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Exploring The Efficacy of Self-Directed Active Exercise Program in Patients with Adhesive Capsulitis: A Systematic Scoping Review

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Abstract
Introduction: *Adhesive capsulitis (AC) is a common debilitating condition identified with painful reduction in range of motion of shoulder joint and functionality. Though its self-limiting nature, the recovery time is long and painful. This review has been aimed to throw light on efficacy of various active exercise programs used for management of AC.*
Methodology: *Articles were searched from Jan 2003 till Jan 2024 through electronic search engines such as PubMed, Google Scholar, PEDro, Scopus, and Science Direct using key words like Adhesive Capsulitis or frozen shoulder or stiff shoulder or painful shoulder or shoulder pain and active exercises or home exercise program or therapy or treatment. Randomized control trials (RCT) published in English language were included in the review. Studies were excluded if they had shoulder pain post mastectomy, rotator cuff disorders, forward head posture, post stroke, tendinopathy and if treatment was given digitally or AI assisted or pharmacologically. Quality of assessment of each study was done using Cochrane risk of bias tool 2 (RoB 2) for RCTs. Prisma Guidelines were followed to report the review.*
Results: *A total of 512 studies were identified out of which 10 RCTs were included for present review. 502 studies were excluded after duplicates and abstract/title screening. 634 participants with mean age 52.08 years (age range 22-90 years) were recruited in the studies reviewed. Low to moderate risk of bias was found for the studies evaluated in the present review. Home-based exercise alone as well as active self-managed exercise showed equal positive clinical improvement in reducing the pain intensity, increasing range of motion and functionality of the individuals.*
Conclusion: *Home-based or active exercises showed positive clinical improvements with no superior treatment. This highlights the substantial research gap in terms of high quality RCTs evaluating long term effects or follow ups of self-management exercise interventions in patients with adhesive capsulitis.*
Keywords: *Active exercises Adhesive Capsulitis, Exercise, Review, Shoulder Pain*

INTRODUCTION:

Adhesive capsulitis (AC) is a progressive thickening of the shoulder joint capsule which is accompanied by pain and gradual and progressive loss of Active and Passive range of motion (ROM) [1,2]. The prevalence of AC is estimated to be more in individuals with diabetes, with 10-76% in insulin-dependent diabetes mellitus (IDDM) and 7-30% in non-insulin-dependent diabetes mellitus (NIDDM) compared to 0-10% in other populations. Further, uncontrolled diabetes is shown to have worse shoulder pain. Women tend to suffer more from AC and people in their 4^{th} to 6^{th} decade of life are generally the most affected [3,4,5]. AC can be primary, for which the cause can be idiopathic or secondary after some pathology/injury. Common risk factors for AC include DM, thyroid dysfunction, cardiac conditions, obesity, Dupuytren's contracture, etc [6,7,8]. The pathophysiology of AC can be attributed to the fibrosis around the glenohumeral joint due to the cascading of fibroblastic activity post-inflammation. The fibroblasts, which are activated phenotypically due to inflammatory cytokine dysregulation, are also thought to be involved in enhancing this fibrotic process[9]. Despite the above-stated risk factors, the presence of AC in the shoulder in diabetic individuals is 11-30% as compared to 2-10% in non-diabetics. Duration and control of diabetes is also one of the common factors associated with AC. Common complaints experienced by individuals with AC include the inability to reach out to the side, overhead, behind the head, and not being able to take a hand behind the back. They have problems with basic activities of daily living like clothing, cooking, combing, cleaning etc. and doing repetitive work for long hours. They often complain about their inability to sleep due to pain at night. The general population

affected by AC is around 2% which is about 11% in persons with diabetes [10]. Zreik et al., (2016) in their meta-analysis estimated the prevalence of DM in people with AC to be 30% to that of 13.4% of people having AC in DM [11]. Various treatments are available for AC, ranging from pharmacological and surgical to physio therapeutic [12,13,14]. The physiotherapy treatments include passive as well as active treatments. Passive treatments may include electrotherapy modalities like TENS, hot packs, Laser, etc., or various mobilization techniques such as Maitland, MWMs, MET, etc. Passive treatments are effective, but the ones that make patients more dependent on therapists are not. Active treatment includes patients doing active shoulder movements guided by the treating therapist. This review tends to find out the efficacy of self-directed exercises or active exercises in people suffering from AC.

