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High-quality research on physical therapy in psoriatic arthritis is needed: a systematic review

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Abstract

Objectives: Although physical therapy is recommended as part of the non-pharmacological management of patients with psoriatic arthritis (PsA), the evidence is still unclear. Therefore, this study aimed to systematically review and appraise the quality of research on physical therapy in the management of patients with PsA.

Methods: In June 2024, a systematic literature search using four different databases (Medline, Embase, Web of Science and the Cochrane Library) was performed to include interventional and observational studies examining physical therapy in patients with PsA (PROSPERO ID 255501). A risk of bias assessment was conducted. Due to the wide variety of interventions and outcomes, a narrative synthesis was used.

Results: Of 9442 abstracts, 15 papers examining physical therapy uptake in clinical practice ($N=2$) and different physical therapy interventions ($N=13$) were included: cardiorespiratory exercises ($N=5$), resistance exercises ($N=2$), therapeutic modalities ($N=4$) and mixed rehabilitation programs ($N=2$). A low risk of bias was scored in only one RCT assessing cardiorespiratory exercises. The well-tolerated 11-week high-intensity interval training resulted in a long-term increase in peak oxygen uptake and a short-term decrease in truncal fat percentage in patients with low disease activity. Resistance training in patients with active disease did not increase muscle strength, but improved functional capacity, disease activity, pain and general health after the intervention. Evidence for other modalities was inconclusive.

Conclusion: High-quality evidence on physical therapy in PsA was scarce. Cardiorespiratory and resistance exercises demonstrated promising results to positively influence cardiometabolic risk as well as disease-related outcomes. Future research on physical therapy in PsA with adequate methodological quality is needed.

Lay Summary

What does this mean for patients?

Although physical therapy is recommended as part of the management of patients with PsA, the scientific evidence is still unclear. Current physical therapy guidelines are mainly supported by research in patients with other rheumatic diseases or based on expert opinion. Therefore, this study aimed to systematically review and appraise the quality of research on physical therapy in patients with PsA. In the results, we discussed 15 studies with different study designs and an overall high risk of bias. Different physical therapy programs (e.g. cardio-training, strength exercises, physiotherapeutic modalities, and mixed rehabilitation programs) were evaluated. We concluded that high-quality evidence on physical therapy in PsA was scarce. Studies assessing cardio-training and strength exercises demonstrated promising results to positively influence risk factors for cardiovascular (e.g. heart infarction) and metabolic diseases (e.g. obesity and diabetes mellitus type II) as well as disease-related outcomes in patients with PsA. More research with adequate study quality on physical therapy in the management of PsA is needed. Especially, the potential of physical therapy treatments to improve residual (non-inflammatory) pain, risk factors for cardiovascular and metabolic diseases as well as physical functioning and participation should be examined in future research.

Keywords: physical therapy, psoriatic arthritis, PsA, systematic review, rehabilitation, spondyloarthropathies, non-pharmacological management, comorbidity.

Key messages

- High-quality evidence on physical therapy in patients with psoriatic arthritis is scarce.
- Cardiorespiratory and resistance exercises demonstrate promising results in patients with psoriatic arthritis.
- More research, with adequate methodology quality, on physical therapy in the management of psoriatic arthritis is needed.

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Introduction

PsA is a heterogeneous chronic inflammatory joint disease affecting 20% of the patients with psoriasis [1–3]. It is characterized by inflammation in the synovium and enthesis as well as skeletal structural damage. PsA presenting symptoms are pain and stiffness often leading to loss of functioning and fatigue [1, 2]. The last decades, there is more insight in the high comorbidity burden including cardiometabolic risk factors and diseases as well as psychological comorbidities [4–7]. Moreover, cardiometabolic risk factors are impacting disease management, worsening the patients' clinical status and might be associated with the onset of PsA [8–17]. Together, PsA with its associated conditions is negatively influencing health-related quality of life [11, 18, 19].

PsA management consists of both a pharmacological and non-pharmacological approach. For longtime, most attention and importance were given to research on pharmacological treatment options for PsA resulting in multiple new pharmacological options nowadays. In contrast, only limited research is focusing on non-pharmacological aspects such as regular exercise and physical therapy, despite the fact that these treatment options are largely recommended by leading professional societies in rheumatology (e.g. EULAR, Group for Research and Assessment of Psoriasis and Psoriatic Arthritis and ACR) [13–15]. The World Confederation for Physical Therapy defines physical therapy as follows 'services provided by physical therapists to develop, maintain and restore maximum movement and functional ability throughout the lifespan' [20]. In addition, scientific cardiology societies from all over the world are highlighting the importance of a non-pharmacological approach to tackle cardiometabolic risk factors in the general population [21, 22]. Education, regular physical activity, smoking cessation, a healthy diet, mental healthcare and bodyweight management are crucial to lower cardiometabolic risk [21, 22].

