Supervised and non-supervised physical exercises in patients with knee osteoarthritis: a systematic review and meta-analysis

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Abstract

Introduction: Analyzing the high cost of long rehabilitation programs and clinical experiences from the recent pandemic, the aim of the study was to compare the effect of supervised and non-supervised physical exercises in patients with knee osteoarthritis considering pain and function.

Methods: Searches were conducted on the database PubMed, EMBASE, PEDro, and Cochrane for randomized clinical trials (RCT) involving adults with knee osteoarthritis. The risk of bias was analyzed using the risk of bias 2 tool and quality of evidence, using the GRADE. Meta-analysis was carried out by applying the differences of means and heterogeneity by the I2 statistics.

Results: Regarding the results, 642 studies were checked, out of them 7 were included in the qualitative analysis and 6 on the quantitative analysis, of which 6 for the outcome pain and 5 for the outcome function. Total sample consisted of 903 individuals, mostly female, mean age 63.05 years (SD=4.40), and strengthening and aerobic exercises were the most used. In general, the

risk of bias was considered uncertain, the randomization process was effective in most articles and participant blinding was impaired because of the intervention with exercises. According to GRADE, the quality of evidence was moderate for both outcomes. Treatment effect was estimated at -0.67 (CI 95%, -2.09 to 0.74) for pain and -1.07 (CI 95%, -4.30 to 2.16) for function,

and heterogeneity was classified as high for both outcomes.

Conclusions: In conclusion, no significant differences were observed between supervised and non-supervised physical exercises in terms of pain and function of the osteoarthritis knee.

Keywords: Pain; Knee osteoarthritis; Home exercises; Resistance exercise; Therapeutic exercise; Functionality.

Introduction

Osteoarthritis (OA) is a chronic degenerative disease that can affect several body joints having pain as its main manifestation followed by loss of physical function[1,2], it is the most common arthritis and can affect over 300 million people worldwide[3], it is among the diseases that cause the most disability and for which a reduced number of people receive adequate conservative treatment[4,5].

Nowadays it is known that there is an important inflammatory process in these joints, which is responsible for the symptoms described[6,7]. The clinical diagnosis associated with simple radiography is the most used approach and the treatment encompasses a multiprofessional team, with the inclusion of physical activities, weight loss, and disease awareness[8].

Physical exercises are widely used in the treatment of patients with knee osteoarthritis. Different forms of exercise seem to produce a positive effect on the improvement of these patients' pain and physical condition[7]. As a general guideline, aerobic and strengthening exercises for 8 to 12 weeks with a duration of 1 hour per session are recommended[9-11].

It is currently known that muscle strength plays an essential role in preventing knee pain caused by OA; studies show a correlation between decreased strength and greater difficulty in performing daily activities[12]. Exercise modalities differ in relation to supervision during sessions. Supervised individualized exercises improved resistance to fatigue and, as a result, the general condition of patients with Guillain-Barre syndrome[13]. Likewise, supervised exercises showed to be more effective than non-supervised exercises in terms of urinary incontinence in patients with prostate cancer submitted to radical surgery[14]. Patients with lumbar pain had much similar results when supervised and non-supervised exercises were compared; for this reason and for easiness and advantages, the application of non-supervised exercises for these patients is suggested[15].

Supervised exercises are understood as exercises done under the supervision of a qualified professional and non-supervised exercises as those prescribed by these professionals, but not under their supervision during the exercises[14,15].

The aim of this review was to analyze the effects of supervised and non-supervised exercises on knee OA patients in terms of pain and function.

Methods

Search strategy

The review was conducted according to guidelines of the PRISMA manual[16], using the following database: PubMed, EMBASE, Physiotherapy Evidence Database (PEDro), and Cochrane in December 2023. Any remote rehabilitation based intervention was excluded from searches given the lack of standardization concerning the classification criteria – supervised and non-supervised exercises.