METHOD:

Search Strategy

Articles were searched from Jan 2003 till Jan 2024 through electronic search engines such as PubMed, Google Scholar, PEDro, Scopus, and Science Direct using keywords like "Adhesive Capsulitis" or "Frozen Shoulder" or "Stiff Shoulder" or "Painful Shoulder" or "Shoulder Pain" and "Active exercises" or "Self-management" or "Home exercise program" or "Therapy" or "Treatment". Randomized control trials (RCT) printed in the English language were included in the review. Prisma Guidelines were followed to report the findings in the review.

Data Extraction:

This review was done to explore the effect of active exercises on AC, so all the studies on the treatment of AC were aggregated. Participants were included in the review if they had symptoms of shoulder pain with restricted range of motion and the pain was idiopathic in nature. Some studies comparing active and passive treatments were also included to see the comparative effect of active exercises. Studies were excluded if they had shoulder pain post-mastectomy, rotator cuff disorders, forward head posture, post-stroke, tendinopathy, and if treatment was given digitally or AI-assisted or with only the help of passive mobilization or manipulation or pharmacological or surgical interventions. Some studies that compared only passive treatments were also excluded.

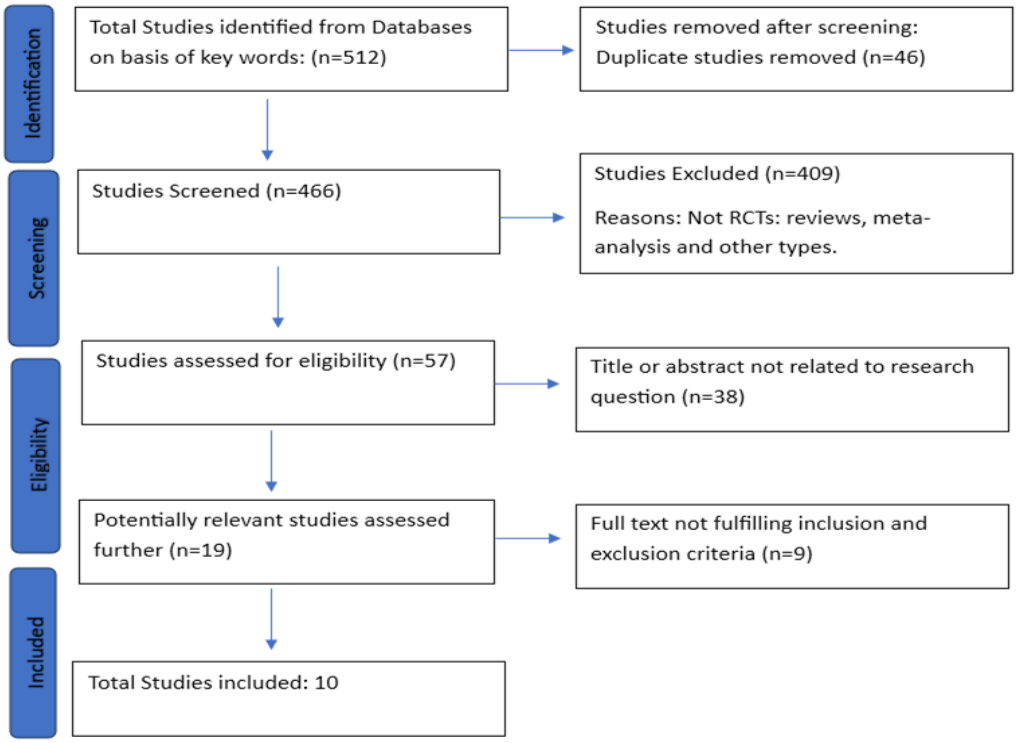

Fig. 1. Consort Diagram for Study Selection[15]

The search strategy was implemented on the selected references and data was extracted from different databases. The titles and abstracts were reviewed independently, removing duplicates or irrelevant articles. The full texts were also retrieved for additional evaluation. Quality of assessment of each study was done using Cochrane risk of bias tool 2 (RoB 2) [16,17] for RCTs.