At present, recommendations for the non-pharmacological management of rheumatic and musculoskeletal diseases (RMDs) are limited to management principles and the evidence base for physical therapy treatment in PsA is unclear [13–15, 23–29]. Hence, a summary of the available evidence on physical therapy in the management of patients with PsA is needed. Therefore, this study aims to systematically review and appraise the quality of research on physical therapy in patients with PsA.

Methods

This systematic review was conducted in accordance with the methods of the Cochrane Handbook for Systematic Reviews of Interventions where appropriate and was reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist [30–32]. The protocol was prospectively registered at the PROSPERO database (ID 255501).

Eligibility criteria

Papers examining physical therapy (according to the definition of the World Confederation for Physical Therapy) in patients with PsA with a minimum age of 18 years were included [20]. Diagnosis of PsA was mandatory confirmed by a physician or by classification criteria. All eligible quantitative studies, interventional and observational, with a full-text paper written in English or Dutch were included without restrictions regarding the publication year. The outcomes of interest were disease activity, physical fitness, pain, function, symptoms, physical activity and quality of life.

Search strategy and study selection

A systematic literature search was performed from inception to June 2024 using four different electronic databases: Medline, Embase, Web of Science and the Cochrane Library. A search string was developed using Mesh Terms for PubMed and Cochrane and Emtree terms for Embase completed with free-text entries. 'Psoriatic arthritis' and synonyms were combined with 'physical therapy' OR 'physical activity' OR 'physical fitness' supplemented with related topics of these concepts. The PICO search strategy and full search string are available in Supplementary Data S3, available at *Rheumatology Advances in Practice* online. During the search, no filters or limits were used to make sure no eligible titles were left out.

The search results of the four online databases were imported in biographic software (EndNote 20, Clarivate, UK), where a deduplication process was performed. After deduplication, the eligible papers were exported to Rayyan QCRI, an online collaborative tool to review papers [33]. First, title and abstract were screened for eligibility by two blinded reviewers (M.K. and T.W.S.). Conflicts were discussed until consensus was reached and involvement of a third rater was not needed. Thereafter, a full-text analysis was performed by two reviewers (M.K. and T.W.S.). Additional eligible studies were added from screening references of screened articles.

Due to the extensiveness of the search, the research group decided to report only studies discussing a physical therapy approach in PsA in this review article. The other topics, physical activity and fitness in PsA, will be reported in a separate review article to allow sufficient in-depth discussions of all three topics.

Risk of bias assessment

Risk of bias of the quantitative studies was independently assessed by reviewers (M.K. and T.W.S.). The Revised Cochrane risk-of-bias tool for randomized trials (RoB2) was used to appraise the quality of randomized controlled trials (RCTs) [34]. The Newcastle-Ottawa Scale (NOS) was used to assess risk of bias in cross-sectional studies [35]. There is no exact cut-off to determine whether a study is of low or high quality, as all items of the NOS are weighted the same. However, a study with a score of seven or more is generally considered to have low risk of bias [36]. For single-group intervention studies, the NOS was supplemented by a modified RoB2 consisting of domain two and the first question of domain four.

Data extraction and synthesis methods

Data of the included articles were extracted into a spreadsheet (Excel version, Microsoft, USA) by two reviewers (M.K. and T.W.S.). The following parameters were gathered in the table: study characteristics (author, publication year, study design, and risk of bias (RoB)), the intervention, patient characteristics (recruitment method, diagnostic criteria, number of patients, age, proportion of female patients, disease activity and disease duration), outcome parameters and effect of the studied intervention on these parameters (disease

activity, physical fitness, pain, function, symptoms, physical activity and quality of life).

A meta-analysis was not possible due to the wide variety of interventions and outcomes. Therefore, a narrative synthesis was performed according to the following topics: physical therapy interventions (cardiorespiratory exercises, resistance exercises, physiotherapeutic modalities and mixed rehabilitation programs) and physical therapy uptake in clinical practice. Due to extensiveness of data, for RCTs, only significant between-group statistics were presented in the table. For single-group intervention studies, significant within-group statistics were extracted into the table. For cross-sectional studies, the descriptive statistics presenting physical therapy uptake in clinical practice were collected in the table. Overall, quantitative data were presented as mean (standard deviation), except when specifically indicated as mean (95% confidence interval) or median (interquartile range). In the main text, significant quantitative data of the primary study outcome(s), if specified, were described. Significant quantitative data of secondary outcome measures were presented in the table in Supplementary Data S1, available at *Rheumatology Advances in Practice* online.

