rotator cuff - subacromial impingement	N= 120 % female 41.0 Age 49.9 (NR) Symptoms NR Training status Other	3	2*(Flexibility, Resistance);1*(Flexibility)	Open chain, closed chain, and range of movement exercises all seem to be effective in bringing about short-term changes in pain and disability in patients with rotator cuff tendinopathy.
Hotta 2020 Brazil[37]	RCT	Rotator cuff - subacromial impingement	N=60 % female 70 Age 49 (9) Symptoms 28.5 (24) Training status Other	2	1*(Resistance, Proprioception);1*(Resistance)	The inclusion of the isolated scapular stabilization exercises, emphasizing retraction and depression of the scapula, to a progressive general periscapular strengthening protocol did not add benefits to self-reported shoulder pain and disability, muscle strength, and ROM in patients with subacromial pain syndrome.
Johansson 2005 Sweden[38]	RCT	Rotator cuff - subacromial impingement	N=85 % female 69.4 Age 49 (7.5) Symptoms NR Training status Other	1	(Flexibility, Resistance)	Acupuncture was more effective than ultrasound when applied in addition to home exercises.
Johnson 2005 Sweden[39]	RCT	Patellar	N= 15 % female 13.3 Age 24.9 (8.2) Symptoms 17.5 (13.2) Training status Performance	2	2*(Resistance)	Eccentric, but not concentric, quadriceps training on a decline board, seems to reduce pain in jumper's knee.
Jonsson 2009 Sweden[40]	Quasi-experimental	Achilles	N= 15 % female 13.3 Age 25.0 (NR)	2	2*(Resistance)	Treatment with painful eccentric calf-muscle training showed good clinical results based on VAS scores, patient

			Symptoms 17.5 (13.2) Training status Other			satisfaction, and return to pre-injury activity levels in patients with chronic painful mid-portion Achilles tendinosis, but not in patients with chronic insertional Achilles tendon pain.
Juul-Kristensen 2019 Denmark[41]	RCT	Rotator cuff - subacromial impingement	N= 58 % female 51 Age 42.9 (12.4) Symptoms NR Training status Other	2	2*(Proprioception, Flexibility)	Electromyography-biofeedback neuromuscular shoulder exercises and neuromuscular shoulder exercises were both effective in reducing pain to a clinically relevant level, while electromyography biofeedback did not make a difference. The current neuromuscular shoulder exercise protocol is recommended
Ketola 2009 Finland[42]	RCT	Rotator cuff - subacromial impingement	N=134 % female 62.9 Age 47.1(23.3-60.0)** Symptoms 2.6 (NR) Training status Other	1	(Resistance, Proprioception)	Arthroscopic acromioplasty provides no clinically important effects over a structured and supervised exercise programme alone in terms of subjective outcome or cost-effectiveness when measured at 24 months.
Ketola 2013 Finland[43]	RCT	Rotator cuff - subacromial impingement	N=140 % female 62.9 Age 41.7 Symptoms Training status Other	1	(Flexibility, Resistance)	Differences in the patient-centred primary and secondary parameters between the two treatment groups were not statistically significant, suggesting that acromioplasty is not cost-effective.
Kim 2017 Korea (Republic of)[44]	RCT	Rotator cuff - subacromial impingement	N= 40 % female 72.5 Age 51.1 (10.6) Symptoms NR Training status Other	2	2*(Proprioception))	The use of visual feedback and 3D motion images can improve pain and function in SIS.
Kim 2020 Korea (Republic of)[45]	RCT	Rotator cuff - subacromial impingement	N= 40 % female 100 Age 46.2 (4.6) Symptoms NR Training status Other	1	(Proprioception, Vibration)	Both the Neurac modality and manual therapy induced pain relief, improved function, and increased ROM. The Neurac intervention also resulted in a significant enhancement of shoulder muscle strength indicating its superiority as an effective therapeutic