RESULTS

The flowchart and the search strategy are provided in Figure 1. Ten studies were eligible for inclusion from 2003 to 2024 and were RCT for which the quality assessment was done using Cochrane risk of bias tool 2 (RoB 2). (Fig. 2)

	Randomization process	Deviations from intended interventions	Mising outcome data	Measurement of the outcome	Selection of the reported result	Overall Bias
Assignment to intervention (the 'intention-to-treat' effect)						
Total number of study = 9						
Low risk	66.7	66.7	100	77.8	55.6	33.3
Some concerns	33.3	22.2	0	11.1	44.4	55.6
High risk	0	11.1	0	11.1	0	11.1
Adhering to intervention (the 'per-protocol' effect)						
Total number of study = 1						
Low risk	100	100	100	100	0	0
Some concerns	0	0	0	0	100	100
High risk	0	0	0	0	0	0

Fig. 2. Cochrane risk of bias tool 2 (RoB 2) analysis.

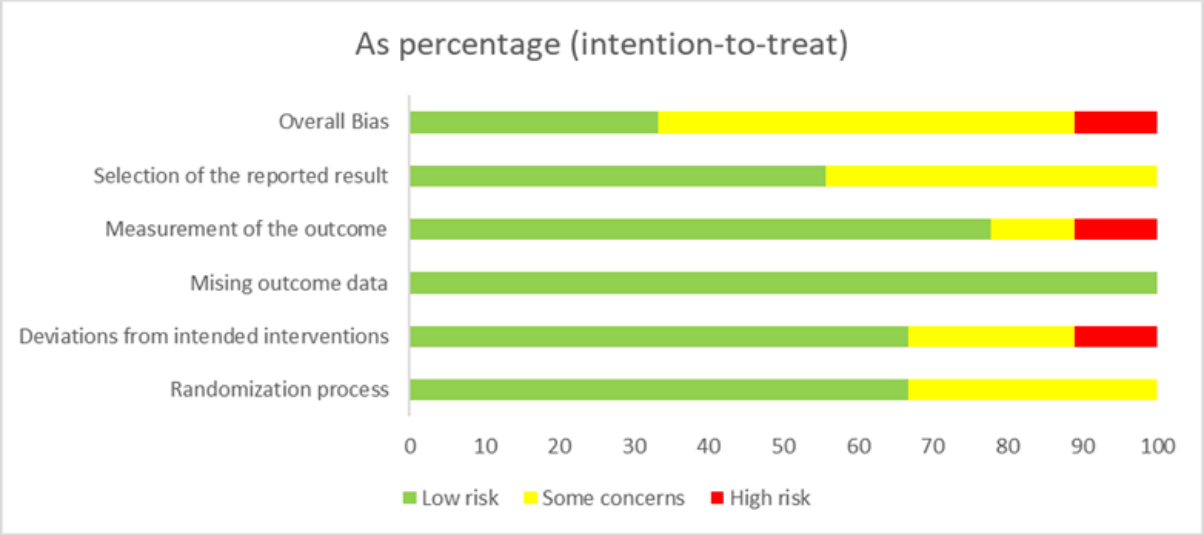

Fig. 3a. Pictorial representation of overall bias analysis for intention to treat studies

