Effectiveness of Hip and Quadriceps Exercises in Improving Functional Abilities and Quality of Life in Knee Osteoarthritis: A Systematic Review and Meta-analysis

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Abstract. Knee osteoarthritis is one of the leading causes of disability. Giving strengthening exercises, especially hip and quadriceps exercises, can help improve the physical function of mild to moderate KOA patients and affect the biomechanics of the hip—the main factor for maintaining stability in the frontal plane during standing activities. This research aims to ascertain (i) whether hip exercise has been depicted to improve functionality and quality of life in people with KOA symptoms and (ii) whether hip exercise has been proven to improve quality of life in people with KOA symptoms when combined with quadriceps exercise. The PubMed and Google Scholar databases, searched until 2022, were employed to discover the study's sources. Using a Randomized Control Trial (RCT), a systematic review and meta-analysis examined the hip and quadriceps training effectiveness on KOA patients' quality of life and functional capacity. The gathered information unveiled that quadriceps exercise alone was not as effective at improving walking function as hip exercise (−0.99, 95% CI −2.19 to 0.22), and patient-reported function was (−0.50, 95% CI −1.32 to 0.32). According to the analysis presented by the subgroups, resistance hip exercise was more successful at enhancing function than functional neuromuscular. Meanwhile, quadriceps strengthening was more helpful for functional (0.15, 95% CI −0.58 to 0.29) than multimodal exercise.

Keywords: Osteoarthritis · Knee Osteoarthritis · Exercise · Hip Exercise · Quadriceps Exercise · Function · Quality of Life

1 Introduction

Around 302 million people worldwide suffer from osteoarthritis (OA), a widespread form of joint inflammation. It is one of the primary factors in senior people's impairment [1–3]. Furthermore, estimates of the general prevalence of OA of the hip and knee in the elderly population are 11% and 24%, respectively [3–5]. According to WHO statistics, OA affects 40% of people over 70 worldwide. Meanwhile, between 2016 and 2020,

B. Ichsan et al. (Eds.): ICHWB 2022, AHSR 61, pp. 428–444, 2023.
https://doi.org/10.2991/978-94-6463-184-5_37

the prevalence in the US climbed by roughly 66% to 70%. An estimated 36.5% of the population in Indonesia suffers from OA, with those over 70 accounting for 40% of cases [6, 7]. Knee osteoarthritis (KOA) is a diverse condition that can impact the synovium, meniscus, bone, and cartilage [8, 41]. The medial tibiofemoral compartment, where chronic diseases can cause functional loss and decreased quality of life, is where the disease manifests itself in KOA [10, 11]. One in four patients over 55 with KOA symptoms [12] experiences disability and decreased functional ability [1, 10, 13]. The burden on global health systems will rise as the number of aged and obese people, as well as the prevalence of KOA, continues to rise [7, 14, 43]. Therefore, to lessen the global and financial burden of KOA patients through primary and secondary prevention, it is crucial to take action to ameliorate symptoms and decrease prevalence [14, 15].

Pain, muscle weakness, and physical dysfunction are the main issues in KOA [16]. Therefore, land-based and strength training is advised as a fundamental intervention for all KOA patients [17]. A systematic review revealed that land- and strength-based exercises could improve physical function in KOA sufferers with short-term effects [10, 18]. According to a study, people with mild to moderate KOA could improve their physical function by exercising and strengthening their muscles [11, 19]. Moreover, increasing quadriceps strength leads to better development of symptoms and disabilities [20, 42]. However, quadriceps exercises are no better than other types of exercises. Accordingly, more research is required to determine the ideal scope of exercise programs for KOA patients [10].

According to moderate quality evidence from a systematic review and meta-analysis, patients with KOA had weaker hip abduction than age-matched controls by 7% to 20% [21]. Hip abduction strength substantially impacts physical health [22] and function in KOA patients [23]. Hip abduction's principal biomechanical function when standing is to keep the frontal plane stable [22]. The hip abduction function also contributes to KOA development. More hip abduction strength, when compared to adequate controls, can help patients with moderate KOA maintain body postures that shift as a result of the condition and produce greater first and second peak adduction moments [24]. Gait modifications regulating medial joint stresses can explain why stronger hip abduction muscles have a shielding impact against the onset of KOA at 18 months [25].