						modality for this particular patient group.
Knobloch 2008 Italy[46]	RCT	Achilles	N= 92 % female 35.0 Age 47.5 (11.0) Symptoms NR Training status Recreational	1	(Resistance)	Patients with tendinopathy of the main body of the AT experienced improved clinical outcome with both management options. Although tendon microcirculation was optimized in the combined group of eccentric training and AirHeel Brace, these micro-vascular advantages do not translate into superior clinical performance when compared with eccentric training alone.
Knobloch 2007 Germany[47]	RCT	Achilles	N= 20 % female 45.0 Age 32.5 (11.0) Symptoms NR Training status	1	(Resistance)	An eccentric-training program performed daily over 12 weeks reduced the increased paratendinous capillary blood flow in Achilles tendinopathy by as much as 45% and decreased pain level based on a visual analog scale. Local paratendon oxygenation was preserved while paratendinous postcapillary venous filling pressures were reduced after 12 weeks of eccentric training, which appears to be beneficial from the perspective of microcirculation.
Knobloch 2007 Germany[48]	RCT	Achilles	N= 118 % female 40 Age 48.5 (12) Symptoms NR Training status Other	1	(Resistance)	Achilles tendon oxygen saturation is increased, and capillary venous clearance facilitated using an Achilles wrap in addition to daily 12-week eccentric training
Kongsgaard 2009 Denmark[49]	RCT	Patellar	N= 37 % female 0 Age 32.4 (8.8) Symptoms 18.7 (12.3) Training status Recreational	2	2*(Resistance)	Corticosteroid injection has good short-term but poor long-term clinical effects, in patellar tendinopathy. Heavy-slow resistance exercise has good short- and long-term clinical effects accompanied by pathology improvement and increased collagen turnover.
Kromer 2014 Germany[50]	RCT	Rotator cuff - subacromial impingement	N= 90 % female 51.1	1	(Flexibility, Proprioception, Resistance)	The use of MT including Physiotherapy provides no additional benefits and is more expensive in

			Age 51.8 (11.2) Symptoms 24.1 (35.1) Training status Other			comparison to exercise only interventions.
Kromer 2013 Germany[51]	RCT	Rotator cuff - subacromial impingement	N= 90 % female 51.1 Age 51.8 (11.2) Symptoms 7.8 (9.8) Training status Other	1	(Flexibility, Proprioception, Resistance)	Individually adapted exercises were effective in the treatment of patients with shoulder impingement syndrome. Individualized manual Physiotherapy contributed only a minor amount to the improvement in pain intensity.
Littlewood 2016 United Kingdom[52]	RCT	Rotator cuff - subacromial impingement	N= 60 % female 50.3 Age 54.7 (NR) Symptoms 14.6 (NR) Training status Other	1	(Resistance)	Self-management programme based on a single exercise were comparable to usual Physiotherapy in the short-, mid- and long-term.
Ludewig 2003 United States[53]	RCT	Rotator cuff - subacromial impingement	N= 85 % female 0.0 Age 48.8 (2.1) Symptoms NR Training status Other	1	(Flexibility, Resistance)	Home exercise programme are more effective in reducing symptoms and improving function (Shoulder Rating Questionnaire, shoulder satisfaction score) than the control group in construction workers with shoulder pain.
Luginbuhl 2008 Switzerland[54]	RCT	Lateral elbow/tennis elbow	N= 30 % female 72.7 Age 47 (9) Symptoms 10 (11) Training status Other	1	(Resistance)	No beneficial effect of neither the forearm support band nor the strengthening exercises could be found.
Maenhout 2013 Belgium[55]	RCT	Rotator cuff - subacromial impingement	N= 61 % female 59.0 Age 39.8 (13.0) Symptoms NR Training status Other	2	2*(Resistance)	Adding heavy load eccentric training resulted in a higher gain in isometric strength at 90 degree of scapular abduction but was not superior for decreasing pain and improving shoulder function. The addition of a limited amount of Physiotherapy sessions combined with a daily home exercise programme is highly effective in patients with impingement.