Search strategies involved the combination of the Medical Subject Headings da National Library of Medicine (Mesh) descriptors: “exercise therapeutic”, “resistance exercise”, “home exercises”, “osteoarthritis knee”, “pain”, and “function” (Table I). In every article selected, other possibility for inclusion was researched in their bibliographic reference. The research study was registered on the PROSPERO database under the identification number CRD42022323266.

Study Selection

The studies identified were exported to the software EndNote X9 (Clarivate Analytics, London, England) for analysis and exclusion of duplicates. Two independent reviewers (MAGS and JSP) employed the search strategy by title and abstract. In case of divergent views, a third reviewer was invited for evaluation. The studies considered eligible were those that met the following inclusion criteria: (1) randomized clinical trial; (2) publication in English, Portuguese or Spanish; (3) published in a journal with peer review in the form of full article; (4) intervention with supervised and non-supervised exercise program; (5) evaluation of pain or function as outcome; (6) adult participants with knee OA, with no surgical intervention; (7) no time delimitation in terms of date; no limitation in sample size or sex.

Non-inclusion criteria involved: (1) data extraction not possible; (2) not having a control group; (3) if participants had been submitted to immobilization procedures or any invasive treatment, such as intra-articular steroid injection in the knee; (4) concomitant pathologies affecting the knee; (5) neurological or cardiovascular condition, except for hypertension; (6) studies with insufficient data or no data on the outcome studied; (7) studies using remote rehabilitation.

Main outcome variables

Data were extracted from 32 studies analyzed in full by two independent reviewers (MAGS and JSP) using standardized forms. The database for extraction included basic information of qualified studies (first author, publication date), individuals' characteristics (number of included patients, mean age, radiologic classification grade), studies' characteristics (types of exercises done, protocol time in weeks, periodicity of the exercise protocol). Measurements of outcomes included pain according to the analog visual scale or numeric scale, with scales from 0 to 10 or from 10 to 100, and Western Ontario and McMaster Universities (WOMAC) subscales[17] for pain and physical function outcomes (WOMAC physical function score). Two reviewers independently assessed the risk of bias of eligible studies through the risk of bias 2 tool[18], which addresses five domains for randomized trials individually evaluated by outcome: (1) bias resulting from randomization process; (2) bias driven by deviation from intended interventions; (3) bias for lack of data on results; (4) bias in outcome measurement; (5) bias in selection of reported result.

Risk of bias assessment

The investigation was undertaken with the aim of checking scientific articles with similar methodology that allowed carrying out specific data analyses of pain and function outcomes in individuals with knee osteoarthritis.

Data were arranged using the Review Manager (RevMan) Version 5.4.1 (Cochrane Collaboration, Copenhagen, Hovedstaden, Denmark). The standard mean difference (SMD) and the 95% confidence interval (CI) were used for continuous data. Random effect models were applied for the calculation of weighted mean differences (WMD). I2 statistical tests were employed to assess statistical heterogeneity. I2 values higher than 50% imply moderate or high heterogeneity and a random effect model was used when heterogeneity occurred. The study result was calculated by the mean change between the study follow-up and start. For the results of pain and physical function, subgroup analyses were performed. A p value of <0.05 showed a significant difference.

The analysis of quality of evidence was evaluated on the platform gradepro.org, using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE)[19], where certainty evaluation was carried out through the risk of bias assessment, inconsistence, indirect evidence, and inaccuracy (random error), evidence was classified as very low, low, moderate or high.

RESULTS

Selected Studies

The search lead to 642 studies referring to the described strategies, the exclusion of duplicates and initial selection showed 32 eligible for full reading. Out of them, 24 were excluded once they did not fit with the type of study, did not have pain as outcome, did not have intervention of interest or they showed incomplete publication. Finally, the process resulted in 7 articles included in the qualitative analysis and 6 for the meta-analysis (Figure 1), 6 articles for the outcome pain and 5 for the outcome function.

