Effectiveness of supervised resistance training for patients with hip osteoarthritis – a systematic review

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Effectiveness of supervised resistance training for patients with hip osteoarthritis – a systematic review

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ABSTRACT

INTRODUCTION: The overall effectiveness of supervised progressive resistance training among patients with hip osteoarthritis is only scarcely investigated. The objective of this study was to estimate the effectiveness of supervised progressive resistance training compared with common treatment for patients with hip osteoarthritis, focusing on patient-reported function, pain, health-related quality of life, performance-based function at end of treatment and patient-reported function at 6-12 months.

METHODS: This was a systematic review and meta-analysis. A systematic search was performed on 30 January 2019 in eight electronic databases (Medline, Embase, Cochrane, Pedro, AMED, Scopus, SPORTDiscus and Cinahl). The methodology of the included studies and the overall quality of evidence was assessed using the Cochrane Risk of Bias tool and the Grading of Recommendations Assessment, Development and Evaluation approach.

RESULTS: A total of 189 participants with hip osteoarthritis ›50 years of age were included in the three studies. A significant difference in favour of the supervised progressive resistance groups was found in patient-reported function (weighted mean difference (MD) = 9.13 (95% confidence interval (CI): 4.45-13.80)), hip-related pain (weighted MD = 7.83 (95% CI: 2.64-13.02)) and health-related quality of life (weighted MD = 6.80 (95% CI: 1.96-11.63)) at end of treatment. The overall quality of evidence was downgraded to low due to a lack of blinding in the included studies and due to imprecision.

CONCLUSIONS: Supervised progressive resistance training might be of clinical relevance for patients with hip osteoarthritis and was effective in improving patient-reported function, hip-related pain and health-related quality of life. The level of evidence is low and future studies may therefore affect the findings reported herein.

The prevalence of hip osteoarthritis is between 8.5 and 10% and has been ranked the eleventh highest contributor to disability in terms of years lived with hip osteoarthritis [1-3]. Patients with hip osteoarthritis experience pain, functional impairment, poorer quality of life and have a lower adherence to health recommendations on physical activity than healthy adults [4-8]. These patients are known to have hip muscle atrophy and strength deficits that are associated with a low self-reported function and with the clinical severity of the condition [9-12]. To improve functional impairment of patients with hip osteoarthritis, identification of muscle deficits and targeted strengthening interventions may be beneficial [9].

The American College of Rheumatology recommends that patients with hip osteoarthritis participate in resistance training interventions, and 95.9% of the physiotherapists in the United Kingdom offer resistance training to this patient population [13, 14]. Exercise interventions meeting the dose recommendations from the American College of Sports Medicine (two weekly sessions) have been shown to induce large improvements in pain and function among patients with hip osteoarthritis [15]. High-load resistance training (> 60% of 1 repetition maximum (RM)) has shown to be superior to low-load resistance training (< 50% of 1 RM) in inducing muscle strength and hypertrophy [16]. Furthermore, an explorative study showed that individuals with physical limitations may benefit from high-load resistance training [17]. It is recommended that the strength exercises are progressed under the supervision of a health professional in order to minimize exercise-related complications [18]. The overall effectiveness of progressive resistance training targeted at people with hip osteoarthritis is scarcely investigated. The effectiveness of interventions in patients with osteoarthritis is often studied by pooling different types of exercises or by pooling patients with hip or knee osteoarthritis [19-21]. Hence, there is a need to explore the effectiveness of progressive resistance training specifically targeted at people with hip osteoarthritis compared with commonly used practice interventions.

KEY POINTS

- Supervised progressive resistance was effective in improving patientreported function, hip-related pain and health-related quality of life for patients with osteoarthritis of the hip.
- The improvement in patient-reported function indicated a clinical relevance for hip osteoarthritis patients.
- Future studies are needed to strengthen the body of evidence.

SYSTEMATIC REVIEW

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Thus, the purpose of this study was to estimate the effectiveness of supervised progressive resistance training compared with common treatment (without progressive resistance training) in patients with hip osteoarthritis on patient-reported function, hip-related pain, health-related quality of life, performance-based function at the end of treatment and patient-reported function at 6-12 months.

