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Efficacy of exercise therapy in workers with rotator cuff tendinopathy: A systematic review

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Review

Efficacy of exercise therapy in workers with rotator cuff tendinopathy: a systematic review

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Abstract: Objective: To perform a systematic review of randomized controlled trials (RCTs) on the efficacy of therapeutic exercises for workers suffering from rotator cuff (RC) tendinopathy. **Methods:** A literature search in four bibliographical databases (Pubmed, CINAHL, EMBASE, and PEDro) was conducted from inception up to February 2015. RCTs were included if participants were workers suffering from RC tendinopathy, the outcome measures included work-related outcomes, and at least one of the interventions under study included exercises. The methodological quality of the studies was evaluated with the Cochrane Risk of Bias Assessment tool. **Results:** The mean methodological score of the ten included studies was 54.4% ± 17.2%. Types of workers included were often not defined, and work-related outcome measures were heterogeneous and often not validated. Three RCTs of moderate methodological quality concluded that exercises were superior to a placebo or no intervention in terms of function and return-to-work outcomes. No significant difference was found between surgery and exercises based on the results of two studies of low to moderate methodological quality. One study of low methodological quality, comparing a workplace-based exercise program focusing on the participants' work demands to an exercise program delivered in a clinical setting, concluded that the work-based intervention was superior in terms of function and return-to-work outcomes. **Conclusion:** There is low to moderate-grade evidence that therapeutic exercises provided in a clinical setting are an effective modality to treat workers suffering from RC tendinopathy and to promote return-to-work. Further high quality studies comparing different rehabilitation programs including exercises in different settings with defined workers populations are needed to draw firm conclusions on the optimal program to treat workers.
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Key words: Rotator cuff, Shoulder, Systematic review, Tendinopathy, Therapeutic exercises, Workers

Introduction

Shoulder pain affects a substantial number of adults, with a prevalence rate that has been reported to stand between 9% to 26% in the general population of Western countries[1)]. Shoulder pain is the third most common musculoskeletal symptom[2,3)] and the most common cause of shoulder pain in adults is rotator cuff (RC) tendinopathy[4)]. RC tendinopathy is an umbrella term that includes different shoulder conditions affecting subacromial structures, such as long head of the biceps tendinopathy, subacromial bursitis, and shoulder impingement syndrome (SIS)[5)].

RC tendinopathy is particularly prevalent in workers and can cause work absenteeism and loss of productivity leading to important societal economic costs[6)]. Rehabilitation of workers with RC tendinopathy may be challeng-

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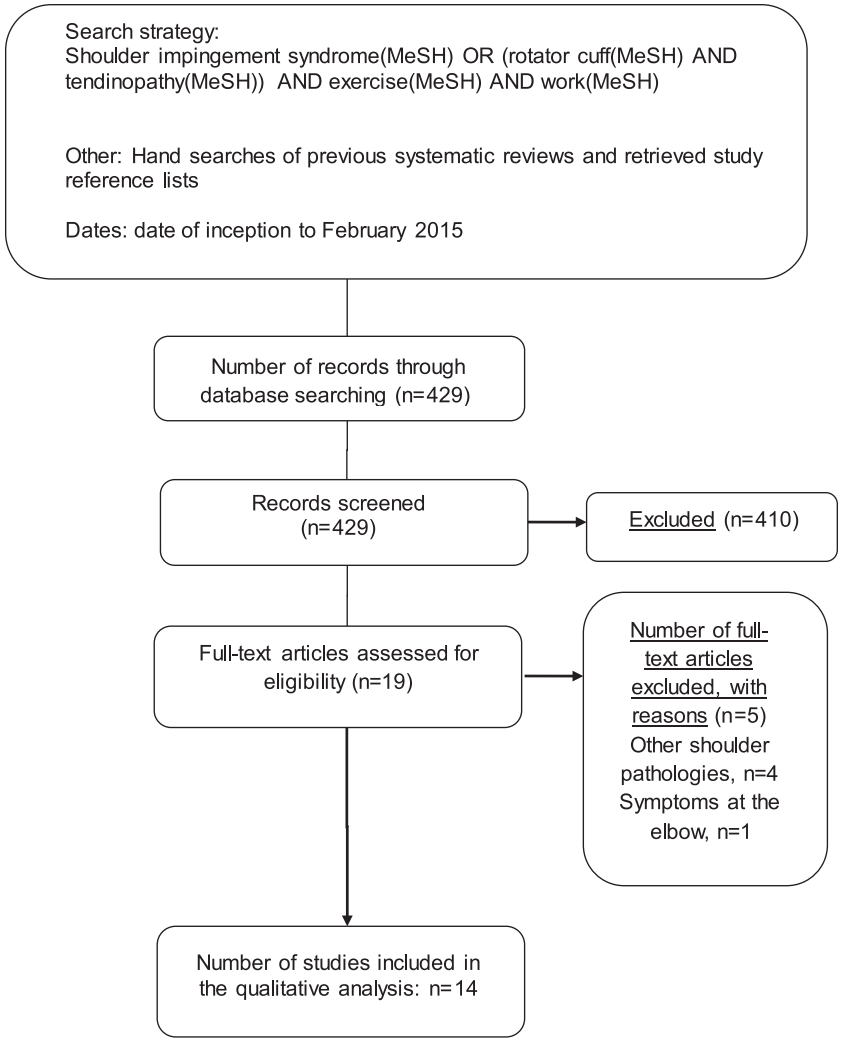


Fig. 1. Literature search results

ing, particularly when exposure to risk factors of shoulder-related pain and disability, such as working with arms above shoulder level, carrying loads, and use of vibrating tools, is common[7-10].