Studies' Characteristics

Once there was no systematic review on the subject, no filter in terms of dates was used by the authors, then, clinical trials were incorporated with no time limitation. A total of 903 individuals were included in the study at the age between 56 and 69 years (mean 62.9 years ± 4.08=SD), mostly women[20-25]. Exercise protocols ranged from strengthening (isometric and isotonic) exercises[21,23,24], aerobic exercises (walking) to a variation of walking on uneven surfaces aiming to improve balance and proprioception[26]. In every selected study, outcomes were always pain[19-24] and function[26].

The periodicity of exercise sessions varied between 2[20,25], 3[21,23] and 5 times a week[24, 25], as well as the period of the intervention 6[21,24,25], 8[26], 9[20], 12[23] and 24 weeks[22], and all protocols showed positive results. Follow-up was performed only in 2 studies, one with up to 24 weeks of follow-up[22] and another with 6 and 12 months[26].

Individuals' characteristics by group and detailed data of studies selected for meta-analysis were summarized in Table II.

Risk of Bias Assessment

The risk of bias analysis was conducted considering 7 articles and the outcomes (function and pain). In general, the risk of bias was considered uncertain for the studies included in the systematic review (Figure 2, a). The process of randomization was deemed effective in 6 articles[20,22-26] and appropriate methods for outcome measurement and selection of reported results were observed. Participants' blinding was impaired because of the approach related to physical exercises; still two articles did not describe in detail the protocols adopted and did not perform intention-to-treat analysis[21,22.] The

absence of data on outcome of a particular article showed methodological issues[9]. Measurement of results and selection of reported result demonstrated limitation in only one study[21]. Figure 2, part b presents the assessment of every risk of bias item for the studies included in the systematic review.

Quality of Evidence

According to the GRADE criteria, the quality of evidence was moderate for both outcomes evaluated (pain and function), as observed in Figure 3. Out of 7 studies, only two randomized over 100 patients[23,24]. There were limitations in the domains of inaccuracy, inconsistence, and publication bias, pointing out very low quality of evidence for the outcomes related to pain and function.

Effect of Exercise on Pain and Function

Supervised exercises did not show to be superior to non-supervised exercises in terms of pain (n=621), 2 studies showed effects favorable to supervised exercises[23, 26]; however, the meta-analysis demonstrated that there was no statistical difference between groups (Figure 4. A). In terms of function (n=628), the conclusion was similar, in this case, only one study showed to be favorable to the supervised exercise group[20], but the meta-analysis demonstrated that there was no statistical difference between groups (Figure 4. B). The results described above can be seen in Table III.

Discussion

The results show that the different modalities of supervised exercises did not seem to be more effective than non-supervised exercises for knee osteoarthritis, as demonstrated in the meta-analysis, considering the outcomes pain and function. In practice, these results justify the use of home exercises for most patients with mild to moderate knee OA, taking into account that it would not be realistic to provide supervised exercise programs in rehabilitation center or clinics, given the number of patients involved or cost of every care session.

The adoption of exercises as a strategy to improve pain and function in knee osteoarthritis is recognized as a major condition for medium and long-term improvement[4,5,27,28]. Such result can also be observed in other conditions, such as in patients after the implantation of total hip prosthesis in which the results show that physical therapy with supervised exercises did not produce stronger effects in terms of strength, physical function, and quality of life when compared to non-supervised exercises[29]. An important relationship is also observed between muscular strength and functionality[12].

A 30-minute non-supervised exercise program for 24 weeks was not able to improve the condition of patients with knee and hip osteoarthritis when compared with patients that took non-steroidal anti-inflammatories in the period of 6 months. According to authors, disease specificity and difficulty in standardizing exercises may justify the result, still they state that simpler exercises, such as walking, and closer exercise supervision should be considered in future studies[30]. This subject was also studied in patients with unspecific chronic lumbar pain where they observed that supervised exercises are statistically superior to the non-supervised home program to improve these patients' pain, functionality, movement fear or quality of life[31]. Nevertheless, the authors highlighted in a footprint that the difference between supervised and non-supervised exercises was relatively small, and the additional effort involved was not worth it.