METHODS

Study design and protocol

This study was a systematic review with meta-analysis. The search strategy, study selection, eligibility criteria, methodology assessment, data extraction and analysis were performed in accordance with a predefined protocol (PROSEPRO: CRD42019116485). Study screening, selection of studies, data extraction, assessment of methodology and quality of evidence were performed by two independent reviewers (IM and SH). Disagreements were resolved through a consensus process.

Search strategy and study selection

Electronic databases were searched systematically for primary studies on 30 January 2019 (supplementary material). The electronic databases searched were Medline, Embase, Cochrane, the Allied and Complementary Medicine Database, Pedro Scopus, SPORTDiscus and Cinahl. Other sources included hand-searching of reference lists of systematic reviews or guidelines, grey literature databases and trial registration databases. There were no limits with respect to language or publication year.

After removal of duplicates, the identified studies were screened at title/abstract level, and eligible studies were full-text screened for final inclusion. Reference lists from the full-text studies were also screened for supplementary relevant studies.

Eligibility criteria

Studies meeting the following criteria were included: randomised controlled trials, patients with hip osteoarthritis, supervised progressive resistance training (a minimum intensity of 60% of 1 RM), two weekly supervised exercise sessions for six weeks) compared with common treatment (without resistance training), studies reporting the primary outcome: patient-reported function at end of treatment; and secondary outcomes: hip-related pain, health-related quality of life, performance-based function at end of treatment and at 6-12 months for patient-reported function. The following outcomes measures were eligible:

Patient-reported function

The Hip Disability and Osteoarthritis Outcome Score (HOOS) function scale, The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) physical function scale and The Short Form Health Survey (SF36) physical function scale.

Patient-reported pain

The HOOS pain scale, the WOMAC pain scale, visual analogue scale and the numerical rank scale. Patient-reported health-related quality of life: The HOOS quality of life scale, the SF36 mental scale and the EuroQoL 5 Dimensions (EQ-5D).

Performance-based function

Sit-to-stand test, walking speed and stair test. The exclusion criteria were previous surgery of the affected hip and other types of hip arthritis among participants. Studies involving neuromuscular stimulation or blood-flow-restricted resistance training were excluded.

Methodology assessment

The methodology of the included studies was evaluated using the Cochrane Risk of Bias tool [22]. The risk of bias was rated as low, unclear or high with respect to random sequence generation, allocation concealment, blinding of participants and staff, blinding of outcome assessment, incomplete outcome data, selective reporting and other types of bias. Furthermore, the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was used to evaluate the quality of evidence for each outcome as either low, moderate or high [23].

Data extraction, management and statistical analysis

Study information and data were collected from a predefined form using Covidence [24]. Data collection comprised contacting authors and extraction of data from a previous review [20]. Data management included calculation of mean and confidence interval (CI) from the median and interquartile range using the recommended method from Cochrane [25]. The following data were collected: author, year, country, population characteristics, description of interventions, duration, follow-up, outcome results and ethical approval.

In the Prospero protocol, the standardised mean difference (MD) was planned to compare different outcomes measures. However, the included studies used the HOOS and WOMAC outcome measures, allowing conversion of WOMAC scores to HOOS scores [26] and presentation of MDs for all outcomes.

Effect estimates were calculated as weighted MD. The weighted MD was calculated as the group MDs in endpoint data. Data are reported as the pooled weighted MD with 95% confidence intervals using random-effects models. The I^2 statistics was subsequently calculated to assess the proportion of variation (consistency) in the combined estimates due to between-study variance.

An I^2 value above 50% was considered indicative of substantial heterogeneity. All statistics were calculated using Review Manager 5.3, the Cochrane Collaboration [27].

RESULTS

Search and selection of studies

Three studies were included [28-30]. A summary of the search result and study selection process is provided in a PRISMA flow diagram (**Figure 1**). Furthermore, a list of excluded studies is specified in the supplementary material.

