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LOAD PROGRESSION CRITERIA IN EXERCISE PROGRAMMES IN LOWER LIMB TENDINOPATHY: A SYSTEMATIC REVIEW

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Title: LOAD PROGRESSION CRITERIA IN EXERCISE PROGRAMMES IN LOWER LIMB TENDINOPATHY: A SYSTEMATIC REVIEW

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Competing interests

None

ABSTRACT

Objective: The objective of this study is to summarise and analyse the current literature about what progression criteria are applied in loading exercise programmes in lower limb tendinopathies and their evidence and effectiveness.

Design: Systematic review

Methods: Two reviewers searched Pubmed and Scopus from inception to 31st August 2019. Randomised, controlled trials were included if they included patients with mid-portion Achilles, patellar, or gluteal tendinopathy; assessed function, pain, or performance; included at least one group where progressive physical exercise was administered as monotherapy; included at least a control group. They were excluded if they included subjects with previous tendon surgical treatment; the control group conducted a supplemented modality of the exercise performed in the intervention group; obtained a PEDro score lower than five.

Results: Twenty-five studies describing progression criteria were included. The criteria found were grouped in six categories. Most of the studies applied a Pain-Based criterion. Criteria based on Conditioning Stages were also commonly applied. To a lesser extent, other criteria such as fatigue, a temporary linear increase, or the subjective perception of the patient's abilities were also applied.

Conclusions: There exists a predominant use of pain-based criteria, but this use is not supported by strong evidence. This review proposes a new classification of the existing progression criteria.

Registrarion: CRD42018110997

Keywords: Musculoskeletal disorders; pain management; rehabilitation medicine; sports medicine

Word count: 4488

Strengths and limitations of the study

- This is the first systematic review that expressly and comprehensively identifies, assesses and summarises the evidence regarding load progression criteria in lower limb tendinopathy.

- This systematic review has been designed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.
- In case of disagreements, a third independent was required for reducing the risk of observer bias.
- A limitation of this systematic review is the non-inclusion of studies in which the effect of exercise programmes was studied without a control group, not being included in the analysis and discussion of the results.
- Heterogeneity and deficiencies in the reporting of data found have not allowed the extraction of accurate and conclusive information for developing a quantitative analysis.

Background

Progressive therapeutic exercise is considered a first-line treatment in tendinopathies due to the extensive evidence published in the last three decades [1–5]. The objective of this treatment modality is to produce mechanical stimuli that provoke biochemical and mechanical responses, generating adaptations of the tendon to load and exercise [1]. In addition to this, the limited adverse effects produced by therapeutic exercise may explain the growing interest of therapists and patients in this approach [6]. The current literature shows positive outcomes of exercise programmes on pain and function in different locations of tendinopathies in the upper and lower extremities [3–5,7,8]. Nevertheless, current evidence is not equally consistent for all tendinopathies. In some locations such as the midportion Achilles, patellar, or gluteal tendinopathies the evidence in favour of exercise is abundant, and current studies attempt to elucidate which exercise methodology and dose are most appropriate [4,5,9,10]. Meanwhile, the evidence in hamstring [7,11], insertional Achilles [2,12], or upper limbs tendinopathies [13], among others, is lower, and additional studies supporting exercise programmes are still needed.

In lower limb tendinopathy, there is not a single modality of therapeutic exercise achieving favourable results, but a broad spectrum of methodologies has been positively applied. Hence, isometric contractions [14], isolated eccentric training [15], combinations of eccentric and concentric contractions [16], or heavy slow resistance training (HSR) [5] are some examples of exercise modalities commonly applied in this pathology. Conversely, traditional passive treatments such as corticosteroids injections [3,5], transverse friction [17], or therapeutic ultrasound [17] have sometimes not shown enough capacity to maintain positive effects on long-term follow-up.

Cook and Purdam (2009) [18] considered the pathological model of tendinopathy as a continuum, distinguishing three theoretical stages (reactive tendinopathy, tendon disrepair, and degenerative tendinopathy). Moreover, a study showed that there is sufficient area with acceptable levels of aligned fibrillar structure in the pathological tendon [19]. These non-affected areas would be able to compensate for the disorganization of affected areas by increasing tendon thickness [19]. According to this approach, the primary stimulus to advance or retreat through the continuum would be adding or removing enough load to obtain changes in the non-

affected structure of the tendon [1,18]. Thus, it would be necessary individualized handling of the load progression for adequate management of the process. Maximum efficiency is pursued with a reduced risk of injury. For this purpose, some authors have established different methodologies to handle load progression. Nevertheless, there is a lack of consensus and objective criteria on how this load progression should be handled.

In sport and physical training, some authors have suggested that a high risk of injury could not be associated with the use of high loads but with inadequate handling of the progression [20]. From this approach, the use as a guidance of the 10% rule among clinicians and trainers is common. According to this rule, it would be essential to control the relationship between the loads applied each week and the average load applied in the previous weeks. Thus, a weekly load progression higher than 10% would considerably increase the risk of injury. Despite its widespread use, the evidence regarding this rule is controversial. While in some team sports a significant increase in the risk of injury has been observed with load increases of more than 10%, and especially 50% [20], other studies suggest that in other areas, such as beginning runners, increases between 20 and 25% could be well tolerated [21]. In this context, using the 10% reasoning only as a guidance seems coherent, if the training experience and the context of each subject for the handling of the load are considered.

In tendinopathies, pain intensity as a load progression criterion is commonly used. Stanish et al. (1986) [22] and Alfredson et al. (1998) [15] described therapeutic exercise protocols that have been massively used in lower limb tendinopathy. In these protocols, load progression consisted of maintaining a feeling of discomfort or pain during exercises. However, recent systematic reviews have shown that despite its widespread use, there exists a striking lack of evidence for the training parameters applied [9,23].

Several studies have analysed the effectiveness of different exercise protocols in tendinopathies [4,5,16,24,25]. Additionally, some of these studies have compared the effect of different symptom management strategies on similar exercise programmes (e.g., pain allowed or not allowed during exercise) [26,27]. There exist abundant reviews about pathology, risk factors, prevention, diagnosis or management in lower limb tendinopathies [2]. However, studies are usually focused on the comparison of different exercise protocols and not on the

study of the different progression criteria. Therefore, there is a gap in the evidence on what load progression criterion should be used, which requires an additional analysis of this topic.

As described above, while there is abundant evidence on the effectiveness of exercise in lower limbs tendinopathies, controversy still exists about which may be the best approach in upper limbs. For this reason, this systematic review has only analysed studies concerning tendinopathies of the lower extremities, focusing on the three most predominant ones (Achilles, patellar, and gluteal) in order to reduce this heterogeneity. Likewise, those studies concerning insertional Achilles tendinopathy have also been discarded from this review to avoid the heterogeneity caused by its apparent different clinical presentation and response to treatment [2].

The objective of this systematic review was to summarise and to analyse the current literature on what criteria of progression are applied in loading exercise programmes in lower limb tendinopathies and their evidence and effectiveness.

METHODS

This systematic review was undertaken following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [28]. This review was prospectively registered in PROSPERO (registration number: CRD42018110997) and its protocol has been published in an impact journal [29].

Patient and Public Involvement

No patient involved

Search

Two reviewers searched Pubmed and Scopus from inception to 31st August 2019. The following search terms relating to the tendinopathy location and exercise were combined for a main search: (“Patellar tendin*” OR “jumper's knee” OR “lander's knee” OR “achilles tendin*” OR

"midportion achilles tendin*" OR "mid-portion achilles tendin*" OR "mid-substance Achilles tendin*" OR "midsubstance Achilles tendin*" OR "non-insertional Achilles tendin*" "gluteal tendin*" OR "greater trochanteric bursitis" OR "greater trochanteric pain syndrome" OR "lower limb tendinopathy" OR "tendinopathy" OR "tendonopathy" OR "tendonitis") AND ("exercise" OR "strength" OR "training" OR "resistance" OR "loading" OR "progressive" OR "physical activity" OR "eccentric"). Extended information about the searches in both search engines is provided in Supplementary Appendix 1.

Eligibility criteria

All randomised controlled trials that met the following eligibility criteria based on the PICO framework were included:

(a) Participants: people with patellar, non-insertional Achilles (those studies where the location of the painful area was not specified or where both locations were analysed as a whole were included, considering the predominant incidence of non-insertional Achilles tendinopathies), or Gluteal tendinopathy; at least 16 years old.

(b) Interventions: progressive exercise programmes; at least one group where physical exercise was administered as monotherapy. Physical exercise has been defined as a subcategory of physical activity consisting of planned, structured, and repetitive movement performed with the purpose of improving or maintaining physical performance or health [30]. Any voluntary action of the neuromuscular system was considered as physical exercise, including strength training; aerobic exercise; plyometrics; active, self-assisted, or guided imagery exercise; active, passive, or self-assisted stretching exercises; other similar forms of exercise; or a combination of these exercises.

(c) Control interventions: no intervention, sham, or other experimental groups.

(d) Outcomes: studies measuring at least function, pain, or performance outcomes.

(e) No gender, ethnicity, year of publication, or language restrictions were imposed.

Those studies that met any of the following exclusion criteria were excluded: (a) including participants with previous tendon surgery; (b) studies in which the exercise was not applied as monotherapy in any of the groups or where the control group involved a supplemented modality of the exercise performed in the intervention group.

Procedures

All references were imported into the bibliographic management software Mendeley and duplicates were identified and removed. Two independent authors screened the remaining results by title and abstract. Two reviewers screened the full texts of selected articles to identify those that satisfied the eligibility criteria. A third reviewer solved any disagreements.

Data extraction and quality assessment

Two reviewers retrieved and independently assessed the full texts of the selected studies using an extraction form that included: study setting; study population; participant demographics and baseline characteristics; details of the intervention and control conditions; permission to perform additional physical activity; load progression criteria of the exercise programmes; recruitment and study completion rates; outcomes; effect size (Cohen's d) or percentage of change of a main outcome; significance level; and relevant information about risk of bias. Disagreements between the two reviewers were discussed with a third reviewer. Authors were contacted by email in order to obtain additional information not reported in their articles.

Two reviewers independently assessed the quality and the existence of potential bias of the studies using the PED*ro* scale [31]. Each study was rated from 0 to 10, according to PED*ro*. Additionally, those studies scoring 7–10 were considered of good methodological quality, those scoring ranging 5–6 were considered of fair methodological quality, while those that score below five were considered of poor quality. Only those articles obtaining a score ≥5 were finally included.

Data synthesis and analysis

A narrative synthesis to report and compare the different load progression criteria existing in the scientific literature and its effectiveness was conducted. Although the authors of most of the studies were contacted by mail in order to obtain the necessary data for inclusion in a meta-analysis, most of these data could not be obtained. Thus, due to the lack of studies with complete data and the existing critical heterogeneity, it was only possible to conduct a narrative synthesis. The different intervention or control groups were organized in the tables by prioritizing exercise interventions over passive interventions regardless of the order of interventions in the original studies. In cases where two or more exercise interventions were compared, the intervention that obtained the greatest effect size in the study was prioritized. In all cases, the latest measurement of the main outcome was selected for analysis, thus focusing on the long-term effectiveness of the interventions.

The Cohen's d of a main clinical and performance outcome was retrieved or calculated to quantify and compare the effectiveness of the interventions [32]. Where possible, the VISA (VISA-A, VISA-P, or VISA-G) questionnaire or VAS were chosen as the main clinical outcome to homogenize the analysis, as they were the most frequently used outcomes. The effect size was classified into four levels: $d<0.2$ was considered a trivial effect size; $d\geq0.2$ was considered a small effect size; $d\geq0.5$ was considered a medium effect size, and $d\geq0.8$ was considered a large effect size [32]. The significance level was set at 0.05.

RESULTS

A total of 7151 citations were identified in PubMed and Scopus, with 6478 of them remaining after deleting duplicates. Among these, 98 articles were selected as potentially eligible after reading the title and the abstract (the full text was retrieved in case of doubt). After evaluating the fulfilment of the eligibility criteria, only 31 studies were included in the qualitative analysis. The flow diagram of the selection process and the reasons for exclusion of the discarded studies are described in Figure 1. Finally, six articles were excluded after the methodological analyses with the PED*ro* scale, as they obtained a score lower than five points. The results of the internal validity analysis of the 24 studies that exceeded the cutpoint are shown in Table 1.

[Figure 1 near here]

[Table 1 near here]

Participants

Supplementary Appendix 2 shows the characteristics of the subjects of the included studies (number of subjects, type of population, age, duration of symptoms, and information about whether the diagnosis was obtained only clinically or supported by imaging tests).

Exercise programmes

Different exercise programmes were identified in the included studies: heavy slow resistance training; isotonic exercise programmes, including both concentric and eccentric phases; isolated isometric exercise programmes, as well as isolated eccentric loading programmes based on the original and modified versions of the Alfredson's protocol [15]. Supplementary Appendix 3 shows the characteristics of the studies, including the exercise programmes applied in each of them and the permission or not to perform additional physical activity.

Load progression criteria

The load progression criteria were identified and grouped into five categories. At the same time, they were subdivided into those using pain as a primary or secondary criterion.

Pain as a primary progression criterion:

1) *Evoking Pain-Based* (EPB, trying to evoke enough pain to produce improvement): load was gradually increased by using a loaded backpack as pain diminished, aiming at keeping a feeling of pain or discomfort during the exercises.

2) *Avoid Pain-based* (trying to avoid pain): exercises were performed without pain.

Pain and symptom control as a secondary criterion, although pain is controlled and allowed up to a certain limit; progression is marked by other main criteria.

3) *Conditioning Stages* (CS): predefined stages prior to the start of the study, based on the increase in the percentage of the repetition maximum (RM) or on an increase in the complexity of the exercises.

4) *Fatigue-based* (FB): extra sets or repetitions were performed if there were no signs of fatigue after the first sets. If these are not enough to produce fatigue, weight was gradually increased.

5) *Subjective Perception* (SP): arbitrary increase according to the subjective perception of patient's ability.

6) *Temporary Linear Increase* (TLI): a linear increase in time (e.g. 2.5% each week).

Table 2 shows summary information about the load progression criteria applied in the included studies. Extended information is available in Supplementary Appendix 3, along with information about the exercise programmes in which they participated.

[Table 2 near here]

Clinical outcomes

All included studies analysed at least one clinical outcome. The most evaluated outcomes were function using the VISA questionnaire (VISA-A, VISA-P, or VISA-G), and pain using an analogue visual scale (VAS), a numerical rating scale (NRS), or a questionnaire. Table 3 shows the Cohen's d, the percentage of change, and the significance level (between-group comparison) of a main clinical outcome of each study. Supplementary Appendix 4 provides extended information about all outcomes and measurement timepoints of each study.

[Table 3 near here]

Performance outcomes

In 16 of the 25 studies included in this review, no performance outcomes were evaluated. The most frequently used performance outcomes were the concentric and eccentric torque measured with an isokinetic dynamometer, and the jumping performance (countermovement jump test), which were measured in four studies. Other measured performance outcomes were the ankle range of motion or the hip abductor torque. Table 4 shows the Cohen's d (between-group comparison), the percentage of change, and the significance level of a main performance outcome, where it was possible to obtain or calculate it, of those studies that evaluated at least one performance outcome. Supplementary Appendix 4 provides extended information about the remaining performance outcomes and the measurement timepoints of each study.

[Table 4 near here]

DISCUSSION

A key finding of this systematic review is that load progression is usually influenced by pain perception and symptomatology and not by physical or structural capacity. Nevertheless, this fact is not based on an evident demonstration of useful properties of the pain-based criteria, but on a historical inheritance of previous protocols. Although there are a large number of studies focused on comparing different exercise programmes or interventions, this review shows the need for high-quality studies designed to determine the efficacy of a key specific aspect of the programmes such as the load progression criteria. As an additional finding, it has been found that much of the current literature does not provide an appropriate reporting of data (effect size, procedures), which hinders adequate dissemination.

Achilles and patellar tendinopathies

Pain-based criteria: Evoking and Avoiding Pain-Based

Most of the studies included in this review applied the decrease in discomfort or pain as the primary criterion for increasing the load. This fact has been probably influenced by the large number of studies that investigated the original or a modified version of the isolated eccentric loading programme popularized by Alfredson [15], since this is the main criterion used in this

procedure. Thus, Alfredson et al. (1998) [15] suggested that the presence of pain is necessary for proper management [15], hypothesizing that painful eccentric exercises could have a direct mechanical effect on neurovascular ingrowth that may be a source of symptoms [33].

In this review, the results obtained by the studies that applied an Evoking Pain-Based criterion in Achilles and patellar tendinopathies were similar. Maintaining a constant feeling of pain or discomfort according to the description of "load was increased gradually using a backpack (or weights in hands) as pain diminished" was the most frequently used criterion. This specific criterion was used in 11 of the 23 studies, all of them applying isolated eccentric exercise programmes. The combination of this *Evoking Pain-Based* criterion with isolated eccentric training only achieved favourable significant differences in the VISA-A questionnaire versus a non-intervention group in Achilles [34], and versus ultrasound therapy and transverse friction massage in patellar tendinopathy [17]. Nevertheless, a passive therapy such as acupuncture was found to be significantly better than this approach. In both locations, the combination of this progression criterion with the isolated eccentric training did not show significant differences in VISA-A or VISA-P versus a HSR programme based on Conditioning Stages [4,5]. In terms of pain assessment, although significant differences were observed in favour of the group with the Evoking Pain-Based criterion versus the placement of a brace [35], the results contrast with another study that found no differences versus the placement of a night splint [36].

Five more studies [37–41] applied this combination of the Evoking Pain-Based criterion and eccentrics. However, the progression was implemented differently. Although in all cases differences within the group were obtained, none of these studies obtained significant differences in the comparison between groups.

A single study described an *Avoiding Pain-Based* progression criterion. Da Cunha et al. (2012) [27] compared the effectiveness of two isolated eccentric programmes, performing the exercise with the greatest pain without altering performance and with the avoiding pain-based criterion, respectively, not showing significant differences in VISA-P between groups. In a similar way, performing the Alfredson's protocol following instructions of "do the protocol as tolerated" achieved better short-term (6 weeks) results in VISA-A than the standard protocol (although without significant differences) [26].

Although the heterogeneity of the studies included in this review does not allow for robust conclusions, the findings do not support the need to apply Evoking Pain-Based progression criteria as a primary option. So although monitoring pain could be important and some studies have previously related changes in rating pain scales to their clinical importance [42], it could not be the most appropriate criterion to establish load progression in therapeutic exercise programmes. Thus, the use of a pain-based criterion instead of an individualized criterion for neuromuscular capacity and function could overestimate or underestimate the actual capacity of the system. Therefore, there is still a gap in the existing knowledge about the relation between Pain-Based criteria and the optimal load in exercise programmes.

Conditioning Stages

As an alternative option to a primary Pain-Based progression criterion, other procedures have been described based on individualized aspects of the patients, such as the load the subjects could handle each week or their current abilities. The use of predefined *Conditioning Stages* in which each week or group of weeks had a previously determined work intensity, usually based on a percentage of the repetition maximum (RM), but also on current abilities of the patient, has also been a commonly applied criterion among the included studies. This criterion, commonly used in sports and physical training, has been included in the last decades in numerous programmes of clinical exercise, also showing beneficial effects [43]. This step-based approach using a progression in the percentage of the maximum repetition ensures a progression in intensity while allowing individualization of the load based on the patient's current capacity. In this review, most of the included studies that have applied this criterion have done so by comparing it to other exercise groups that also used stage-based criteria [16,25,44], which makes it harder to draw conclusions. As described above, Beyer et al. (2015) [4] and Kongsgaard et al. (2009) [5] in Achilles and patellar tendinopathy, respectively, found a larger effect size in the HSR group that applied this criterion than in the isolated eccentric training group that used a pain-based criterion, although these differences were not statistically significant. Additionally, in one of these studies, the good clinical effects observed in the HSR group were accompanied by reductions of tendon abnormality and an increased collagen

turnover not found with the Evoking Pain-Based criterion of the isolated eccentric group [5]. However, the existing evidence is still not enough to determine that this criterion is the most appropriate.

A previous study carried out in plantar fasciopathy did not find any differences in pain reduction between performing a HSR protocol based on predetermined stages compared and a group that performed the same exercises in a self-administered manner, allowing work with the highest tolerated load from the start, setting the load margins of the group based on stages as limits [45]. These findings may suggest that the effectiveness of the Conditioning Stages criteria may be related to the individualised calculation of the percentage of the RM and the observation of the current capacities of the patients, and not to the division into stages of the programme.

Temporary Linear Increase, Fatigue-Based, and Subjective Perception criteria

To a lesser extent, other criteria applied in the included studies were the use of a *Temporary Linear Increase* (for example, 2.5% weekly) where possible, fatigue control, or an arbitrary increase in volume (series or repetitions) or intensity where it was considered subjectively necessary.

Two studies increased weight by 2.5% every week where possible as a progression criterion, including isolated isometric and isotonic exercise programmes [14,46]. Additional studies comparing this criterion to others are still necessary. However, it seems evident that the use of these linear criteria does not allow load individualisation, since the increase of an absolute percentage (2.5% in the example) can mean very different variations in individuals with different capacities, which may reduce the potential effectiveness of the programmes where it is applied.

Only one study applied a *Fatigue-Based* criterion [47]. In this study, significant differences were found in pain on palpation (measured with VAS) in favour of the exercise group versus a whole body vibration and a non-intervention group. Nevertheless, no significant differences were found in the isokinetic concentric ankle dorsiflexion torque (60°/sec) performance outcome.

A single study in Achilles tendinopathy considered the *Subjective Perception* of the current participant's abilities and skills as the main progression criterion [16]. In this study, this criterion

was applied in combination with a Conditioning Stages criterion. Thus, although the progression over the weeks was previously predefined, the progression was supervised by a physiotherapist and dependent on the patient's ability and symptoms. This study did not find significant differences in the pain or performance outcomes of the addition of a Subjective Perception to a Conditioning Stages criterion versus the isolated Conditioning Stages criterion [16].

Gluteal tendinopathy

Regarding gluteal tendinopathy, only two studies were included in this review. Mellor et al. (2018) [3] and Ganderton et al. (2018) [48] compared the effectiveness of an exercise and education programme, finding no significant differences in the VISA-G versus any of the control groups. Both studies applied a Conditioning Stages criterion. Moreover, in one of the studies [48], the progression through the stages was additionally dependent on the patient's abilities.