Mafi 2001 Sweden[56]	RCT	Achilles	N= 44 % female 45.5 Age 48.3 (8.8) Symptoms 20.5 (3-120)** Training status Other	2	2*(Resistance)	Eccentric calf muscle training showed superior results to concentric training in the treatment of chronic Achilles tendinosis based on patient satisfaction and return to activity level.
Manias 2006 United Kingdom[57]	RCT	Lateral elbow/tennis elbow	N= 40 % female 67.5 Age 42.86 (6.23) Symptoms NR Training status Other	2	2*(Resistance)	An exercise programme consisting of eccentric and static stretching exercises had reduced the pain in patients with lateral epicondyle tendinopathy at the end of the treatment and at the follow up whether or not ice was included.
Martinez-Silvestrini 2005 United States[58]	Quasi-experimental	Lateral elbow/tennis elbow	N= 81 % female 46.8 Age 45.5 (7.7) Symptoms NR Training status Other	3	2*(Flexibility, Resistance);1*(Flexibility)	Eccentric strengthening for the wrist extensors in subjects with lateral epicondylitis demonstrated improvement at six weeks but was not statistically different from that achieved with a conservative program with stretching or a concentric strengthening program.
Marzetti 2014 Italy[59]	RCT	Rotator cuff - subacromial impingement	N= 48 % female 61.4 Age 62.1 (12.5) Symptoms NR Training status Other	2	1*(Flexibility, Resistance);1*(Proprioception)	Neurocognitive rehabilitation is effective in reducing pain and improving function in patients with shoulder impingement syndrome, with benefits maintained for at least 24 weeks.
McCormack 2016 United States[60]	RCT	Achilles	N= 15 % female 68.8 Age 53.6 (38-69)** Symptoms 9.9 (NR) Training status Other	1	(Resistance)	Soft tissue treatment (Astym) plus eccentric exercise was more effective than eccentric exercise alone at improving function during both short- (26 weeks) and long-term (52 weeks) follow-up periods.
Melegati 2000 Italy[61]	RCT	Rotator cuff - subacromial impingement	N= 90 % female 65.5 Age 54.4 (3.0) Symptoms NR Training status Other	1	(Flexibility, Resistance)	Groups A (kinesitherapy) and B (ESWT + kinesitherapy) achieved a significant constant score improvement, whereas the increase in group C (control) was not significant.

Mulligan 2016 United States[62]	RCT	Rotator cuff - subacromial impingement	N=50 % female 65 Age 50.1 (10.7) Symptoms 7.9 (7.4) Training status Other	1	(Proprioception, Resistance)	Patients with SAIS demonstrate improvement in pain and function with a standardized program of physical therapy regardless of group exercise sequencing.
Nishizuka 2017 Japan[63]	RCT	Lateral elbow/tennis elbow	N=110 % female 39.1 Age 53.6 (11.8) Symptoms 2.04 (1.77) Training status Other	1	(Flexibility)	A forearm band may have no more than a placebo effect and is not recommended based on its effectiveness.
Nørregaard 2007 Denmark[64]	RCT	Achilles	N= 35 % female 49.0 Age 42.0 (2.0)*** Symptoms 28.4 (8.8)*** Training status Other	2	1*(Resistance);1*(Flexibility)	Symptoms gradually improved during the 1-year follow-up period and were significantly better assessed by pain and symptoms after 3 weeks and all later visits. However, no significant differences could be observed between the two groups.
Nowotny 2018 Germany[65]	RCT	Lateral elbow/tennis elbow	N= 31 % female 57 Age 46 (NR) Symptoms NR Training status Other	1	(Resistance)	The use of an elbow orthosis appears to reduce pain and improve other subjective outcome measures. However, the long-term results do not appear to be any greater than those received through Physiotherapy alone.
Østerås 2010 Norway[66]	RCT	Rotator cuff - subacromial impingement	N=61 % female 20.5 Age 43.9 (13) Symptoms 40.2 (56.3) Training status Other	2	2*(Flexibility, Resistance)	In long-term subacromial pain syndrome, high dosage medical exercise therapy is superior to a conventional low dosage exercise programme
Paavola 2018 Finland[67]	RCT	Rotator cuff - subacromial impingement	N= 186 % female 69.8 Age 50.6 (5.0) Symptoms 19.5 (18.9) Training status NR	1	(Flexibility, Proprioception, Resistance)	Arthroscopic subacromial decompression provided no benefit over diagnostic arthroscopy in patients with shoulder impingement syndrome.
Park 2010	RCT	Lateral elbow/tennis elbow	N=31 % female 61.3	1	(Resistance)	Isometric strengthening exercises done early in the course of LE (within 4