Study characteristics

The characteristics of the included studies are presented in **Table 1**. The studies included 189 participants with hip osteoarthritis > 50 years of age. All studies investigated the effect of supervised progressive resistance training compared with home-based exercises or telephone calls for 6-12 weeks. All three studies reported patient-reported function, pain and health-related quality of life at end of treatment. Only one study reported performance-based function at end of treatment [29] and none of the studies reported patient-reported function at 6-12 months of follow-up.

Quality assessment

The quality assessment of the included studies is presented in **Figure 2**. The studies had a low risk of bias in the majority of the domains; all studies had a high risk of bias in *blinding of participants and staff* and in one study, the risk of bias was unclear in the domain *risk of selective reporting*.

Meta-analysis on patient-reported outcomes at end of treatment

All patient-reported outcomes at end of treatment showed a statistically significant effect in favour of the group undergoing progressive resistance training compared to controls: patient-reported function 9.13 weighted MD (95% CI: 4.45-13.80), hip-related pain 7.83 weighted MD (95% CI:2.64-13.02) and health-related quality of life 6.80 weighted MD (95% CI: 1.96-11.63) (**Figure 3**). Hip-related pain and quality of life differences were measured on a 0-100 scale, 0 representing extreme difficulty and 100 no difficulty. The meta-analysis displayed a heterogeneity (I2) of 0% across all outcomes.

Narrative synthesis on performance-based outcome

Bieler et al [28] found a non-significant change score in favour of the strength-training group compared with the home-based exercise group for the 30-second chair stand test –0.2 (95% CI: –1.0-0.7) and the six-minute walk test –7.0 (95% CI: –25-11).

FIGURE 1 / PRISMA flow chart.

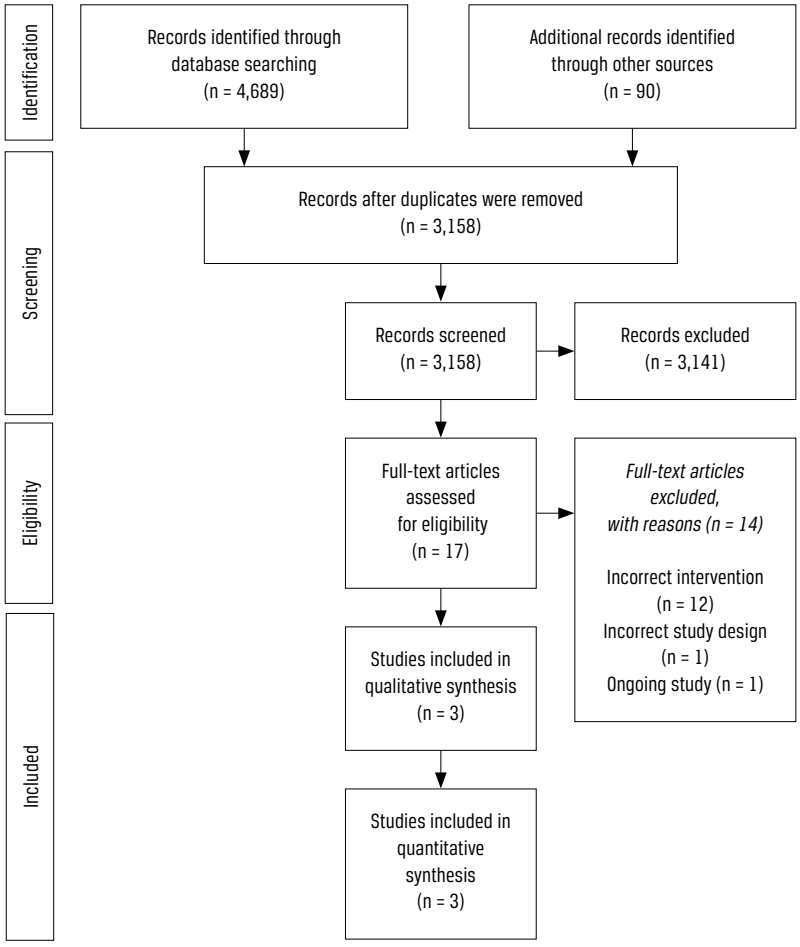
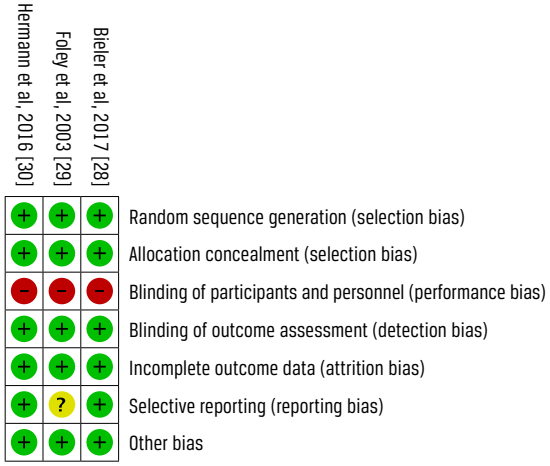