Study outcomes

The widespread use of the VISA questionnaire (in its different versions) and the VAS scale for pain has allowed some degree of homogeneity in the clinical outcomes studied in the current literature. However, an additional finding of this review is that despite the growing knowledge about the importance of performance outcomes in tendinopathy and the controversial relationship of pain and structure with function and recovery of the tendon, no performance outcomes were measured in most of the studies included in this review.

Additional physical activity

The fact that the studies were not homogeneous in the prohibition of performing additional physical activity during the programme may have influenced the results of the different protocols and criteria. Nevertheless, a previous systematic review showed that there is no strong evidence supporting the need of withdrawal from the sport in the management of patellar tendinopathy [49], so the possible influence of the additional activity must still be verified.

What has been excluded from this systematic review?

Due to the selection criteria chosen for this review, several studies have not been included, as they compare exercise interventions versus supplemented exercise. Although this is a common practice in the research of complementary therapies, it does not allow a proper analysis of the programmes [50–52]. During the selection phase, a significant number of studies including exercise with no load progression were identified, but they were excluded from the review. A lack of analysis of structural outcomes such us thickness has been found. This may be due to the fact that the studies where structural variables are analysed are usually designed as non-controlled longitudinal prospective studies using magnetic resonance imaging [53–55]. Finally, describing well-designed high-quality studies have been found but they are not available yet [10].

Strengths and limitations

The main strength of this study is that has identified a significant gap in the literature. Another essential strength is the new approach presented for the study of exercise programmes in tendinopathies, based on a new classification of the different progression criteria in loading exercise. However, heterogeneity and deficiencies in the reporting of data found have not allowed the extraction of accurate and conclusive information, not allowing to fulfill the second of the purposes set in this review. Some limitations are the absence of washout from previous treatments in most of the studies, and the permission to take analgesics or non-steroidal anti-inflammatory drugs (NSAIDs) in some studies.

Future studies comparing interventions applying different load progression criteria to the same exercise programme are needed, allowing a trustworthy review of the subject. In addition, it is necessary to search for new progression criteria adapted to the existing knowledge, as well as for more accurate information about neuromuscular ability, training parameters, the minimum number of sessions required, or the adherence levels of exercise programmes.

Conclusions

Despite the limitations, this systematic review offers a comprehensive summary of the current evidence regarding the load progression criteria in lower limb tendinopathy.

The findings of this systematic review reveal a predominant use of pain-based criteria, which is the result of a historical and scientific inheritance of exercise protocols but it is not supported by strong evidence. The lack of evidence found regarding the effectiveness of the commonly applied load progression criteria and the contradictory results of existing studies make it essential to study and search for new criteria that can be supported by the current knowledge and evidence. Thus, the current criteria should be used by practicioners cautiously and critically, waiting for strong evidence to support their use.

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Author Statement

All authors contributed to the study design. AEE and AICV searched and screened the articles, with assistance from JC. AEE and AICV contributed to data analysis and interpretation of the data. AEE drafted the manuscript, AICV revised it critically, and all authors contributed to revisions and approved the final manuscript.

Data Statement

Data will be accessible upon request in the institutional repository of the University of Malaga (RIUMA).

TABLES

TABLE 1. Internal validity analysis (PED*ro* scale)

Study	2	3	4	5	6	7	8	9	10	11	TOTAL
ACHILLES TENDINOPATHY											
Yu et al. (2013)**[25]**	•	•	•	-	-	•	•	•	•	•	8
Rompe et al. (2007)**[34]**	•	•	•	-	-	•	•	•	•	•	8
Horstmann et al. (2013)**[47]**	•	•	•	-	-	•	•	-	•	•	7
Stevens & Tan (2014)**[26]**	•	•	•	-	-	•	-	•	•	•	7
Stefansson et al. (2019)**[37]**	•	•	•	-	-	•	•	-	•	•	7
Yelland et al. (2011)**[56]**	•	•	-	-	-	•	•	•	•	•	7
Beyer et al. (2015)**[4]**	•	•	•	-	-	-	-	•	•	•	6
Kearney et al. (2013)**[38]**	•	•	-	-	-	-	•	•	•	•	6
Zhang et al. (2013)**[57]**	•	•	•	-	-	-	•	-	•	•	6
Roos et al. (2004)**[36]**	•	•	•	-	-	-	-	•	•	•	6
Mafi et al. (2001)**[24]**	•	•	-	-	-	-	•	-	•	•	5
Silbernagel et al. (2001)**[16]**	•	-	•	-	-	•	-	-	•	•	5
Petersen et al. (2007)**[35]**	•	-	•	-	-	-	•	-	•	•	5
PATELLAR TENDINOPATHY											
Kongsgaard et al. (2009)**[5]**	•	•	•	-	-	•	•	-	•	•	7
Bahr et al. (2006)**[39]**	•	•	•	-	-	-	•	•	•	•	7
Stasinopoulos & Stasinopoulos (2004)**[17]**	•	•	-	-	-	•	•	•	•	•	7
Cannell et al. (2001)**[44]**	•	•	•	-	-	•	•	-	•	•	7
Visnes et al. (2005)**[40]**	•	•	•	-	-	-	•	•	•	•	7
Rio et al. (2017)**[14]**	•	•	•	-	-	-	-	•	•	•	6
Frohm et al. (2007)**[58]**	•	•	•	-	-	-	•	-	•	•	6
Young et al. (2005)**[41]**	•	•	-	-	-	•	•	-	•	•	6
Da Cunha et al. (2012)**[27]**	•	•	•	-	-	-	•	-	•	•	6
Van ark et al. (2016)**[46]**	•	•	•	-	-	-	-	-	•	•	5
GLUTEAL TENDINOPATHY											
Mellor et al. (2018)**[3]**	•	•	•	-	-	•	•	•	•	•	8
Ganderton et al. (2018)**[48]**	•	•	-	•	-	•	•	•	•	•	8

●: Yes; -: no

TABLE 2. Load progression criteria applied in the included studies.

Study	Cat.	Progression criterion (Exercise Group 1)	Cat.	Progression criterion 2 (Exercise Group 2, if any)
ACHILLES TENDINOPATHY				
Stefansson et al. (2019)[37]	EPB	If the patient was pain-free for the full 15 repetitions for 3 sets, weight was added for the next phase.		
Beyer et al. (2015)[4]	CS	3x15 repetition maximum (15RM), in week 1; 3x12 (12RM), in weeks 2 to 3; 4x10 (10RM), in weeks 4 to 5; 4x8 (8RM), in weeks 6 to 8; and 4x6 (6RM), in weeks 9 to 12.	EPB	Load was increased gradually using a loaded backpack as pain diminished.
Stevens & Tan (2014)[26]	EPB	Load was increased gradually using a loaded backpack as pain diminished.	EPB	Load was increased gradually using a loaded backpack as pain diminished.
Kearney et al. (2013)[38]	EPB	Progressed as pain allowed. Firstly, by advancing from double-leg exercises to single-leg exercises. Secondly, load was increased gradually using a loaded backpack.		
Yu et al. (2013)[25]	CS	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol.	CS	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol.
Zhang et al. (2013)[57]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Horstmann et al. (2013)[47]	FB	Participants performed an extra set if no signs of fatigue were present after the 3 first sets. If necessary, load was increased gradually using a backpack.		
Yelland et al. (2011)[56]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Petersen et al. (2007)[35]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Rompe et al. (2007)[34]	EPB	Load was increased gradually using a loaded back pack as pain diminished.		
Roos et al. (2004)[36]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Mafi et al. (2001)[24]	EPB	Load was increased gradually using a loaded backpack as pain diminished.	CS	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol.
Silbernagel et al. (2001)[16]	CS,SP	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol. Additionally, volume was increased gradually as ability and symptoms allowed.	SP	Volume and complexity of exercises were increased gradually as ability and symptoms allowed.
PATELLAR TENDINOPATHY				
Rio et al. (2017)[14]	TLI	Weight was increased by 2.5% every week if possible.	TLI	Weight was increased by 2.5% every week if possible.
Van ark et al. (2016)[46]	TLI	Weight was increased by 2.5% every week if possible.	TLI	Weight was increased by 2.5% every week if possible.
Da Cunha et al.	EPB	Painful group increased weight to perform exercise with	APB	When the subjects from the “not painful” group, even

(2012)[27]		the greatest pain without altering performance.		without load addition, presented pain during the exercise, they were told to rest the upper limbs on a bar with the purpose to decrease overload on the patellar tendon.
Kongsgaard et al. (2009)[5]	CS	4x15 repetition maximum (15RM) week 1; 4x12 (12RM) weeks 2–3; 4x10 (10RM) weeks 4–5; 4x8 (8RM) weeks 6–8; and 4x6 (6RM) weeks 9–12.	EPB	Load was increased gradually using a loaded backpack as pain diminished.
Frohm et al. (2007)[58]	EPB	Increase weight if VAS < 3	EPB	Increase weight (5kg) if VAS < 3; Inertial exercise: maximal effort.
Bahr et al. (2006)[39]	EPB	When pain decreased to <3, the participant added load in a backpack.		
Visnes et al. (2005)[40]	EPB	With less pain than 3 to 4, were recommended to increase the weight.		
Young et al. (2005)[41]	EPB	Load was increased gradually using a loaded backpack as pain diminished.	EPB	Progressed as pain diminished (firstly from slow to fast, secondly increasing load).
Stasinopoulos & Stasinopoulos (2004)[17]	EPB	Load was increased gradually holding weights in their hands as pain diminished.		
Cannell et al. (2001)[44]	CS	When the subject was able to do three sets of 20 drops easily, they progressed to the next level according a stage-based protocol of four levels.	CS	Subjects began with a 5 kg weight and gradually increased their repetitions until they could do three sets of 10 with that weight. Once this was achieved, subjects progressed in weight according to a stage-based protocol of four levels.
GLUTEAL TENDINOPATHY				
Mellor et al. (2018)[3]	CS	Different, exercises, frequency, volume, and intensity in each week, according to a Stage-Based protocol.		
Ganderton et al. (2018)[48]	CS,SP	Different, exercises, frequency, volume, and intensity in each week, according to a Stage-Based protocol. The progression through the stages was additionally dependent on the patient's abilities.		

APB= Avoiding Pain-Based; Cat.= Load progression criteria category; CS= Conditioning Stages; EPB= Evoking Pain-Based; FB= Fatigue-Based; RM= repetition maximum; SP= Subjective Perception; TLI= Temporary Linear Increase; VAS= Visual Analogue Scale

TABLE 3. Cohen's d, percentage of change, and significance level (between-group comparison) of main clinical outcomes.

Study	Results				
	Clinical outcome	Time	Cohen's d (main outcome)	% of change	p
ACHILLES TENDINOPATHY					
Stefansson et al. (2019)[37]	VISA-A-IS	24 weeks	N/A	EPB (ECC) – Pressure massage: N/A	Pressure massage -EPB (ECC): >0.05
Beyer et al. (2015)[4]	VISA-A	52 weeks	CS (HSR) – EPB (ECC): 1.66	62.96% CS (HSR) – 46.55% EPB (ECC)	HSR - ECC: >0.05
Stevens & Tan (2014)[26]	VISA-A	6 weeks	(EPB) Do as tolerated ECC – Standard ECC 0.42	32.69% Do as tolerated – 18.34% Standard	>0.05
Kearney et al. (2013)[38]	VISA-A	26 weeks	EPB (ECC) – PRP: -0.55	58,33% ECC – 85,36% PRP	>0.05
Yu et al. (2013)[25]	VAS	8 weeks	CS (ECC) – CS (CONC): 1.74	-62,23% CS (ECC) – -43,00% CS (CONC)	<0.05*
Zhang et al. (2013)[57]	VISA-A	24 weeks	EPB (ECC) – Acupuncture: 1.40	64,14% acupuncture – ECC 36,24%	<0.05*
Horstmann et al. (2013)[47]	VAS: palpation pain 2 cm proximal to insertion	12 weeks	FB (ECC) - Wait and see: 0.89; FB (ECC) – Whole-Body Vibration: 0.27	-67.24% FB (ECC); -51.44% Vibration; -27.95% Wait and see	<0.05*
Yelland et al. (2011)[56]	VISA-A	52 weeks	EPB (ECC) – Prolotherapy injections: -0.09	N/A	>0.05
Petersen et al. (2007)[35]	VAS daily living activities	54 weeks	N/A	30% EPB (ECC) - 27% Brace	<0.05*
Rompe et al. (2007)[34]	VISA-A	16 weeks	EPB (ECC) - Shockwave: 0.28; ECC - Wait and see: 1.13	49.40% EPB (ECC) – 39.96% Shockwave – 14.10% Wait and see	ECC VS SWT: >0.05 ECC VS W&S: <0.05
Roos et al. (2004)[36]	Pain measured with FAOS	52 weeks	EPB (ECC) – Night splint: 0.22	43,33% EPB (ECC) – 36,06% Night splint	>0.05
Mafi et al. (2001)[24]	VAS during activity (running or walking)	12 weeks	N/A	EPB (ECC) – CS (CONC): N/A	N/A
Silbernagel et al. (2001)[16]	VAS on palpation	26 weeks	CS, SP (ECC+CONC) – SP (ECC): 0.42	-57.14% CS, SP (ECC+CONC) - -66.67% SP (ECC)	>0.05
PATELLAR TENDINOPATHY					

Rio et al. (2017)[14]	Pain measured with a Numeric Rating Scale during a single leg decline squat	4 weeks	TLI (Isometric) – TLI (Isotonic): 2.75	N/A	<0.05*
Van ark et al. (2016)[46]	Pain measured with a Numeric Rating Scale during a single leg decline squat	4 weeks	N/A	63,63% TLI (Isotonic) – 36,50% TLI (Isometric)	>0.05
Da Cunha et al. (2012)[27]	VISA-P	12 weeks	N/A	EPB (Decline Board ECC) – APB (Decline Board ECC) N/A	>0.05
Kongsgaard et al. (2009)[5]	VISA-P	26 weeks	N/A	65±71% CS (HSR) – 54±57% EPB (ECC) – 13±33% CORT	HSR VS ECC: >0.05 HSR VS CORT: <0.05* ECC VS CORT: <0.05*
Frohm et al. (2007)[58]	VISA-P	12 weeks	N/A	108.33% EPB (Decline board ECC) – 78.72% EPB (Overload ECC Device)	>0.05
Bahr et al. (2006)[39]	VISA-P	52 weeks	EPB (Decline Board ECC) – Surgery: -0.2	127.04% EPB (Decline Board ECC) – 136.13% Surgery	>0.05
Visnes et al. (2005)[40]	VISA-P	40 weeks	N/A	EPB (Decline Board ECC) – Usual training: N/A	ECC VS Usual training: >0.05
Young et al. (2005)[41]	VISA-P	52 weeks	N/A	EPB (ECC) – EPB (ECC): N/A	>0.05
Stasinopoulos & Stasinopoulos (2004)[17]	Status of pain from: worse, no change, somewhat better, much better, no pain.	16 weeks	N/A	EPB (ECC) – Transverse Friction – US: N/A	ECC VS TF: <0.05* ECC VS US: <0.05*
Cannell et al. (2001)[44]	VAS	12 weeks	N/A	CS (Drop squats ECC) – CS (Leg extension/curl): N/A	>0.05
GLUTEAL TENDINOPATHY					
Mellor et al. (2018)[3]	VISA-G	52 weeks	CS (Exercise + Edu.) - Corticosteroids: 0.58; CS (Exercise + Edu.) - Wait and see: 0.61	39.36% CS (Edu. + exercise) - 20.86% Corticosteroids - 19.39% Wait and see	>0.05
Ganderton et al. (2018)[48]	VISA-G	52 weeks	N/A	23,38% CS, SP (GLOBE) - 31,04% Sham	>0.05

*Significant differences between groups; APB= Avoiding Pain-Based; CONC= Isolated Concentric exercise; CORT= Corticosteroid injections; CS= Conditioning Stages; ECC= Isolated Eccentric Exercise; Edu.= education; EPB= Evoking Pain-Based; FAOS= Foot and Ankle Outcome Score; FB= Fatigue-Based; HSR= Heavy slow resistance training; N/A= not available; p= Significance level; PRP= Platelet-Rich Plasma; SP= Subjective Perception; SWT= Shockwave therapy; TF= Transverse friction; TLI= Temporary Linear Increase; US= Ultrasound Therapy; VAS= visual analogue scale; VISA-A= Victorian Institute of Sport Assessment Questionnaire for Achilles tendon; VISA-P= Victorian Institute of Sport Assessment Questionnaire for patellar tendon; VISA-G= Victorian Institute of Sport Assessment Questionnaire for gluteal tendinopathy

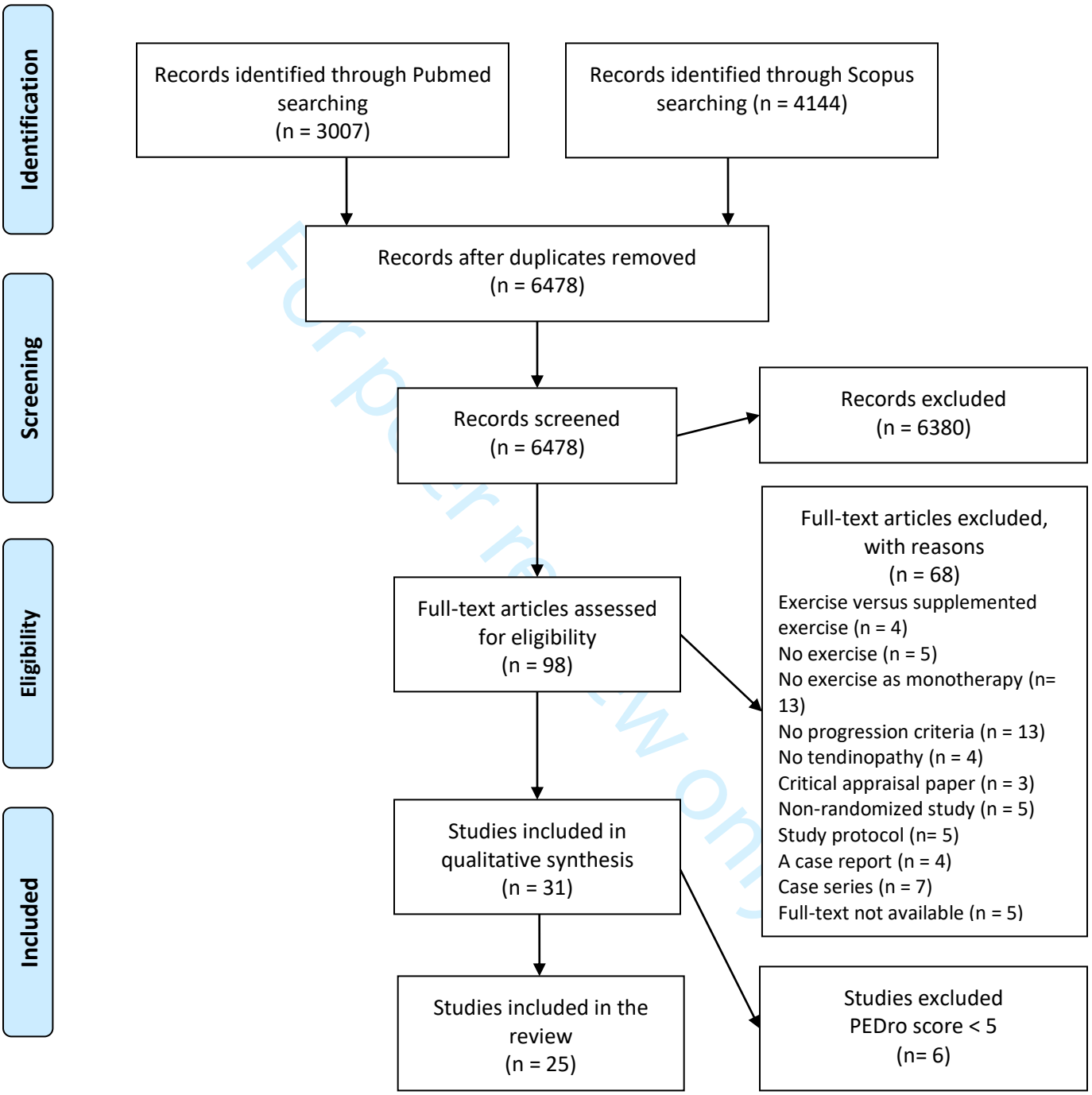
TABLE 4. Cohen's d, percentage of change, and significance level (between-group comparison) of main performance outcomes.

Study	Results				
	Performance main outcome	**Time**	**Cohen's d**	**% of change**	**p**
ACHILLES TENDINOPATHY					
Stefansson et al. (2019)[37]	Ankle dorsiflexion range of motion (bent and straight knee)	24 weeks	Bent knee: EPB (ECC)-Pressure massage: 0.07 Straight knee: EPB (ECC)-Pressure massage: -0.17	Bent knee: 6.68% EPB (ECC) – 5.45% Pressure massage Straight knee: 2.04% EPB (ECC) – 4.87% Pressure massage	>0.05 >0.05
Yu et al. (2013)[25]	Isokinetic concentric ankle dorsiflexion torque (30°/sec)	8 weeks	CS (ECC)-CS (CONC): 0.06	20.77% CS (ECC) – 19.36% CS (CONC)	>0.05
Horstmann et al. (2013)[47]	Isokinetic concentric ankle dorsiflexion torque (60°/sec)	12 weeks	N/A	FB (ECC) – Whole-Body Vibration – Wait and See: N/A	>0.05
Silbernagel et al. (2001)[16]	Countermovement jump test (one leg)	26 weeks	CS, SP (ECC+CONC) – SP (ECC): 0.28	30.77% CS, SP (ECC+CONC) – 13.33% SP (ECC)	>0.05
PATELLAR TENDINOPATHY					
Frohm et al. (2007)[58]	Isokinetic concentric knee extension torque (90°/sec)	12 weeks	EPB (Decline board ECC) – EPB (Overload ECC device): 0.05	3.55% EPB (Decline board ECC) – 0.92% EPB (Overload ECC device)	>0.05
Bahr et al. (2006)[39]	Countermovement jump test (both legs)	52 weeks	N/A	EPB (Decline Board ECC) – Surgery: N/A	>0.05
Visnes et al. (2005)[40]	Countermovement jump test (both legs)	40 weeks	N/A	EPB (Decline Board ECC) – Usual training: N/A	>0.05
Cannell et al. (2001)[44]	Isokinetic concentric knee extension torque (30°/sec)	12 weeks	CS (Drop squats ECC) – CS (Leg extension/curl): 0.72	14.8% CS (Drop squats ECC) – -4.67% CS (Leg extension/curl)	>0.05
GLUTEAL TENDINOPATHY					
Mellor et al. (2018)[3]	Gluteal muscle torque	8 weeks	CS (Edu. + exercise) – Corticosteroids: 0 CS (Edu. + exercise) – Wait and see: 0	12.5% CS (Education + exercise) – 12.5% Corticosteroids – 12.5% Wait and see	>0.05

*Significant differences between groups; APB= Avoiding Pain-Based; CS= Conditioning Stages; CONC= Isolated Concentric exercise; ECC= Isolated Eccentric Exercise; edu.= education; EPB= Evoking Pain-Based; FB= Fatigue-Based; N/A= not available; p= significance level; SP= Subjective Perception

FIGURE LEGEND

FIGURE 1. Flow diagram of the selection process.