Korea (Republic of)[68]			Age 50.2 (34-63)** Symptoms 6.3 (2-17)** Training status NR			weeks) provides a clinically significant improvement.
Pearson 2012 New Zealand[69]	RCT	Patellar	N= 40 % female 62.5 Age 50.0 (8.2) Symptoms 11.0 (10.0) Training status Other	1	(Resistance)	There is some evidence for small short-term symptomatic improvements with the addition of autologous blood injection to standard treatment for Achilles tendinopathy.
Pearson 2018 Australia[70]	RCT	Achilles	N= 16 % female 0 Age 28 (4.25) Symptoms 34.17 (1.95) Training status Performance	2	2*(Resistance)	Pain was significantly reduced after isometric loading on both SLDS and hop tests. Pain and quadriceps function improved over the 4 weeks. Short-duration isometric contractions are found to be as effective as longer duration contractions for relieving patellar tendon pain when total time under tension is equalized.
Pekyavas 2016 Turkey[71]	RCT	Rotator cuff - subacromial impingement	N=70 % female NR Age 47.1 (13.8) Symptoms NR Training status Other	1	(Flexibility, Resistance)	HILT and MT were found to be more effective in reducing pain and disability and improving ROM in patient with SAIS.
Petersen 2007 Germany[72]	RCT	Achilles	N= 86 % female 40.0 Age 42.5 (11.1) Symptoms 7.4 (2.3) Training status Recreational	1	(Resistance)	The AirHeel brace is as effective as eccentric training in the treatment of chronic Achilles tendinopathy. There is no added benefit to combining both treatments.
Peterson 2011 Sweden[73]	RCT	Lateral elbow/tennis elbow	N= 81 % female 42 Age 48.25 (8.35) Symptoms 23.3 (35.9) Training status Other	2	2*(Resistance)	Exercise appears to be superior to the control group in reducing pain in chronic lateral epicondylosis.

Peterson 2014 Sweden[74]	RCT	Lateral elbow/tennis elbow	N= 120 % female 47.5 Age 47.9 (8.1) Symptoms NR Training status Other	1	(Resistance)	Eccentric graded exercise reduced pain and increased muscle strength in chronic tennis elbow more effectively than concentric graded exercise at follow-up. However, there were no significant differences in function or quality of life measures between the two groups.
Polimeni 2003 Italy[75]	RCT	Rotator cuff - subacromial impingement	N= 50 % female 72.0 Age 56 (16) Symptoms NR Training status Other	1	(Flexibility)	All patients experienced improvement with treatment, but the association of physical therapy and functional rehabilitation did not seem to lead to added benefit for the patient.
Praet 2019 Australia[76]	RCT	Achilles	N= 20 % female 35.0 Age 43.7 (7.9) Symptoms 54 (90) Training status Recreational	1	(Resistance)	Oral supplementation of specific collagen peptides may accelerate the clinical benefits of a well-structured calf-strengthening and return-to-running programme in patients with chronic Achilles tendinopathy.
Rabusin 2020 Australia[77]	RCT	Achilles	N= 100 % female 52.0 Age 45.85 (9.4) Symptoms 20.25 (NR) Training status Other	1	(Resistance)	In adults with mid-portion Achilles tendinopathy, heel lifts were more effective than calf muscle eccentric exercise in reducing pain and improving function at 12 weeks.
Reyhan 2020 Turkey[78]	RCT	Lateral elbow/tennis elbow	N= 40 % female 82.5 Age 42.4 (9.9) Symptoms 4 (0.78) Training status Other	1	(Flexibility, Resistance)	MWM plus exercise and cold therapy is safe and effective at improving elbow pain, functional capacity, and grip strength.
Rio 2017 Australia[79]	RCT	Patellar	N= 20 % female 10.0 Age 22.5 (4.7) Symptoms NR Training status Performance	2	2*(Resistance)	Both isometric and isotonic contraction protocols appear efficacious for in-season athletes to reduce pain, however, isometric contractions demonstrated significantly greater immediate analgesia throughout the 4-week trial.