FIGURE 2 / Risk of bias summary, using the Cochrane Risk of Bias tool.



The body of evidence (GRADE)

An evidence profile for each outcome is presented in **Table 2**. The level of evidence was low for all outcomes

TABLE 1 / Characteristics of included studies.

Reference	Method	Participants description	n	Intervention group	Control group	Duration/ follow-up	Outcome reported: tool, scale	Ethical approval?
Bieler et al, 2017 Denmark [28]	RCT	Hip OA according to ARC: Age ≥ 60 yrs Not scheduled for THA	91	Supervised progressive resistance training 3 × a week Target load at 10 RM	Home-based exercises: range of motion, stretching and strengthening exercises without resistance	4 mo.s/EoT	Patient-reported function: HOOS function, 0-100 Hip-related pain: HOOS pain, 0-100 Health-related QoL; HOOS QoL, 0-100 Performance-based function: 30sCS and 6 MW	Yes
Foley et al, 2003 Australia [29]	RCT	Radiologically diagnosed hip OA: Age ≥ 50 yrs Mixed in scheduled or not scheduled for THA	18	Supervised progressive resistance training 3 × a week Target load at 10 RM	Telephone calls every fortnight to record changes in condition, medication use or injuries	6 wks/EoT	Patient-reported function: WOMAC function, 0-68 Hip-related pain: WOMAC pain, 0-20	Yes
Hermann et al, 2016 Denmark [30]	RCT	Clinical and radiological hip OA: Age ≥ 50 yrs Scheduled for THA	80	Supervised progressive resistance training 2 × a week Target load at 8-12 RM	Preoperative information and a home-based exercise programme	10 wks/EoT	Patient-reported function: HOOS function, 0-100 Hip-related pain: HOOS pain, 0-100 Health-related QoL: HOOS QoL, 0-100	Yes

6 MW = 6-min. walk test; 30sCS = 30-second chair stand test; ARC = American college of Rheumatology; EoT = end of treatment; HOOS = Hip disability and Osteoarthritis Outcome Score; OA = osteoarthritis; QoL = quality of life; RCT = randomised controlled trial; RM = repetition maximum; THA = total hip replacement; WOMAC = The Western Ontario and McMaster Universities Osteoarthritis Index.

TABLE 2 / Summary of findings.

	Certainty assessment								Findings	
							patients, n			
Criterion	studies, n	study design	risk of bias	inconsistency	indirectness	imprecision	intervention	control	effect, absolute, MD (95% CI)	quality of evidence
Patient-reported function: EoT	3	RCT	1 serious	None serious	None serious	1 serious	94	95	9.13 (4.45-13.80)	Low
Patient-reported pain: EoT	3	RCT	1 serious	None serious	None serious	1 serious	94	95	7.83 (2.64-13.02)	Low
Patient-reported health-related QoL: EoT	2	RCT	1 serious	None serious	None serious	1 serious	88	83	6.80 (1.96-11.63)	Low

CI = confidence intervals; EoT = end of treatment; MD = mean difference; QoL = quality of life; RCT = randomised controlled trial.

due to risk of bias and imprecision caused by a limited number of participants and different clinical implications of the upper and lower 95% confidence interval.