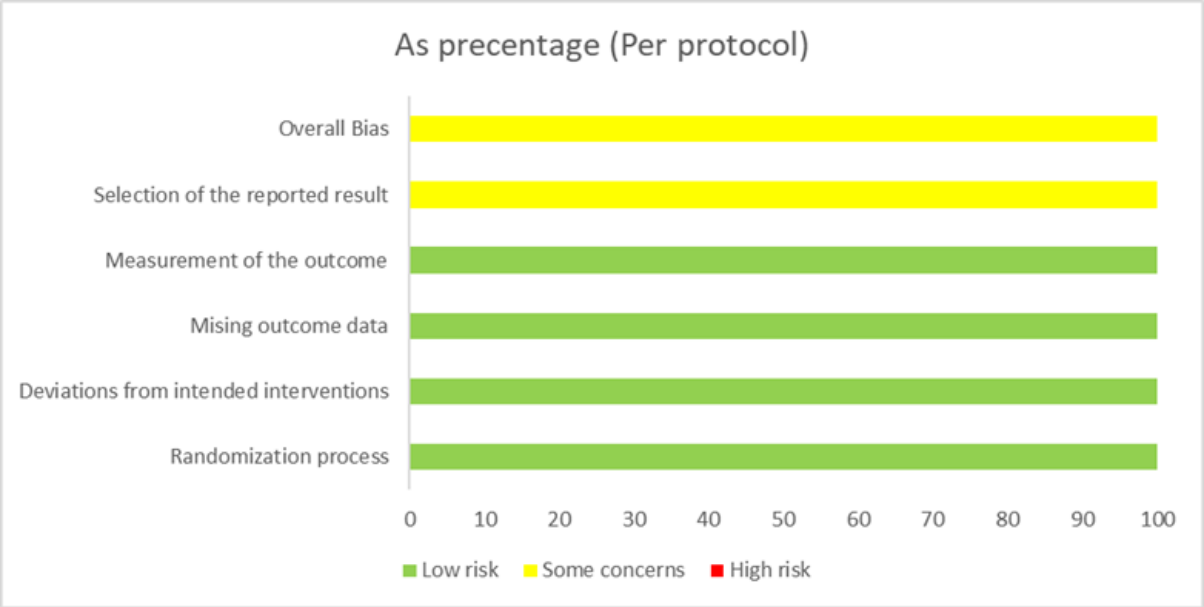

Fig. 3b. Pictorial representation of overall bias analysis for per protocol studies

All the studies had active exercises as one of their groups which was given for shoulder pain. Primary AC was only considered for inclusion and secondary AC due to any other injury or trauma or any other specific pathology or surgery were excluded as stated above. A total number of 634 participants with a mean age of 52.08 years (age ranging from 22-90 years) were recruited in the studies reviewed. Interventions given were mechanical diagnosis and treatment (MDT), an active home-based program, a neuromuscular training program, and multimodal physiotherapy with home exercises.

Three studies gave mechanical diagnosis and treatment (MDT) [18, 22, 26] for assessment of the shoulder to classify them into various classifications of derangement, dysfunction, and spinal and gave them matched treatment according to their directional preference. Two studies had an active home-based program[21, 25], four had a neuromuscular training program [19, 20, 23, 27] and one consisted of multimodal physiotherapy with home exercises [24].

All studies gave active movements as part of their treatment which were to be performed supervised or at home. Only three of them conducted follow-ups to see the prolonged effect of the treatment given. Outcome measures assessed were pain, range of motion of shoulder and scapula, functionality, and disability status of the shoulder. Assessment of disability or functionality was assessed through the upper extremity functional index (UEFI), Shoulder Rating Questionnaire (SRQ), SPADI, Penn Shoulder Score, Constant-Murley Score, Oxford Shoulder Scale, and Simple Shoulder Test. One of the studies assessed Quality of life by using SF-36 as an outcome measure. Ginn et al. used isometric abduction force assessed with the help of a hand-held dynamometer as an outcome measure[19]. Capsular Thickness assessed through MRI has also been used as an outcome measure by Lin et. al 2022 [20].

Pain

Pain was taken as an outcome measure in 6 studies which was assessed by Visual Analog scale (VAS) in 4 studies and by Numerical Pain Rating Scale (NPRS) in 2 studies. Other studies assessed pain as a part of various questionnaires assessed to use functionality which are discussed further. Ginn and Cohen [19] showed that pain was reduced equally in all three groups of exercise, injection, and MPM. Lin et al.[20] compared PNF exercises to Manual Therapy and discovered that pain was significantly reduced in the PNF group (p=0.007). Shriwatri et al.[22] reported that pain reduction was significant and reduced equally for both the groups when comparing conventional exercises with that of Mckenzie exercises (between group analysis p value = 0.261). Wang et.al [27] found out that neuromuscular training along with regular physical therapy is superior to that of strengthening exercises with regular physical therapy. Abady et. al.[18] used MDT as a choice of assessment and treatment for shoulder pain. They classified shoulder pain into derangement, articular dysfunction and contractile dysfunction and reported that pain was significantly reduced for the derangement group in 4 weeks as compared to the dysfunction group. They also reported that scores were affected significantly by the time factor of time [F (1.6–126.1) = 239.63, p < 0.001]; the effect of time varied among the MDT classifications. Metgud et. al.[26]showed that the post-intervention score for NPRS is highly significant. The percentage of change is 29.29% (p-value 0.0001) after treatment with MDT.