Bronfort et al.[32] who also enrolled patients with chronic lumbar pain obtained similar results. In this case, supervised exercises achieved stronger gains in resistance and trunk muscle strength, but they did not differ from the gains of patients who received chiropractic spinal manipulation or home exercises in terms of pain and other individual results evaluated by the patient, either in short and long term. The results of supervised exercises seem to be slightly better when pain involves the lumbar region, because it does not result, in most cases, from degenerative chronic diseases.

The attention that the professional devotes to patient, as well as the attention patients pay to their pain or function, seems to exert influence on the results perceived by patients, mainly for subjective evaluations.

Patients with lumbar stenosis also benefited in relation to short-term supervised exercises when compared to non-supervised exercises; for the authors, the results favored the traditional individualized approach diversified in exercises[33]. It is worth highlighting that both groups did not do the same exercises, once for the manual therapy supervised group cycling and treadmill walking with body weight support were added. The authors underline the costs involved in both protocols, the mean cost of US$ 331 for the supervised group and US$ 100 for the non-supervised group, without considering patients' own expenses, generating a mean difference of US$ 44 between the groups.

The cost of therapeutic interventions in functional limitations and in pain should be considered for requiring long-lasting protocols. In these cases, strategies involving the management of catastrophizing and kinesiophobia should be included. The evaluation of anxiety, depression, pain catastrophizing, and kinesiophobia seems not to differ between the supervised exercise and non-supervised exercise groups[33]. Monticone et al. (2014) adds that a rehabilitation program including strategies for the management of catastrophizing and kinesiophobia was superior to a single exercise

program for reducing disability, dysfunctional thoughts and pain as well as in improving patients' quality of life after spine surgeries.

The French Society of Physical and Rehabilitation Medicine, for degenerative problems of lower limbs, reinforces the importance of employing protocols involving different exercise modalities, such as the ones analyzed in the present study. The recommendations suggest starting with principles of awareness concerning the benefits of exercises to degenerative problems, followed then by exercises supervised by physical therapists and, after the particular period, the continuity with non-supervised home exercises[27]. These recommendations justify for the effectiveness of exercises already reported in chronic degenerative diseases, as well as the amplification in the number of treated patients, and minimization of the costs involved in rehabilitation programs. The results from a systematic review addressing the rehabilitation of patients with rotator cuff injury corroborate the results shown in our study, in which there were no significant differences in terms of the pain score in the numeric scale when compared to supervised and non-supervised exercise modalities[35].

As we can observe there is not a consensus over the results of supervised and non-supervised exercises for different conditions. Considering that the results from the meta-analysis did not demonstrate superiority of the outcomes pain and function for knee osteoarthritis between both protocols, the professional should contemplate the need for adding strategies involving awareness about pain, the management of catastrophizing and kinesiophobia, either in a supervised way or not, which may exert influence on the results from prescribed exercises.

No differences were observed between supervised and non-supervised exercises for knee osteoarthritis, having pain and function as outcomes. Once this is the first review involving the subject of supervised and non-supervised exercises in patients with knee osteoarthritis, new clinical trials with more stringent methodological control should be encouraged.

The study has interesting practical implications, especially for patients who do not have the capacity and/or possibility to perform supervised exercises on a daily basis. In this context, unsupervised exercises also show effective results in terms of improving pain, strength and functional capacity.

Acknowledgments

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Tables and Figures

Table I. Search strategies for individual database.