DISCUSSION

This systematic review and meta-analysis evaluated the effectiveness of progressive resistance training compared with common treatment among patients with hip osteoarthritis. We found a significant effectiveness of supervised progressive resistance training compared with common treatment measured on patient-reported function, hip-related pain and health-related quality of life, and non-significant improvements of performance-based outcomes.

These results correspond to those reported by Goh et al [31], who found a moderate effect of strengthening exercises on patient-reported function, pain, quality of life and performance in patients with osteoarthritis in the hip and knee. Earlier reviews have found a significant effect of different types of exercises on patient-reported function and pain in populations with both hip and knee osteoarthritis [19, 20].

Fransen et al [20] estimated a non-significant effect of combined land-based interventions on quality of life whereas the current meta-analysis showed a significant effect on quality of life. The conflicting results may be explained by the higher intensity in progressive resistance training in fitness machines compared with various types of low-intensity land-based exercises (aerobic exercises, flexibility exercises, resistance with elastic bands, neuromuscular and tai chi exercises). Furthermore, studies in the present meta-analysis on health-related quality of life had an overall high methodological quality compared with studies of low quality in the review by Fransen et al. Only one study in the present review reported performance-based outcomes, and future studies may therefore alter the results considerably.

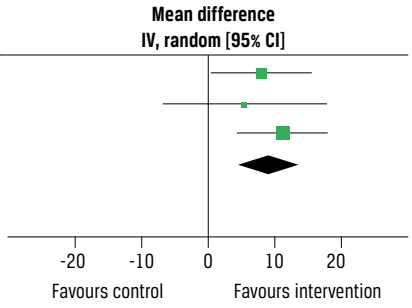
We found an MD of 9.13 in patient-reported function on a 0-100 scale (relative difference 9.13%). To our knowledge, the minimal clinically important im-

FIGURE 3 / Forest plots. Displays pooled weighted mean difference by random effect model for all outcomes: patient-reported function, hip-related pain and patient-reported health-related quality of life at end of treatment.

1.1.1 Patient-reported function, end of treatment

	Intervention			Control				Mean difference
Study or subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, random [95% CI]**
Bieler et al, 2017 [28]	85	12.59	48	77	22.22	43	38.6%	8.00 [0.46-15.54]
Foley et al, 2003 [29]	60.3	10.9	6	54.9	15.3	12	14.5%	5.40 [-6.89-17.69]
Hermann et al, 2016 [30]	59.9	17.1	40	48.7	13.9	40	46.9%	11.20 [4.37-18.03]
Subtotal [95% CI]			**94**			**95**	**100.0%**	**9.13 [4.45-13.80]**

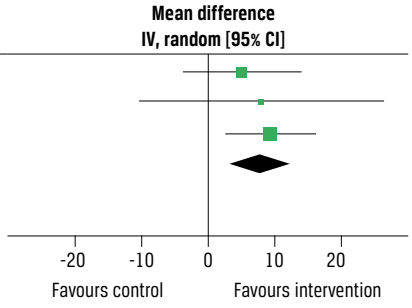
Heterogeneity: tau² = 0.00; chi² = 0.79, df = 2 (p = 0.67); I² = 0%
Test for overall effect: Z = 3.82 (p = 0.0001)



1.3.1 Patient-reported pain, end of treatment

	Intervention			Control				Mean difference
Study or subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, random [95% CI]**
Bieler et al, 2017 [28]	75	17.78	48	70	24.44	43	34.2%	5.00 [-3.87-13.87]
Foley et al, 2003 [29]	55	17.9	6	47.1	20.6	12	7.9%	7.90 [-10.57-26.37
Hermann et al, 2016 [30]	55.4	16.9	40	45.9	14.1	40	57.9%	9.50 [2.68-16.32]
Subtotal [95% CI]			**94**			**95**	**100.0%**	**7.83 [2.64-13.02]**