SUPPLEMENTARY FILE

BMJ Open

LOAD PROGRESSION CRITERIA IN EXERCISE PROGRAMMES IN LOWER LIMB TENDINOPATHY: A SYSTEMATIC REVIEW

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Supplementary appendix 1. Search strategy.

PubMed search

Dates: From inception to 31st August 2019

Fields: "All Fields"

Keywords:

("Patellar tendin*" OR "jumper's knee" OR "lander's knee" OR "achilles tendin*" OR "midportion achilles tendin*" OR "mid-portion achilles tendin*" OR "mid-substance Achilles tendin*" OR "midsubstance Achilles tendin*" OR "non-insertional Achilles tendin*" "gluteal tendin*" OR "greater trochanteric bursitis" OR "greater trochanteric pain syndrome" OR "lower limb tendinopathy" OR "tendinopathy" OR "tendonopathy" OR "tendonitis")

AND

("exercise" OR "strength" OR "training" OR "resistance" OR "loading" OR "progressive" OR "physical activity" OR "eccentric")

Search chain: ((((((((((((((((((Patellar tendin*) OR jumper's knee) OR lander's knee) OR achilles tendin*) OR midportion achilles tendin*) OR mid-portion achilles tendin*) OR mid-substance Achilles tendin*) OR midsubstance Achilles tendin*) OR non-insertional Achilles tendin*) OR gluteal tendin*) OR greater trochanteric bursitis) OR greater trochanteric pain syndrome) OR lower limb tendinopathy) OR tendinopathy OR tendonopathy) OR tendonitis)))))) AND ((((((((exercise) OR strength) OR training) OR resistance) OR loading) OR progressive) OR physical activity) OR eccentric)

Search Chain Details: ((((((((((((((patellar tendinitis[All Fields] OR patellar tendinopathies[All Fields] OR patellar tendinopathy[All Fields] OR patellar tendinosis[All Fields]) OR (jumper's[All Fields] AND ("knee"[MeSH Terms] OR "knee"[All Fields] OR "knee joint"[MeSH Terms] OR ("knee"[All Fields] AND "joint"[All Fields]) OR "knee joint"[All Fields]))) OR (lander's[All Fields] AND ("knee"[MeSH Terms] OR "knee"[All Fields] OR "knee joint"[MeSH Terms] OR ("knee"[All Fields] AND "joint"[All Fields]) OR "knee joint"[All Fields]))) OR (achilles tendinitis[All Fields] OR achilles tendinopathies[All Fields] OR achilles tendinopathy[All Fields] OR achilles

tendinopaty[All Fields] OR achilles tendinoscopy[All Fields] OR achilles tendinosis[All Fields])) OR (midportion achilles tendinopathy[All Fields] OR midportion achilles tendinosis[All Fields])) OR (mid portion achilles tendinopathy[All Fields] OR mid portion achilles tendinosis[All Fields])) OR mid substance achilles tendinopathy[All Fields]) OR midsubstance achilles tendinopathy[All Fields]) OR non insertional achilles tendinopathy[All Fields]) OR (gluteal tendinitis[All Fields] OR gluteal tendinopathy[All Fields] OR gluteal tendinosis[All Fields])) OR (greater[All Fields] AND trochanteric[All Fields] AND ("bursitis"[MeSH Terms] OR "bursitis"[All Fields]))) OR (greater[All Fields] AND trochanteric[All Fields] AND ("somatoform disorders"[MeSH Terms] OR ("somatoform"[All Fields] AND "disorders"[All Fields]) OR "somatoform disorders"[All Fields] OR ("pain"[All Fields] AND "syndrome"[All Fields]) OR "pain syndrome"[All Fields]))) OR (("lower extremity"[MeSH Terms] OR ("lower"[All Fields] AND "extremity"[All Fields]) OR "lower extremity"[All Fields] OR ("lower"[All Fields] AND "limb"[All Fields]) OR "lower limb"[All Fields]) AND ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields]))) OR ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields]) OR ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields] OR "tendonopathy"[All Fields]) OR ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields] OR "tendonitis"[All Fields])) AND (((((((("exercise"[MeSH Terms] OR "exercise"[All Fields]) OR strength[All Fields]) OR ("education"[Subheading] OR "education"[All Fields] OR "training"[All Fields] OR "education"[MeSH Terms] OR "training"[All Fields])) OR resistance[All Fields]) OR loading[All Fields]) OR ("Progressive"[Journal] OR "progressive"[All Fields])) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("physical"[All Fields] AND "activity"[All Fields]) OR "physical activity"[All Fields])) OR eccentric[All Fields])

Scopus search Scopus®

Dates: From inception to 31st August 2019

Fields: "Title, Keywords, and Abstract"

Keywords:

("Patellar tendin*" OR "jumper's knee" OR "lander's knee" OR "achilles tendin*" OR "midportion achilles tendin*" OR "mid-portion achilles tendin*" OR "mid-substance Achilles tendin*" OR "midsubstance Achilles tendin*" OR "non-insertional Achilles tendin*" "gluteal tendin*" OR "greater trochanteric bursitis" OR "greater trochanteric pain syndrome" OR "lower limb tendinopathy" OR "tendinopathy" OR "tendonopathy" OR "tendonitis")

AND

("exercise" OR "strength" OR "training" OR "resistance" OR "loading" OR "progressive" OR "physical activity" OR "eccentric")

NOT

("supraspinatus" OR "biceps" OR "subacromial" OR "epicondylitis")

Limits: Document type: "Article"; Excluded subject areas: "Agricultural and Biological Sciences", "Immunology and Microbiology", "Veterinary", "Chemical Engineering", "Physics and Astronomy", "Social Sciences"

Complete search chain:

(((((((((((((((((((patellar AND tendin*) OR jumper's AND knee) OR lander's AND knee) OR achilles AND tendin*) OR midportion AND achilles AND tendin*) OR mid-portion AND achilles AND tendin*) OR mid-substance AND achilles AND tendin*) midsubstance AND achilles AND tendin*) non-insertional AND achilles AND tendin*) OR gluteal AND tendin*) OR greater AND trochanteric AND bursitis) OR greater AND trochanteric AND pain AND syndrome) OR lower AND limb AND tendinopathy) OR tendinopathy) OR tendonopathy) OR tendonitis)))) AND ((((((((exercise) OR strength) OR training) OR resistance) OR loading) OR progressive) OR physical AND activity) OR eccentric) AND NOT supraspintus AND NOT biceps AND NOT subacromial AND NOT epicondylitis AND (LIMIT-TO (DOCTYPE , "ar")) AND (EXCLUDE (SUBJAREA , "AGRI") OR EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "VETE") OR EXCLUDE (SUBJAREA , "CENG") OR EXCLUDE (SUBJAREA , "PHYS") OR EXCLUDE (SUBJAREA , "SOCI"))

Additionally, one reviewer manually checked the reference lists of different studies and reviews to identify possible additional studies.

Supplementary appendix 2. Characteristics of the subjects of the included studies.

Study	N	Subjects	Age	Duration of symptoms	Diagnosis
ACHILLES TENDINOPATHY					
Stefansson et al. (2019)	N=40‡	Recruited from clinicians and physical therapists	>18 years	At least 12 months	Clinical and US diagnosis
Beyer et al. (2015)	N=58	Recreational athletes	18-60 years	At least 3 months	US diagnosis
Stevens & Tan (2014)	N=28	Subjects identified on clinic waiting lists	>18 years	At least 3 months	Clinical diagnosis
Kearney et al. (2013)	N=20	Clinic patients	35-66 years	At least 3 months	Clinical and US diagnosis
Yu et al. (2013)	N=32	Clinic patients	20-30 years	At least 6 months	US diagnosis
Zhang et al. (2013)	N=64	Hospital patients	18-70 years	At least 2 months	Clinical diagnosis
Horstmann et al. (2013)	N=58	Recreational runners	25-55 years	At least 6 months	US diagnosis
Yelland et al. (2011)	N=29‡	VISA-A <80 (athletes), VISA-A <70 (not athletes); analgesics were allowed	>18 years	At least 6 weeks	Clinical and US diagnosis
Petersen et al. (2007)	N=72‡ (100 tendons)¥	Recreational athletes	Mean age 42.5±11.07	At least 3 months (7.4 months)	Clinical and US diagnosis
Rompe et al. (2007)	N=75	Clinic patients; 12 weeks washout period required.	18-70 years	At least 6 months	Clinical and US diagnosis
Roos et al. (2004)	N=29‡	Primary care patients	26-60 years	At least 1 month	Clinical diagnosis
Mafi et al. (2001)	N=44	People with severe tendinopathy candidate for surgical treatment	36-72 years	At least 3 months	Clinical and US diagnosis
Silbernagel et al. (2001)	N=40 (57 tendons)¥	Recreational athletes	19-77 years	At least 3 months	Clinical diagnosis
PATELLAR TENDINOPATHY					
Rio et al. (2017)	N=20	Volleyball and basketball players	>16 years	N/A	Clinical and US diagnosis
Van ark et al. (2016)	N=29	Volleyball and basketball players	16-32 years	At least 1 month (35.8±33.8 months)	Clinical diagnosis
Da Cunha et al. (2012)	N=7	Athletes	>18 years	N/A	Clinical and US or MRI diagnosis
Kongsgaard et al. (2009)	N=39	4 weeks wash-out period required	18-50 years	At least 3 months	US diagnosis
Frohm et al. (2007)	N=20	Competitive and recreational athletes	26±8-28±8 years	At least 3 months	MRI or US diagnosis
Bahr et al. (2006)	N=40¥	Subjects with pain during and after activity and unable to participate in sports at the same level as before the onset of pain	>18 years	At least 3 months	Clinical and MRI diagnosis
Visnes et al. (2005)	N=29	Volleyball players, VISA-P score <80 point; NSAIDs were allowed	18-35 years	At least 3 months	Clinical diagnosis
Young et al. (2005)	N=17	Elite volleyball players with VISA-P score <80 points	18-35 years	N/A	Clinical and US diagnosis
Stasinopoulos & Stasinopoulos (2004)	N=30	Athletes	21-31 years	At least 3 months	Clinical diagnosis
Cannell et al. (2001)	N=19	Athletes	15-50 years	At least 1 month	Clinical diagnosis
GLUTEAL TENDINOPATHY					
Mellor et al. (2018)	N=204	At least 4 on the pain numerical rating scale	35-70 years	At least 3 months	Clinical and MRI diagnosis
Ganderton et al. (2018)	N=94	Postmenopausal women	61.14±6.70-62.538±92 years	N/A	Clinical diagnosis

‡ = Sample (N) excluding subjects included in the combined treatment group, not taken into account in the review; ¥ = Number of tendons (Both sides were included if the patient had bilateral involvement); N/A= Not available; NSAIDs= Non-Steroidal Anti-Inflammatory Drugs; MRI: magnetic resonance imaging; US= ultrasound; VISA-A= Victorian Institute of Sport Assessment Questionnaire for Achilles tendon; VISA-P= Victorian Institute of Sport Assessment Questionnaire for patellar tendon

Supplementary appendix 3. Characteristics the interventions of the included studies.

Study	PA*	Intervention			Control		
		Characteristics [Type; duration of programme; frequency; volume; series x repetitions (exercises)]	Total weekly volume	Progression criterion	Characteristics [Type; duration of programme; frequency; volume; series x repetitions (exercises)]	Total weekly volume	Progression criterion
ACHILLES TENDINOPATHY							
Stefansson et al. (2019)	N/A	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	Week 1: 150 reps; week 2: 630 reps; weeks 3 to 12: 1260 reps	Evoking Pain-based: If the patient was pain-free for the full 15 repetitions for 3 sets, another 5 kg was added for the next phase.		Pressure massage	
Beyer et al. (2015)	Partially	HSR; 12 weeks; 3 times/week; 3-4x6-15 (three two-legged exercises: heel rises with straight and bent knee in machine, and heel rises with straight knee standing on a disc weight)	Week 1: 405 reps; weeks 2 and 3: 324 reps; weeks 4 and 5: 360 reps; weeks 6,7, and 8: 288 reps; weeks 9, 10, 11, and 12: 216 reps.	Conditioning Stages: 3x15 repetition maximum (15RM), in week 1; 3x12 (12RM), in weeks 2 to 3; 4x10 (10RM), in weeks 4 to 5; 4x8 (8RM), in weeks 6 to 8; and 4x6 (6RM), in weeks 9 to 12.	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.
Stevens & Tan (2014)	Partially	ECC "do as tolerated"; 6 weeks; twice daily; 3x15 (heel raises with straight and bent knee); recommendation to achieve a repetition volume similar to that of the standard group, but they could choose to complete a lower repetition volume that was tolerable.	1260 reps/week if tolerated (mean: 595 reps/week)	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.	ECC; 6 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week (mean: 1162 reps/week)	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.
Kearney et al. (2013)	N/A	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Progressed as pain allowed. Firstly, by advancing from double-leg exercises to single-leg exercises. Secondly, load was increased gradually using a loaded backpack.		PRP injection	
Yu et al. (2013)	N/A	ECC; 8 weeks; 3 times/week; 3x15 (heel raises with straight and bent knee; different variants according to the corresponding week)	270 reps/week	Conditioning Stages: Eccentric contraction using both feet, in week 1; Use both feet to achieve eccentric contraction or increase weight bearing on the injured side, in week 2; Use the injured-side foot to achieve eccentric contraction, in week 3; Use only the injured-side foot and apply 10% of weight, in week 4; Use only the injured-side foot and additionally apply 5-10 lbs	CONC; 8 weeks; 3 times/week; 3x15 (plantarflexion using elastic band, heel raises, side jump; different variants according to the corresponding week)	405 reps/week	Conditioning Stages: Plantarflexion using elastic band while sitting on the floor with straightened knees. Sit on a chair and lift the heels with partial weight bearing. Hold onto the wall and lift the heels of both feet. Hamstring and calf muscle stretching, in weeks 1 and 2; Plantarflexion using elastic band while sitting on the floor with straightened knees. Plantarflexion while lifting the injured-side

				of load to the resistance of the previous week, in week 5 to 8.			foot on a chair. Hold onto the wall and lift the heel of one foot. Hamstring and calf muscle stretching, in weeks 3 and 4; Use the injured-side foot to achieve eccentric contraction, in week 3; Use only the injured-side foot and apply 10% of weight, in week 4; Plantarflexion using elastic band while sitting on the floor with straightened knees. Hold onto the wall and lift the heel of one foot. Side jump. Hamstring and calf muscle stretching., in week 5 to 8
Zhang et al. (2013)	N/A	ECC; 8 weeks; 3 times/week; 3x15 (heel raises with straight and bent knee)	270 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.		Acupuncture	
Horstmann et al. (2013)	Yes	ECC; 12 weeks; 3 times/week; 3x15 on each leg (heel raises with straight and bent knee)	270 reps/week	Fatigue-based: Participants performed an extra set if no signs of fatigue were present after the 3 first sets. If necessary, load was increased gradually using a backpack.	Control group 1: Whole-body Vibration Group; control group 2: wait and see group		
Yelland et al. (2011)	Yes	ECC; 12 weeks; 3 times daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.		Polidocanol injections	
Petersen et al. (2007)	Yes	ECC; 12 weeks; 3 times daily; 3x15 (heel raises with straight and bent knee)	1890 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.		AirHeel brace	
Rompe et al. (2007)	Partially	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.	Control group 1: Shockwave/ Control group 2: Wait and see		
Roos et al. (2004)	N/A	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.		Night splint	
Mafi et al. (2001)	Partially	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.	CONC; 12 weeks; twice daily; 3x15 (different exercises according to stages and weeks).	Approximately 1260 reps/week	Conditioning Stages: Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol.
Silbernagel et al. (2001)	N/A	ECC+CONC; 12 weeks; frequency, volume, and exercises variable in each week.	Variable	Conditioning Stages and Subjective Perception: Stage-based progression in complexity and load. Additionally, volume	ECC; 12 weeks; 3 times/day; 3x30 (including exercises that combine eccentric and concentric phases)	Variable	Subjective Perception: Volume and complexity of exercises were increased gradually as ability and symptoms allowed

				was increased gradually as ability and symptoms allowed.			
PATELLAR TENDINOPATHY							
Rio et al. (2017)	Yes	ISOM (knee joint angle of 60◦); 4 weeks; 4 times/week; 5x45" holds 80% MVIC (calculated at baseline)	900”/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible.	Isotonic exercise; 4 weeks; 4 times/week; 4x8 80% 8RM (calculated at baseline)	128 reps/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible.
Van ark et al. (2016)	Yes	Isotonic exercise; 4 weeks; 4 times/week; 4x8 80% RM at the beginning	128 reps/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible.	ISOM (knee joint angle of 60◦); 4 weeks; 4 times/week; 5x45” 80%MVC	900”/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible.
Da Cunha et al. (2012)	Partially	Painful ECC decline board squat (squat instrument with guided bar); 12 weeks; 3 times/week; 3x15	135 reps/week	Evoking Pain-based: Painful group increased weight to perform exercise with the greatest pain without altering performance.	Not painful ECC decline board squat (squat instrument with guided bar); 12 weeks; 3 times/week; 3x15	135 reps/week	Avoiding Pain-Based: When the subjects from the “not painful” group, even without load addition, presented pain during the exercise, they were told to rest the upper limbs on a bar with the purpose to decrease overload on the patellar tendon.
Kongsgaard et al. (2009)	Partially	HSR; 12 weeks; 3 times/week; Volume variable; 3 exercises (squat, leg press and hack squat)	Week 1: 540 reps; weeks 2 and 3: 432 reps; weeks 4 and 5: 360 reps; weeks 6,7, and 8: 288 reps; weeks 9, 10, 11, and 12: 216 reps.	Conditioning Stages: 4x15 repetition maximum (15RM) week 1; 4x12 (12RM) weeks 2–3; 4x10 (10RM) weeks 4–5; 4x8 (8RM) weeks 6–8; and 4x6 (6RM) weeks 9–12.	Control Group 1: ECC decline board squat; 12 weeks; twice daily, 3x15 (supervised training once a week)/ Control Group 2: Corticosteroid injection	ECC: 630 reps/week	ECC: Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished.
Frohm et al. (2007)	Partially	Mutual exercise (3x15 sit-ups and 3x1min one-legged stance) + ECC decline board squat; 12 weeks; 2 times/week (supervised); 3x15. During the last 6 weeks of the intervention, participants slowly resumed supervised jogging and plyometric jump training	90 (sit-ups) + 90 (squats) reps/week	Evoking Pain-based: Increase weight (5kg) if VAS < 3	Mutual exercise (3x15 sit-ups and 3x1min one-legged stance) + exercise overload ECC (Bromsman device); 12 weeks; 2 times/week (supervised); 4x4 (maximal effort). During the last 6 weeks of the intervention, participants slowly resumed supervised jogging and plyometric jump training.	90 (sit-ups) + 32 (squats) reps/week	Evoking Pain-Based: Increase weight (5kg) if VAS < 3; Inertial exercise: maximal effort.
Bahr et al. (2006)	Partially	ECC decline board squat; 12 weeks; twice daily; 3x15 (squat performed with the knee flexed to 90°).	630 reps/week	Evoking Pain-based: When pain decreased to <3, the participant added load in a backpack. Recommended to have a pain value of 4.		Surgery	
Visnes et al. (2005)	Yes	ECC decline board squat during season; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-based: With less pain than 3 to 4, were recommended to increase the weight. Recommended to have a		Usual Training (no intervention)	

				pain value of 5 on a VAS during ECC programme.			
Young et al. (2005)	Yes	ECC decline board squat; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-Based: Load was increased gradually using a loaded backpack as pain diminished.	ECC squat on 10 cm step; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-Based: Progressed as pain diminished (firstly from slow to fast, secondly increasing load)
Stasinopoulos & Stasinopoulos (2004)	N/A	ECC squat + static stretching, 4 weeks, 3 times/week, 3x15 (unilateral squat)		Evoking Pain-Based: Load was increased gradually holding weights in their hands as pain diminished.	Control group 1: Transverse friction/ Control group 2: US		
Cannell et al. (2001)	Yes	ECC squat + modification activity level; 12 weeks; once a day, 5 times/week; 3x20. Subjects were not asked to refrain from sporting activities once their initial symptoms were relieved.	300 reps/week	Conditioning Stages: When the subject was able to do three sets of 20 drops easily, they progressed to the next level according stage-based protocol of four levels.	Leg extension/curl + modification activity level, 12 weeks, 5 times/week, 3x10 each one.	300 reps/week	Conditioning Stages: Subjects began with a 5 kg weight and gradually increased their repetitions until they could do three sets of 10 with that weight. Once this was achieved, subjects progressed in weight according to a stage-based protocol of four levels.
GLUTEAL TENDINOPATHY							
Mellor et al. (2018)	N/A	Exercise + education; 8 weeks (14 sessions) + home exercise programme (4-6 exercises); once daily	Variable	Conditioning Stages: Different, exercises, frequency, volume, and intensity in each week, according to a Stage-Based protocol.	Control group 1: Corticosteroids/ Control group 2: Wait-and-See approach		
Ganderton et al. (2018)	No	Exercise + education; 12 weeks; twice daily; 2-4x5-15	Variable	Conditioning Stages and Subjective Perception: Different, exercises, frequency, volume, and intensity in each week, according to a Stage-Based protocol. The progression through the stages was additionally dependent on the patient's abilities.	Sham exercise		

PA*= allowed additional physical activity; CONC= concentric exercise training; ECC= eccentric exercise training; HSR= heavy slow resistance training; ISOM= isometric exercise training; MVC= maximal voluntary contraction; N/A = not available; RM= repetition maximum; US= ultrasound therapy; VAS= Visual Analogue Scale

Supplementary appendix 4. Outcomes and measurement time.