Generally, prescription of non-steroidal anti-inflammatory drugs (NSAIDs), exercises, and surgery are common treatment options in the management of RC tendinopathy in workers. No consensus, however, exists on the best approach needed for workers. Furthermore, it has never been established if work-related interventions are required and if interventions for workers need to include work-related functional exercises[11]. Evidence regarding the efficacy of exercises in adults is substantial, and exercise has been advocated as a cost-effective treatment for RC tendinopathy[12]. Two recent systematic reviews were published on the efficacy of physiotherapy exercises for adults with SIS and RC tendinopathy[13,14]. The authors of both reviews concluded that therapeutic exercises are effective in the management of patients suffering from RC tendinopathy. Their conclusions were, however, limited to general adults, and no specific conclusions for workers or information on work-related outcomes were presented. Thus, the effectiveness of exercises in workers remains unelucidated. Considering the high prevalence of RC tendinopathy in workers, there is a need to further investigate the specific efficacy of exercises for this population. The aim of this review was to evaluate the published literature concerning the efficacy of therapeutic exercises for workers suffering from RC tendinopathy.

Methods

This systematic review conforms to the PRISMA methodological guidelines[15].

Literature search and study identification

A literature search in four bibliographical databases was conducted (Pubmed, CINAHL, EMBASE, and PEDro) using a combination of keywords and MESH terms (Fig. 1). All databases were searched from their

date of inception to February 2015. Previous published reviews were also reviewed, and study reference lists were retrieved and searched for additional relevant studies.

Data extraction and quality assessment

Study selection

Two evaluators independently reviewed the title and abstract of each article to determine whether it met the following inclusion criteria: 1) Participants suffered from RC tendinopathy or other related diagnostics, such as impingement syndrome, subacromial bursitis, or bicipital tendinitis. 2) Participants were adults (≥18 years). 3) The majority of participants were workers or specific work-related outcome measures were used. The main outcomes of interest were work-related, but other clinical outcomes were also considered, such as pain and disability. 4) At least one of the interventions under study included exercises for the shoulder and could also include the upper quadrant. 5) Study design was a randomized controlled trials (RCTs). 6) The language of articles was either English or French. Studies that included participants suffering from shoulder pain were also eligible, as long as it could be determined that the majority of the study participants were suffering from RC tendinopathy. Studies were excluded if they had recruited patients with full thickness RC rupture, capsulitis, or post-surgery.

Data extraction

One evaluator extracted characteristics of the included studies with a standardized form that covered: characteristics of participants (mean age, gender, and duration of symptoms), occupation, type of interventions, outcome measures, follow-up period, and main results. Data extraction was later verified by a second independent evaluator.

Risk of bias tool

The risk of bias of the included studies was assessed with the Cochrane risk of bias tool[16]. This instrument is a well-known and validated assessment tool used to assess the risk of bias in RCTs. This tool appraised the risk of bias of a study in six methodological domains: sequence generation, allocation concealment, blinding (participants, provider, and assessor), incomplete outcome data, selective outcome data reporting, and other sources of bias[16]. Each item is appraised independently by two evaluators regarding its risk of potential bias: "unclear" indicates an unclear or unknown risk of bias based on the information presented in the study, "yes" indicates low risk of bias, and "no" indicates high risk of bias. For each methodological item, we also attributed a numerical score: a score of 2 was given if a low risk of bias was present, a score of 1 was given if the risk of bias was unclear or unknown, and a score of 0 was given if a high risk of bias was found to be present. A total score (out of 16) was then calculated and converted to a percentage to give an overview of the methodological quality and risk of bias of the included RCTs; higher scores signaled better methodological quality. Studies were rank ordered based on their quality, but there was no formal mechanism to exclude studies according to their quality. A pair of raters met to compare ratings and resolve disparities after the independent evaluation of each study. A structured consensus approach was used that involved: 1) re-review of the articles, 2) discussion of the adherence to standards, and 3) use of an independent third evaluator if consensus was not achieved.

Data analyses

The kappa statistic was used to calculate pre-consensus inter-rater agreement on individual methodological items, and an intraclass correlation coefficient (ICC) was calculated to evaluate inter-rater reliability of the total methodological scores using Statistical Package for Social Sciences (IBM SPSS Statistics 21, Chicago, USA). Studies that compared similar interventions with comparable outcome measures were identified for possible meta-analysis. The statistical significance was set at α=0.05.

Results

Description and findings of the included studies

The literature search resulted in the initial identification of 429 studies (Fig. 1). After title and abstract review, 14 articles (10 studies) met the inclusion criteria and were reviewed (Table 1)[17-30]. The studies by Brox et al.[17,18], Haahr et al.[21,22], and Kromer et al.[23,24] each reported short- and long-term results from the same cohort of participants in two publications; therefore, these results were analyzed together. The two studies by Osteras et al. reported in one paper the long-term clinical outcomes, while the associated costs of the interventions were reported in another publication[28,29]. These results were, therefore, also analyzed together (Table 1).

Three RCTs compared therapeutic exercises to no intervention or to a placebo[17,18,25,26], two studies compared therapeutic exercises to arthroscopic subacromial decompression[17,18,21,22], one study compared two exercise programs of different intensities[28,29] and one RCT compared two different exercises programs[27]. Another study compared two exercise programs performed in different environments (clinical setting or in the worker's environment)[19], one RCT compared exercises to radial extracorporeal shockwave therapy (ECSWT)[20], one study compared therapeutic exercises to a naturopathic intervention[30], and one study compared an exercise program to individualized manual therapy in conjunction with an exercise program[23,24]. Samples of workers included construction journeymen, postal employees, and nurses[26,27,30]; however, the other studies did not mention the type of work performed by participants or define their work-related environment or work demands.