According to research comparing exercise programs with those that did not involve exercise, hip and quadriceps strengthening were both advised [26]. Despite contradicting information on clinical results when hip and quadriceps exercises were combined [11], more study is required to generate quantitative proof to provide therapeutic references about exercise therapy for KOA.

This meta-analysis review aims to (i) ascertain the performance of hip workouts combined with quadriceps exercise on functional improvement and quality of life in patients with KOA symptoms and (ii) ascertain whether these types of hip exercise are proven to be impactful in developing functional and quality of life in patients with symptomatic KOA.

2 Method

2.1 Research Design

A systematic review and meta-analysis were employed in this research.

2.2 Search Strategy

An internet search of the literature was performed using the PubMed and Google Scholar databases to disclose the study's sources.

The database search was carried out following the PICO formula, with keywords encompassing Osteoarthritis, Knee Osteoarthritis, Exercise, Hip Exercise, Quadriceps Exercise, Function and Quality of Life. This meta-analysis included studies released up to 2022.

2.3 Study Criteria

The inclusion criteria included articles (1) employing a *Randomized Control Trial* (RCT) study design, (2) involving people with primary tibia femoral KOA symptoms in one leg or both as the subject, (3) examining land-based exercise and (4) in full text. Meanwhile, the exclusion criteria covered studies (1) not involving sport-based activities and (2) using English languages.

2.4 Data Extraction

Details extracted in each article encompassed authors, the number of participants, participant demographics (age, gender, and BMI), and a description of the intervention program following the Consensus on Exercise Reporting Template (CERT) [27]. Table 3 lists the intervention report for each trial.

Table 1. Risk of bias (PEDro) score

No	*Study*	*Quality*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*Total*
1	Bennel *et al.*	High	1	1	1	1	0	0	1	0	1	1	1	7
2	Singh *et al.*	Low	0	1	0	1	0	0	1	1	0	1	1	6
3	Verma and Agarwal	Low	0	1	1	1	0	0	0	1	1	1	1	7*
4	Callaghan *et al.*	Low	1	1	0	0	0	0	1	0	0	1	1	4
5	Chaipinyo and Karoonsupchareon	High	1	1	1	1	0	0	1	1	0	1	1	7
6	Olablegi *et al.*	Low	1	1	0	1	0	0	0	0	1	1	1	5*

* Study rated by the researchers

2.5 Quality of Evidence

Table 1 lists the risk of bias ratings for each study. This study utilized the Physiotherapy Evidence Database (PEDro) to evaluate affective bias in each RCT. The inter-rater reliability of the PEDro scale ranges from fair to good [28], and it has a reliable methodological quality metric for control tests [29]. The PEDro scale has 11 elements that determine if the methodological component is present or not, and a score of 10 overall indicates it. When the archived PEDro database was available, scores were directly obtained from it; otherwise, the researchers evaluated the study. A third reviewer fixed a difference within the issue. The study was dichotomized: high quality (PEDro score >6) and low quality (PEDro score ≤ 6) utilizing a predetermined method. No studies were outed from the quality assessment.

2.6 Data Synthesis

Studies were categorized based on outcome indicators and post-intervention evaluation time frames. Time points were described as follows: short-term (<3 months), medium-term (3–12 months), and long-term (>12 months) [30]. Review Manager Software (Version 5.4.1) was applied to perform statistical analysis. The Review Manager (RevMan) was employed to ascertain Standardized Mean Differences (SMDs) with 95% confidence intervals for each result measure after the intervention. This study discovered the same results and periods after gathering data for a meta-analysis. $P < 0.05$ demonstrated statistically substantial distinctions between all forms of exercise in different subgroup analyses according to the kind of hip treatment (including low-intensity resistance, neuromuscular function, or multimodal). An analysis of sensitivity was carried out in high-quality studies. Moderate, medium and high heterogeneity were the respective interpretations of the effect parameters 0.2, 0.5, and 0.8 [31]. The I^2 statistic was utilized to evaluate statistical heterogeneity. Values of 25%, 50%, and 75%, respectively, were regarded as a moderate, medium, and high heterogeneity levels [32].