DATABASE	#	SEARCH	RESULTS
Medline (Pubmed)	**#1**	(((((exercise therapeutic) OR (resistance exercise)) OR (home exercises)) OR (Endurance Training)) OR (Muscle Stretching Exercises)) OR (Resistance Training)	
	#2	(((Osteoarthritis, Knee) OR (Osteoarthritis)) OR (Arthritis)) OR (Joint Diseases)	
	#3	Musculoskeletal Pain	
	#4	function knee	
	#5	#1 and #2 and #3 and #4	**293**
Embase	**#1**	kinesiotherapy	
	#2	'knee osteoarthritis'	
	#3	musculoskeletal AND pain	
	#4	'knee function'	
	#5	#1 and #2 and #3 and #4	**45**
Cochrane Library	**#1**	(((((exercise therapeutic) OR (resistance exercise)) OR (home exercises)) OR (Endurance Training)) OR (Muscle Stretching Exercises)) OR (Resistance Training)	
	#2	(((Osteoarthritis, Knee) OR (Osteoarthritis)) OR (Arthritis)) OR (Joint Diseases)	
	#3	Musculoskeletal Pain	
	#4	'knee function'	
	#5	#1 and #2 and #3 and #4	**154**
PEDro	**#1**	Exercise Therapy in Patients With Knee Osteoarthritis	**150**
Total			**642**

Table II. Individuals' characteristics by group and of the studies included in the qualitative analysis.

Author, year. Country	Individuals	% Women	Age (Mean) / SD (years)	Outcome	Clinical characteristics	KL	Intervention	Frequency of Treatment	Result
Çolak, 2017. Turkey	56 S – 33 NS - 23	S - 73 NS - 65	69 / 24.75	P – Pain S - Function	- Age equivalent or older than 45 years; - Kellgren-Lawrence grade II-III OA clinical- and radiographically determined.	2 and 3	- The supervised exercise group received isometric and isotonic exercises and simple balance exercises; - The home exercise group, under the supervision and instruction of a physical therapist, received it in an exercise session.	6 weeks, 3 times a week	For patient satisfaction with treatment, greater pain reduction and muscle strength improvement, supervised exercise programs are indicated to knee OA patients.
McCarthy, 2004. UK	151 S – 80 NS - 71	-	64,5 / 9,80	P – Function S - Pan	- Guidelines on clinical diagnosis by the American College of Rheumatology (ACR) for knee osteoarthritis; - Radiologic evidence of osteophytes, as reported by a radiologist.	-	- Home exercises: two muscle strengthening exercises; one of muscle resistance, balance, and proprioception were adopted; - Supervised exercises: supervised circuit training, progressive resistance training, brisk walking, and stretching and balance exercises.	8 weeks, twice a week	The supplementation of supervised exercises improved pain by walking and the function.
Kudo, 2013. Japan	203 S – 81 NS - 122	S - 100 NS - 100	64,7 / 5,90	P – Pain S - Function	- Women at the age between 55 and 75 years with pain in the knee.	1, 2, 3 and 4	- In-group exercises performed in a room (in-group exercise) or a group doing home exercise therapy (home exercise) through raffle.	9 weeks, 2 times a week	In-group supervised exercises showed significant improvement in comparison with non-supervised home exercises.
Evcik, 2002. Turkey	55 S – 28 NS – 27	S - 35 NS – 33	56,3 / 6,10	P – Pain S - Function	- Patients with knee OA; - Age range between 48 and 71 years.	1, 2, 3	- Group 1: isometric and isotonic exercises for quadriceps strengthening at home (no supervision); - Group 2: regular supervised walking. At first 10 minutes and progressively increasing up to 30 minutes; - Group 3: Control group with normal activities.	12 weeks, 3 times a week	Study showed that home simple exercises and regular walking improved pain, physical ability, and quality of life.