Table 1. Description of trials evaluating the efficacy of exercise therapy in workers with RC tendinopathy

Study	Participants	Interventions	Number of participants	Follow-up period	Outcome measures	Main results	Methodological score (0-16)
Therapeutic Exercise compared to No Intervention or Placebo							
Lombardi et al., 2008	Adults with subacromial impingement syndrome, diagnose by positive Neer and Hawkin test Type of work: not mentioned Mean age: 55.5	Supervised progressive resistance exercise program (X's) No intervention (Co)	30 30	8 weeks	DASH work module score (%). Pain during movement assessed with a 10 cm VAS (Baseline and after 8 weeks) DASH score (%)	X's: 49.6±23.5 and 28.7±24.8 p=0.032 Co: 47.4±24.7 and 44.2±28.2 p=0.731 Inter-group comparison p=0.007 X's: 7.4±1.0 and 5.2±2.0, p=0.002 Co: 7.1±1.5 and 7.1±2.5, p=0.304 Inter-group comparison: p=0.001 X's: 44.0±17.6 and 33.2±18.7 p=0.032 Co: 44.8±18.3 and 43.4±22.8 p=0.855 Inter-group comparison: p=0.013	11
Ludewig, et al., 2002	Adults with shoulder pain with 2 positive impingement tests: Neer, Hawkins/ Kennedy, Yocum, Jobe or Speed test Type of work: Construction journeyman Mean age: 48.8 Gender: Male: 67	Home stretching and strengthening exercise program (X's) No intervention (Co)	34 33	10 weeks	Mean change in work related disability (1 to 10 scale) Mean change in Work related pain (0-10 scale) Mean change in SRQ score (%)	X's: –1.52±0.35 Co: –0.09±0.31 *X's vs. Co: p<0.05* X's: –1.95±0.28 Co: –0.48±0.34 *X's vs Co: p<0.05* X's: 11.17±2.83 Co: –1.6±2.5 X's vs Co: p≥0.05	9

Table 1. Description of trials evaluating the efficacy of exercise therapy in workers with RC tendinopathy (continued)

Study	Participants	Interventions	Number of participants	Follow-up period	Outcome measures	Main results	Methodological score (0-16)
Therapeutic exercises compared to Surgery							
Haahr, et al., 2005, and 2006	Adults with subacromial impingement syndrome diagnosed with impingement injection test with symptoms between 6 months and 3 years Type of work: not mentionned Mean age: 44.4±7.8 Gender: Male: 26 Female: 58	Conservative treatment with exercises (X's) Supervised by a physiotherapist Arthroscopic subacromial decompression (Su)	43 41	4-8 years	Mean change in self-evaluated working capability (scale 0-10) Mean change between groups: 1. Impaired activity (work and ADL. Scale 0-9) 2. Sick leave index 4 years after treatment (results from ANOVA) 3. Disability pension index 4 years after treatment (results from ANOVA) Number of participants working Mean change in Constant Score (%) at 12 months	X's: 5.0 (3.9-6.1) Su: 5.3 (4.3-6.3) p=0.69 1. 0.2 (95%CI: –1.1 to 1.4) 2. 0.05 (95%CI: –0.04 to 0.16) 3. –0.03 (95%CI: –0.22 to 0.15) X's: 21 (53%) Su: 20 (51%) p=0.88 X's: 23.0 (95%CI 16.9 to 29.1) Su: 18.8 (95%CI 11.5 to 26.1) Inter-group comparison: p=0.38	11
Brox, et al., 1993, and 1999	Adults with pain in the shoulder for at least 3 months, and with positive impingement test Type of work: not mentioned Mean age: 47.6 Gender: Female: 59 Male: 66	Home and supervised by a physiotherapist resistance exercises (X's) Arthroscopic subacromial decompression (Su) Placebo laser 2x/week for 6 weeks (Pl)	50 At 2 yr 1/2: 45 45 At 2 yr 1/2: 39 30 At 2 yr 1/2: 29	6 months	Proportion (%) of participants on shoulder-related absence from work at: 1. Baseline 2. 2 yr 1/2 Mean change in Neer score (%) at: 1. 3 months 2. 6 months	1. X's: 43, Su: 53, Pl: 55 2. X's: 20, Su: 41, Pl: 36 1. X's: 6.5, Su: 20, Pl: 4.5 2. X's: 18.5, Su: 23, Pl: 0.5	8

Table 1. Description of trials evaluating the efficacy of exercise therapy in workers with RC tendinopathy (continued)