Study	N	Clinical Outcomes		Performance Outcomes	
		Time	Secondary Outcomes	Time	Secondary Outcomes
ACHILLES TENDINOPATHY					
Stefansson et al. (2019)	N=40‡	0, 4, 8, 12, 24 weeks	VISA-A-IS, pain on palpation (algometer), thickness and degree of vascularization (US)	0, 4, 8, 12, 24 weeks	Ankle range of motion
Beyer et al. (2015)	N=58	0, 12, 52 weeks	VAS during 5 heel raises on step, VAS during running, US measurements		
Stevens & Tan (2014)	N=28	0, 3, 6 weeks	VISA-A, VAS; 6 weeks: treatment satisfaction		
Kearney et al. (2013)	N=20	0, 6, 12, 26 weeks	VISA-A, The EuroQol-5D		
Yu et al. (2013)	N=32	0, 8 weeks	VAS	0, 8 weeks	Isokinetic measurement (strength), side-step test (endurance), sargent jump test (physical function)
Zhang et al. (2013)	N=64	0, 8, 16, 24 weeks	VISA-A, VAS (after activity, at rest), treatment satisfaction, use of painkillers, and working status.		
Horstmann et al. (2013)	N=58	0, 12 weeks	Change of symptoms (standard Likert scale), VAS (family and responsibility at home, recreation, social activities, running training or others physical activities), sonographic assessment.	0, 12 weeks	Isokinetic measurements.
Yelland et al. (2011)	N=29‡	0, 6, 12, 26, 52 weeks	VISA-A, treatment satisfaction (standard Likert scale), Patient Global Impression of Change scale		
Petersen et al. (2007)	N=72‡ (100 tendons)¥	0, 6, 12 weeks	VAS (at rest, during gait, during sports activities), AOFAS hindfoot scale, SF-36, US. 54 weeks: AOFAS, VAS		
Rompe et al. (2007)	N=75	0, 16 weeks	VISA-A, general assessment (6-point Likert scale), NRS scale (pain), algometer (pain), US		
Roos et al. (2004)	N=29‡	0, 6, 12, 26, 52 weeks	FAOS [Pain measured with FAOS was considered the primary outcome]	0, 6, 12, 26, 52 weeks	Activities of Daily Living, Sport and Recreation Function, and Foot and Ankle-related Quality of Life; Physical activity level (seven grade scale from 0 to 6)
Mafi et al. (2001)	N=44	0, 12 weeks	VAS during activity (running or walking), patient satisfaction		
Silbernagel et al. (2001)	N=40 (57 tendons)¥	0, 6, 12, 26 weeks	Pain (palpation test and pain evaluation during jumping, toe-raises and at rest), presence of symptoms, and a questionnaire (physical activity level, work, other injuries, previous treatments for the Achilles tendon disorder, and medication)	0, 6, 12, 26 weeks	Range of motion test, jumping test, toe raise test
PATELLAR TENDINOPATHY					

Rio et al. (2017)	N=20	0, 4 weeks	Pain during single leg decline squat with a numerical rating scale (0-10), VISA-P		
Van ark et al. (2016)	N=29	0, 4 weeks	Pain during a single leg decline squat on a Numerical Rating Scale (0-10), VISA-P		
Da Cunha et al. (2012)	N=7	0, 8, 12 weeks	VISA-P , VAS		
Kongsgaard et al. (2009)	N=39	0, 12, 26 weeks	VISA-P, VAS, treatment satisfaction, tendon swelling, tendon vascularization, tendon mechanical properties, collagen crosslink properties		
Frohm et al. (2007)	N=20	0, 3, 6, 9, 12 weeks	VISA-P, VAS	0, 3, 6, 9, 12 weeks	Isokinetic muscle torque, dynamic function, muscle flexibility.
Bahr et al. (2006)	N=40¥	0, 12, 26, 52 weeks	VISA-P, global evaluation score, treatment satisfaction. Functional tests of strength and jumping performance	0, 12, 26, 52 weeks	Standing jump, counter-movement jump, leg press
Visnes et al. (2005)	N=29	0, 12 weeks	VAS, VISA-P, patient satisfaction	0, 1, 4, 8, 12, 18, 40 weeks	Counter-movement jump
Young et al. (2005)	N=17	0, 1, 4, 8, 12, 18, 40 weeks	VISA-P, global evaluation score (pain and function)		
Stasinopoulos & Stasinopoulos (2004)	N=30	0, 4, 8, 16 weeks	Status of pain from the following alternatives: worse, no change, somewhat better, much better, no pain.		
Cannell et al. (2001)	N=19	0, 6, 12 weeks	VAS	0, 6, 12 weeks	Return to sport, isokinetic (strength)
GLUTEAL TENDINOPATHY					
Mellor et al. (2018)	N=204	0, 4, 8, 12, 26, 52 weeks	Global rating of change and pain intensity, VISA-G, lateral hip pain questionnaire, patient specific functional scale; pain self-efficacy questionnaire, pain catastrophising scale, Patient Health Questionnaire, Active Australia survey, and EuroQOL-5D	0, 8 weeks	Hip abductor muscle torque, active abduction lag
Ganderton et al. (2018)	N=94	0, 12, 52 weeks	VISA-G, hip pain and function questionnaires, global rating of change in symptom questionnaire, HOOS, OHS, AQoL-8D (quality of life)		

ǂ = Sample (N) excluding subjects included in the combined treatment group, not taken into account in the review; ¥ = Number of tendons (Both sides were included if the patient had bilateral involvement);

AQoL-8D: Assessment of Quality of Life 8-Dimenssion; AOFAS: American Orthopaedic Foot & Ankle Society score; EuroQOL-5D= European quality of life-5D questionnaire; FAOS= Foot and Ankle Outcome Score; HOOS= Hip dysfunction and Osteoarthritis Outcome Score; OHS= Oxford Hip Score; SF-36: Short-form 36 Questionnaire; US: ultrasound; VAS= visual analogue scale; VISA-A= Victorian Institute of Sport Assessment Questionnaire for Achilles tendon; VISA-P= Victorian Institute of Sport Assessment Questionnaire for patellar tendon; VISA-G= Victorian Institute of Sport Assessment Questionnaire for gluteal tendinopathy

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	9
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	9
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9-10
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	1

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LOAD PROGRESSION CRITERIA IN EXERCISE PROGRAMMES IN LOWER LIMB TENDINOPATHY: A SYSTEMATIC REVIEW

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Title: LOAD PROGRESSION CRITERIA IN EXERCISE PROGRAMMES IN LOWER LIMB TENDINOPATHY: A SYSTEMATIC REVIEW

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Competing interests

None

ABSTRACT

Objective: The objective of this study is to summarise and analyse the current literature about what progression criteria are applied in loading exercise programmes in lower limb tendinopathies and their evidence and effectiveness.

Design: Systematic review

Methods: Pubmed, Embase, Scopus, and PED*ro* were searched from inception to 24th September 2020. The inclusion criteria were randomised controlled trials that included patients with midportion Achilles, patellar, or gluteal tendinopathy; assessed function, pain, or performance; included at least one group where progressive physical exercise was administered as monotherapy; included at least a control group. We excluded studies that included subjects with previous tendon surgical treatment; studies with control group that conducted a supplemented modality of the exercise performed in the intervention group. A narrative synthesis was conducted. Cohen's d and the percentage of change of main clinical and performance outcomes was obtained. Methodological quality was assessed using the PEDro scale.

Results: Thirty studies that described progression criteria were included. Six types of criteria grouped in two categories were identified and included in a new classification proposal: pain as a primary criterion (Evoking and Avoid-pain based), and pain and symptom control as a secondary criterion (Conditioning Stages, Fatigue-based, Subjective Perception, and Temporary Linear Increase). Most of the studies applied a pain-based criterion. Criteria based on Conditioning Stages were also commonly applied. Other criteria such as fatigue, a temporary linear increase, or the subjective perception of the patient's abilities were occasionally applied.

Conclusions: There is a predominant use of pain-based criteria, but the utilization of these criteria is not supported by strong evidence. This review evidences the need for studies that compare the same exercise programme using different progression criteria. A new classification of the existing progression criteria is proposed based on the use of pain as the primary or secondary criterion.

Registration: CRD42018110997

Keywords: Musculoskeletal disorders; pain management; rehabilitation medicine; sports medicine

Word count: 4998

Strengths and limitations of the study

- This is the first systematic review that expressly and comprehensively identifies, assesses and summarises the evidence regarding load progression criteria in lower limb tendinopathy.
- This systematic review has been designed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.
- In case of disagreements, a third independent was required for reducing the risk of observer bias.
- A limitation of this systematic review is the non-inclusion of studies in which the effect of exercise programmes was studied without a control group, not being included in the analysis and discussion of the results.
- Heterogeneity and deficiencies in the reporting of data found have not allowed the extraction of accurate and conclusive information for developing a quantitative analysis.

Background

Progressive therapeutic exercise is considered a first-line treatment in tendinopathies due to the extensive evidence published in the last three decades [1–5]. The objective of this treatment modality is to produce mechanical stimulus that provoke biochemical and mechanical responses, generating adaptations of the tendon to load and exercise [1]. In addition to this, the limited adverse effects produced by therapeutic exercise may explain the growing interest of therapists and patients in this approach [6]. The current literature shows positive outcomes of exercise programmes on pain and function in different locations of tendinopathies in the upper and lower extremities [3–5,7,8]. Nevertheless, current evidence is not equally consistent for all tendinopathies. In some locations such as the midportion Achilles, patellar, or gluteal tendinopathies the evidence in favour of exercise is abundant, and current studies attempt to elucidate which exercise methodology and dose are most appropriate [4,5,9,10]. Meanwhile, the evidence in hamstring [7,11], insertional Achilles [2,12], or upper limbs tendinopathies [13], among others, is lower, and additional studies supporting exercise programmes are still needed.

In lower limb tendinopathy, there is not a single modality of therapeutic exercise achieving favourable results, but a broad spectrum of methodologies has been positively applied. Hence, isometric contractions [14], isolated eccentric training [15], combinations of eccentric and concentric contractions [16], or heavy slow resistance training (HSR) [5] are some examples of exercise modalities commonly applied in this pathology. Conversely, traditional passive treatments such as corticosteroids injections [3,5], transverse friction [17], or therapeutic ultrasound [17] have sometimes not shown enough capacity to maintain positive effects on long-term follow-up.

Cook and Purdam (2009) [18] considered the pathological model of tendinopathy as a continuum, distinguishing three theoretical stages (reactive tendinopathy, tendon disrepair, and degenerative tendinopathy). Moreover, a study showed that there is sufficient area with acceptable levels of aligned fibrillar structure in the pathological tendon [19]. These non-affected areas would be able to compensate for the disorganization of affected areas by increasing tendon thickness [19]. According to this approach, the primary stimulus to advance or retreat through the continuum would be adding or removing enough load to obtain changes in the non-

affected structure of the tendon [1,18]. Thus, it would be necessary individualised handling of the load progression for adequate management of the process. Maximum efficiency is pursued with a reduced risk of injury. For this purpose, some authors have established different methodologies to handle load progression. Nevertheless, there is a lack of consensus and objective criteria on how this load progression should be handled.

In sport and physical training, some authors have suggested that a high risk of injury could not be associated with the use of high loads but with inadequate handling of the progression [20]. From this approach, the use as a guidance of the 10% rule among clinicians and trainers is common. According to this rule, it would be essential to control the relationship between the loads applied each week and the average load applied in the previous weeks. Thus, a weekly load progression higher than 10% would considerably increase the risk of injury. Despite its widespread use, the evidence regarding this rule is controversial. While in some team sports a significant increase in the risk of injury has been observed with load increases of more than 10%, and especially 50% [20], other studies suggest that in other areas, such as beginning runners, increases between 20 and 25% could be well tolerated [21]. In this context, using the 10% reasoning only as a guidance seems coherent, if the training experience and the context of each subject for the handling of the load are considered.

In tendinopathies, pain intensity as a load progression criterion is commonly used. Stanish et al. (1986) [22] and Alfredson et al. (1998) [15] described therapeutic exercise protocols that have been massively used in lower limb tendinopathy. In these protocols, load progression consisted of maintaining a feeling of discomfort or pain during exercises. However, recent systematic reviews have shown that despite its widespread use, there exists a striking lack of evidence for the training parameters applied [9,23].

Several studies have analysed the effectiveness of different exercise protocols in tendinopathies [4,5,16,24,25]. Additionally, some of these studies have compared the effect of different symptom management strategies on similar exercise programmes (e.g., pain allowed or not allowed during exercise) [26,27]. There exist abundant reviews about pathology, risk factors, prevention, diagnosis or management in lower limb tendinopathies [2]. However, studies are usually focused on the comparison of different exercise protocols and not on the

study of the different progression criteria. Therefore, there is a gap in the evidence on what load progression criterion should be used, which requires an additional analysis of this topic.

As described above, while there is abundant evidence on the effectiveness of exercise in lower limbs tendinopathies, controversy still exists about which may be the best approach in upper limbs. For this reason, this systematic review has only analysed studies concerning tendinopathies of the lower extremities, focusing on the three most predominant ones (Achilles, patellar, and gluteal) in order to reduce this heterogeneity. Likewise, those studies concerning insertional Achilles tendinopathy have also been discarded from this review to avoid the heterogeneity caused by its apparent different clinical presentation and response to treatment [2].

The objective of this systematic review was to summarise and to analyse the current literature on what criteria of progression are applied in loading exercise programmes in lower limb tendinopathies and their evidence and effectiveness.

METHODS

This systematic review was undertaken following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [28]. This review was prospectively registered in PROSPERO (registration number: CRD42018110997) and its protocol has been published in an impact journal [29].

Patient and Public Involvement

No patient involved

Search

Two reviewers searched Pubmed, Embase, Scopus, and PED*ro* from inception to 24th September 2020. The following search terms relating to the tendinopathy location and exercise were combined for a main search: (“Patellar tendin*” OR “jumper's knee” OR “lander's knee” OR

"achilles tendin*" OR "midportion achilles tendin*" OR "mid-portion achilles tendin*" OR "mid-substance Achilles tendin*" OR "midsubstance Achilles tendin*" OR "non-insertional Achilles tendin*" "gluteal tendin*" OR "greater trochanteric bursitis" OR "greater trochanteric pain syndrome" OR "lower limb tendinopathy" OR "tendinopathy" OR "tendonopathy" OR "tendonitis") AND ("exercise" OR "strength" OR "training" OR "resistance" OR "loading" OR "progressive" OR "physical activity" OR "eccentric" OR "plyometric" OR "guided imagery" OR "stretching"). Extended information about the searches in the different search engines is provided in Supplementary Appendix 1.

Eligibility criteria

All randomised controlled trials that met the following eligibility criteria based on the PICO framework were included:

(a) Participants: people with patellar, midportion Achilles (those studies where the location of the painful area was not specified or where both locations were analysed as a whole were included, considering the predominant incidence of midportion Achilles tendinopathies), or gluteal tendinopathy; at least 16 years old.

(b) Interventions: progressive exercise programmes; at least one group where physical exercise was administered as monotherapy. Physical exercise has been defined as a subcategory of physical activity consisting of planned, structured, and repetitive movement performed with the purpose of improving or maintaining physical performance or health [30]. Any voluntary action of the neuromuscular system was considered as physical exercise, including strength training; aerobic exercise; plyometrics; active, self-assisted, or guided imagery exercise; active , or self-assisted stretching exercises; other similar forms of exercise; or a combination of these exercises.

(c) Control interventions: no intervention, sham, or other experimental groups.

(d) Outcomes: studies measuring at least function, pain, or performance outcomes.

(e) No gender, ethnicity, year of publication, or language restrictions were imposed.

Those studies that met any of the following exclusion criteria were excluded: (a) including participants with previous tendon surgery; (b) studies in which the exercise was not applied as monotherapy in any of the groups or where the control group involved a supplemented modality of the exercise performed in the intervention group.

Procedures

All references were imported into the bibliographic management software Mendeley and duplicates were identified and removed. Two independent authors screened the remaining results by title and abstract. Two reviewers screened the full texts of selected articles to identify those that satisfied the eligibility criteria. A third reviewer solved any disagreements.

Data extraction and quality assessment

Two reviewers retrieved and independently assessed the full texts of the selected studies using an extraction form that included: study setting; study population; participant demographics and baseline characteristics; details of the intervention and control conditions; permission to perform additional physical activity; load progression criteria of the exercise programmes; recruitment and study completion rates; outcomes; effect size (Cohen's d) or percentage of change of a main outcome; significance level; and relevant information about risk of bias. Disagreements between the two reviewers were discussed with a third reviewer. Authors were contacted by email in order to obtain additional information not reported in their articles.

Two reviewers independently assessed the quality and internal validity, as well as the existence of potential bias of the studies using the PED*ro* scale [31]. This 11-item scale is considered a valid and reliable measure of methodological quality of RCTs [31,32]. Each satisfied item from 2-11 (items corresponding to internal validity, that is to say, the extent to which a study establishes a trustworthy cause-and-effect relationship between a treatment and an outcome) contributes one point to the total PEDro score (0, worst score; 10, best score). Item 1 pertains to external validity and is not considered for the total score. Therefore, the PED*ro* scale has the objective of classifying those studies of different methodological quality to allow an adjusted

analysis. In this review, those studies scoring 7–10 were considered of good methodological quality, those scoring ranging 5–6 were considered of fair methodological quality, while those that score below five were considered of poor quality.

Data synthesis and analysis

A narrative synthesis to report and compare the different load progression criteria existing in the scientific literature was conducted. Although the authors of most of the studies were contacted by mail in order to obtain the necessary data for inclusion in a meta-analysis, most of these data could not be obtained. Thus, due to the lack of studies with complete data and the existing critical heterogeneity, it was only possible to conduct a narrative synthesis. The different intervention or control groups were organized in the tables by prioritizing exercise interventions over passive interventions regardless of the order of interventions in the original studies. In cases where two or more exercise interventions were compared, the intervention that obtained the greatest effect size in the study was prioritized. In all cases, the latest measurement of the main outcome was selected for analysis, thus focusing on the long-term effectiveness of the interventions. Additionally, the heterogeneity of the included studies was assessed ordering the results by methodological characteristics (location of tendinopathy, intervention, type of control group used, progression criteria, data reporting).

The Cohen's d of a main clinical and performance outcome was retrieved or calculated to quantify and compare the effectiveness of the interventions [33]. Where possible, the VISA (VISA-A, VISA-P, or VISA-G) questionnaire or VAS were chosen as the main clinical outcome to homogenize the analysis, as they were the most frequently used outcomes. The effect size was classified into four levels: $d<0.2$ was considered a trivial effect size; $d\geq0.2$ was considered a small effect size; $d\geq0.5$ was considered a medium effect size, and $d\geq0.8$ was considered a large effect size [33]. The significance level was set at 0.05.

RESULTS

A total of 9182 citations were identified in PubMed, Embase, Scopus, and PED*ro* with 6870 of them remaining after deleting duplicates. Among these, 117 articles were selected as potentially eligible after reading the title and the abstract (the full text was retrieved in case of doubt). After evaluating the fulfilment of the eligibility criteria, only 30 studies were included in the systematic review. The flow diagram of the selection process and the reasons for exclusion of the discarded studies are described in Figure 1. A complete list of the full-text articles excluded in the last phase is available in Supplementary Appendix 2.

[Figure 1 near here]

Participants

Supplementary Appendix 3 shows the characteristics of the subjects of the included studies (number of subjects, type of population, age, duration of symptoms, and information about whether the diagnosis was obtained only clinically or supported by imaging tests).

Exercise programmes

Different exercise programmes were identified in the included studies: heavy slow resistance training [4,5]; isotonic exercise programmes, including both concentric and eccentric phases [3,14,16,34–36]; isotonic exercise programmes combined with isometric exercises [37]; isolated isometric exercise programmes [14,34,36]; isolated concentric exercise programmes [24,25,38,39]; eccentric loading programmes [4,5,16,17,24–27,27,37–53] based on the original and modified versions of the Alfredson's protocol [15]; as well as isolated or combined stretching programmes [52,53]. Supplementary Appendix 4 shows the characteristics of the studies, including the exercise programmes applied in each of them and the permission or not to perform additional physical activity.

Load progression criteria: a proposal for a new classification

The load progression criteria were identified and included in a new classification proposal. Therefore, the identified criteria were grouped into two categories: pain as a primary progression criterion, and pain and symptom control as a secondary criterion. Two criteria were included in the first category while four criteria were included in the second option of this proposal.

Pain as a primary progression criterion:

1) *Evoking Pain-Based* (EPB, trying to evoke enough pain to produce improvement): load was gradually increased by using a loaded backpack as pain diminished, aiming at keeping a feeling of pain or discomfort during the exercises [4,5,17,24,26,27,40–46,48–54].

2) *Avoid Pain-based* (APB, trying to avoid pain): exercises were performed without pain [27,37,38].

Pain and symptom control as a secondary criterion, although pain is controlled and allowed up to a certain limit; progression is marked by other main criteria:

3) *Conditioning Stages* (CS): predefined stages prior to the start of the study, based on the increase in the percentage of the repetition maximum (RM) or on an increase in the complexity of the exercises [3–5,16,24,25,35,53].

4) *Fatigue-based* (FB): extra sets or repetitions were performed if there were no signs of fatigue after the first sets. If these are not enough to produce fatigue, weight was gradually increased [47].

5) *Subjective Perception* (SP): arbitrary increase according to the subjective perception of patient's ability [16,35–37].

6) *Temporary Linear Increase* (TLI): a linear increase in time (e.g. 2.5% each week) [14,34].

Table 1 shows summary information about the load progression criteria applied in the included studies. Extended information is available in Supplementary Appendix 4, along with information about the exercise programmes in which they were included.