The quality of evidence of each meta-analysis was evaluated using the modified version of the Grading of Recommendation Assessment, Development and Evaluation (GRADE) and presented in Table 4, combining all hip strengthening treatments in the meta-analysis rated very low for all outcomes due to the insufficient number of studies and excluded biased publications [33]. This measuring instrument categorized the quality levels of evidence into high, moderate, low, or very low. This classification was established following four assessment indicators: bias risk, consistency issues, indirectness issues, and imprecision issues [33]. During the initial assessment, each meta-analysis' evidence quality was considered to have a high level and then lowered by one level (moderate, low, or very low) for each not met item, for example, risk of bias (studies with a low overall PEDro score ≤ 6), inconsistency ($I^2 \geq 50\%$) [21], indirectness (clinically heterogeneous, e.g., different severity of KOA or affected Knee Compartment) and imprecision (upper or lower CI > 0.5 in both directions). The degree of quality of the evidence was limited when the assessment results demonstrated no possible meta-analysis.

3 Results

3.1 Identification and Selection of Articles

The results of identifying and selecting articles using a search strategy resulting in 1,390,849 articles were summarized in the PRISMA flowchart in Fig. 1. Six studies meeting the inclusion criteria after 409 full-text articles that passed the screening process and were deemed feasible were produced.

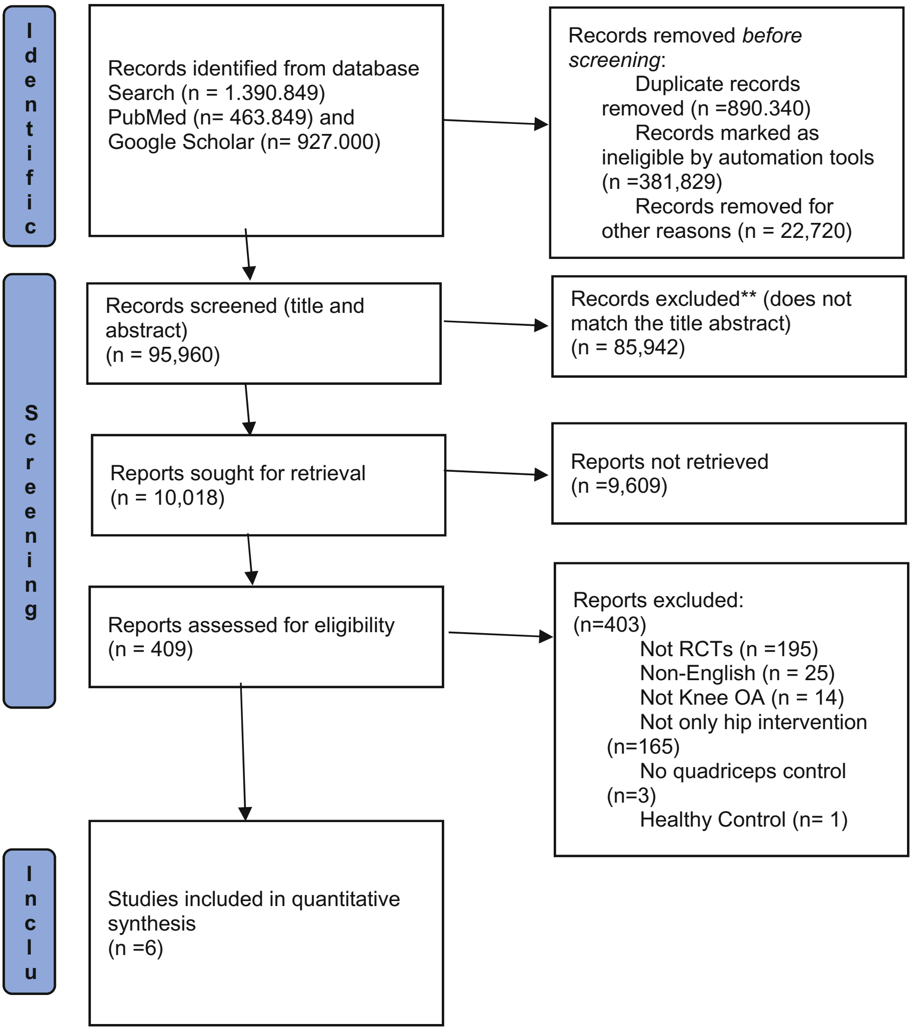

Fig. 1. Search results with the PRISMA flowchart diagram

3.2 Study Characteristics

Table 2 displays the summary of each characteristic and outcome. This study involved 281 participants, 89 of whom were male. One study failed to include participant gender information [34]. Body Mass Index (BMI) [11, 35, 36] was recorded in three investigations, with an average of 25 to 31 kg/m^2 (72.24% of the total participants). In three studies [11, 34, 37] with Medial Compartment KOA, 56.94% of the total participants were also recorded as such. The Kellgren-Lawrence severity ranging from Grade 1 to 4 radiographic severity was also reported by three studies [11, 36, 37].