Study	Participants	Interventions	Number of participants	Follow-up period	Outcome measures	Main results	Methodological score (0-16)
Therapeutic Exercise compared to Other Interventions							
Engebretsen et al., 2011	Adults with subacromial shoulder pain with positive Kennedy-Hawkins sign Type of work: not mentioned Mean age: 48 Gender: Male: 52 Female: 52	Supervised exercise program: resisted exercise and scapular control (X's) Radial extracorporeal shock-wave therapy (Sw)	52 52	1 year	Proportion of participants at work pre and post intervention SPADI score (%)	X's: 64 and 84% Sw: 52 and 65% OR: 1.1 (95% CI 1.0 to 1.2) Mean change: X's: 24.8 (SD: 19.2), *p<0.001* Sw: 17.2 (SD: 31.4), *p=0.001* Mean change difference between groups: –7.6 (95% CI –16.6 to 0.5) *p=0.093*	12
Szczurko et al., 2009	Adults with rotator cuff tendinitis, diagnosed with positive Neer Impingement test and Speed test Type of work: Postal employees Mean age: 56.8 Gender: Male: 35 Female: 50	Naturopathic care group (acupuncture, Phlogenzym supplement 2 tablets TIE and dietary counseling), 30 min, 1x/week (Na) Physical exercise: supervised passive, active-assisted and active muscle strengtheningwith joint therapy and placebo tablets (Pe)	43 42	12 weeks	Mean change between groups in VAS score (0-7) at 12 weeks Mean change between groups in SPADI score (0-130) at 12 weeks Mean change between groups in the SF-36 items (0-100): 1. Bodily pain 2. Physical functioning 3. Role physical	–1.67 (95%CI –2.47 to –0.88) p=0.0001 in favour of NC group –29.7 (95%CI –42.4 to –17) p<0.0001 in favour of NC group 1. 16.52 (95%CI 7.7 to 25.3) p=0.0004 in favour of NC 2. 13.52 (95%CI 4.91 to 22.13) p=0.0025 in favour of NC 3. 17.34 (95%CI 6.85 to 27.84) p=0.0015 in favor of NC group	12

Table 1. Description of trials evaluating the efficacy of exercise therapy in workers with RC tendinopathy (continued)

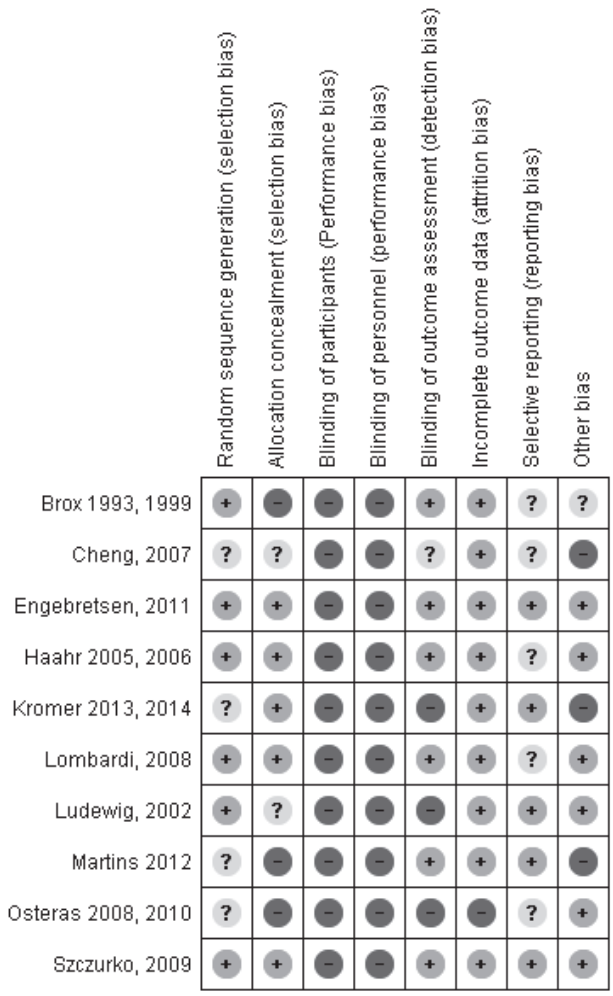
Study	Participants	Interventions	Number of participants	Follow-up period	Outcome measures	Main results	Methodological score (0-16)
Kromer et al., 2013, and 2014	Adults with at least one clinical sign of shoulder impingement syndrome: Neer, Hawkins-Kennedy, painful arc with active abduction or flexion Type of work: not mentioned (86.7% working) Mean age: 51.8 Gender: Male: 44 Female: 46	Home and supervised by a physiotherapist individualizedresistance exercise protocol (X's) Individualized manual physiotherapy and supervised exercise protocol (MT)	44 (38 working) 46 (40 working)	52 weeks	No. of sick days (no. of patients) Mean change in SPADI score (0-100)	X's: 165 (3) MT: 46 (3) p=0.13 X's: 31.5 (16.5) (CI 95% 26.5-36.6) MT: 25.2 (21.5) (CI 95% 18.7-31.7) p=0.38	7
Therapeutic exercise regimens with different modalities							
Martins et al., 2012	Adults with impingement syndrome Type of work: nurse Gender: Male: 2 Female: 14	Stretching and strengthening exercise with proprioceptive drills (X's) Stretching and strengthening exercises (Co)	9 9	6 weeks	Difference in values of the WORC questionnaire after intervention for (Wilcoxon test) 1. Work module 2. Physical symptoms	1. X's: p=0.01 Co: p=0.23 Inter-group comparison: 0.52 2. X's: p=0.01 Co: p=0.03 Inter-group comparison: 0.17	7
Cheng et al., 2007	Workers with rotator cuff tendinitis, diagnose by a questionnaire and physical examination Type of work: medium physical demand level	Clinic-based work hardening training-with work simulation (3x/week) (CH) Work place-based work hardening group (3x/week) (WH)	48 46	4 weeks	Proportion of participants returned to work Mean change in SPADI score	CH: 37.5% WH: 71.7% X^2: 11.1, p=0.001 CH: 13.75±2.93 WH: 20.55±4.92 p inter-group: 0.034	6

Table 1. Description of trials evaluating the efficacy of exercise therapy in workers with RC tendinopathy (continued)