[Table 1 near here]

Clinical outcomes

All included studies analysed at least one clinical outcome. The most evaluated outcomes were function using the VISA questionnaire (VISA-A, VISA-P, or VISA-G) [3–5,26,27,35–37,39,40,42–46,48,49], and pain using an analogue visual scale (VAS) [4,5,16,24–27,39,41,47,49–51,55], a numerical rating scale (NRS) [14,34,36,38,40], isolated questions related to pain as painkillers intake [49], global rating of change scales [3,36,44,46], using dimensions of different questionnaires as the Foot and Ankle Outcome Score questionnaire (FAOS) [54], the Hip dysfunction and Osteoarthritis Outcome Score (HOOS), the Oxford Hip Score (OHS), and the Lateral Hip Pain questionnaire [35], or self-designed pain scales and questionnaires [53]. Table 2 shows the Cohen's d, the percentage of change, and the significance level (between-group comparison) of a main clinical outcome of each study. Supplementary Appendix 5 provides extended information about all outcomes and measurement timepoints of each study.

[Table 2 near here]

Performance outcomes

In 20 of the 30 studies included in this review, no performance outcomes were evaluated. The most frequently used performance outcomes were the concentric and eccentric torque measured with an isokinetic dynamometer [25,38,47,50,53], and the jumping performance (countermovement jump test) [16,25,44,45], which were measured in five and four studies, respectively. Other measured performance outcomes were the ankle range of motion [16,42] or the hip abductor torque [3]. Table 3 shows the Cohen's d (between-group comparison), the percentage of change, and the significance level of a main performance outcome, where it was possible to obtain or calculate it, of those studies that evaluated at least one performance outcome. Supplementary Appendix 5 provides extended information about the remaining performance outcomes and the measurement timepoints of each study.

[Table 3 near here]

Quality assessment

According to the results of the methodological quality and internal validity analysis (PED*ro* scale), 12 studies showed a good quality, 14 studies showed a fair quality, while six articles were considered of low quality for obtaining a score lower than five points. In general, items 2, 3, 10 and 11, those involving the random and concealed allocation, the between-group statistical comparisons and the point measures and variability data, showed high compliance (between 83.9% and 100%). Items 4, 7, 8 and 9, including essential items as the similarity of the groups at baseline, the assessor blinding, the number of dropouts, and the intention-to-treat analysis showed moderate compliance (between 38.7% and 64.5%). However, items 5 and 6, those that assessed the subject and therapist blinding, showed a negligible compliance rate (0% and 3.2%, respectively). Extended information about the compliance of each item are available in Table 4.

[Table 4 near here]

DISCUSSION

A key finding of this systematic review is that load progression is usually influenced by pain perception and symptomatology and not by physical or structural capacity. Nevertheless, this fact is not based on an evident demonstration of useful properties of the pain-based criteria, but on a historical inheritance of previous protocols. Although there are a large number of studies focused on comparing different exercise programmes or interventions, this review shows the need for high-quality studies designed to determine the efficacy of a key specific aspect of the programmes such as the load progression criteria. As an additional finding, it has been found

that much of the current literature does not provide an appropriate reporting of data (effect size, procedures), which hinders adequate dissemination.

Achilles and patellar tendinopathies

Pain-based criteria: Evoking and Avoid Pain-Based

Most of the studies included in this review applied the decrease in discomfort or pain as the primary criterion for increasing the load. This fact has been probably influenced by the large number of studies that investigated the original or a modified version of the isolated eccentric loading programme popularized by Alfredson [15], since this is the main criterion used in this procedure. Thus, Alfredson et al. (1998) [15] suggested that the presence of pain is necessary for proper management [15], hypothesizing that painful eccentric exercises could have a direct mechanical effect on neurovascular ingrowth that may be a source of symptoms [56].

In this review, the results obtained by the studies that applied an Evoking Pain-Based criterion in Achilles and patellar tendinopathies were similar. Maintaining a constant feeling of pain or discomfort according to the description of "load was increased gradually using a backpack (or weights in hands) as pain diminished" was the most frequently used criterion. This specific criterion was used in 20 of the 30 studies, most of them applying isolated eccentric exercise programmes. The combination of this *Evoking Pain-Based* criterion with isolated eccentric training only achieved favourable significant differences in the VISA-A questionnaire versus a non-intervention group in Achilles [40], and versus ultrasound therapy and transverse friction massage in patellar tendinopathy [17]. Nevertheless, a passive therapy such as acupuncture was found to be significantly better than this approach. In both locations, the combination of this progression criterion with the isolated eccentric training did not show significant differences in VISA-A or VISA-P versus a HSR programme based on Conditioning Stages [4,5]. In terms of pain assessment, although significant differences were observed in favour of the group with the Evoking Pain-Based criterion versus the placement of a brace [41], the results contrast with another study that found no differences versus the placement of a night splint [54].

Five more studies [42–46] applied this combination of the Evoking Pain-Based criterion and eccentrics. However, the progression was implemented differently. Although in all cases differences within the group were obtained, none of these studies obtained significant differences in the comparison between groups.

Three studies described an *Avoiding Pain-Based* progression criterion. Da Cunha et al. (2012) [27] compared the effectiveness of two isolated eccentric programmes, performing the exercise with the greatest pain without altering performance and with the avoiding pain-based criterion, respectively, not showing significant differences in VISA-P between groups. These results could be related with the findings of the study of Stevens et al. (2014), where performing the Alfredson's protocol following instructions of "do the protocol as tolerated" achieved better short-term (6 weeks) results in VISA-A than the standard protocol (although without significant differences) [26]. Gatz et al. (2020) [37] and Niesen-Vertommen et al. (1992) [38] assessed the effectiveness of an isolated eccentric protocol versus a combination of isometric and eccentric exercises and versus a concentric exercise programme, respectively. In both studies, the progression was based on the absence of discomfort in the last serie. None of the two studies showed differences between groups, all of them using the same pro-pressure criterion.

Although the heterogeneity of the studies included in this review does not allow for robust conclusions, these findings do not support the need to apply Evoking Pain-Based progression criteria as a primary option. So although monitoring pain could be important and some studies have previously related changes in rating pain scales to their clinical importance [57], it could not be the most appropriate criterion to establish load progression in therapeutic exercise programmes. Thus, the use of a pain-based criterion instead of an individualized criterion for neuromuscular capacity and function could overestimate or underestimate the actual capacity of the system. Therefore, there is still a gap in the existing knowledge about the relation between Pain-Based criteria and the optimal load in exercise programmes.

Conditioning Stages

As an alternative option to a primary Pain-Based progression criterion, other procedures have been described based on individualized aspects of the patients, such as the load the subjects

could handle each week or their current abilities. The use of predefined *Conditioning Stages* in which each week or group of weeks had a previously determined work intensity, usually based on a percentage of the repetition maximum (RM), but also on current abilities of the patient, has also been a commonly applied criterion among the included studies. This criterion, commonly used in sports and physical training, has been included in the last decades in numerous programmes of clinical exercise, also showing beneficial effects [58]. This step-based approach using a progression in the percentage of the maximum repetition ensures a progression in intensity while allowing individualization of the load based on the patient's current capacity. In this review, most of the included studies that have applied this criterion have done so by comparing it to other exercise groups that also used stage-based criteria [16,25], which makes it difficult to draw conclusions. As described above, Beyer et al. (2015) [4] and Kongsgaard et al. (2009) [5] in Achilles and patellar tendinopathy, respectively, found a larger effect size in the HSR group that applied this criterion than in the isolated eccentric training group that used a pain-based criterion, although these differences were not statistically significant. Additionally, in one of these studies, the good clinical effects observed in the HSR group were accompanied by reductions of tendon abnormality and an increased collagen turnover not found with the Evoking Pain-Based criterion of the isolated eccentric group [5]. However, the existing evidence is still not enough to determine that this criterion is the most appropriate.

Although no similar studies have been found in the study population, a previous study carried out in plantar fasciopathy did not find any differences in pain reduction between performing a HSR protocol based on predetermined stages compared and a group that performed the same exercises in a self-administered manner, allowing work with the highest tolerated load from the start, setting the load margins of the group based on stages as limits [59]. These findings may suggest that the effectiveness of the Conditioning Stages criteria may be related to the individualised calculation of the percentage of the RM and the observation of the current capacities of the patients, and not to the division into stages of the programme.

Temporary Linear Increase, Fatigue-Based, and Subjective Perception criteria

To a lesser extent, other criteria applied in the included studies were the use of a *Temporary Linear Increase* (for example, 2.5% weekly) where possible, fatigue control, or an arbitrary increase in volume (series or repetitions) or intensity where it was considered subjectively necessary.

Two studies increased weight by 2.5% every week where possible as a progression criterion, including isolated isometric and isotonic exercise programmes [14,34]. Additional studies comparing this criterion to others are still necessary. However, it seems evident that the use of these linear criteria does not allow load individualisation, since the increase of an absolute percentage (2.5% in the example) can mean very different variations in individuals with different capacities, which may reduce the potential effectiveness of the programmes where it is applied.

Only one study applied a *Fatigue-Based* criterion [47]. In this study, significant differences were found in pain on palpation (measured with VAS) in favour of the exercise group versus a whole body vibration and a non-intervention group. Nevertheless, no significant differences were found in the isokinetic concentric ankle dorsiflexion torque (60°/sec) performance outcome.

Two studies considered the *Subjective Perception* of the current participant's abilities and skills as the main progression criterion [16,36]. In Silbernagel et al. (2001)[16], this criterion was applied in combination with a Conditioning Stages criterion. Thus, although the progression over the weeks was previously predefined, the progression was supervised by a physiotherapist and dependent on the patient's ability and symptoms. This study did not find significant differences in the pain or performance outcomes of the addition of a Subjective Perception to a Conditioning Stages criterion versus the isolated Conditioning Stages criterion [16].

Gluteal tendinopathy

Regarding gluteal tendinopathy, only three studies were included in this review. Mellor et al. (2018) [3] and Ganderton et al. (2018) [35] compared the effectiveness of an exercise and education programme, finding no significant differences in the VISA-G versus any of the control groups. Both studies applied a Conditioning Stages criterion. Moreover, in one of the studies [35], the progression through the stages was additionally dependent on the patient's abilities.

Clifford et al. (2019)[36] did not find significant differences in VISA-G between a group performing an isometric isolated eccentric programme versus a group applying a isotonic exercise programme, both with a progression criteria based on the participant's ability to complete the exercises. Clifford et al. (2019)[36] did not find significant differences in VISA-G between a group performing an isometric isolated eccentric programme versus a group applying a isotonic exercise programme, both with a progression criteria based on the participant's ability to complete the exercises.

Study outcomes

The widespread use of the VISA questionnaire (in its different versions) and the VAS scale for pain has allowed some degree of homogeneity in the clinical outcomes studied in the current literature. However, an additional finding of this review is that despite the growing knowledge about the importance of performance outcomes in tendinopathy and the controversial relationship of pain and structure with function and recovery of the tendon, no performance outcomes were measured in most of the studies included in this review.

Additional physical activity

The fact that the studies were not homogeneous in the prohibition of performing additional physical activity during the programme may have influenced the results of the different protocols and criteria. Nevertheless, a previous systematic review showed that there is no strong evidence supporting the need of withdrawal from the sport in the management of patellar tendinopathy [60], so the possible influence of the additional activity must still be verified.

What has been excluded from this systematic review?

Due to the selection criteria chosen for this review, several studies have not been included, as they compare exercise interventions versus supplemented exercise. Although this is a common practice in the research of complementary therapies, it does not allow a proper analysis of the

programmes [61–63]. During the selection phase, a significant number of studies including exercise with no load progression were identified, but they were excluded from the review. A lack of analysis of structural outcomes such us thickness has been found. This may be due to the fact that the studies where structural variables are analysed are usually designed as non-controlled longitudinal prospective studies using magnetic resonance imaging [64–66]. Finally, describing well-designed high-quality study protocols have been found but they are not available yet [10,67].

Strengths and limitations

The main strength of this study is that has identified a significant gap in the literature that future studies should fill. Another essential strength is the proposal for a new approach presented for the study of exercise programmes in tendinopathies, based on a possible new classification of the different progression criteria in loading exercise. However, heterogeneity and deficiencies in the reporting of data found have not allowed the extraction of accurate and conclusive information, not allowing to fulfill the second of the purposes set in this review: the study of the efectiveness. Some limitations are the absence of washout from previous treatments in most of the studies, and the permission to take analgesics or non-steroidal anti-inflammatory drugs (NSAIDs) in some studies. Additionally, there is a potential selection and reporting bias from those studies that may only be present in databases that have not been consulted. These bias have been tried to reduce by increasing the number of databases analysed and expanding the selection criteria.

Future studies comparing interventions applying different load progression criteria to the same exercise programme are needed, allowing a trustworthy review of the subject. In addition, it is necessary to search for new progression criteria adapted to the existing knowledge, as well as for more accurate information about neuromuscular ability, training parameters, the minimum number of sessions required, or the adherence levels of exercise programmes.

Conclusions

Despite the limitations, this systematic review offers a comprehensive summary of the current evidence regarding the load progression criteria in lower limb tendinopathy.

The findings of this systematic review reveal a predominant use of pain-based criteria, which is the result of a historical and scientific inheritance of exercise protocols but it is not supported by strong evidence. The lack of evidence found regarding the effectiveness of the commonly applied load progression criteria and the contradictory results of existing studies make it essential to study and search for new criteria that can be supported by the current knowledge and evidence. Thus, the current criteria should be used by practicioners cautiously and critically, waiting for strong evidence to support their use.

Data availability statement

No additional data available.

Contributorship Statement

All authors contributed to the study design. AEE and AICV searched and screened the articles, with assistance from JC. All authors contributed to data analysis and interpretation of the data. AEE drafted the manuscript, AICV and JC revised it critically, and all authors contributed to revisions and approved the final manuscript.

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TABLE 1. Load progression criteria applied in the included studies.

Study	Cat.	Progression criterion (Exercise Group 1)	Cat.	Progression criterion 2 (Exercise Group 2, if any)
ACHILLES TENDINOPATHY				
Gatz et al. (2020)[37]	APB, SP	Patients were briefed to do the exercises cautiously and pain-free, going to the next level if they were not feeling pain or exhaustion at maximum load.	APB, SP	Patients were briefed to do the exercises cautiously and pain-free, going to the next level if they were not feeling pain or exhaustion at maximum load.
Stefansson et al. (2019)[42]	EPB	If the patient was pain-free for the full 15 repetitions for 3 sets, weight was added for the next phase.		
Beyer et al. (2015)[4]	CS	3x15 repetition maximum (15RM), in week 1; 3x12 (12RM), in weeks 2 to 3; 4x10 (10RM), in weeks 4 to 5; 4x8 (8RM), in weeks 6 to 8; and 4x6 (6RM), in weeks 9 to 12.	EPB	Load was increased gradually using a loaded backpack as pain diminished.
Stevens & Tan (2014)[26]	EPB	Load was increased gradually using a loaded backpack as pain diminished.	EPB	Load was increased gradually using a loaded backpack as pain diminished.
Kearney et al. (2013)[43]	EPB	Progressed as pain allowed. Firstly, by advancing from double-leg exercises to single-leg exercises. Secondly, load was increased gradually using a loaded backpack.		
Yu et al. (2013)[25]	CS	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol.	CS	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol.
Zhang et al. (2013)[49]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Horstmann et al. (2013)[47]	FB	Participants performed an extra set if no signs of fatigue were present after the 3 first sets. If necessary, load was increased gradually using a backpack.		
Yelland et al. (2011)[48]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Chester et al. (2008)[51]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Petersen et al. (2007)[41]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Rompe et al. (2007)[40]	EPB	Load was increased gradually using a loaded back pack as pain diminished.		
Nørregaard et al. (2007)[52]	EPB	Load was increased gradually using a loaded back pack as pain diminished.		
Roos et al. (2004)[54]	EPB	Load was increased gradually using a loaded backpack as pain diminished.		
Mafi et al. (2001)[24]	EPB	Load was increased gradually using a loaded backpack as pain diminished.	CS	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol.
Silbernagel et al. (2001)[16]	CS,SP	Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol. Additionally,	SP	Volume and complexity of exercises were increased gradually as ability and symptoms allowed.

		volume was increased gradually as ability and symptoms allowed.		
Niesen-Vertommen et al. (1992)[38]	APB	Pain free range of motion, progression when discomfort in the last five to 10 repetitions was absent or minimal.	APB	Pain free range of motion, progression when discomfort in the last five to 10 repetitions was absent or minimal.
PATELLAR TENDINOPATHY				
Rio et al. (2017)[14]	TLI	Weight was increased by 2.5% every week if possible.	TLI	Weight was increased by 2.5% every week if possible.
Van ark et al. (2016)[34]	TLI	Weight was increased by 2.5% every week if possible.	TLI	Weight was increased by 2.5% every week if possible.
Da Cunha et al. (2012)[27]	EPB	Painful group increased weight to perform exercise with the greatest pain without altering performance.	APB	When the subjects from the "not painful" group, even without load addition, presented pain during the exercise, they were told to rest the upper limbs on a bar with the purpose to decrease overload on the patellar tendon.
Kongsgaard et al. (2009)[5]	CS	4x15 repetition maximum (15RM) week 1; 4x12 (12RM) weeks 2–3; 4x10 (10RM) weeks 4–5; 4x8 (8RM) weeks 6–8; and 4x6 (6RM) weeks 9–12.	EPB	Load was increased gradually using a loaded backpack as pain diminished.
Frohm et al. (2007)[50]	EPB	Increase weight if VAS < 3.	EPB	Increase weight (5kg) if VAS < 3; Inertial exercise: maximal effort.
Bahr et al. (2006)[44]	EPB	When pain decreased to <3, the participant added load in a backpack.		
Visnes et al. (2005)[45]	EPB	With less pain than 3 to 4, were recommended to increase the weight.		
Young et al. (2005)[46]	EPB	Load was increased gradually using a loaded backpack as pain diminished.	EPB	Progressed as pain diminished (firstly from slow to fast, secondly increasing load).
Jonsson & Alfredson (2005)[39]	EPB	Load was increased gradually using a loaded backpack as pain diminished.	EPB	Load was increased gradually using a loaded backpack as pain diminished.
Stasinopoulos & Stasinopoulos (2004)[17]	EPB	Load was increased gradually holding weights in their hands as pain diminished.		
Jensen & Di Fabio (1989)[53]	CS	The intensity of the exercise was progressed over eight weeks by gradually increasing the speed of the eccentric contraction from 30 to 70°/sec.		
GLUTEAL TENDINOPATHY				
Clifford et al. (2019)[54]	SP	Exercise progression with the resistance bands was individualised and based on each participant's ability to complete the exercises without increasing their pain beyond 5/10.	SP	Exercise progression with the resistance bands was individualised and based on each participant's ability to complete the exercises without increasing their pain beyond 5/10. All bands
Mellor et al. (2018)[3]	CS	Different, exercises, frequency, volume, and intensity in each week, according to a Stage-Based protocol.		
Ganderton et al.	CS,S	Different, exercises, frequency, volume, and intensity in		

(2018)[35]	P	each week, according to a Stage-Based protocol. The progression through the stages was additionally dependent on the patient's abilities.

APB= Avoiding Pain-Based; Cat.= Load progression criteria category; CS= Conditioning Stages; EPB= Evoking Pain-Based; FB= Fatigue-Based; RM= repetition maximum; SP= Subjective Perception; TLI= Temporary Linear Increase; VAS= Visual Analogue Scale

TABLE 2. Cohen's d, percentage of change, and significance level (between-group comparison) of main clinical outcomes.