The resume of the exercise, time point, and outcome are presented in Table 3. Two studies utilized low-intensity [34, 37]. The multimodal exercise program combined neuromuscular activity with low-intensity hip resistance exercise [11]. Three hip workout subgroups comprised low-intensity resistance hip exercise [34, 37], neuromuscular function, and multimodal program [11].

Time points for the intervention and assessment ranged from four [35, 38] to twelve weeks [11, 36]. No intervention looked at long- or medium-term results. One study provided KOOS-activity of daily living, while three studies reported function as established by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [11, 34, 37]. Three studies examined one of the performance-based physical function assessments advised by the OARSI [34, 35, 37]. Two studies [11, 34] unveiled that step tests produced balanced results.

The quality of life result was reported in two studies: one applied the KOOS-QoL to assess the knee-related quality of life [35], and the other employed the assessment of the quality of life scale to evaluate health-related quality of life [11].

3.3 Quality of Evidence

PEDro's average score was 6, as depicted in Fig. 1 (about 4 [38] to 7 [11, 34, 35]). Four studies were rated as low-quality [34, 36–38] and two as high-quality [11, 35]. Four studies were blinded; however, none met the criteria for participant or therapist blindness, given the nature of exercise treatment. Three studies reported an intention-to-treat analysis [11, 34, 36]. Moreover, three studies failed to meet the requirements for satisfactory follow-up [35, 37, 38].

3.4 Patient-Report-Outcome

3.4.1 Function

Two high-quality [11, 35] and two low-quality [34, 37] outcome function evaluations were reported with a total of 208 participants. The data collected unveiled no substantial difference between the combination of hip and quadriceps exercises and only quadriceps exercise (−0.50, 95% CI −1.32 to 0.32), as displayed in Fig. 2A. The subgroup analysis results disclosed that hip exercise could affect potential utility when combined with quadriceps workouts for KOA (test for subgroup differences, $p < 0.004$). Compared to quadriceps exercise alone, hip exercise appeared to have a greater positive impact on function. Evidence of a large effect was obtained from two low-intensity resistance exercise studies (−1.25, 95% CI −2.11 to −0.39) [34, 37]. According to one study (0.52,

Table 2. Characteristics of included studies

Author	Participant Characteristics					Outcome Measure		
	KOA Diagnosis	N total (N males)	Age	BMI	K-L grade	Patient-reported function	Physical function test	QoL
Bennell et al.	MC	100 (48)	62.7 ± 7.3	29.7 ± 3.9	2–4	WOMAC	10 m walk; step test Square step test	AQoL
Callaghan et al.	ACR	18 (12)	59 ± ranging from 35–80	NR	NR		50 m walk	
Chaipinyo and Karoonsupcharoen	ACR	48 (11)	62 ± 6	25 ± 4	NR	KOOS-PS	50 m walk; 15 m walk TUG/GUAG	KOOS-QoL
Olagbegi et al.	ACR	55 (4)	61.1 ± 13.75	31.26 ± 8.54	2	PASE	NR	
Singh et al.	ACR MC, U/B	30 (14)	55.33 ± 3.99	NR	2–3	WOMAC	6 MWT	
Verma et al.	U, MC	30 (NR)	50–70	NR	NR	WOMAC	TUG/GUAG Step test	

QoL (Quality of Life), STS (Sit to Stand Test), TUG/TUG (Knee Osteoarthritis Outcome Score), AQoL (Assessment of Quality of Life), MC (Medial Compartment), 6MWT (6 Min Walk Test), KL (Kellgren-Lawrence), PASE (Physical Activity Scale for the Elderly), KOA (Knee Osteoarthritis), WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index.