Study	Participants	Interventions	Number of participants	Follow-up period	Outcome measures	Main results	Methodological score (0-16)
Osteras et al., 2008, and 2010	Adults with unilateral primary shoulder impingement syndrome with symptoms ≥3 months Type of work: not mentioned Mean age: 43.9 Gender: Male: 36 Female: 25	High dosage supervised exercise program) (Hd) Low dosage supervised exercise program (Ld)	31 30	6 months	Difference between sick leave: At inclusion and after treatment Mean change in pain assessed with a 10 cm VAS Mean change in function score assessed with SRQ (17-90)	Hd: 33.4% and 8.4% (–25%) Ld: 44.4% and 22.0% (–22.4%) Hd: –4.3 (95%CI –3.7 to –5.0) Ld: –1.8 (95%CI –0.7 to –2.7) Inter-group comparison: p=0.01 Hd: 29.2 (95%CI 21.7 to 36.0) Ld: 7.3 (95%CI 0.2 to 19.7) Inter-group comparison: p=0.01	4

SRQ: Shoulder Rating Questionnaire (A higher score indicates a better status)
SPADI: Shoulder Pain and Disability Index
VAS: Visual Analogue Scale (0-10)
DASH: Disability of Arm and Shoulder Questionnaire (0-100)
95%CI: 95% Confidence Interval
ANOVA: Analysis of Variance
OR: Odd Ratio
TIE: Three times a day
SF-36: Short Form 36
WORC: Western Ontario Rotator Cuff Index
ADL: Activity of Daily Living

Table 2. Risk of bias of included studies



We planned to pool results from multiple studies to perform a meta-analysis, but the only two studies that compared exercises to a placebo[25,26] and exercises to subacromial decompression[17,18,21,22] did not use the same outcome measures, thus rending any pooling of results meaningless.

Methodological quality of included studies

The ICC reflecting reviewers' agreement on the evaluation of risk of bias of included studies for overall methodological score was 0.91 (95% CI: 0.67 to 0.98). Preconsensus inter-rater agreement for each item of the risk of bias scale ranged from moderate to perfect agreement (κ=0.44 to 1.0). Mean score for the methodological quality of the included studies was 54.4% ± 17.2, an overall indicator of low to moderate methodological quality of the included studies (Table 2)[20,30]. The two RCTs with the highest methodological quality received a score of 75%[20,30]. As shown in Table 2, all studies lacked some relevant information on the appraised methodological criteria, particularly on blinding of participants and providers[17-30]. However, blinding of outcome assessors was adequately reported in six studies[17,18,20-22,25,27,30]. All but four studies reported their allocation sequence generation[19,23,24,27-29], and only five studies reported the procedure for allocation concealment[20-25,30]. Selective outcome reporting was rated as "unclear" in five studies and was attributed to the fact that authors did not initially publish their protocol[17-19,21,22,25,28,29]. Two studies had an "unclear" other risk of bias (did not monitor compliance to intervention)[17-19], and two had a high risk of bias (one because severity of symptoms was more important in one group at inclusion[23,24], and one because the authors did not calculate the required sample size for adequate statistical power)[27].

Four out of nine studies described in detail their exercise program[20,23,25,26], and three RCTs referred to previously published exercise protocols[17,18,27,30]. The active treatment period differed across studies, from eight to twelve weeks, and in two studies, participants were encouraged to pursue the program for a longer time[21-24]. Lengths of follow-up were heterogeneous across studies, with five RCTs that followed participants for eight to twelve weeks[19,25-27,30] while the other five studies had a longer follow-up, ranging from 6 months to 8 years[17,18,20-24,28,29]. In terms of work outcomes, studies were very heterogeneous. Four studies reported the percentage of patients that returned to work[17-20,28,29], one study reported the number of sick days[23,24], and three studies reported work function with different scales[21,22,25,26]. Two studies did not report on any specific work outcomes, but the study population included postal employees[30] and nurses[27].

Efficacy of therapeutic exercises compared to a placebo or to no intervention

Two RCTs (n=127) of moderate methodological quality compared an exercise regimen to no intervention[25,26], and one RCT (n=125) of moderate methodological quality compared therapeutic exercises to a placebo laser intervention[17,18]. In the study by Ludewig et al., participants were adults working as construction journeymen with at least 30% of their work tasks performed in overhead positions[26]. The exercise program aimed at restoring scapular control and was performed by the participants three times per week for ten weeks. Physiotherapists supervised two sessions with the participants, and the remaining time, the exercise program was performed at home. The control group received no intervention. In this study, the exercise group was found to be superior to the control group in terms of work-related disability (1-10 scale) for post-intervention scores ($p<0.05$), with a mean of 2.5 ± 0.29 for the exercise group and of 3.7 ± 0.29 for the control group after ten weeks[26]. In terms of work-related pain (1-10 scale), a statistically significant difference for post-intervention score was observed ($p<0.05$), with a mean of 2.8 ± 0.29 for the exercise group compared to a mean of

4.1 ± 0.29 for the control group[26].

In the study by Lombardi et al., participants (exact work not specified) were involved in a repetitive maximum exercise regimen using a multi-pulley system with maximum bearable weight for four shoulder movements; the program duration was eight weeks[25]. The control group received no intervention, but both experimental and control groups were asked to take acetaminophen when experiencing pain. The authors used the *Disabilities of the Arm, Shoulder and Hand* (DASH) questionnaire to assess the work-related disability and general pain and function. In terms of work disability, the exercise group showed statistically significant improvement compared to the control group for inter-group comparison (p=0.001)[25].