Study	Results				
	Clinical outcome	Time	Cohen's d (main outcome)	% of change	p
ACHILLES TENDINOPATHY					
Gatz et al. (2020)[37]	VISA-A	12 weeks	APB, SP (ECC+ISOM) – APB, SP (ECC): 0.06	22.97% APB, SP (ECC+ISOM) – 20.49% APB, SP (ECC)	>0.05
Stefansson et al. (2019)[42]	VISA-A-IS	24 weeks	N/A	EPB (ECC) – Pressure massage: N/A	Pressure massage -EPB (ECC): >0.05
Beyer et al. (2015)[4]	VISA-A	52 weeks	CS (HSR) – EPB (ECC): 1.66	62.96% CS (HSR) – 46.55% EPB (ECC)	HSR - ECC: >0.05
Stevens & Tan (2014)[26]	VISA-A	6 weeks	(EPB) Do as tolerated ECC – Standard ECC 0.42	32.69% Do as tolerated – 18.34% Standard	>0.05
Kearney et al. (2013)[43]	VISA-A	26 weeks	EPB (ECC) – PRP: -0.55	58.33% ECC – 85.36% PRP	>0.05
Yu et al. (2013)[25]	VAS	8 weeks	CS (ECC) – CS (CONC): 1.74	-62.23% CS (ECC) – -43.00% CS (CONC)	<0.05*
Zhang et al. (2013)[49]	VISA-A	24 weeks	EPB (ECC) – Acupuncture: 1.40	64.14% acupuncture – ECC 36.24%	<0.05*
Horstmann et al. (2013)[47]	VAS: palpation pain 2 cm proximal to insertion	12 weeks	FB (ECC) - Wait and see: 0.89; FB (ECC) – Whole-Body Vibration: 0.27	-67.24% FB (ECC); -51.44% Vibration; -27.95% Wait and see	<0.05*
Yelland et al. (2011)[48]	VISA-A	52 weeks	EPB (ECC) – Prolotherapy injections: -0.09	N/A	>0.05
Chester et al. (2008)[51]	VAS rest	12 weeks	EPB (ECC) – Therapeutic ultrasound: -0.05	4.00% EPB (ECC) – 7.01% Therapeutic ultrasound:	>0.05
Petersen et al. (2007)[41]	VAS daily living activities	54 weeks	N/A	30% EPB (ECC) - 27% Brace	<0.05*
Rompe et al. (2007)[40]	VISA-A	16 weeks	EPB (ECC) – Shockwave: 0.28; ECC - Wait and see: 1.13	49.40% EPB (ECC) – 39.96% Shockwave – 14.10% Wait and see	ECC VS SWT: >0.05 ECC VS W&S: <0.05
Nørregaard et al. (2007)[52]	Pain (tenderness palpation)	39 weeks	EPB (ECC) – Stretching: 0.00	N/A	>0.05

Roos et al. (2004)[54]	Pain measured with FAOS	52 weeks	EPB (ECC) – Night splint: 0.22	43,33% EPB (ECC) – 36,06% Night splint	>0.05
Mafi et al. (2001)[24]	VAS during activity (running or walking)	12 weeks	N/A	EPB (ECC) – CS (CONC): N/A	N/A
Silbernagel et al. (2001)[16]	VAS on palpation	26 weeks	CS, SP (ECC+CONC) – SP (ECC): 0.42	-57.14% CS, SP (ECC+CONC) - -66.67% SP (ECC)	>0.05
Niesen-Vertommen et al. (1992)[67]	Numerical Rating Scale	12 weeks	N/A	-78.33% APB (ECC) – -46.15% APB (CONC)	N/A
PATELLAR TENDINOPATHY					
Rio et al. (2017)[14]	Pain measured with a Numerical Rating Scale during a single leg decline squat	4 weeks	TLI (Isometric) – TLI (Isotonic): 2.75	N/A	<0.05*
Van ark et al. (2016)[34]	Pain measured with a Numerical Rating Scale during a single leg decline squat	4 weeks	N/A	63,63% TLI (Isotonic) – 36,50% TLI (Isometric)	>0.05
Da Cunha et al. (2012)[27]	VISA-P	12 weeks	N/A	EPB (Decline Board ECC) – APB (Decline Board ECC) N/A	>0.05
Kongsgaard et al. (2009)[5]	VISA-P	26 weeks	N/A	65±71% CS (HSR) – 54±57% EPB (ECC) – 13±33% CORT	HSR VS ECC: >0.05 HSR VS CORT: <0.05* ECC VS CORT: <0.05*
Frohm et al. (2007)[50]	VISA-P	12 weeks	N/A	108.33% EPB (Decline board ECC) – 78.72% EPB (Overload ECC Device)	>0.05
Bahr et al. (2006)[44]	VISA-P	52 weeks	EPB (Decline Board ECC) – Surgery: -0.2	127.04% EPB (Decline Board ECC) – 136.13% Surgery	>0.05
Visnes et al. (2005)[45]	VISA-P	40 weeks	N/A	EPB (Decline Board ECC) – Usual training: N/A	ECC VS Usual training: >0.05
Young et al. (2005)[46]	VISA-P	52 weeks	N/A	EPB (ECC) – EPB (ECC): N/A	>0.05
Jonsson & Alfredson (2005)[39]	VISA-P	12 weeks	EPB (Decline board ECC) – EPB (Decline board CONC): 2.08	102.4% EPB (Decline board ECC) – -5.65% EPB (Decline board CONC):	N/A
Stasinopoulos & Stasinopoulos (2004)[17]	Status of pain from: worse, no change, somewhat better, much better, no pain.	16 weeks	N/A	EPB (ECC) – Transverse Friction – US: N/A	ECC VS TF: <0.05* ECC VS US: <0.05*

Jensen & Di Fabio (1989)[53]	Pain intensity scale	8 weeks	N/A	N/A	N/A
GLUTEAL TENDINOPATHY					
Clifford et al. (2019)[54]	VISA-G	12 weeks	SP (Isotonic) – SP (Isometric): 0.005	16.96% SP (Isotonic) – 19.04% SP (Isometric)	>0.05
Mellor et al. (2018)[3]	VISA-G	52 weeks	CS (Exercise + Edu.) - Corticosteroids: 0.58; CS (Exercise + Edu.) - Wait and see: 0.61	39.36% CS (Edu. + exercise) - 20.86% Corticosteroids - 19.39% Wait and see	>0.05
Ganderton et al. (2018)[35]	VISA-G	52 weeks	N/A	23,38% CS, SP (GLOBE) - 31,04% Sham	>0.05

*Significant differences between groups; APB= Avoiding Pain-Based; CONC= Isolated Concentric exercise; CORT= Corticosteroid injections; CS= Conditioning Stages; ECC= Isolated Eccentric Exercise; Edu.= education; EPB= Evoking Pain-Based; FAOS= Foot and Ankle Outcome Score; FB= Fatigue-Based; HSR= Heavy slow resistance training; N/A= not available; p= Significance level; PRP= Platelet-Rich Plasma; SP= Subjective Perception; SWT= Shockwave therapy; TF= Transverse friction; TLI= Temporary Linear Increase; US= Ultrasound Therapy; VAS= visual analogue scale; VISA-A= Victorian Institute of Sport Assessment Questionnaire for Achilles tendon; VISA-P= Victorian Institute of Sport Assessment Questionnaire for patellar tendon; VISA-G= Victorian Institute of Sport Assessment Questionnaire for gluteal tendinopathy

TABLE 3. Cohen's d, percentage of change, and significance level (between-group comparison) of main performance outcomes.

Study	Results				
	Performance main outcome	**Time**	**Cohen's d**	**% of change**	**p**
ACHILLES TENDINOPATHY					
Stefansson et al. (2019)[42]	Ankle dorsiflexion range of motion (bent and straight knee)	24 weeks	Bent knee: EPB (ECC)-Pressure massage: 0.07 Straight knee: EPB (ECC)-Pressure massage: -0.17	Bent knee: 6.68% EPB (ECC) – 5.45% Pressure massage Straight knee: 2.04% EPB (ECC) – 4.87% Pressure massage	>0.05 >0.05
Yu et al. (2013)[25]	Isokinetic concentric ankle dorsiflexion torque (30°/sec)	8 weeks	CS (ECC)-CS (CONC): 0.06	20.77% CS (ECC) – 19.36% CS (CONC)	>0.05
Horstmann et al. (2013)[47]	Isokinetic concentric ankle dorsiflexion torque (60°/sec)	12 weeks	N/A	FB (ECC) – Whole-Body Vibration – Wait and See: N/A	>0.05
Silbernagel et al. (2001)[16]	Countermovement jump test (one leg)	26 weeks	CS, SP (ECC+CONC) – SP (ECC): 0.28	30.77% CS, SP (ECC+CONC) – 13.33% SP (ECC)	>0.05
Niesen-Vertomen et al. (1992)[68]	Isokinetic concentric and eccentric ankle plantar flexion torque (30°/sec, 50°/sec)	12 weeks	N/A	N/A	N/A
PATELLAR TENDINOPATHY					
Frohm et al. (2007)[50]	Isokinetic concentric knee extension torque (90°/sec)	12 weeks	EPB (Decline board ECC) – EPB (Overload ECC device): 0.05	3.55% EPB (Decline board ECC) – 0.92% EPB (Overload ECC device)	>0.05
Bahr et al. (2006)[44]	Countermovement jump test (both legs)	52 weeks	N/A	EPB (Decline Board ECC) – Surgery: N/A	>0.05
Visnes et al. (2005)[45]	Countermovement jump test (both legs)	40 weeks	N/A	EPB (Decline Board ECC) – Usual training: N/A	>0.05
Jensen & Di Fabio (1989)[53]	Isokinetic eccentric and concentric knee extension torque (50°/sec)	8 weeks	CS (Isokinetic eccentric training) + Static stretching – Static stretching: 0.54	35.90% CS (Isokinetic eccentric training) + Static tretching – 14.63% Static stretching	>0.05
GLUTEAL TENDINOPATHY					
Mellor et al. (2018)[3]	Gluteal muscle torque	8 weeks	CS (Edu. + exercise) – Corticosteroids: 0 CS (Edu. + exercise) – Wait and see: 0	12.5% CS (Education + exercise) – 12.5% Corticosteroids – 12.5% Wait and see	>0.05

*Significant differences between groups; APB= Avoiding Pain-Based; CS= Conditioning Stages; CONC= Isolated Concentric exercise; ECC= Isolated Eccentric Exercise; edu.= education; EPB= Evoking Pain-Based; FB= Fatigue-Based; N/A= not available; p= significance level; SP= Subjective Perception

TABLE 4. Internal validity analysis (PED*ro* scale).

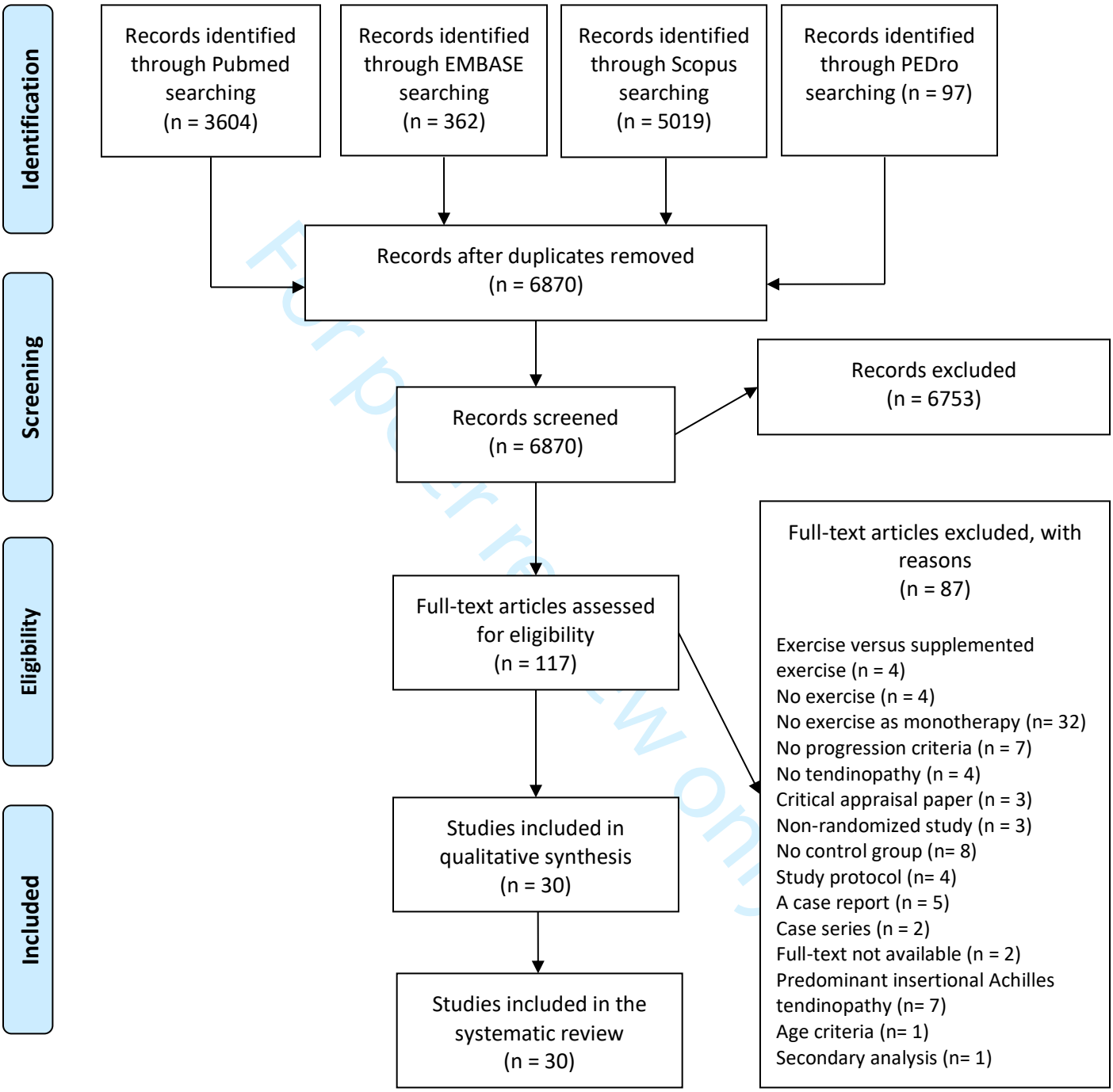
Study	2	3	4	5	6	7	8	9	10	11	TOTAL
ACHILLES TENDINOPATHY											
Yu et al. (2013)**[25]**	•	•	•	-	-	•	•	•	•	•	8
Rompe et al. (2007)**[40]**	•	•	•	-	-	•	•	•	•	•	8
Horstmann et al. (2013)**[47]**	•	•	•	-	-	•	•	-	•	•	7
Stevens & Tan (2014)**[26]**	•	•	•	-	-	•	-	•	•	•	7
Stefansson et al. (2019)**[42]**	•	•	•	-	-	•	•	-	•	•	7
Yelland et al. (2011)**[48]**	•	•	-	-	-	•	•	•	•	•	7
Beyer et al. (2015)**[4]**	•	•	•	-	-	-	-	•	•	•	6
Kearney et al. (2013)**[43]**	•	•	-	-	-	-	•	•	•	•	6
Zhang et al. (2013)**[49]**	•	•	•	-	-	-	•	-	•	•	6
Roos et al. (2004)**[54]**	•	•	•	-	-	-	-	•	•	•	6
Mafi et al. (2001)**[24]**	•	•	-	-	-	-	•	-	•	•	5
Silbernagel et al. (2001)**[16]**	•	-	•	-	-	•	-	-	•	•	5
Petersen et al. (2007)**[41]**	•	-	•	-	-	-	•	-	•	•	5
Gatz et al. (2020)**[37]**	•	•	•	-	-	-	-	-	•	•	5
Chester et al. (2008)**[51]**	•	•	-	-	-	-	-	-	•	•	4
Nørregaard et al. (2007)**[52]**	•	•	-	-	-	-	-	-	•	•	4
PATELLAR TENDINOPATHY											
Kongsgaard et al. (2009)**[5]**	•	•	•	-	-	•	•	-	•	•	7
Bahr et al. (2006)**[44]**	•	•	•	-	-	-	•	•	•	•	7
Stasinopoulos & Stasinopoulos (2004)**[17]**	•	•	-	-	-	•	•	•	•	•	7
Visnes et al. (2005)**[45]**	•	•	•	-	-	-	•	•	•	•	7
Rio et al. (2017)**[14]**	•	•	•	-	-	-	-	•	•	•	6
Frohm et al. (2007)**[50]**	•	•	•	-	-	-	•	-	•	•	6
Young et al. (2005)**[46]**	•	•	-	-	-	•	•	-	•	•	6
Da Cunha et al. (2012)**[27]**	•	•	•	-	-	-	•	-	•	•	6
Van ark et al. (2016)**[34]**	•	•	•	-	-	-	-	-	•	•	5
Jensen & Di Fabio (1989)**[53]**	•	-	-	-	-	-	•	-	•	•	4
Jonsson & Alfredson (2005)**[39]**	•	-	-	-	-	-	-	-	•	•	3

GLUTEAL TENDINOPATHY											
Mellor et al. (2018)[3]	•	•	•	-	-	•	•	•	•	•	8
Ganderton et al. (2018)**[35]**	•	•	-	•	-	•	•	•	•	•	8
Clifford et al. (2019)**[54]**	•	•	•	-	-	-	-	-	•	•	5
% OF AGREEMENT	**100**	**83.9**	**64.5**	**3.2**	**0**	**38.7**	**61.3**	**41.9**	**100**	**100**	

•: Yes; -: no. 2: Random allocation; 3: Concealed allocation; 4: Groups similar at baseline; 5: Subject blinding; 6: Therapist blinding; 7: Assessor blinding; 8: Less than 15% dropouts; 9: Intention-to-treat analysis; 10: Between-group statistical comparisons; 11: Point measures and variability data.

FIGURE LEGEND

FIGURE 1. Flow diagram of the selection process.



SUPPLEMENTARY FILE

BMJ Open

LOAD PROGRESSION CRITERIA IN EXERCISE PROGRAMMES IN LOWER LIMB TENDINOPATHY: A SYSTEMATIC REVIEW

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Supplementary appendix 1. Search strategy.

PubMed search

Dates: From inception to 24th September 2020

Fields: "All Fields"

Keywords:

("Patellar tendin*" OR "jumper's knee" OR "lander's knee" OR "achilles tendin*" OR "midportion achilles tendin*" OR "mid-portion achilles tendin*" OR "mid-substance Achilles tendin*" OR "midsubstance Achilles tendin*" OR "non-insertional Achilles tendin*" "gluteal tendin*" OR "greater trochanteric bursitis" OR "greater trochanteric pain syndrome" OR "lower limb tendinopathy" OR "tendinopathy" OR "tendonopathy" OR "tendonitis")

AND

("exercise" OR "strength" OR "training" OR "resistance" OR "loading" OR "progressive" OR "physical activity" OR "eccentric" OR "plyometric" OR "guided imagery" OR "stretching")

Search chain: ((((((((((((((((((Patellar tendin*) OR jumper's knee) OR lander's knee) OR achilles tendin*) OR midportion achilles tendin*) OR mid-portion achilles tendin*) OR mid-substance Achilles tendin*) OR midsubstance Achilles tendin*) OR non-insertional Achilles tendin*) OR gluteal tendin*) OR greater trochanteric bursitis) OR greater trochanteric pain syndrome) OR lower limb tendinopathy) OR tendinopathy OR tendonopathy) OR tendonitis)))))) AND ((((((((((exercise) OR strength) OR training) OR resistance) OR loading) OR progressive) OR physical activity) OR eccentric) OR plyometric) OR (guided imagery)) OR stretching)

Search Chain Details: ((((((((((((((patellar tendinitis[All Fields] OR patellar tendinopathies[All Fields] OR patellar tendinopathy[All Fields] OR patellar tendinosis[All Fields]) OR (jumper's[All Fields] AND ("knee"[MeSH Terms] OR "knee"[All Fields] OR "knee joint"[MeSH Terms] OR ("knee"[All Fields] AND "joint"[All Fields]) OR "knee joint"[All Fields]))) OR (lander's[All Fields] AND ("knee"[MeSH Terms] OR "knee"[All Fields] OR "knee joint"[MeSH Terms] OR ("knee"[All Fields] AND "joint"[All Fields]) OR "knee joint"[All Fields]))) OR (achilles tendinitis[All Fields] OR achilles tendinopathies[All Fields] OR achilles tendinopathy[All Fields] OR achilles tendinopaty[All Fields] OR achilles tendinoscopy[All Fields] OR achilles tendinosis[All Fields]))

OR (midportion achilles tendinopathy[All Fields] OR midportion achilles tendinosis[All Fields])) OR (mid portion achilles tendinopathy[All Fields] OR mid portion achilles tendinosis[All Fields])) OR mid substance achilles tendinopathy[All Fields]) OR midsubstance achilles tendinopathy[All Fields]) OR non insertional achilles tendinopathy[All Fields]) OR (gluteal tendinitis[All Fields] OR gluteal tendinopathy[All Fields] OR gluteal tendinosis[All Fields])) OR (greater[All Fields] AND trochanteric[All Fields] AND ("bursitis"[MeSH Terms] OR "bursitis"[All Fields]))) OR (greater[All Fields] AND trochanteric[All Fields] AND ("somatoform disorders"[MeSH Terms] OR ("somatoform"[All Fields] AND "disorders"[All Fields]) OR "somatoform disorders"[All Fields] OR ("pain"[All Fields] AND "syndrome"[All Fields]) OR "pain syndrome"[All Fields]))) OR (("lower extremity"[MeSH Terms] OR ("lower"[All Fields] AND "extremity"[All Fields]) OR "lower extremity"[All Fields] OR ("lower"[All Fields] AND "limb"[All Fields]) OR "lower limb"[All Fields]) AND ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields]))) OR ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields]) OR ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields] OR "tendonopathy"[All Fields]) OR ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields] OR "tendonitis"[All Fields])) AND ((((((((((("exercise"[MeSH Terms] OR "exercise"[All Fields]) OR strength[All Fields]) OR ("education"[Subheading] OR "education"[All Fields] OR "training"[All Fields] OR "education"[MeSH Terms] OR "training"[All Fields])) OR resistance[All Fields]) OR loading[All Fields]) OR ("Progressive"[Journal] OR "progressive"[All Fields])) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("physical"[All Fields] AND "activity"[All Fields]) OR "physical activity"[All Fields])) OR eccentric[All Fields]) OR stretching[All Fields]) OR plyometric[All Fields]) OR guided imagery[All Fields])

Scopus search Scopus

Dates: From inception to 24th September 2020

Fields: "Title, Keywords, and Abstract"

Keywords:

("Patellar tendin*" OR "jumper's knee" OR "lander's knee" OR "achilles tendin*" OR "midportion achilles tendin*" OR "mid-portion achilles tendin*" OR "mid-substance Achilles tendin*" OR "midsubstance Achilles tendin*" OR "non-insertional Achilles tendin*" "gluteal tendin*" OR "greater trochanteric bursitis" OR "greater trochanteric pain syndrome" OR "lower limb tendinopathy" OR "tendinopathy" OR "tendonopathy" OR "tendonitis")

AND

("exercise" OR "strength" OR "training" OR "resistance" OR "loading" OR "progressive" OR "physical activity" OR "eccentric" OR "plyometric" OR "guided imagery" OR "stretching")

NOT

("supraspinatus" OR "biceps" OR "subacromial" OR "epicondylitis")

Limits: Document type: "Article"; Excluded subject areas: "Agricultural and Biological Sciences", "Immunology and Microbiology", "Veterinary", "Chemical Engineering", "Physics and Astronomy", "Social Sciences"

Complete search chain:

((((((((((((((((((patellar AND tendin*) OR jumper's AND knee) OR lander's AND knee) OR achilles AND tendin*) OR midportion AND achilles AND tendin*) OR mid-portion AND achilles AND tendin*) OR mid-substance AND achilles AND tendin*) midsubstance AND achilles AND tendin*) non-insertional AND achilles AND tendin*) OR gluteal AND tendin*) OR greater AND trochanteric AND bursitis) OR greater AND trochanteric AND pain AND syndrome) OR lower AND limb AND tendinopathy) OR tendinopathy) OR tendonopathy) OR tendonitis)))) AND ((((((((((exercise) OR strength) OR training) OR resistance) OR loading) OR progressive) OR physical AND activity) OR eccentric) OR plyometric) OR (guided AND imagery)) OR stretching) AND NOT (supraspintus) AND NOT (biceps) AND NOT (subacromial) AND NOT (epicondylitis) AND (LIMIT-TO (DOCTYPE , "ar")) AND (EXCLUDE (SUBJAREA , "AGRI") OR EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "VETE") OR EXCLUDE (SUBJAREA , "CENG") OR EXCLUDE (SUBJAREA , "PHYS") OR EXCLUDE (SUBJAREA , "SOCI"))

EMBASE search Embase

Dates: From inception to 24th September 2020

Keywords:

("tendinitis", including the synonyms "hypertrophic infiltrative tendinitis", "nodular tendinitis" "tendinitis", "tendinopathy", "tendinosis", "tendonitis", "tendonopathy", "tenonitis", "tenontitis", and "tenositis")

AND

("exercise", including the synonyms "exercise", "exercise performance", "exercise training", "fitness training", "physical conditioning", and "physical exercise" OR "training" OR "eccentric exercise" OR "eccentric muscle contraction" OR "concentric muscle contraction" OR "eccentric muscle isometric contraction" OR "muscle isotonic contraction", including "isotonic contraction", OR "aerobic exercise" OR "resistance training")

Limits: Study design: Randomized controlled trial

Complete search chain:

('tendinitis'/exp OR 'tendinitis' OR 'tendinopathy' OR 'tendinosis' OR 'tendonitis' OR 'tendonopathy' OR 'tenonitis' OR 'tenontitis' OR 'tenositis' OR 'hypertrophic infiltrative tendinitis' OR 'nodular tendinitis') AND ('exercise'/exp OR 'exercise' OR 'exercise performance' OR 'exercise training' OR 'fitness training' OR 'physical conditioning, human' OR 'physical exercise' OR 'training'/exp OR 'eccentric exercise'/exp OR 'eccentric muscle contraction'/exp OR 'concentric muscle contraction'/exp OR 'muscle isometric contraction'/exp OR 'muscle isotonic contraction'/exp OR 'isotonic contraction' OR 'aerobic exercise'/exp OR 'resistance training'/exp) AND ('randomized controlled trial'/exp OR 'controlled trial, randomized' OR 'randomised controlled study' OR 'randomised controlled trial' OR 'randomized controlled study' OR 'randomized controlled trial' OR 'trial, randomized controlled')

PED*ro* search

Dates: From inception to 24th September 2020

Keywords:

("tendinopathy") AND ("exercise) [Abstract & Title]

Additionally, one reviewer manually checked the reference lists of different studies and reviews to identify possible additional studies.