Table 3. Summary reports for both intervention and control groups

Author	Intervention Group	Control Group		Intervention Duration and Type	SMD Result (95%CI)
	Hip Exercise	Quadriceps Exercise			
Low-intensity resistance exercise					
Singh et al.	Side lying abduction 3 × 10 with weight cuff	QS 3 × 10 IRQ 3 × 10 SLR 3 × 10	QS 3 × 10 with hold IRQ 3 × 10, SLR 3 × 10 with hold at 65% of 1 RM	6 weeks stretching hamstrings, calves, quads, iliotibial band, posterior, capsule 3 × 30 s	6 weeks: WOMAC: −1.71(−2.53 to −0.86), 6MWT: −1.48 (−2.30 to −0.66)
Verma et al.	Side lying abduction 3 × 10 RM Abduction in standing 3 × 5 RM Isometric abduction 3 × 5 RM	KE 3 × 10 RM SLR 3 × 10 RM	KE with hold 3 × 10 RM, SLR 3 × 10 RM, IRQ 3 × 10 RM, 5 min bike	5 weeks of lower limb stretches	5 weeks: WOMAC: −0.84(−1.59 to −0.09), TUG: −0.93(−1.69 to 0.17), Step test: −0.99 (−1.76 to −0.23)
Functional neuromuscular exercise					
Callaghan	Step-downs 2 × 10	Sit to stand 2 × 10, Mini-squats 2 × 10	IRQ 3 × 10, SLR 3 × 10, Isometric quadriceps exercise 3 × 10	4 weeks N/A	4 weeks: 50m walk: data requested
Chaipinyo and Karoonsupcharoen	Stepping forward, backward, sideways 1 × 30 each	Mini-squats 1 × 10	KE 3 × 10 with hold	4 weeks N/A	4 weeks: KOOS-ADL: 0.09 (0.52 to 0.70); 15 m walk: −1.63 (−2.34 to −0.91)

(*continued*)

Table 3. (*continued*)

Author	Intervention Group	Control Group		Intervention Duration and Type	SMD Result (95%CI)
	Hip Exercise	Quadriceps Exercise			
Olagbegi dkk	Forward, backward and lateral step up/step down 1 × 10	QS 1 × 10, Wall squats 10 RM	SLR, QS 1 × 10, Wall Squats 10 RM, KE with hold 10 RM	12 weeks N/A	4 weeks: IKHOAM: −0.16 (−0.69 to 0.36)
Multimodal exercise					
Bennel dkk	Isometric abduction 2 × 5, Side Stepping 2 × 30, Stepping forward, backward, sideways 3 × 10 each, Step-up/step-downs 3 × 10	Wall squats ± Split feet 3 × 10	IRQ 10RM, KE 10RM, KE with 30 degrees hold 10RM, SLR 10RM, Outer ROM KE	12 weeks N/A	12 weeks: WOMAC: −0.15 (−0.58 to 0.29); stair ascent: 0.13(−0.30 to 0.57); 30s STS: 0.13 (−0.31 to 0.56); step test: −0.08 (−0.51 to 0.36); Aqol: 0(−0.43 to 0.43)

SLR (straight leg raise); KE (knee extension); N/A (not available); IRQ (inner range quadriceps); IKHOAM (Ibadan Knee/Hip Osteoarthritis Outcome Measure); QS (quadriceps setting); 6MWT (6 min walk test); VAS (visual analogue scale); KOOS (Knee Injury and Osteoarthritis Outcome Score); ADL (activities of daily living); TUG (Time up and go); WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index); 3x10/5 RM (3 repetitions of 10/5 repetition maximum).

95% CI −0.10 to 1.14) [35], adding neuromuscular or multimodal function exercise to quadriceps exercise alone had no discernible benefit.

3.4.2 Quality of Life

Two high-quality studies [11, 35] reported the quality of life of 148 participants. Health quality of life and knee-related outcomes were not combined because each was a different measure of the variable. Single studies with limited evidence revealed that hip exercise was functional neuromuscular (−0.43, 95% CI −1.05 to 0.19)[35] or multimodal exercise (0.00, 95% CI −0.43 to 0.43) [11]. No substantial distinction was discovered between hip and quadriceps exercises, and only quadriceps workouts in improving the quality of life, as exhibited in Fig. 2B.