In the study by Brox et al., one group performed therapeutic exercises using a suspended sling for 1 h daily for three to 6 months in addition to ergonomic advice (anatomic and function learning) and was compared to a placebo group (detuned laser treatment)[17,18]. The type of work of the participants was not mentioned, but 48% of the participants were working with the hand above shoulder level, and, at baseline, 77% of them reported shoulder pain while working. A greater reduction in the proportion of participants reporting shoulder-related absence from work was observed in the therapeutic exercise group (−23%) than in the placebo group (−19%). However, no statistical testing was reported for this outcome[17,18].

Efficacy of therapeutic exercise vs. surgery

Two RCTs compared subacromial surgical decompression to therapeutic exercises with a follow-up of 2.5 years in one study (n=125)[17] and of 4 to 8 years in the other study (n=84)[21]. The study by Haahr et al., of moderate methodological quality, included 84 subjects of whom 73% were on sick leave because of shoulder pain, and 70% previously had a potentially strenuous job, but the exact type of work was not reported. An exercise program aimed at recruiting periscapular muscles and strengthening the stabilizing muscles of the shoulder joint was supervised for 19 sessions and continued at home two to three times per week afterwards. No significant differences were found between groups in terms of sick leave associated with financial compensation (p<0.05) in the 4 years following treatment. At the end of follow-up, 53% of participants in the exercise group were working, and 51% of participants in the surgery group were working (p=0.88)[21]. Inter-group comparison did not reach statistical significance in terms of function assessed with the Constant-Murley Score (%) at 3, 6, and 12 months (p=0.27, p=0.76, and p=0.38, respectively)[22]. In the longer timespan (four to eight years), more workers felt recovered or improved in the therapeutic exercises group (67.5%) than in the surgery group (60%)[21].

In the study by Brox et al., a greater decrease in the proportion of participants with shoulder-related absence from work was observed at 2.5 years in the exercise group, with a mean decrease of 23%, whereas in the surgery group, the mean decrease was 12%[17]. However, no statistical testing was reported[18].

Different therapeutic exercise programs

One study of low methodological quality by Osteras et al. (n=61 workers; type of work not reported) compared two different exercise regimens of twelve weeks duration with a follow-up of 6 months[28,29]. The exercise program was not only aimed at strengthening the shoulder but also at improving general health condition. The main differences between the two exercise regimens were time on bike, number of weight resisted exercises, and number of repetitions. The high-dosage group performed eight exercises (three sets of thirty repetitions), and the low-dosage group performed five exercises (two sets of ten repetitions)[28,29]. At 6 months, inter-group comparison also showed a statistically significant difference (p<0.05) in favor of the high-dosage exercise group for mean reduction of 59.1% in the costs of sick leave compared to the low-dosage exercise group with a reduction of 42.3%. The mean difference of sick leave duration between the groups was 4.1 days per month, with the low-dosage group accounting for the longer sick leave periods[28].

Mean change in pain (1-10 VAS) was statistically significant (p<0.05) at 6 months for between-group comparison, with a change of −4.3 cm (95% CI: −3.7 to −5.0) for the high-dosage group and −1.8 cm (95% CI: −0.7 to −2.7) for the low-dosage group[29]. This difference between groups of 2.5 cm ± 0.2 may be considered clinically important since it is over the minimal clinically important change on a VAS of 1.4 cm[31]. Authors also reported a significant difference (p<0.05) in the Shoulder Rating Questionnaire (SRQ) scores (range 17-90) at 6 months, with a mean improvement of 29.2 (95% CI: 21.7 to 36.0) for the high-dosage group and 7.3 (95% CI: 0.2 to 19.7) for the low-dosage group[29]. Again, the difference between groups is over the minimal clinically important change of 12 points for the SRQ[32].

A study of low methodological quality by Cheng et al. compared a clinic-based intervention (n=48) to a workplace-based intervention (n=46) on workers performing various tasks of moderate physical demands[19]. Both groups received an exercise program including shoulder stretches and strengthening as well as scapular control exercises. The clinic-based group received work simulation in a clinical setting while the workplace-based group had a job coach assigned and received biomechanics and ergonomic education. At four weeks, a significantly higher percentage of workers returned to work in the work-based group (71.7%) than in the clinic-based group (37.5%), p=0.001[19]. The *Shoulder Pain and Disability Index* (SPADI; range 0-100) reached statistical significance for inter-group comparison (p=0.03) in favor of the workplace-based group. However, the difference between groups may not be considered clinically impor-

tant[33].

The study by Martins et al.[27], of low methodological quality, compared two different rehabilitation programs on a sample of nurses (n=18). The program was composed of stretching and strengthening exercises, with a progressive increase in resistance at every three sessions followed by ice application. In the experimental group, proprioceptive exercises, such as joint position, rhythmic stabilization, and repositioning of arm exercises as well as use of unstable base, proprioceptive neuromuscular facilitation and speed and accuracy exercises were added to the program performed by the control group. There was a significant reduction in pain for both groups ($p<0.01$), but no significant difference was found between groups ($p \geq 0.05$). In terms of change in function assessed by the Western Ontario Rotator Cuff Index (WORC), only the experimental group achieved statistically significant improvement in every domain of the questionnaire, including work domain (p=0.01). However, no statistical difference was found for inter-group comparison ($p>0.05$)[27].