Supplementary appendix 2. Excluded articles (with at least one reason).

Author; year	Title	Reasons for exclusion (at least)
Abat et al. (2014)[1]	Effectiveness of the Intratissue Percutaneous Electrolysis (EPI®) technique and isoinertial eccentric exercise in the treatment of patellar tendinopathy at two years follow-up	3
Alfredson et al. (1999)[2]	Bone mass in the calcaneus after heavy loaded eccentric calf-muscle training in recreational athletes with chronic achilles tendinosis	8
Angermann & Hovgaard (1999)[3]	Chronic Achilles tendinopathy in athletic individuals: results of nonsurgical treatment	8
Balius et al. 2016 [4]	A 3-Arm Randomized Trial for Achilles Tendinopathy: Eccentric Training, Eccentric Training Plus a Dietary Supplement Containing Mucopolysaccharides, or Passive Stretching Plus a Dietary Supplement Containing Mucopolysaccharides	1
Basas et al. (2018)[5]	Effects of a strength protocol combined with electrical stimulation on patellar tendinopathy: 42 months retrospective follow-up on 6 high-level jumping athletes	3, 8
Bell et al. (2013)[6]	Impact of autologous blood injections in treatment of mid-portion Achilles tendinopathy: double blind randomised controlled trial	3
Biernat et al. 2014[7]	Rehabilitation protocol for patellar tendinopathy applied among 16- to 19-year old volleyball players	4
Boesen et al. (2017)[8]	Effect of High-Volume Injection, Platelet-Rich Plasma, and Sham Treatment in Chronic Midportion Achilles Tendinopathy: A Randomized Double-Blinded Prospective Study	3
Brown et al. (2006)[9]	Aprotinin in the management of Achilles tendinopathy: a randomised controlled trial	3
Cannell et al. 2001 [10]	A randomised clinical trial of the efficacy of drop squats or leg extension/leg curl exercises to treat clinically diagnosed jumper's knee in athletes: pilot study	14
Chen et al. (2015)[11]	High-intensity stepwise conditioning programme for improved exercise responses and agility performance of a badminton player with knee pain	10
Cook (2007)[12]	Eccentric exercise and shock-wave therapy benefit patients with chronic Achilles tendinopathy	6
De Jonge et al. (2016)[13]	The Tendon Structure Returns to Asymptomatic Values in Nonoperatively Treated Achilles Tendinopathy but Is Not Associated With Symptoms: A Prospective Study	3
De Vos et al. (2010)[14]	Platelet-rich plasma injection for chronic Achilles tendinopathy: a randomized controlled trial	3
De Vos et al. (2011)[15]	No effects of PRP on ultrasonographic tendon structure and neovascularisation in chronic midportion Achilles tendinopathy	3
De Vries et al. (2016)[16]	Effect of patellar strap and sports tape on pain in patellar tendinopathy: A randomized controlled trial	3
Deans & James-Ramos (2012)[17]	A prospective series of patients with chronic Achilles tendinopathy treated with autologous-conditioned plasma injections combined with exercise and therapeutic ultrasonography	3, 8
Dimitrios et al. 2011 [18]	Comparing the effects of eccentric training with eccentric training and static stretching exercises in the treatment of patellar tendinopathy. A controlled clinical trial	4*
Dragoo et al. 2014 [19]	Platelet-rich plasma as a treatment for patellar tendinopathy: a double-blind, randomized controlled trial.	3
Fitzpatrick et al. 2018 [20]	The effectiveness of platelet-rich plasma injections in gluteal tendinopathy-a randomised, double-blind controlled trial comparing a single platelet-rich plasma injection with a single corticosteroid injection	2
Ganderton et al. 2016 [21]	Does menopausal hormone therapy (MHT), exercise or a combination of both, improve pain and function in post-menopausal women with greater trochanteric pain syndrome (GTPS)? A randomised controlled trial	3

Gärdin et al. (2010)[22]	The long-term clinical and MRI results following eccentric calf muscle training in chronic Achilles tendinosis	8
Garrick (2007)[23]	Return to sport after patellar tendinosis through eccentric or concentric quadriceps training.	6
Grigg et al. (2009)[24]	Eccentric calf muscle exercise produces a greater acute reduction in Achilles tendon thickness than concentric exercise	5
Gual et al. (2016)[25]	Effects of In-Season Inertial Resistance Training With Eccentric Overload in a Sports Population at Risk for Patellar Tendinopathy	5
Habets et al. (2017)[26]	Alfredson versus Silbernagel exercise therapy in chronic midportion Achilles tendinopathy: study protocol for a randomized controlled trial	9
Herrington & McCulloch, 2007 [27]	The role of eccentric training in the management of Achilles tendinopathy: A pilot study	3
Holden et al. 2020 [28]	Isometric exercise and pain in patellar tendinopathy: A randomized crossover trial	4
Jayaseelan et al. 2017 [29]	Manual therapy and eccentric exercise in the management of Achilles tendinopathy	11
Jonsson et al. (2008)[30]	New regimen for eccentric calf-muscle training in patients with chronic insertional Achilles tendinopathy: results of a pilot study	13
Kedia et al. (2014)[31]	The effects of conventional physical therapy and eccentric strengthening for insertional achilles tendinopathy	13
Knobloch et al. 2007 [32]	Eccentric Training Decreases Paratendon Capillary Blood Flow and Preserves Paratendon Oxygen Saturation in Chronic Achilles Tendinopathy	13
Knobloch et al. 2008 [33]	Eccentric exercises for the management of tendinopathy of the main body of the Achilles tendon with or without the AirHeel Brace. A randomized controlled trial. A: effects on pain and microcirculation	1
Knobloch et al. 2010 [34]	Gender and eccentric training in Achilles mid-portion tendinopathy	8
Koszalinski et al. 2020 [35]	Trigger point dry needling, manual therapy and exercise versus manual therapy and exercise for the management of Achilles tendinopathy: a feasibility study	3
Lee et al. 2020 [36]	Changes on Tendon Stiffness and Clinical Outcomes in Athletes Are Associated With Patellar Tendinopathy After Eccentric Exercise	3
Mansur et al. (2017)[37]	Shock wave therapy associated with eccentric strengthening versus isolated eccentric strengthening for Achilles insertional tendinopathy treatment: a double-blinded randomised clinical trial protocol	9, 13
Mayer et al. 2007 [38]	Effects of short-term treatment strategies over 4 weeks in Achilles tendinopathy	2
McCormack (2012)[39]	The management of mid-portion achilles tendinopathy with astym® and eccentric exercise: a case report	3, 10
Miners & Bougie (2011)[40]	Chronic Achilles tendinopathy: a case study of treatment incorporating active and passive tissue warm-up, Graston Technique, ART, eccentric exercise, and cryotherapy	10
Morrisey et al. 2011[41]	The effect of eccentric and concentric calf muscle training on Achilles tendon stiffness	5
Munteanu et al. (2015)[42]	Effectiveness of customised foot orthoses for Achilles tendinopathy: a randomised controlled trial	3
Ohberg & Alfredson (2004)[43]	Effects on neovascularisation behind the good results with eccentric training in chronic mid-portion Achilles tendinosis?	8
O'Neill et al. (2019)[44]	Acute sensory and motor response to 45-s heavy isometric holds for the plantar flexors in patients with Achilles tendinopathy	4, 8
Paoloni et al. (2004)[45]	Topical glyceryl trinitrate treatment of chronic noninsertional achilles tendinopathy. A randomized, double-blind, placebo-controlled trial	3
Papa (2012)[46]	Conservative management of Achilles Tendinopathy: a case report	3, 10
Pavone et al. (2016)[47]	Low-Energy Extracorporeal Shock-Wave Therapy in the Treatment of Chronic Insertional Achilles Tendinopathy: A Case Series	11, 13

Pinitkwamdee et al. 2020[48]	Effectiveness of Extracorporeal Shockwave Therapy in the Treatment of Chronic Insertional Achilles Tendinopathy	2
Purdam et al. (2004)[49]	A pilot study of the eccentric decline squat in the management of painful chronic patellar tendinopathy	7
Rabusin et al. 2019 [50]	Efficacy of heel lifts versus calf muscle eccentric exercise for mid-portion Achilles tendinopathy (the HEALTHY trial): study protocol for a randomised trial	9
Ram et al. (2013)[51]	The limited effectiveness of a home-based eccentric training for treatment of Achilles tendinopathy	12
Ramon et al. 2020 [52]	Focused Shockwave Treatment for Greater Trochanteric Pain Syndrome: A Multicenter, Randomized, Controlled Clinical Trial	3
Rees et al. (2008)[53]	The mechanism for efficacy of eccentric loading in Achilles tendon injury; an in vivo study in humans	5
Rio et al. (2015)[54]	Isometric exercise induces analgesia and reduces inhibition in patellar tendinopathy	4
Romero-Morales et al. 2020 [55]	Vibration increases multifidus cross-sectional area versus cryotherapy added to chronic non-insertional Achilles tendinopathy eccentric exercise	3
Romero-Rodriguez & Gual et al. (2011)[56]	Efficacy of an inertial resistance training paradigm in the treatment of patellar tendinopathy in athletes: a case-series study	11
Rompe et al. (2008)[57]	Eccentric loading compared with shock wave treatment for chronic insertional achilles tendinopathy. A randomized, controlled trial	13
Rompe et al. (2009)[58]	Eccentric loading versus eccentric loading plus shock-wave treatment for midportion achilles tendinopathy: a randomized controlled trial	1
Ross et al. (2017)[59]	Combined osteopathy and exercise management of Achilles tendinopathy in an athlete	3
Sancho et al. 2019 [60]	Education and exercise supplemented by a pain-guided hopping intervention for male recreational runners with midportion Achilles tendinopathy: A single cohort feasibility study	8
Sartorio et al. (2018)[61]	The EdUReP approach plus manual therapy for the management of insertional Achilles tendinopathy	13
Scattone-Silva et al. (2015)[62]	Rehabilitation of Patellar Tendinopathy Using Hip Extensor Strengthening and Landing-Strategy Modification: Case Report With 6-Month Follow-up	10
Shalabi et al. (2004)[63]	Immediate Achilles tendon response after strength training evaluated by MRI	4
Silbernagel et al. 2007 [64]	Continued sports activity, using a pain-monitoring model, during rehabilitation in patients with Achilles tendinopathy: a randomized controlled study	1**
Sinnot et al. (2017)[65]	Autologous Blood and Platelet-Rich Plasma Injections in the Treatment of Achilles Tendinopathy: A Critically Appraised Topic	6
Solomons et al. 2020 [66]	Intramuscular stimulation vs sham needling for the treatment of chronic midportion Achilles tendinopathy: A randomized controlled clinical trial	3
Stasinopoulos et al. 2013 [67]	Comparing two eccentric exercise programmes for the management of Achilles tendinopathy. A pilot trial	7
Stergioulas et al. (2008)[68]	Effects of low-level laser therapy and eccentric exercises in the treatment of recreational athletes with chronic achilles tendinopathy	3
Steunebrink et al. (2013)[69]	Topical glyceryl trinitrate treatment of chronic patellar tendinopathy: a randomised, double-blind, placebo-controlled clinical trial	3
Thijs et al. 2017 [70]	Effectiveness of shockwave treatment combined with eccentric training for patellar tendinopathy: A double-blinded randomized study	3
Tumilty et al. (2008)[71]	Laser therapy in the treatment of achilles tendinopathy: a pilot study	3
Tumilty et al. (2012)[72]	Clinical effectiveness of low-level laser therapy as an adjunct to eccentric exercise for the treatment of Achilles' tendinopathy: a randomized controlled trial	3

Tumilty et al. 2016 [73]	Photobiomodulation and eccentric exercise for Achilles tendinopathy: a randomized controlled trial	3
Van Ark et al. (2013)[74]	An exercise-based physical therapy program for patients with patellar tendinopathy after platelet-rich plasma injection	3, 8
Van Ark et al. 2016 [75]	Does the adolescent patellar tendon respond to 5 days of cumulative load during a volleyball tournament?	5, 8
Van Ark et al. 2018[76]	Clinical Improvements Are Not Explained by Changes in Tendon Structure on Ultrasound Tissue Characterization After an Exercise Program for Patellar Tendinopathy	15
Van der Vlist et al. 2020 [77]	Isometric exercises do not provide immediate pain relief in Achilles tendinopathy: A quasi-randomized clinical trial	4
Van der Worp et al. (2011)[78]	The TOPSHOCK study: effectiveness of radial shockwave therapy compared to focused shockwave therapy for treating patellar tendinopath - design of a randomised controlled trial	3, 9
Van der Worp et al. (2014)[79]	No difference in effectiveness between focused and radial shockwave therapy for treating patellar tendinopathy: a randomized controlled trial	3
Verrall et al. 2011 [80]	Chronic Achilles tendinopathy treated with eccentric stretching program	8
Von Wehren et al. 2019 [81]	Injection with autologous conditioned serum has better clinical results than eccentric training for chronic Achilles tendinopathy	7
Warden et al. (2008)[82]	Low-intensity pulsed ultrasound for chronic patellar tendinopathy: a randomized, double-blind, placebo-controlled trial	3
Wasterlain et al. 2012 [83]	Platelet-Rich Plasma as a Treatment for Patellar Tendinopathy: A Double-Blind Randomized Controlled Trial	2
Wei et al. (2017)[84]	Comparison of Clinical Efficacy Among Endoscopy-Assisted Radio-Frequency Ablation, Extracorporeal Shockwaves, and Eccentric Exercises in Treatment of Insertional Achilles Tendinosis	13
Wesner et al. (2016)[85]	A Pilot Study Evaluating the Effectiveness of Platelet-Rich Plasma Therapy for Treating Degenerative Tendinopathies: A Randomized Control Trial with Synchronous Observational Cohort	3
Wheeler et al. 2019 [86]	Extracorporeal Shock Wave Therapy Plus Rehabilitation for Insertionaland Noninsertional Achilles Tendinopathy Shows Good Results Across a Range of Domains of Function	3, 8
Yıldızgören et al. (2015)[87]	Conservative Treatment of Achilles Tendinosis, and Importance of Ultrasonography in The Follow-Up: A Case Report	12

1: exercise versus supplemented exercise; 2: no exercise; 3: no exercise as monotherapy; 4: no progression/ no progression criteria; 5: no tendinopathy; 6: critical appraisal paper; 7: non-randomized study; 8: no control group; 9: study protocol; 10: a case report; 11: case series; 12: full-text not available; 13: predominant insertional Achilles tendinopathy; 14: non-compliance with the age criteria; 15: secondary analysis of another included study

*Progression occurs in the treatment shared by both groups, not in the additional treatment being studied

**Same exercise programme studied with and without continued sports activity

Supplementary appendix 3. Characteristics of the subjects of the included studies.

Study	N	Subjects	Age	Duration of symptoms	Diagnosis
ACHILLES TENDINOPATHY					
Gatz et al. (2020)	N=42 (62¥)	Subjects with a tendinopathy treated unsuccessfully	21-73 years	At least 2 months	Clinical diagnosis
Stefansson et al. (2019)	N=40‡	Recruited from clinicians and physical therapists	>18 years	At least 12 months	Clinical and US diagnosis
Beyer et al. (2015)	N=58	Recreational athletes	18-60 years	At least 3 months	US diagnosis
Stevens & Tan (2014)	N=28	Subjects identified on clinic waiting lists	>18 years	At least 3 months	Clinical diagnosis
Kearney et al. (2013)	N=20	Clinic patients	35-66 years	At least 3 months	Clinical and US diagnosis
Yu et al. (2013)	N=32	Clinic patients	20-30 years	At least 6 months	US diagnosis
Zhang et al. (2013)	N=64	Hospital patients	18-70 years	At least 2 months	Clinical diagnosis
Horstmann et al. (2013)	N=58	Recreational runners	25-55 years	At least 6 months	US diagnosis
Yelland et al. (2011)	N=29‡	VISA-A <80 (athletes), VISA-A <70 (not athletes); analgesics were allowed	>18 years	At least 6 weeks	Clinical and US diagnosis
Chester et al. (2008)	N=16	Clinic patients	31-76 years	At least 3 months	Clinical diagnosis
Petersen et al. (2007)	N=72‡ (100¥)	Recreational athletes	Mean age 42.5±11.07	At least 3 months (7.4 months)	Clinical and US diagnosis
Rompe et al. (2007)	N=75	Clinic patients; 12 weeks washout period required	18-70 years	At least 6 months	Clinical and US diagnosis
Nørregaard et al. (2007)	N=45 (67 ¥)	Clinic patients	18-70 years	At least 3 months	Clinical and US diagnosis
Roos et al. (2004)	N=29‡	Primary care patients	26-60 years	At least 1 month	Clinical diagnosis
Mafi et al. (2001)	N=44	People with severe tendinopathy candidate for surgical treatment	36-72 years	At least 3 months	Clinical and US diagnosis
Silbernagel et al. (2001)	N=40 (57 ¥)	Recreational athletes	19-77 years	At least 3 months	Clinical diagnosis
Niesen-Vertommen et al. (1992)	N=17	Recreational athletes	22-49 years	At least 1 month	Clinical diagnosis
PATELLAR TENDINOPATHY					
Rio et al. (2017)	N=20	Volleyball and basketball players	>16 years	N/A	Clinical and US diagnosis
Van ark et al. (2016)	N=29	Volleyball and basketball players	16-32 years	At least 1 month (35.8±33.8 months)	Clinical diagnosis
Da Cunha et al. (2012)	N=7	Athletes	>18 years	N/A	Clinical and US or MRI diagnosis
Kongsgaard et al. (2009)	N=39	4 weeks wash-out period required	18-50 years	At least 3 months	US diagnosis
Frohm et al. (2007)	N=20	Competitive and recreational athletes	26±8-28±8 years	At least 3 months	MRI or US diagnosis
Bahr et al. (2006)	N=40¥	Subjects with pain during and after activity and unable to participate in sports at the same level as before the onset of pain	>18 years	At least 3 months	Clinical and MRI diagnosis
Visnes et al. (2005)	N=29	Volleyball players, VISA-P score <80 point; NSAIDs were allowed	18-35 years	At least 3 months	Clinical diagnosis
Young et al. (2005)	N=17	Elite volleyball players with VISA-P score <80 points	18-35 years	N/A	Clinical and US diagnosis
Jonsson & Alfredson (2005)	N=15 (19 ¥)	Clinic patients	17-42	At least 8 months	Clinical and US diagnosis
Stasinopoulos & Stasinopoulos (2004)	N=30	Athletes	21-31 years	At least 3 months	Clinical diagnosis
Jensen & Di Fabio (1989)	N=15‡	Recreational athletes	21-45 years	At least 3 months	Clinical diagnosis
GLUTEAL TENDINOPATHY					
Clifford et al. (2019)	N=30	Subjects identified on clinic waiting lists	>18 years	At least 3 months	Clinical diagnosis
Mellor et al. (2018)	N=204	At least 4 on the pain numerical rating scale	35-70 years	At least 3 months	Clinical and MRI diagnosis
Ganderton et al. (2018)	N=94	Postmenopausal women	61.14±6.70-62.538±92 years	N/A	Clinical diagnosis

‡ = Sample (N) excluding subjects included in the combined treatment group, not taken into account in the review; ¥ = Number of tendons (Both sides were included if the patient had bilateral involvement); N/A= Not available; NSAIDs= Non-Steroidal Anti-Inflammatory Drugs; MRI: magnetic resonance imaging; US= ultrasound; VISA-A= Victorian Institute of Sport Assessment Questionnaire for Achilles tendon; VISA-P= Victorian Institute of Sport Assessment Questionnaire for patellar tendon

Supplementary appendix 4. Characteristics of the interventions of the included studies.