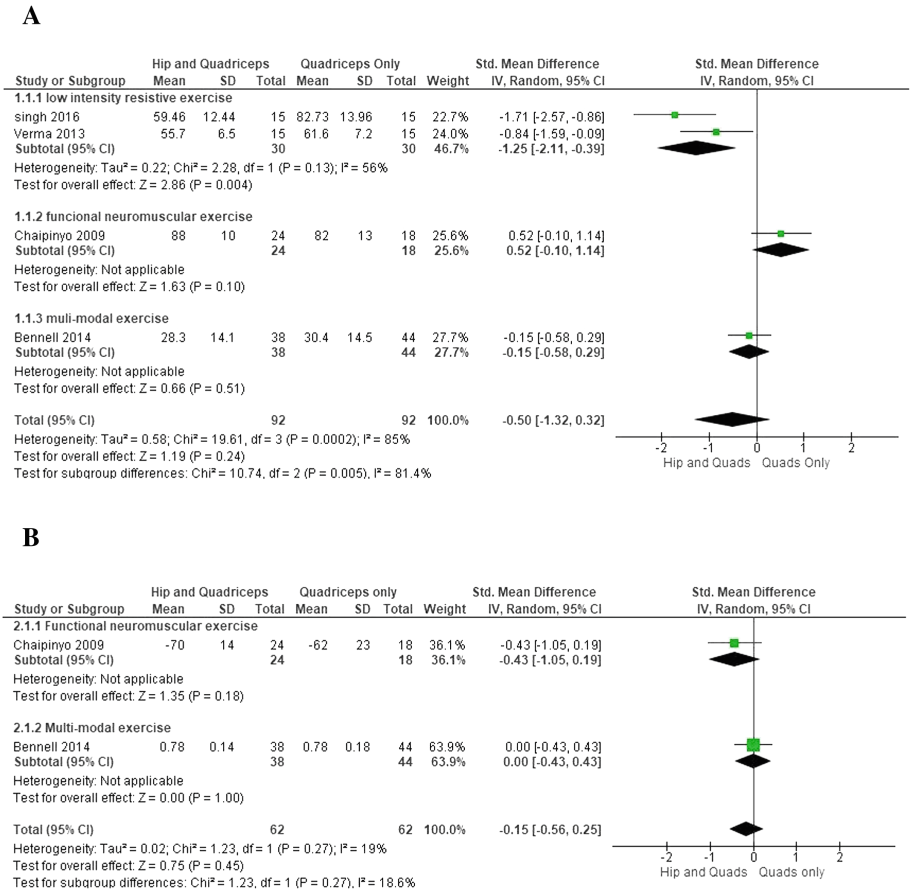

Fig. 2. Forest plot: patient-report-outcome. (A) Function, (B) Quality of Life

3.4.3 Performance-Based Measure of Physical Function

Five studies involved 226 participants (two of them high-quality) [11]. One result matched the five activities suggested by the OARSI, as displayed in Table 2 [35] (three low-quality) [18, 34, 37, 38].

3.4.3.1 Walking

The results of walking were provided in two trials with high quality [11, 35] and two studies with low quality [37, 38], totaling 196 participants. There were three [11, 35, 37] research data collected in the meta-analysis. There was no substantial difference between the combination of hip and quadriceps exercises compared to only quadriceps exercise (−0.99, 95% CI −2.19 to 0.22), as displayed in Fig. 3A.

Significant differences between the various hip workout types were seen in the subgroup analysis (test for subgroup difference p 0.0004). No research investigated how high-intensity hip resistance exercise affected walking function. There were no appreciable distinctions between the quadriceps exercise alone. Similarly, the combination of