Romero-Morales 2020 Spain[80]	RCT	Achilles	N= 61 % female 26 Age 41.6 (8.7) Symptoms 4.25 (3.5) Training status Other	2	1*(Resistance, Vibration);1*(Resistance)	Authors encourage the use of vibration with respect to cryotherapy added to eccentric exercise programs in order to enhance multifidus cross-sectional area in addition to lower limb functionality in individuals who suffer from chronic non-insertional AT.
Rompe 2007 Germany[81]	RCT	Achilles	N= 75 % female 61.3 Age 48.5 (10.6) Symptoms 10.8 (8.5) Training status Other	1	(Flexibility, Resistance)	At 4-month follow-up, eccentric loading and low-energy shock-wave therapy showed comparable results. The wait-and-see strategy was ineffective for the management of chronic recalcitrant Achilles tendinopathy.
Rompe 2009 Germany[82]	RCT	Achilles	N= 68 % female 55.9 Age 49.7 (9.9) Symptoms 14.5 (6.0) Training status Other	1	(Resistance)	The likelihood of recovery after 4 months was higher after a combined approach of both eccentric loading and shock-wave therapy compared to eccentric loading alone.
Rompe 2008 Germany[83]	RCT	Achilles	N= 50 % female 60.0 Age 39.8 (11) Symptoms 25.55 (9.45) Training status Other	1	(Resistance)	Eccentric loading as applied in the present study showed inferior results to low-energy shock wave therapy as applied in patients with chronic recalcitrant tendinopathy of the insertion of the Achilles tendon at four months follow-up.
Roos 2004 Sweden[84]	RCT	Achilles	N= 44 % female 52.3 Age 45 (26-60)** Symptoms 5.5 (1-180)* Training status Recreational	1	(Resistance)	Eccentric exercises reduce pain and improve function in patients with Achilles tendinopathy.
Şenbursa 2011 Turkey[85]	RCT	Rotator cuff - subacromial impingement	N= 47 % female NR Age 49.0 (9.3) Symptoms NR Training status Other	2	2*(Flexibility, Resistance)	Supervised exercise, supervised and MT, and home-based exercise are all effective and promising treatments for patients with subacromial impingement syndrome. The addition of an initial MT may improve outcomes with exercise.

Seven 2017 Turkey[86]	RCT	Rotator cuff - subacromial impingement	N= 101 % female 45.5 Age 48.5 (11.6) Symptoms 19.5 (12.4) Training status Other	1	(Proprioception)	Prolotherapy is an easily applicable treatment which may be superior in enhancing pain and function outcomes in comparison to exercise alone.
Sevier 2015 United States[87]	RCT	Lateral elbow/tennis elbow	N= 90 % female 57.9 Age 46.95 (6.55) Symptoms NR Training status Other	1	(Flexibility, Resistance)	Astym therapy is an effective treatment option for patients with LE tendinopathy, as an initial treatment, and after an eccentric exercise program has failed.
Silbernagel 2007 Sweden[88]	RCT	Achilles	N= 38 % female 47.4 Age 46.0 (8.0) Symptoms 36.2 (66.5) Training status Other	2	1*(Flexibility, Plyometric, Resistance);1*(Flexibility, Plyometric)	Our treatment protocol which gradually increases the load on the Achilles tendon and calf muscle, demonstrated significant improvements. Continuing tendon loading activity such as running and jumping with the use of a pain-monitoring model did not have any adverse effect.
Silbernagel 2001 Sweden[89]	RCT	Achilles	N= 47 % female 22.5 Age 44.0 (12.5) Symptoms 30.5 (40.7) Training status Recreational	2	1*(Flexibility, Proprioception, Resistance);1*(Flexibility)	The eccentric overload protocol used in the present study can be recommended for patients with chronic pain from the Achilles tendon. More patients achieved full recovery, improved pain and ROM in the Exp group compared to the control group.
Şimşek, 2013 Turkey[90]	RCT	Rotator cuff - subacromial impingement	N= 38 % female 65.8 Age 51.0 (18-69)** Symptoms NR Training status Other	1	(Proprioception, Resistance)	Findings were inconclusive and require further research.
Stasinopoulos 2017 Cyprus[91]	RCT	Lateral elbow/tennis elbow	N= 34 % female 55.8 Age 43.7 (4.6) Symptoms 6 (NR) Training status Recreational	3	2*(Flexibility, Resistance);1*(Resistance)	Eccentric training, eccentric-concentric training, and eccentric-concentric training combined with isometric contraction reduced pain and improved function at the end of the treatment and follow-up. The eccentric-concentric