Study	PA*	Intervention			Control		
		Characteristics [Type; duration of programme; frequency; volume; series x repetitions (exercises)]	Total weekly volume	Progression criterion	Characteristics [Type; duration of programme; frequency; volume; series x repetitions (exercises)]	Total weekly volume	Progression criterion
ACHILLES TENDINOPATHY							
Gatz et al. (2020)	N/A	ECC+ISOM; 12 weeks; twice (ECC) and once (ISOM) daily; 3x15 (ECC) and 5x45 seconds (ISOM) (heel raises with straight knee)	630 reps/week (ECC); 1575"/week (ISOM)	Avoid Pain-based and Subjective Perception: Patients were briefed to do the exercises cautiously and pain-free, Advance to the next level if they were not feeling pain or exhaustion at maximum load.	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight knee)	630 reps/week	Avoid Pain-Based and Subjective Perception: Patients were briefed to do the exercises cautiously and pain-free, Advance to the next level if they were not feeling pain or exhaustion at maximum load.
Stefansson et al. (2019)	N/A	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	Week 1: 150 reps; week 2: 630 reps; weeks 3 to 12: 1260 reps	Evoking Pain-based: If the patient was pain-free for the full 15 repetitions for 3 sets, another 5 kg was added for the next phase		Pressure massage	
Beyer et al. (2015)	Partially	HSR; 12 weeks; 3 times/week; 3-4x6-15 (three two-legged exercises: heel rises with straight and bent knee in machine, and heel rises with straight knee standing on a disc weight)	Week 1: 405 reps; weeks 2 and 3: 324 reps; weeks 4 and 5: 360 reps; weeks 6,7, and 8: 288 reps; weeks 9, 10, 11, and 12: 216 reps	Conditioning Stages: 3x15 repetition maximum (15RM), in week 1; 3x12 (12RM), in weeks 2 to 3; 4x10 (10RM), in weeks 4 to 5; 4x8 (8RM), in weeks 6 to 8; and 4x6 (6RM), in weeks 9 to 12	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished
Stevens & Tan (2014)	Partially	ECC "do as tolerated"; 6 weeks; twice daily; 3x15 (heel raises with straight and bent knee); recommendation to achieve a repetition volume similar to that of the standard group, but they could choose to complete a lower repetition volume that was tolerable	1260 reps/week if tolerated (mean: 595 reps/week)	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished	ECC; 6 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week (mean: 1162 reps/week)	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished
Kearney et al. (2013)	N/A	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Progressed as pain allowed. Firstly, by advancing from double-leg exercises to single-leg exercises. Secondly, load was increased gradually using a loaded backpack		PRP injection	
Yu et al. (2013)	N/A	ECC; 8 weeks; 3 times/week; 3x15 (heel raises with straight and bent knee; different variants according to the corresponding week)	270 reps/week	Conditioning Stages: Eccentric contraction using both feet, in week 1; Use both feet to achieve eccentric contraction or increase weight bearing on the injured side, in week 2; Use the injured-side foot to achieve eccentric contraction, in week 3; Use only the injured-side foot and apply 10% of weight, in week 4;	CONC; 8 weeks; 3 times/week; 3x15 (plantarflexion using elastic band, heel raises, side jump; different variants according to the corresponding week)	405 reps/week	Conditioning Stages: Plantarflexion using elastic band while sitting on the floor with straightened knees. Sit on a chair and lift the heels with partial weight bearing. Hold onto the wall and lift the heels of both feet. Hamstring and calf muscle stretching, in weeks 1 and 2; Plantarflexion using elastic band while sitting on the floor with straightened knees. Plantarflexion while lifting the

				Use only the injured-side foot and additionally apply 5-10 lbs of load to the resistance of the previous week, in week 5 to 8			injured-side foot on a chair. Hold onto the wall and lift the heel of one foot. Hamstring and calf muscle stretching, in weeks 3 and 4; Use the injured-side foot to achieve eccentric contraction, in week 3; Use only the injured-side foot and apply 10% of weight, in week 4; Plantarflexion using elastic band while sitting on the floor with straightened knees. Hold onto the wall and lift the heel of one foot. Side jump. Hamstring and calf muscle stretching., in week 5 to 8
Zhang et al. (2013)	N/A	ECC; 8 weeks; 3 times/week; 3x15 (heel raises with straight and bent knee)	270 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished		Acupuncture	
Horstmann et al. (2013)	Yes	ECC; 12 weeks; 3 times/week; 3x15 on each leg (heel raises with straight and bent knee)	270 reps/week	Fatigue-based: Participants performed an extra set if no signs of fatigue were present after the 3 first sets. If necessary, load was increased gradually using a backpack	Control group 1: Whole-body Vibration Group; control group 2: wait and see group		
Yelland et al. (2011)	Yes	ECC; 12 weeks; 3 times daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished		Prolotherapy injections	
Chester et al. (2008)	N/A	ECC; 12 weeks; once daily; 3x15 (heel raises with straight and bent knee)	630 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack or increasing number of repetitions as pain settled		Therapeutic ultrasound	
Petersen et al. (2007)	Yes	ECC; 12 weeks; 3 times daily; 3x15 (heel raises with straight and bent knee)	1890 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished		AirHeel brace	
Rompe et al. (2007)	Partially	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished	Control group 1: Shockwave/ Control group 2: Wait and see		
Nørregaard et al. (2007)	Yes	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished	Stretching; 12 weeks; twice daily; 5x30” (standing stretching with straight and bent knee)	4200”/week	No progression
Roos et al. (2004)	N/A	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished		Night splint	
Mafi et al. (2001)	Partially	ECC; 12 weeks; twice daily; 3x15 (heel raises with straight and bent knee)	1260 reps/week	Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished	CONC; 12 weeks; twice daily; 3x15 (different exercises according to stages and weeks)	Approximately 1260 reps/week	Conditioning Stages: Different exercises, intensity, and complexity in each week, according to a Stage-Based protocol

Silbernagel et al. (2001)	N/A	ECC+CONC; 12 weeks; frequency, volume, and exercises variable in each week	Variable	Conditioning Stages and Subjective Perception: Stage-based progression in complexity and load. Additionally, volume was increased gradually as ability and symptoms allowed	ECC; 12 weeks; 3 times/day; 3x30 (including exercises that combine eccentric and concentric phases)	Variable	Subjective Perception: Volume and complexity of exercises were increased gradually as ability and symptoms allowed
Niesen-Vertommen et al. (1992)	Partially	ECC; 12 weeks; once daily; 6 times/week; 5x10 (heel raises with straight knee)	300 reps/week	Avoid Pain-based: Pain free range of motion, progression when discomfort in the last five to 10 repetitions was absent or minimal.	CONC; 12 weeks; once daily; 6 times/week; 5x10 (heel raises with straight knee)	300 reps/week	Avoid Pain-based: Pain free range of motion, progression when discomfort in the last five to 10 repetitions was absent or minimal.
PATELLAR TENDINOPATHY							
Rio et al. (2017)	Yes	ISOM (knee joint angle of 60◦); 4 weeks; 4 times/week; 5x45" holds 80% MVIC (calculated at baseline)	900”/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible	Isotonic exercise; 4 weeks; 4 times/week; 4x8 80% 8RM (calculated at baseline)	128 reps/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible
Van ark et al. (2016)	Yes	Isotonic exercise; 4 weeks; 4 times/week; 4x8 80% RM at the beginning	128 reps/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible	ISOM (knee joint angle of 60◦); 4 weeks; 4 times/week; 5x45” 80%MVC	900”/week	Temporary Linear increase: Weight was increased by 2.5% every week if possible
Da Cunha et al. (2012)	Partially	Painful ECC decline board squat (squat instrument with guided bar); 12 weeks; 3 times/week; 3x15	135 reps/week	Evoking Pain-based: Painful group increased weight to perform exercise with the greatest pain without altering performance	Not painful ECC decline board squat (squat instrument with guided bar); 12 weeks; 3 times/week; 3x15	135 reps/week	Avoiding Pain-Based: When the subjects from the “not painful” group, even without load addition, presented pain during the exercise, they were told to rest the upper limbs on a bar with the purpose to decrease overload on the patellar tendon
Kongsgaard et al. (2009)	Partially	HSR; 12 weeks; 3 times/week; Volume variable; 3 exercises (squat, leg press and hack squat)	Week 1: 540 reps; weeks 2 and 3: 432 reps; weeks 4 and 5: 360 reps; weeks 6,7, and 8: 288 reps; weeks 9, 10, 11, and 12: 216 reps	Conditioning Stages: 4x15 repetition maximum (15RM) week 1; 4x12 (12RM) weeks 2–3; 4x10 (10RM) weeks 4–5; 4x8 (8RM) weeks 6–8; and 4x6 (6RM) weeks 9–12	Control Group 1: ECC decline board squat; 12 weeks; twice daily, 3x15 (supervised training once a week)/ Control Group 2: Corticosteroid injection	ECC: 630 reps/week	ECC: Evoking Pain-based: Load was increased gradually using a loaded backpack as pain diminished
Frohm et al. (2007)	Partially	Mutual exercise (3x15 sit-ups and 3x1min one-legged stance) + ECC decline board squat; 12 weeks; 2 times/week (supervised); 3x15. During the last 6 weeks of the intervention, participants slowly resumed supervised jogging and plyometric jump training	90 (sit-ups) + 90 (squats) reps/week	Evoking Pain-based: Increase weight (5kg) if VAS < 3	Mutual exercise (3x15 sit-ups and 3x1min one-legged stance) + exercise overload ECC (Bromsman device); 12 weeks; 2 times/week (supervised); 4x4 (maximal effort). During the last 6 weeks of the intervention, participants slowly resumed supervised jogging and plyometric jump training	90 (sit-ups) + 32 (squats) reps/week	Evoking Pain-Based: Increase weight (5kg) if VAS < 3; Inertial exercise: maximal effort
Bahr et al. (2006)	Partially	ECC decline board squat; 12 weeks; twice daily; 3x15 (squat performed with the knee flexed to 90°)	630 reps/week	Evoking Pain-based: When pain decreased to <3, the participant added load in a backpack. Recommended to have a pain value of 4		Surgery	

Visnes et al. (2005)	Yes	ECC decline board squat during season; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-based: With less pain than 3 to 4, were recommended to increase the weight. Recommended to have a pain value of 5 on a VAS during ECC programme	Usual training (no intervention)		
Young et al. (2005)	Yes	ECC decline board squat; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-Based: Load was increased gradually using a loaded backpack as pain diminished	ECC squat on 10 cm step; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-Based: Progressed as pain diminished (firstly from slow to fast, secondly increasing load)
Jonsson & Alfredson (2005)	Partially	ECC decline board squat; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-Based: Load was increased gradually using a loaded backpack as pain diminished	CONC decline board squat; 12 weeks; twice daily; 3x15	630 reps/week	Evoking Pain-Based: Load was increased gradually using a loaded backpack as pain diminished
Stasinopoulos & Stasinopoulos (2004)	N/A	ECC squat + static stretching, 4 weeks, 3 times/week, 3x15 (unilateral squat)		Evoking Pain-Based: Load was increased gradually holding weights in their hands as pain diminished	Control group 1: Transverse friction/ Control group 2: US		
Jensen & Di Fabio (1989)	N/A	ECC isokinetic training + static stretching; 8 weeks; twice daily		The intensity of the exercise was progressed over eight weeks by gradually increasing the speed of the eccentric contraction from 30 to 70°/sec.	Static Stretching; 8 weeks; twice daily (No progression)		
GLUTEAL TENDINOPATHY							
Clifford et al. (2019)	Yes	Isotonic exercise; 12 weeks; once daily; 3x10x6" (two exercises: side-lying hip abduction, hip abduction slide)	360 reps/weeks; 2520"/week	Exercise progression with the resistance bands was individualised and based on each participant's ability to complete the exercises without increasing their pain beyond 5/10.	ISOM exercise; 12 weeks; once daily; two exercises: side-lying hip abduction, 6x30"; hip abduction slide, 3x10x6")	2520"/week	Exercise progression with the resistance bands was individualised and based on each participant's ability to complete the exercises without increasing their pain beyond 5/10.
Mellor et al. (2018)	N/A	Exercise + education; 8 weeks (14 sessions) + home exercise programme (4-6 exercises); once daily	Variable	Conditioning Stages: Different, exercises, frequency, volume, and intensity in each week, according to a Stage-Based protocol	Control group 1: Corticosteroids/ Control group 2: Wait-and-See approach		
Ganderton et al. (2018)	No	Exercise + education; 12 weeks; twice daily; 2-4x5-15	Variable	Conditioning Stages and Subjective Perception: Different, exercises, frequency, volume, and intensity in each week, according to a Stage-Based protocol. The progression through the stages was additionally dependent on the patient's abilities	Sham exercise		

PA*= allowed additional physical activity; CONC= concentric exercise training; ECC= eccentric exercise training; HSR= heavy slow resistance training; ISOM= isometric exercise training; MVC= maximal voluntary contraction; N/A = not available; RM= repetition maximum; US= ultrasound therapy; VAS= Visual Analogue Scale

Supplementary appendix 5. Outcomes and measurement time.

Study	N	Clinical Outcomes		Performance Outcomes	
		Time	Outcomes	Time	Outcomes
ACHILLES TENDINOPATHY					
Gatz et al. (2020)	N=42 (62¥)	0, 4, 12 weeks	VISA-A, AOFAS, Likert Scale, Roles and Maudsley, hypoechogenicity (US)		
Stefansson et al. (2019)	N=40‡	0, 4, 8, 12, 24 weeks	VISA-A-IS, pain on palpation (algometer), thickness and degree of vascularization (US)	0, 4, 8, 12, 24 weeks	Ankle range of motion
Beyer et al. (2015)	N=58	0, 12, 52 weeks	VISA-A, VAS during 5 heel raises on step, VAS during running, US measurements		
Stevens & Tan (2014)	N=28	0, 3, 6 weeks	VISA-A, VAS; 6 weeks: treatment satisfaction		
Kearney et al. (2013)	N=20	0, 6, 12, 26 weeks	VISA-A, EuroQol-5D		
Yu et al. (2013)	N=32	0, 8 weeks	VAS	0, 8 weeks	Isokinetic measurement (strength), side-step test (endurance), sargent jump test (physical function)
Zhang et al. (2013)	N=64	0, 8, 16, 24 weeks	VISA-A, VAS (after activity, at rest), treatment satisfaction, use of painkillers, and working status.		
Horstmann et al. (2013)	N=58	0, 12 weeks	Change of symptoms (standard Likert scale), VAS (family and responsibility at home, recreation, social activities, running training or others physical activities), sonographic assessment	0, 12 weeks	Isokinetic measurements
Yelland et al. (2011)	N=29‡	0, 6, 12, 26, 52 weeks	VISA-A, treatment satisfaction (standard Likert scale), Patient Global Impression of Change scale		
Chester et al. (2008)	N=16	0, 2, 4, 6, 12 weeks	VAS (rest, walking, during recreational sport), FILLA, EuroQol-5D		
Petersen et al. (2007)	N=72‡ (100 tendons)¥	0, 6, 12 weeks	VAS (at rest, during gait, during sports activities), AOFAS hindfoot scale, SF-36, US. 54 weeks: AOFAS, VAS		
Rompe et al. (2007)	N=75	0, 16 weeks	VISA-A, general assessment (6-point Likert scale), Numerical Rating Scale (pain), algometer (pain), US		
Nørregaard et al. (2007)	N=45 (67 ¥)	0, 1, 3, 6, 12, 39 weeks	Pain (tenderness palpation); ultrasonography, self-reported symptoms in questionnaire; patient's global assessment		
Roos et al. (2004)	N=29‡	0, 6, 12, 26, 52 weeks	FAOS [Pain measured with FAOS was considered the primary outcome]	0, 6, 12, 26, 52 weeks	Activities of Daily Living, Sport and Recreation Function, and Foot and Ankle-related Quality of Life; Physical activity level (seven grade scale from 0 to 6)
Mafi et al. (2001)	N=44	0, 12 weeks	VAS during activity (running or walking), patient satisfaction		
Silbernagel et al. (2001)	N=40 (57 tendons)¥	0, 6, 12, 26 weeks	Pain measured with VAS (palpation test and pain evaluation during jumping, toe-raises and at rest), presence of symptoms, and a questionnaire (physical activity level, work, other injuries, previous treatments for the Achilles tendon disorder, and medication)	0, 6, 12, 26 weeks	Range of motion test, jumping test, toe raise test

Niesen-Vertommen et al. (1992)	N=17	0, 4, 8, 12 weeks	Pain measured with Numerical Rating Scale, return to sport activity measured with Numerical Rating Scale		Isokinetic concentric and eccentric ankle plantar flexion torque (30°/sec, 50°/sec)
PATELLAR TENDINOPATHY					
Rio et al. (2017)	N=20	0, 4 weeks	Pain during single leg decline squat with a Numerical Rating scale (0-10), VISA-P		
Van ark et al. (2016)	N=29	0, 4 weeks	Pain during a single leg decline squat on a Numerical Rating Scale (0-10), VISA-P		
Da Cunha et al. (2012)	N=7	0, 8, 12 weeks	VISA-P , VAS		
Kongsgaard et al. (2009)	N=39	0, 12, 26 weeks	VISA-P, VAS, treatment satisfaction, tendon swelling, tendon vascularization, tendon mechanical properties, collagen crosslink properties		
Frohm et al. (2007)	N=20	0, 3, 6, 9, 12 weeks	VISA-P, VAS	0, 3, 6, 9, 12 weeks	Isokinetic muscle torque, dynamic function, muscle flexibility.
Bahr et al. (2006)	N=40¥	0, 12, 26, 52 weeks	VISA-P, global evaluation score, treatment satisfaction. Functional tests of strength and jumping performance	0, 12, 26, 52 weeks	Standing jump, counter-movement jump, leg press
Visnes et al. (2005)	N=29	0, 12 weeks	VAS, VISA-P, patient satisfaction	0, 1, 4, 8, 12, 18, 40 weeks	Counter-movement jump
Young et al. (2005)	N=17	0, 1, 4, 8, 12, 18, 40 weeks	VISA-P, global evaluation score (pain and function)		
Jonsson & Alfredson (2005)	N=15 (19 ¥)	0, 6, 12 weeks	VAS, VISA-P, patient satisfaction		
Stasinopoulos & Stasinopoulos (2004)	N=30	0, 4, 8, 16 weeks	Status of pain from the following alternatives: worse, no change, somewhat better, much better, no pain.		
Jensen & Di Fabio (1989)	N=15‡	0, 4, 8 weeks	Pain scales (rest, during activity); Self-designed pain questionnaire	0, 4, 8 weeks	Isokinetic eccentric and concentric knee extension torque (50°/sec)
GLUTEAL TENDINOPATHY					
Clifford et al. (2019)	N=30	0, 4 ,12 weeks	VISA-G, Numerical Rating Scale, global rating of change scale, pain catastrophizing scale, HOOS, EuroQOL-5D, International Physical Activity Questionnaire Short Form (IPAQ-SF)		
Mellor et al. (2018)	N=204	0, 4, 8, 12, 26, 52 weeks	Global rating of change and pain intensity, VISA-G, lateral hip pain questionnaire, patient specific functional scale; pain self-efficacy questionnaire, pain catastrophising scale, Patient Health Questionnaire, Active Australia survey, and EuroQOL-5D	0, 8 weeks	Hip abductor muscle torque, active abduction lag
Ganderton et al. (2018)	N=94	0, 12, 52 weeks	VISA-G, hip pain and function questionnaires, global rating of change in symptom questionnaire, HOOS, OHS, AQoL-8D (quality of life)		

‡ = Sample (N) excluding subjects included in the combined treatment group, not taken into account in the review; ¥ = Number of tendons (Both sides were included if the patient had bilateral involvement);

AQoL-8D: Assessment of Quality of Life 8-Dimenssion; AOFAS: American Orthopaedic Foot & Ankle Society score; EuroQOL-5D= European quality of life-5D questionnaire; FAOS= Foot and Ankle Outcome Score; FILLA= Functional Index of the Leg and Lower Limb; HOOS= Hip dysfunction and Osteoarthritis Outcome Score; OHS= Oxford Hip Score; SF-36: Short-form 36 Questionnaire; US: ultrasound; VAS= visual analogue scale; VISA-A= Victorian Institute of Sport Assessment Questionnaire for Achilles tendon; VISA-P= Victorian Institute of Sport Assessment Questionnaire for patellar tendon; VISA-G= Victorian Institute of Sport Assessment Questionnaire for gluteal tendinopathy

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Synthesis Without Meta-analysis (SWiM) reporting items

The citation for the Synthesis Without Meta-analysis explanation and elaboration article is: Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, Hartmann-Boyce J, Ryan R, Shepperd S, Thomas J, Welch V, Thomson H. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline BMJ 2020;368:l6890 http://dx.doi.org/10.1136/bmj.l6890

SWiM is intended to complement and be used as an extension to PRISMA			
SWiM reporting item	**Item description**	**Page in manuscript where item is reported**	**Other***
Methods			
1 Grouping studies for synthesis	1a) Provide a description of, and rationale for, the groups used in the synthesis (e.g., groupings of populations, interventions, outcomes, study design)	6 and 7	
	1b) Detail and provide rationale for any changes made subsequent to the protocol in the groups used in the synthesis	No changes were needed	
2 Describe the standardised metric and transformation methods used	Describe the standardised metric for each outcome. Explain why the metric(s) was chosen, and describe any methods used to transform the intervention effects, as reported in the study, to the standardised metric, citing any methodological guidance consulted	9	
3 Describe the synthesis methods	Describe and justify the methods used to synthesise the effects for each outcome when it was not possible to undertake a meta-analysis of effect estimates	9	
4 Criteria used to prioritise results for summary and synthesis	Where applicable, provide the criteria used, with supporting justification, to select the particular studies, or a particular study, for the main synthesis or to draw conclusions from the synthesis (e.g., based on study design, risk of bias assessments, directness in relation to the review question)	9	

Synthesis Without Meta-analysis (SWiM) reporting items

SWiM reporting item	Item description	Page in manuscript where item is reported	Other*
5 Investigation of heterogeneity in reported effects	State the method(s) used to examine heterogeneity in reported effects when it was not possible to undertake a meta-analysis of effect estimates and its extensions to investigate heterogeneity	9	
6 Certainty of evidence	Describe the methods used to assess certainty of the synthesis findings	8 and 9	
7 Data presentation methods	Describe the graphical and tabular methods used to present the effects (e.g., tables, forest plots, harvest plots). Specify key study characteristics (e.g., study design, risk of bias) used to order the studies, in the text and any tables or graphs, clearly referencing the studies included	9	
Results			
8 Reporting results	For each comparison and outcome, provide a description of the synthesised findings, and the certainty of the findings. Describe the result in language that is consistent with the question the synthesis addresses, and indicate which studies contribute to the synthesis	From 10 to 13	
Discussion			
9 Limitations of the synthesis	Report the limitations of the synthesis methods used and/or the groupings used in the synthesis, and how these affect the conclusions that can be drawn in relation to the original review question	19	

PRISMA=Preferred Reporting Items for Systematic Reviews and Meta-Analyses.
*If the information is not provided in the systematic review, give details of where this information is available (e.g., protocol, other published papers (provide citation details), or website (provide the URL)).

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-9
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	n/a
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	9
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	9
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	n/a
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9-10
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	n/a
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	1

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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