Range of Motion

8 out of 10 studies assessed range of motion as one of the outcome measures. Ginn & Cohen[19] reported that the improvement in all the ranges measured was similar in all three groups over time whether it be the exercise group or MPM group or injection group, except for isometric abduction force in which effect of time X treatment had a statistically significant effect (p = 0.04, F (sub x treat) 2,199 = 3.39). The rest of all [20-24,26,27] those measured ROM as their outcome measure suggested that any kind of self-directed active exercises are superior to regaining range of motion than any other passive treatment like injection or mobilization alone. Along with shoulder ROM, Mohamed et.al [23] assessed scapular upward rotation as an outcome measure and quoted it to be significant at the 2nd and 6th month when treated with active exercise (p=0.02 at 2 weeks, p<0.01 at 2 months, p=0.02 at 6 months).

Functionality

The shoulder Questionnaire was used in 4 studies to measure functionality. Abady et. al. [18] used UEFI and showed that upper extremity function improved significantly in all three groups individually, but when the between-group analysis was performed then, it showed a significant difference in derangement and spinal vs dysfunction group (DER vs. DYS: p=0.001 at 2 weeks, p=0.01 at 4 weeks, DER vs. Spinal: NS at 2 weeks, NS at 4 week, DYS vs. Spinal: p=0.001 at 2 week, p=0.007 at 4 week). SRQ was used by Ludwig et al. [25], and they found that the scores were non-significant when comparing the intervention

group to that of the symptomatic control group but significant in the case of the asymptomatic group. Metgud [26] found the rating on Penn shoulder score to be significant when comparing pre- to post-intervention given by MDT (p=0.0001). Russell et al. [24] used the Constant-Murley Score (CMS) and Oxford Shoulder Scale (OSS) to measure the functional ability of the shoulder joint. They stated that when comparing circuit training to a home exercise program or multimodal PT, the above-stated scores were statistically significant (Table 1).Simple shoulder test (SST) and American Shoulder and Elbow Surgeons shoulder assessment form (ASES) scores for pain and function scores used by Teytelbaum et. al.[21] showed the scores significant at 6 months for between-group analysis of HIS device vs Physiotherapy Group (SST score: significant at 6 months (p=0.045) & ASES Total: significant at 6 months (p=0.048))

Disability

Disability-related to the shoulder was measured by SPADI. SPADI is a valid and reliable outcome measure as related to AC [28]. Ludwig et. al.,[25] Shriwatri et. al.[22] and Mohamed et. al.[23] used SPADI as one of their outcome measures. Ludwig et al.[25] reported that work-related pain and disability were reduced significantly in the intervention group than in symptomatic or asymptomatic control groups. Shriwatri et. al. [22] found out that in Mckenzie group the disability reduction was statistically more significant when compared to control group ($p<0.001$) and Mohamed et. al. reported that improvement in disability started at 2 months and was maintained at 6 months when performing self-directed exercises (p=0.02 at 2 weeks, $p<0.01$ at 2 months, $p<0.01$ at 6 months).

Change in Thickness of capsule in axillary recess and coracohumeral ligament

Lin et al.[20] took the thickness of the capsule in axillary recess and coracohumeral ligament as their primary outcome measure and stated that PNF exercises significantly reduced thickness (CHL Thickness: p=0.021, CAR Thickness: p=0.013) as compared to joint mobilization as in their control group.

DISCUSSION

This study showed that treatments ranging from active home-based programs, neuromuscular training programs, mechanical diagnosis and therapy to multimodal physiotherapy with home exercises all have significant effects on pain, ROM, disability, and functionality of shoulder joints in various capacities.6 out of 10 studies[18-20,22,26,27] assessed pain relief as their outcome measure. 8 studies [19-24,26, 27] assessed the effect on the range of motion of the shoulder. Till date the pathophysiology behind AC remains unclear. Immunocytochemical and histological studies have shown that conversion to myofibroblast from fibroblasts accompanied by proliferation of active fibroblast. Structural changes, i.e. fibrosis and inflammation have also been confirmed in cases of AC. These structural changes can lead to adhesions within and around the joint capsule. Pain relief and increase in range of motion have been the primary focus of treatments given for the condition. The improvement in pain and the restoration of range of motion can be attributed to loosening of the adhesions around the capsule and increase in the joint cavity volume [20]. Aina and May [29] stated that repeated active movements with or without pain as utilized in MDT have been associated with stimulation of mechanoreceptors and hence reduce the pain. This also helps in movement of synovial fluid around joint capsule which may lead to decrease in inflammation and hence reducing pain [30].Neuromuscular exercises include coordination, proprioception, balance and strength. These active exercises help in pain management through exercise induced hypoalgesia which includes reduced sensitivity to painful stimuli and activation of endogenous pain inhibitory mechanisms[31-33].