Yilmaz, 2018. Turkey	80 S – 39 NS - 41	S - 77 NS – 73	60,21 / 9,49	P – Pain S - Function	- Early diagnosis of knee OA; - Knee osteoarthritis grade II–III according to Kellgren-Lawrence.	2 and 3	- In the first weeks, active range of motion exercises (ROM) of knee flexion and extension, hip abduction and adduction in the lying position, quadriceps isometry, adductor and abductor, straight leg elevation and terminal knee extension. - In subsequent weeks, knee flexion and extension in the prone and sitting position with a 1-kilogram weight and isotonic contraction of the hamstring muscles were added to exercises in the first three weeks; - Both groups undergo the same home exercise program, however group 1 had no supervision and group 2 had the supervision of a physical therapist.	6 weeks, 5 days a week	Significant difference was found by comparing values of VAS, knee range of motion, WOMAC and SF-36 in both groups. When the difference between both groups was compared, a significant improvement was found in all the scores of the supervised exercise group.
Gohir, 2021. United Kingdom	152 S – 74 NS – 78	S – 48 NS – 45	66,7 / 9,20	P – Pain S - Function	- Clinical diagnosis of knee osteoarthritis (defined as pain in the knee for 3 months); - Morning stiffness <30 minutes; - Crepitation, bone sensitivity and no palpable heat).	1	- Control group received habitual care, including exercises and information provided by their general clinician and physical therapist. - Intervention group had a structured exercise program and information on the osteoarthritis disease digitally sent via a smartphone application with no supervision.	6 weeks, 5 days a week	Non-supervised digitally sent exercises were superior to self-care (exercises recommended and managed by physical therapists). No harmful effect was observed in the groups.
Nelligan, 2021. Melbourne	206 S – 103 NS – 103	S – 60 NS - 66	60 / 8,4	P – Pain S - Function	- OA clinical criteria (age ≥45 years, activity-related knee pain and knee morning stiffness ≤30 minutes); - Overall mean knee pain severity 4 or higher in a numeric	-	- Group 1 list of exercises associated with text messages (non-supervised exercises). - Group 2 (control) awareness and conventional exercises used in the treatment.	24 weeks, no information on frequency	The non-supervised program had a better performance than the control program.

								scale of 11 points (NRS) in the week before.	

S- **Supervised; NS- Non-supervised; P-Primary; S-Secondary**

Table III. Supervised exercises versus non-supervised exercises in patients with knee AO.

Outcome	Number of RCT	Number of Patients	Estimated Effect (95% CI)
Pain **(0-10 NPS)**	6	621	SMD -0.67 (-2.09, 0.74)
Function **(WOMAC)**	5	628	SMD -1.07 (-4.30, 2.16)

CI: confidence interval; N: number; RCT: Randomized Clinical Trial; SMD: Standardized mean difference; NPS: numeric pain scale, *WOMAC (Western Ontario and McMaster*).

Figure 1. Report items preferred for systematic reviews and flow diagram of the meta-analysis of the study selection process. RCT: randomized clinical trial.