						training combined with isometric contraction produced the largest effect at the end of the treatment and follow-up.
Stasinopoulos 2006 Greece[92]	Quasi-experimental	Lateral elbow/tennis elbow	N= 75 % female 38.6% Age 40.3 (5.8) Symptoms 5 (NR) Training status Other	1	(Flexibility, Resistance)	Cyriax Physiotherapy, a supervised exercise programme, and polarized polychromatic non-coherent light reduced pain and improved function at the end of the treatment and at any of the follow-up time points. The supervised exercise programme produced the largest effect in the short, intermediate and long term.
Stasinopoulos 2010 Greece[93]	Quasi-experimental	Lateral elbow/tennis elbow	N= 70 % female 52.9 Age 45.1 (5.8) Symptoms 5 (NR) Training status NR	2	2*(Flexibility, Resistance)	Supervised exercise programme is superior to home exercise programme to reduce pain and improve function in patients with LET at the end of the treatment and at the follow-up.
Stefansson 2019 Iceland[94]	RCT	Achilles	N= 58 % female 20.0 Age NR Symptoms NR Training status Other	1	(Resistance)	Similar results for pressure massage and eccentric exercise. Combining pressure massage and eccentric exercise did not improve outcomes
Steunebrink 2013 Netherlands[95]	RCT	Patellar	N= 33 % female 24.2 Age 32.9 (10) Symptoms 11 (8) Training status Recreational	1	(Resistance)	Continuous topical GTN treatment in addition to an eccentric exercise programme does not improve clinical outcome compared to placebo patches and an eccentric exercise programme in patients with chronic patellar tendinopathy.
Stevens 2014 United Kingdom[96]	RCT	Achilles	N= 28 % female 60.7 Age 48.7 (10.8) Symptoms 7.4 (4.0) Training status Other	2	2*(Resistance)	Performing a 6-week do-as-tolerated program of eccentric heel-drop exercises compared to the recommended 180 repetitions per day, did not lead to lesser improvement for individuals with midportion Achilles tendinopathy, based on VISA-A and VAS scores.
Svernlov 2001 Sweden[97]	Quasi-experimental	Lateral elbow/tennis elbow	N= 57 % female 61.3	1	(Flexibility, Resistance)	Significant improvements observed for VAS and grip strength warrants clinical use of this regime.

			Age 50.15 (NR) Symptoms 6.3 (NR) Training status Other			
Tahran 2020 Turkey[98]	RCT	Rotator cuff - subacromial impingement	N= 67 % female 30.5 Age 52.9 (11.0) Symptoms NR Training status Other	2	2*(Flexibility)	All treatments improved pain, shoulder mobility, function, and disability in patients with SIS. However, modified posterior shoulder stretching exercises in addition to a treatment program was superior to the treatment program alone in improving pain with activity, internal rotation ROM, and dysfunction. Moreover, stretching provided clinically significant improvements.
Tonks 2007 United Kingdom[99]	RCT	Lateral elbow/tennis elbow	N= 34 % female NR Age 44.3 (7.1) Symptoms NR Training status Other	1	(Flexibility, Resistance)	Patients who received steroid injection were statistically significantly better for all outcome measures at follow up. No statistically significant effect of Physiotherapy nor interaction between Physiotherapy and injection was found.
Turgut 2017 Turkey[100]	RCT	Rotator cuff - subacromial impingement	N= 30 % female 46.7 Age 36.45 (17.5) Symptoms 6.28 (5.4) Training status Other	2	1*(Flexibility, Proprioception, Resistance);1*(Flexibility)	Progressive exercise training independent from specific scapular stabilization exercises provides decreased disability and pain severity in impingement syndrome. All groups showed improvement, however, there were no significant differences between the groups.
Vallés-Carrascosa 2018 Spain[101]	RCT	Rotator cuff - subacromial impingement	N= 22 % female 54 Age 59.0 (58.5-70.0)* Symptoms Training status Other	2	2*(Flexibility, Resistance)	Both rotator cuff eccentric exercise protocols with scapular stabilising and stretching of upper trapezius were equally effective in improving pain, function, and active ROM in the short-term in patients with subacromial syndrome.
vanArk 2016 Australia[102]	RCT	Patellar	N= 19 % female 6.9 Age 23 (4.7) Symptoms 35.8 (33.8)	2	2*(Resistance)	This study found favourable results for athletes with patellar tendinopathy without modification of the training. Both isometric and isotonic exercise programs