Mohamed et. al.[23] stated that scapular dyskinesis is one of the common features in AC and restoration of normal scapular pattern of movement can result in pain relief and recovery of joint range of motion. A significant change in range of motion was also found when PNF and neuromuscular exercises were given as a therapy. These exercises improve the diagonal pattern of movement, increasing awareness of joint position sense and kinaesthesia. They also help in correct muscle recruitment leading to more stable and coordinated movements [20,23, 27]. Further, self-directed repeated exercises will lead to improvement in overall kinematics of shoulder joint, Wong et. al.[34] stated that specific training causes decrease in positional movement fault leading to better quality of movement resulting in improvement in joint range of motion. Mercer and Bogduk,2007[35] observed that decrease in range of motion can also be due to joint inclusions like fat pad leading to obstructed movements which can be taken care by doing exercises in a particular direction to remove the occlusions and realign tissues which leads to increased range of motion[36,37].

Loss of motion around the shoulder joint affects simple activities of daily living like dressing, combing, cooking etc. which were assessed by 7 studies which were included in the review. Various questionnaires like upper extremity functional index (UEFI), Shoulder Rating Questionnaire (SRQ), SPADI, Penn Shoulder Score, Constant-Murley Score, Simple Shoulder Test and Oxford Shoulder Scale were used by them to evaluate disability or functionality of the individual. Decrease in pain and increase in range of motion are found to be answer for increasing functionality and decreasing disability related to AC. Improvement not only in quantity but quality of movement also helps in improving function and completion of tasks which were earlier not possible due to limited range and pain. Decrease in disability also leads to better quality of life as the individuals feels confident enough to engage in various day to day and recreational activities at ease. Russell et al [24] assessed Quality of life by using SF-36 as an outcome measure. Ginn et al. [19] used isometric abduction force assessed with the help of a hand-held dynamometer as an outcome measure. Capsular Thickness assessed through MRI has also been used as an outcome measure by Lin et al. 2022[20], Abady et.al.[18] showed that if classified according to MDT, derangement and spinal conditions get relief earlier as compared to dysfunction group where structural changes have taken place in capsule around the shoulder joint. These results were similar to that of Aytona and Dudley,2013[37] and Bowser and Swanson, 2016 [38] Ginn & Cohen[19] found that the injection group, exercise group, and MPM group had significant results for within-group analysis but were non-significant for between-group analysis after treatment of 5 weeks, indicating that none of the treatments was superior. Lin et al.[20], Russell et al.[24], and Wang et al [27]. compared the effect of joint mobilization to that of guided exercise therapy (PNF and circuit training) and found that results were statistically significant, stating guided exercises are superior.

However, no statistical difference was found for capsular thickness when comparing joint mobilization vs exercises for duration of 4 weeks by Lin et.al. [20] Only 3 studies [21,23,24] included follow-up in their intervention to evaluate the long-term effect of guided exercises and home exercises. Teytelbaum et al. [21] found that HIS (High-intensity stretch) and PT+ HIS groups reached minimal clinically important differences for ASES score for pain and function and SST scores in the period of 12 months. This study was supported by a similar study conducted by Ibrahim et. al.[39] who combined passive stretch with PT and found decrease in pain and increase in joint ROM. Russell et. al.[24] found significant difference at all time points of 6 months and 1 year when comparing supervised self exercises to pamphlet-based home exercise program. Significant difference was found by Mohamed et. al.[23] at 6th months analysis for pain and disability when compared guided exercise to that of placebo showing that guided exercises may be beneficial in long term. All these studies demonstrate that there is some statistical evidence showing short-term effects, which have been mostly evaluated till 8 weeks but there is a dearth of studies evaluating follow ups and long-term effects.

CONCLUSION

Home-based or active exercise showed positive clinical improvements with no superior treatment. This highlights the substantial research gap in terms of high-quality RCTs evaluating long-term effects or follow-ups of self-management exercise interventions in patients with AC.

Conflicts of interest: Nil

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