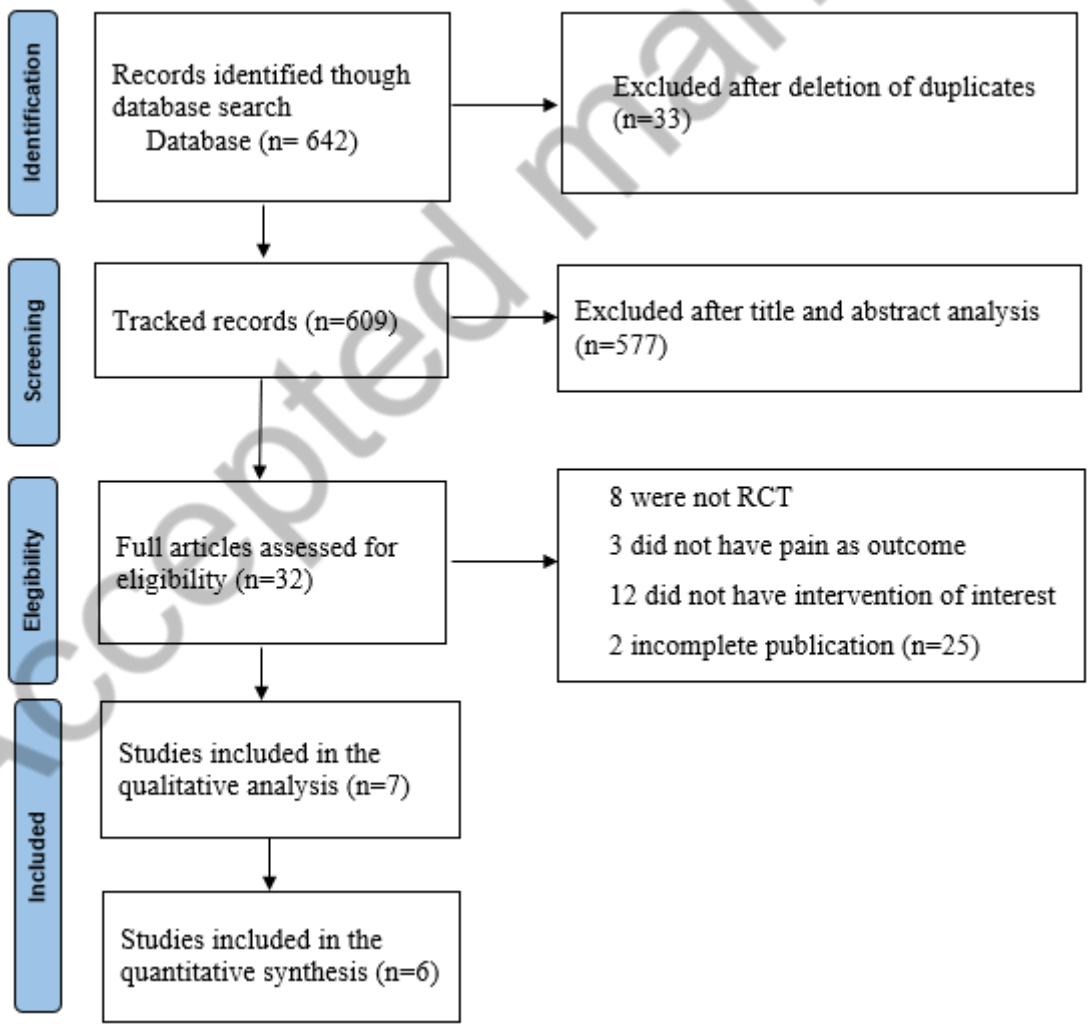


Figure 2. Authors' review judgments about each risk of bias

a) Authors' review judgments about each risk of bias item shown as percentage in all the studies included (pain and function).

b) Authors' review judgments about each risk of bias item for every study included (pain and function).

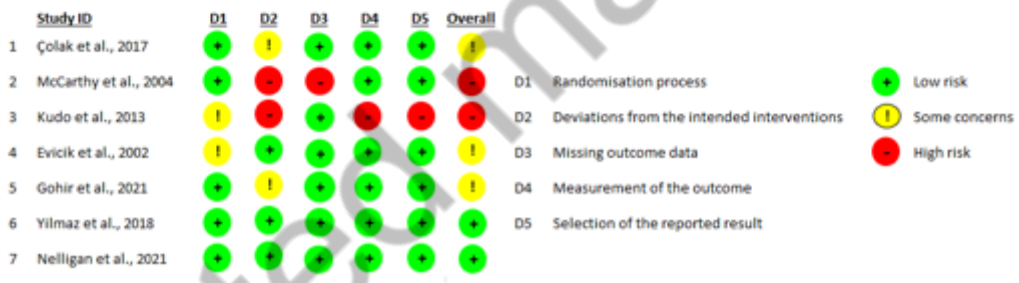


Figure 3. GRADE assessment for the effects of supervised and non-supervised exercises on pain and function of patients with knee osteoarthritis.

Certainty assessment							Summary of findings				
							Study event rates (%)			Anticipated absolute effects	
Participants (studies) Follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	With non-supervised exercises	With supervised exercises	Relative effect (95% CI)	Risk with non-supervised exercises	Risk difference with supervised exercises
Dor (Scale from: 0 to 10)											
621 (6 RCTs)	not serious	serious[a]	serious[b]	serious[c]	strong association all plausible residual confounding would reduce the demonstrated effect	⨁⨁⨁◯ Moderate	325	296	-	The mean dor was **0**	MD **0.67 lower** (2.09 lower to 0.74 higher)
Função											
628 (5 RCTs)	not serious[d]	serious[e]	serious[b]	serious[f]	strong association all plausible residual confounding would reduce the demonstrated effect	⨁⨁⨁◯ Moderate	323	305	-	The mean função was **0**	MD **1.07 lower** (4.3 lower to 2.16 higher)