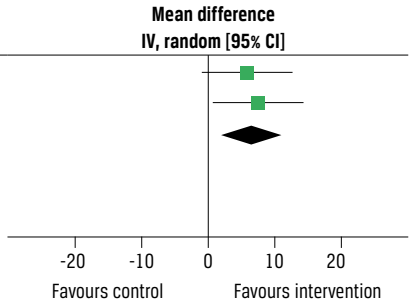
Heterogeneity: tau² = 0.00; chi² = 0.62, df = 2 (p = 0.73); I² = 0%
Test for overall effect: Z = 2.96 (p = 0.003)



1.4.1 Patient-reported health-related quality of life, end of treatment

	Intervention			Control				Mean difference
Study or subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, random [95% CI]**
Bieler et al, 2017 [28]	56	14.07	48	50	18.51	43	50.3%	6.00 [-0.82-12.82]
Hermann et al, 2016 [30]	38.8	17.2	40	31.2	13.9	40	47.9%	7.60 [0.75-14.45]
Subtotal [95% CI]			**88**			**83**	**100.0%**	**6.80 [1.96-11.63]**

Heterogeneity: tau² = 0.00; chi² = 0.11, df = 1 (p = 0.75); I² = 0%
Test for overall effect: Z = 2.76 (p = 0.006)



provements (MCII) have not been investigated in a sample of patients with hip osteoarthritis exclusively. In a pooled sample of knee and hip osteoarthritis patients, a relative MCII of 13 (95% CI: 9-17) on functional disability was estimated [32]. Thus, the present relative change of 9.13% is within in the MCII range which may indicate a clinical relevance for patients with hip osteoarthritis. The results of the present study therefore support the recommendations from the American College of Rheumatology [13] and the continuous use of progressive resistance training in clinical practice.

The American College of Sports Medicine recommended supervision of exercise programmes in order to minimise exercise-related complaints [18]. The level of supervision may have an influence on the results, whereas the revealed MDs may be caused by supervision during exercise as well as the by type of exercise (progressive resistance training). However, the level of supervision ensured a target load of > 60 % of 1 RM in each session.

The strengths of this study include an a priori protocol, an extensive electronic search, hand searching of existing reviews and grey literature. Two authors independently screened for inclusion, extracted data, assessed the methodology of the studies and evaluated the body of evidence in accordance with a prior protocol. All studies were considered without limitations with respect to language, publication year and status (published or unpublished).

The results of the present study are limited to patients with hip osteoarthritis, and the effect of progressive resistance training in the various stages of osteoar-

thritis remains unknown due to lack of data. Future studies should include a subgroup analysis on osteoarthritis stage if data are available. The patients in the three included studies encompass both patients with early and end-stage hip osteoarthritis alike, indicating that progressive resistance training is applicable in all stages of the disease.

The small number of included studies is a limitation. One ongoing study was discovered and an updated future review may alter the results when more studies can be included. In order to strengthen the level of evidence for the effectiveness of progressive resistance training, future studies are warranted. Alternatively, the inclusion criteria in this systematic review may be altered to obtain a larger study sample. In the inclusion process, particularly the study by Sandal et al [33] was noticed investigating the effect of resistance training compared with common treatment comprising two weekly sessions, where only one was supervised. Changing the inclusion criteria for supervision would have increased the study sample and improved the level of evidence. A future systematic review may consider subgroup analysis for different levels of training compliance since a high level of compliance to the exercise regime was associated with significant improvements in pain and function among patients with hip osteoarthritis [15].

Another limitation is the skewed data from one of the included studies [29]. The foundation of a meta-analysis relies on normally distributed data; however, we have used the method recommended by the Cochrane Handbook [25] to include data.

CONCLUSIONS

Supervised progressive resistance training may be of clinical relevance for patients with hip osteoarthritis and was effective in improving patient-reported function, hip-related pain and health-related quality of life. The level of evidence is low, and future studies may therefore affect the findings reported herein.

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