Efficacy of therapeutic exercise vs. Radial Extracorporeal-Shock Wave Therapy (ECSWT)

A study of moderate methodological quality by Engebretsen et al. compared a supervised exercise regimen to ECSWT on a sample of workers, but the type of work was not mentioned. At inclusion, 45% were on sick leave[20]. The exercise program was provided twice weekly for 45 minutes for a maximum of 12 weeks and was mainly aimed at regaining scapular motor control. The proportion of participants who returned to work in the exercise group reached 20% while the proportion was 13% in the ECSWT group (OR: 1.1; 95% CI: 1.0 to 1.2)[20]. In terms of pain (10-point scale), none of the groups showed statistically significant differences, with a mean difference between groups of −0.4 (95% CI: −0.7 to 0.3) for pain at rest and a mean difference of −0.4 (95% CI: −1.4 to 0.4) for pain during activity[20]. The SPADI score revealed statistically significant improvement for pre-post treatment comparison in both groups ($p<0.001$ for the exercise group and p=0.001 for the ECSWT group). However, no statistically significant difference was observed in inter-group comparison (mean change of −7.6% [95% CI: −16.6 to 0.5]).

Therapeutic exercises vs. naturopathic treatment

A study of moderate methodological quality by Szczurko et al. in 85 postal employees compared the efficacy of therapeutic exercises, including isometric strength and endurance exercises as well as passive, active-assisted, and active joint therapy, with the addition of placebo tablets to a combination of naturopathic treatment that included acupuncture, Phlogenzym supplements, and dietary counseling for 12 weeks[30]. Pain assessment at week 12 using an 8-point VAS scale revealed a statistically significant mean difference between groups in favor of the naturopathic treatments (−1.7; 95% CI: −2.5 to −0.88). The authors also reported the SPADI score (range: 0-100), with a mean difference between groups of −29.7 (95% CI: - 42.4 to −17), which is clinically important[33], again in favor of the naturopathic treatment group. No work-related outcomes were assessed in this study.

Manual therapy and therapeutic exercise vs. therapeutic exercise alone

A study of low methodological quality by Kromer et al.[23,24] compared the efficacy of therapeutic exercises alone to a combination of therapeutic exercises and manual therapy on 90 patients from which 78 were currently working (type of work not reported). Participants to the manual therapy group received two treatments a week for five weeks. The treatments consisted of manual mobilizations of the shoulder, cervical spine, and thoracic spine. The manual therapy group as well as the exercise only group received supervised sessions of stretching and strengthening exercises for the shoulder joint, and for the cervical spine, two times per week. They also had to do two to five training sessions per week at home. There was no statistically significant difference between groups in terms of days of sick leave (p=0.13), but both groups improved significantly in terms of function measured with the SPADI at 1 year; however, no significant differences were found between groups, with a change of 25.2% (95% CI: 18.7-31.7) for the group receiving manual therapy and exercise and a change of 31.5% (95% CI: 26.5-36.6) for the exercise group.

Discussion

The aim of this review was to evaluate the current scientific literature with respect to the efficacy of therapeutic exercises in workers suffering from RC tendinopathy. Ten studies were included, and the mean methodological quality of trials was low to moderate with an average quality score of 54.4% ± 17.2. All studies lacked some information on blinding of participants and providers, which is understandable considering the nature of the interventions. The heterogeneity in terms of work-related outcome measures and follow-up periods was too important to perform a meta-analysis. Moreover, the majority of studies did not report the types of workers, the work environment, or work demands. Despite these limitations, we are able to draw some conclusions on the currently available evidence as to the efficacy of exercises for workers suffering from RC tendinopathy.

Previous reviews have shown moderate evidence that exercise therapy is an effective modality to treat RC tendinopathy in general adults[11-14,34,35]. However, there was a lack of evidence on the effectiveness of exercises for specific populations of workers. It is often believed that the rehabilitation of worker populations is more difficult and the outcomes could be poorer, at least for certain workers.

Based on three studies of moderate methodological quality, we conclude that there is moderate evidence that an exercise regimen in workers suffering from RC tendinopathy is an effective modality in terms of pain reduction, improvement in work-ability, and potential improvement for return-to-work when compared to a control intervention or to a placebo[17,18,25,26]. A statistically significant and clinically important improvement in the work module of the DASH score was shown in the study by Lombardi et al. In the study by Ludewig et al., participants in the exercise group had significantly better outcomes in terms of work-related pain and work-related disability after intervention. Interestingly, in this study, the exercise program was performed at home. In the study by Brox et al., although no statistical testing was performed, more participants returned to work in the exercise group (23%) than in the placebo laser group (19%). These results are consistent with the results of the systematic review by Kuhn et al. that concluded that exercise is effective for the reduction of pain and function in general adults and that home exercise programs may be as effective as supervised exercises[11].

When exercise therapy is compared to surgery, there is low to moderate evidence that both interventions are equally effective in workers in terms of pain relief, function, and return-to-work, and this conclusion is supported by two RCTs. In the study by Haahr et al., 53% of the subjects in the exercise group were working compared to 51% in the surgery group at 4-8 years follow-up. However, there was a greater decrease in the proportion of participants with shoulder-related absences from work in the exercise group (23%) than in the surgery group (12%) in the study by Brox et al.[17,18], while none of the treatments showed a clear superiority in terms of pain and function. Regarding the costs of interventions, therapeutic exercises presented lower average costs, which were nearly half the surgical costs. Based on the results of these two RCTs, we can conclude that exercise could be recommended as a modality for workers suffering from RC tendinopathy prior to the surgical option for reduction in pain and improvement in function as well as for return-to-work. These recommendations are consistent with those of another systematic review on the efficacy of surgery for RC tendinopathy in adults, which concluded that there is no significant difference between exercise therapy and surgery as a treatment for adults suffering from a RC tendinopathy[40].