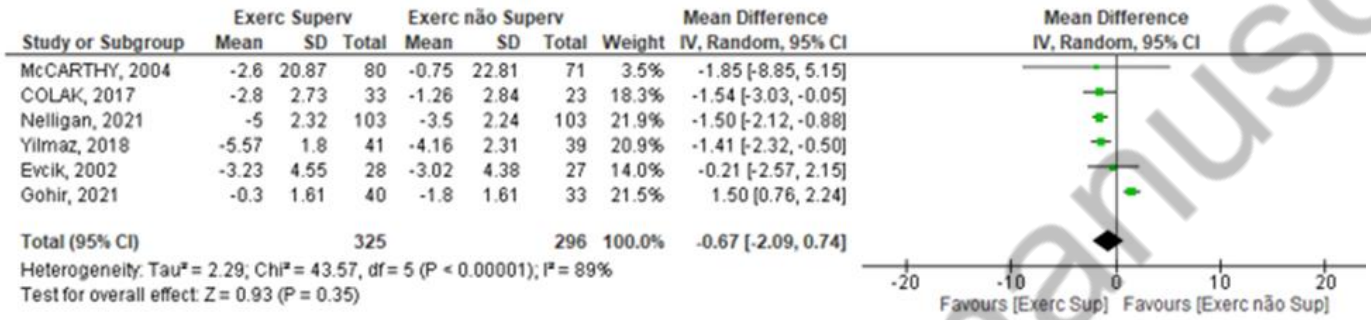
CI: confidence interval; **MD:** mean difference

Explanations

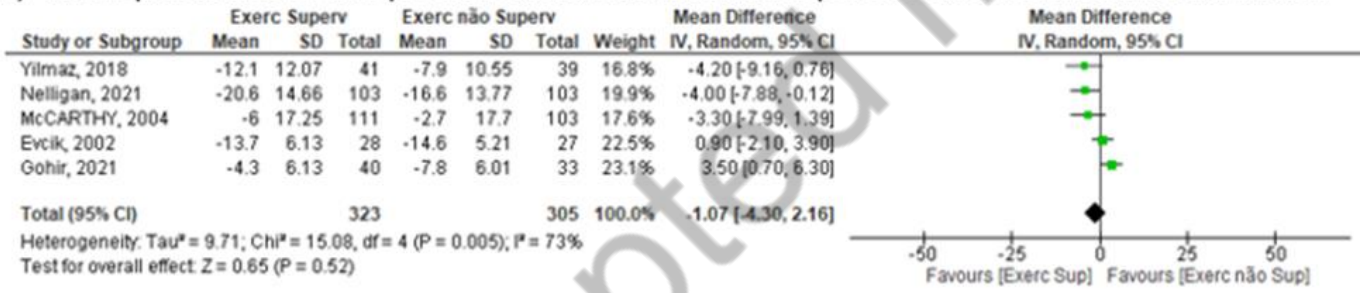
a. Inconsistency in the point effect estimate, overlapping confidence intervals.
b. Analysis carried out due to the different types of exercise modalities used in the articles. However, there is still consistency with the issues relating to the PICO question.
c. Moderate imprecision, move down 1 level in relation to the midpoints of the studies and confidence intervals.
d. 2 studies with a high risk of bias and others with some concerns.
e. Inconsistency in relation to the point effect estimate, overlapping confidence intervals. No attempt at correction.
f. Only 1 study in favor of supervised exercise, another 3 touching the center line, downgraded 1 level for imprecision.

Figure 4. Forest Plot effects of supervised exercises versus non-supervised exercises in pain and function

a) Forest plot of effects of supervised exercises versus non-supervised exercises in terms of pain.



b) Forest plot of effects of supervised exercises versus non-supervised exercises in terms of function.



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