			Training status Recreational			reduced pain and improve function in athletes with patellar tendinopathy during a season.
Vinuesa-Montoya 2017 Spain[103]	RCT	Rotator cuff - subacromial impingement	N= 40 % female 26.8 Age 47.0 (9.0) Symptoms 6.2 (3.8) Training status Other	1	(Flexibility, Resistance)	Cervicothoracic manipulative treatment with mobilisation plus exercise therapy may improve intensity of pain and ROM compared with home exercise alone.
Visnes 2005 Norway[104]	RCT	Patellar	N= 29 % female 38.5 Age 26.58 (NR) Symptoms 73.6 (62.3) Training status Performance	1	(Resistance)	There was no effect on knee function (VISA) from a 12-week program with eccentric training among a group of volleyball players with patellar tendinopathy who continued to train and compete during the treatment period. Whether the training would be effective if the patients did not participate in sports activity is not known.
Vuvan 2019 Australia[105]	RCT	Lateral elbow/tennis elbow	N= 39 % female 28 Age 48.5 (9) Symptoms 4 (NR) Training status Other	2	2*(Flexibility, Resistance)	Unsupervised isometric exercise was effective in improving pain and disability, but not perceived rating of change and pain-free grip strength when compared with wait-and-see at 8 wk. With only one of the three primary outcomes being significantly improved, it is doubtful if isometric exercises can be an efficacious standalone treatment.
Walther 2004 Germany[106]	RCT	Rotator cuff - subacromial impingement	N= 60 % female 43.3 Age 50.7 (NR) Symptoms 27.3 (NR) Training status Other	2	1*(Flexibility, Resistance);1*(Flexibility, Proprioception)	There were no statistically significant differences among the groups. Guided self-training can lead to results similar to those of conventional Physiotherapy.
Wegener 2016 Australia[107]	RCT	Lateral elbow/tennis elbow	N= 40 % female 70 Age 49.52 (8.09) Symptoms NR Training status NR	1	(Flexibility, Resistance)	Whilst all groups improved on key outcomes, it is possible that exercise alone and/or natural recovery were responsible for improvements.

Wen 2011 United States[108]	RCT	Lateral elbow/tennis elbow	N= 28 % female 46.4 Age 46 (7.3) Symptoms 3.3 (2.2) Training status Other	1	(Resistance)	The authors were unable to show any statistical advantage to eccentric exercises for lateral epicondylosis compared with local modalities and stretching exercises.
Werner 2002 Germany[109]	RCT	Rotator cuff - subacromial impingement	N=20 % female 50 Age 51.75 (NR) Symptoms 27.5 Training status Other	2	1*(Flexibility, Resistance);1*(Proprioception, Resistance)	Strengthening of the centering muscles around the humeral head lead to positive outcomes for subacromial impingement. Self-training after instruction showed no difference to physiotherapist-supervised exercises.
Wiedmann 2017 Germany[110]	RCT	Achilles	N= 20 % female 65.0 Age 43.0 (6.0) Symptoms NR Training status Other	1	(Resistance)	Eccentric training improved the VISA-A and VAS scores after 12 weeks more than Physiotherapy treatment.
Yelland 2011 Australia[111]	RCT	Achilles	N= 43 % female NR Age 46.7 (NR) Symptoms 17 (NR) Training status Other	1	(Resistance)	Prolotherapy and particularly eccentric loading exercises combined with prolotherapy gave more rapid improvements in Achilles tendinosis symptoms than eccentric loading exercises alone. Long term VISA-A scores were similar.
Yerlikaya 2018 Turkey[112]	Quasi-experimental	Lateral elbow/tennis elbow	N= 90 % female 71.1 Age 48.6 (8.8) Symptoms NR Training status Other	1	(Flexibility, Resistance)	Lateral epicondylitis does not seem to be affected by either leukocyte-rich-PRP or leukocyte-poor-PRP on pain and function in the short term.
Young 2005 Australia[113]	RCT	Patellar	N= 17 % female 23.5 Age 27.3 (1.8) Symptoms NR Training status Performance	2	2*(Resistance)	Both exercise protocols improved pain and sporting function in volleyball players over 12 months. The decline squat protocol offers greater clinical gains during a rehabilitation programme for patellar tendinopathy in athletes who continue to train and play with pain.

Yu 2013 Korea (Republic of)[114]	Quasi-experimental	Achilles	N= 32 % female 0.0 Age 30.3 (1.6) Symptoms 11.7 (2.1) Training status Other	2	1*(Resistance, Flexibility)1*(Resistance)	Eccentric strengthening was more effective than concentric strengthening in reducing pain and improving function in patients with Achilles tendinopathy.

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