Based on the studies included in this systematic review, we could not conclude on the optimal exercise program to treat workers suffering from RC tendinopathy. Moreover, the type of exercises in relation to a worker's environment or his or her work demands that is required to promote return-to-work is still unknown. In terms of intensity, the results from one study of low methodological quality showed that the exercise regimen with the higher dosage provided greater pain relief than the lower dosage exercise program, and there was a more important reduction in cost of sick leave in workers for the high-dosage exercise program (59.1%) than the low-dosage exercise regimen (42.3%). However, in terms of function, none of the groups showed statistically significant differences for inter-group comparisons[28,29]. In terms of types of exercises, adding proprioceptive exercises to the exercise program did not result in any added benefit compared to range-of-motion and strengthening exercises, according to one study of low methodological quality that included nurses[27].

At the moment, there is no consensus on the optimal exercise treatment program for adults suffering from RC tendinopathy. Recent systematic reviews recommend that exercises should focus on strengthening the RC muscle and the scapular stabilizing muscles[13,35].

In terms of treatment setting, one study of low methodological quality compared clinic-based interventions to workplace-based interventions[19]. There was a statistically significant change in favor of the workplace-based intervention for the SPADI score, but this difference was below the minimal clinically important difference[33]. However, significantly more participants returned to work in the workplace-based intervention (71.7%) than in the clinic-based intervention (37.5%).

Based on the results of the current systematic review, we can conclude that there is clearly a need for RCTs of higher methodological quality regarding the optimal nature, intensity, and environment of exercise therapy programs for RC tendinopathy to draw firm conclusions on the benefit of a multimodal workplace-based intervention. The evidence concerning the best approach for workers in terms of type and intensity of exercises, as well as the environment in which they are provided, either in the work place, in a clinical setting, or at home, remains scarce[36]. This is an area of great interest as many worker programs focus on comprehensive rehabilitation programs that not only include clinical exercises but also work-related functional exercises and psychosocial intervention to address potential work-related stress factors[37-39]. It thus remains unclear what kind of intervention is the most effective and cost-effective for workers with RC tendinopathy and if different populations of workers need different approaches.

Three RCTs of low methodological quality compared therapeutic exercises to other interventions. When comparing supervised exercise therapy with radial extracorporeal shock-wave therapy (ECSWT), one RCT of moderate quality concluded that more participants in the exercise group returned to work (20.4%) than in the ECSWT group (13%), but these results were not statistically significant[20]. One study of moderate methodological quality was conducted on postal employees and concluded that participants in both groups were improved in terms of

pain and function, but there was a greater improvement in the naturopathic treatment group. However, the exercise program in this study consisted of active, active-assisted, and passive ROM exercises as well as isometric endurance and strength training exercises initially developed to treat patients with cervicobrachialgia, which could not be adequate to treat efficiently patients with RC tendinopathy[41,42]. Also, no outcomes in this study were specific to work[30]. Another study evaluated the benefit of adding manual therapy to an exercise program[23,24]. Both groups improved significantly, but there were no statistical differences between groups in the SPADI scores or in terms of days and costs of sick leave. Of note, a recent systematic review concluded that manual therapy, when added to an exercise program, could be beneficial in terms of pain and function in the management of adults suffering from RC tendinopathy[43]. There is, therefore, a need for further studies on the benefit of adding manual therapy to an exercise program in the treatment of workers suffering from RC tendinopathy.

In our review, only seven studies used specific work-related outcomes. Work-related outcomes are often understudied even though authors have stressed that, for workers, these work-related outcomes can differ from pain and function outcomes in the general population[39]. Future studies will need to systematically assess work-related outcomes and health care costs.

Strengths and limitations of the review

A complete literature search was performed by the authors using four databases. Inclusion criteria were specific to ensure that a majority of participants suffered from RC tendinopathy. RCT was the only research design included in the present review, which is the highest form of evidence for clinical trials. The inter-rater agreement was good to excellent for all the items of the risk of bias assessment tool.

Our study has some limitations that arise from the RCTs included in the review, which had small sample sizes and moderate to high risk of bias. Also, because of the heterogeneity of the results, we could not conduct meta-analyses. Some of the studies presented data about the return-to-work rate of workers, but the information was not available in all the trials. Moreover, the authors used non-validated and heterogeneous return-to-work outcomes.

Conclusions

Low to moderate-grade evidence exists that therapeutic exercises provided in a clinical setting are an effective modality to treat workers suffering from RC tendinopathy in terms of pain reduction, improvement in function, and return-to-work. Since exercise therapy is a simple and cost-effective approach to treat RC tendinopathy that seems to favor return-to-work, it should be considered first. However, the optimal intensity and context in which the therapeutic exercise program is provided remain unclear, as does whether other interventions would be useful. Further studies are needed, particularly trials that assess multimodal rehabilitation treatments with specific populations of workers and work-related outcomes to draw firm conclusions on the optimal exercise program to treat workers.

Type of contribution

FD participated in the design, coordination, led the interpretation of results and writing of the manuscript. JB performed the collection of data, statistical analyses, interpretation of results and drafted the manuscript. CED participated in the design, interpretation of results and writing of the manuscript. PF participated in the design, interpretation of results and writing of the manuscript. VL participated in the collection of data, statistical analyses, interpretation of results and drafted the manuscript. JCM participated in the design, interpretation of results and writing of the manuscript. JSR participated in the design, interpretation of results and writing of the manuscript. All authors read and approved the final version of the paper.

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