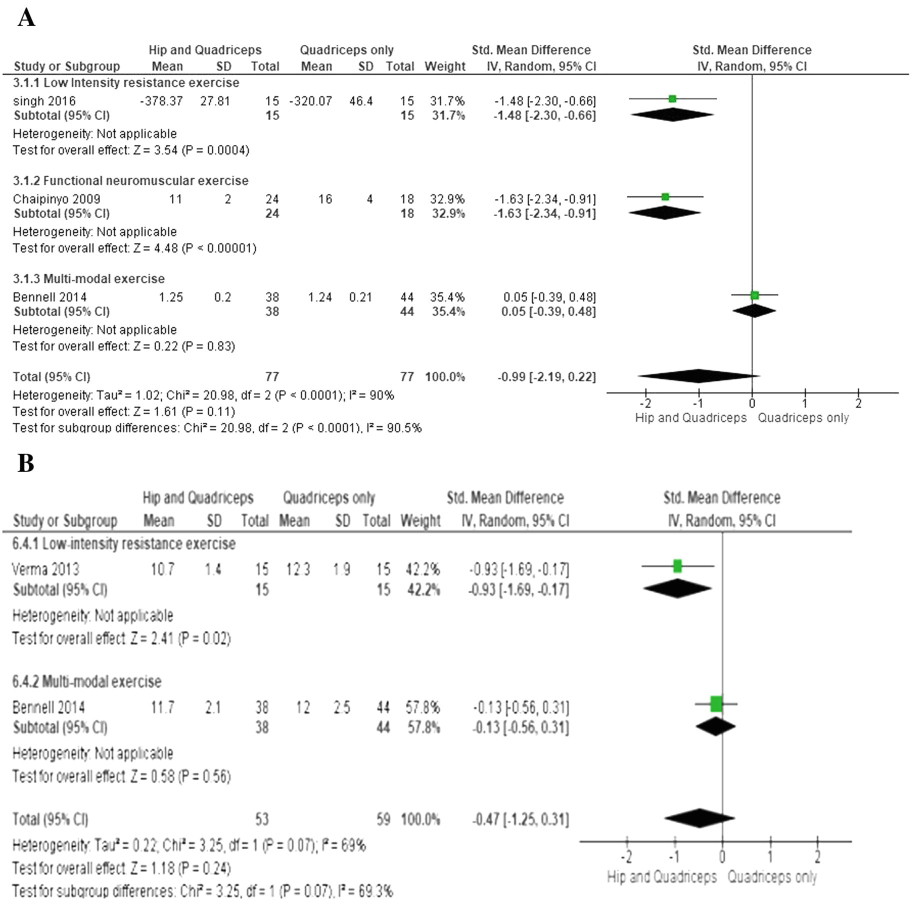

Fig. 3. Forest plot: Physical functional test. (A) Walking, (B) Sit to Stand.

low-intensity hip resistance training (−1.48, 95% CI −2.30 to −0.66) and functional neuromuscular exercise (−1.63, 95% CI −2.34 to −0.91) decreased the risk of hip fracture [35]. Regarding walking function, adding the multimodal hip exercise to the quadriceps exercise did not offer any advantages over the quadriceps alone [11].

3.4.3.2 Sit to Stand

Figure 3B exhibits three studies (two of high quality [11, 35] and one of low quality [34]), with a total of 178 participants reporting sit-to-stand movement. According to research for the two medial KOA investigations [11, 34], hip exercise was not more effective in improving sit-to-stand performance than quadriceps training (−0.47, 95% CI −1.25 to 0.31). The hip exercise types employed by the subgroups (p 0.02) varied. Unfortunately, there was only weak support for the conclusion that low-intensity resistance [34] (−0.93, 95% CI −1.69 to −0.17) was better than quadriceps training for the sit-to-stand function. Subsequently, data from one study revealed no appreciable improvement in sit-to-stand

Table 4. Quality of evidence for each meta-analysis (GRADE)

Outcome	Meta-Analysis		Risk of Bias	Inconsistency	Indirectness	Imprecision	Level of Evidence
Patient-reported outcomes							
Function	Overall:	Low-intensity resistance; FNM; multi-modal	X	X	X	X	Very low
	Sub-group analysis	Low-intensity resistance	X	X		X	Very low
Physical functional test							
Walk test	Overall:	Low-intensity resistance; FNM; multi-modal		X	X	X	Very low
	Sub-group analysis	FNM			X	X	Low
Sit to stand	Overall:	Low-intensity resistance; FNM; multi-modal		X	X	X	Very low

FNM (functional neuromuscular), PRO (patient-reported outcome), Overall (included all varieties of hip strengthening activities), X* (most studies were of low quality; PEDRO 6). X§ = (I2 ≥ 50%). X denotes clinical heterogeneity, changes in hip exercise prescription, or comparator exercises among the meta-analyzed studies. X = means that the confidence interval, in either direction, was 0.5

function when multimodal hip training and quadriceps exercise were combined (−0.13, 95% CI −0.56 to 0.31) [11].

4 Discussion

The very low-quality data from six trials involving 281 participants with KOA symptoms did not support the pairing of hip exercise with quadriceps to improve functional capacity and quality of life. Compared to quadriceps exercise alone, subgroup analysis of resisted hip and quadriceps activity consistently yielded positive results beneficial for walking. When the hip activity was combined with quadriceps exercise rather than quadriceps exercise alone, the subgroup analysis of people with medial KOA unveiled good functional outcomes.

Compared to hip exercise alone, low-intensity resistance exercise posed a significant and positive impact on function. Functional walking and sit-to-stand performance were also significantly impacted by low-intensity resistance training. The effects of hip exercise on functional neuromuscular quadriceps strengthening were crucial for standing and walking. Exercises using multiple modalities, such as resistance and functional neuromuscular hip exercises, did not consistently produce notable effects.

The findings of this systematic review demonstrate that to achieve better results than quadriceps exercise alone, therapists should consider the kind of hip exercise planned for patients with KOA. In terms of short-term function, hip exercises with a resistance component appeared more advantageous than those that only target the quadriceps. According to a resistance quadriceps report [10], resistance hip exercise in people with accurate KOA revealed benefits for identifiable disability in people who achieved at least a 30% gain in quadriceps strength. Enhancing pelvic descent and trunk control during the standing phase could be accomplished by strengthening muscles, particularly the hip abductors [24]. As a result, the medial knee compartment load increased while the knee adduction moment decreased. It could account for the observed larger benefit in function reported in people with medial KOA and the considerable improvement in walking function relative to others regardless of the type of hip workout program employed.

The improvement in strength brought on by the hip strengthening exercise was substantial for the enhancement in patient-reported function. According to one study, low-intensity resistance training significantly impacted patients' reported function and increased hip abduction strength by 22% [37]. Comparatively, a study uncovering no difference in patient-reported function between multimodal hip training and quadriceps exercise alone only discovered a 9% increase in hip abduction strength. It implies that a bigger improvement in patient-reported function might be linked to a greater change in hip abduction strength [11]. Although programs to strengthen the quadriceps have been demonstrated to improve knee extensor strength, the impact of exercise programs on physical function in people with KOA has been reduced in half [39]. Thus, researchers could not analyze the relationship in this systematic review, which lacked reports of changes in strength over time [19]. However, future studies on hip muscle strengthening should reassess the impact of altered symptoms, function, and quality of life.

On patient-reported functional and quality of life outcomes, low-intensity resistance hip exercise was not more useful than quadriceps exercise alone. However, it could offer greater advantages in sitting, standing up and walking. Functional neuromuscular hip exercise had no additional benefits for functional and quality of life over the quadriceps alone. Furthermore, walking and standing up from a sitting position provided advantages.

There was a slight difference in the results between this study with previous research concerning high-intensity and low-intensity [40]. The fact that only a few studies have been reported in a brief period suggests it can be the case. The KOA determined that low-intensity and high-intensity resistance programs resulted in modest short-term strength gains. In this instance, low-intensity and high-intensity exercises exhibited the same short-term advantages.

A thorough report of the exercise was required to evaluate the heterogeneity between the study and the dummy intervention [31]. In this review, more than 80% of the studies provided information on the exercise, including the technique and tools. Poor reporting was made of motivational techniques, exercise efficacy, program adherence, therapist experience, or therapist caliber. The findings with no statistically substantial distinction between quadriceps and hip exercise combined with quadriceps exercise resulted in ineffectiveness and different levels of compliance [32]. There are several limitations to this study. When identifying types of hip activity other than quadriceps exercise, the value of high-quality evidence was quite low (GRADE). There were inconsistent results, with some interventions supporting only the quadriceps [35, 38]. All time points were within three months or less. The various kinds of quadriceps interventions were only examined in one study. Although KOA is a chronic ailment requiring long-term care techniques to prevent its worsening, there have been reports of radiological diagnoses of KOA with only mild to moderate severity. More studies are required, especially about the short- to long-term effects of functional neuromuscular exercise and hip-focused resistance training in KOA.

5 Conclusion

Except for short-term walking in people with KOA, hip exercises combined with quadriceps exercise did not generally offer greater utility. These outcomes might be influenced by the KOA location and the type of hip intervention (such as resistance) (e.g., medial compartment). Quadriceps strengthening exercise combined with hip resistance training could significantly affect patient-reported outcome function. These results suggest that hip and quadriceps exercises should be provided to people with KOA symptoms, especially those with medial KOA. The impact of hip workouts other than quadriceps exercise and high-intensity hip strength on KOA cases in the long-term effect or follow-up requires further investigation.

Acknowledgments. The authors would like to thank all parties who helped with the research, writing, and editing of this work.

Authors' Contributions. The authors attest that the names of all authors were included in the final manuscript. M.T.N. contributed to the creation of the article by collecting, processing, and writing the data. S.S.P. and A.N.A. reviewed the articles and offered writing and general analytical methodology advice.

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