Results

Study selection

The systematic literature search resulted in 12 472 records (Fig. 1). After deduplication, a total of 9442 abstracts were retrieved, of which 511 abstracts were selected for full-text analysis. Ultimately, 59 papers published between 1994 and 2024 were identified, of which four papers were added from screening references. Fifteen papers discussing physical therapy as part of the management of PsA were included in this review.

Study characteristics and risk of bias assessment

A summary of study characteristics and findings is presented in Table 1 and a complete data overview of the individual studies is available in Supplementary Data S1, available at *Rheumatology Advances in Practice* online. Physical therapy interventions were examined in 13 studies of which ten were RCTs and three were single-group intervention studies. The reported physical therapy interventions were cardiorespiratory exercises ($N = 5$), resistance exercises ($N = 2$), physiotherapeutic modalities ($N = 4$) and mixed rehabilitation programs ($N = 2$) [37–49]. The intervention studies had a median sample size of 41 patients with PsA (Min-Max: 9–166). Two studies with a cross-sectional design evaluated physical therapy uptake in clinical practice [50, 51].

Overall, risk of bias was high in the physical therapy intervention studies, except in one RCT that scored low risk of bias and one RCT that had some concerns (Fig. 2). The risk of bias scores of the individual studies are presented in Supplementary Data S2, available at *Rheumatology Advances in Practice* online. Risk of bias was mainly increased due to selection bias or insufficient described recruitment process, an insufficient randomization process, the lack of blinding possibilities of the physical therapy interventions, and the use of non-validated and/or patient-reported outcomes [37–48].

Physical therapy intervention

Cardiorespiratory exercises (N = 5)

The effect of 11-week high-intensity interval training (HIIT) in PsA-patients with low disease activity ($N = 30$) versus a control group ($N = 31$) was studied by one Norwegian research group and reported in four different papers [37, 38, 40, 41]. Eleven-week HIIT was associated with a substantial increase in the primary outcome peak oxygen uptake (baseline mean both groups: 29.51 ml/kg/min (95% CI 27.97–31.05)) with a mean between-group difference of 3.72 ml/kg/min (95% CI 2.38–5.06, $P < 0.001$) and, secondary, a reduction in truncal fat percentage at 3 months (RCT, RoB: low, data presented in Supplementary Data S1, available at *Rheumatology Advances in Practice* online) [37]. In addition, a long-term effect on the increase of peak oxygen uptake at 9 months with a mean between-group difference of 3.08 ml/kg/min (95% CI 1.63–4.53, $P < 0.001$) was reported [37]. The authors conclude that HIIT was well tolerated in patients with PsA with no deleterious effect on peripheral and axial disease activity evaluated by patient global assessment, clinical examination as well as by ultrasound and magnetic resonance imaging (RCT, RoB: high). An Italian study assessing a 12-week home-based aerobic exercise program (circuit training, twice a week) in PsA-patients with minimal disease activity ($N = 30$) reported high adherence rate of 76.6% [39]. No significant effects on the main study outcomes, disease activity and quality of life, were noted, but SF-36 bodily pain was reduced after the exercise program (see Supplementary Data S1, available at *Rheumatology Advances in Practice* online) [39].

Resistance exercises (N = 2)

The effect of a 12-week resistance training program using weight machines for upper limbs, lower limbs, and trunk according to the American College of Sports Medicine (ACSM) training guidelines was examined in PsA-patients with active disease ($N = 20$) versus a waitlist control group ($N = 21$) [42]. The resistance program was effective in improving the primary outcome functional capacity (HAQS: IG-baseline 0.72 (0.45), IG-week12 0.45 (0.43), between-$P = 0.048$). Secondary, significant beneficial effects on disease activity, pain, and general health were observed after 12 weeks training (RCT, RoB: high). By contrast, no overall significant improvement in muscle strength was observed, except for leg extension of the right leg [42]. A similar study comparing programs using elastic bands ($N = 20$) to weight machines ($N = 21$) with the same exercise repertoire and sets showed equal results for both groups (RCT, RoB: some concerns) [43]. Adherence was high for both programs with a frequency of 83.4% for the functional training and 91.7% for the resistance training [43]. Both training programs were equally effective in improving functional capacity, disease activity, pain, muscle strength, and quality of life after 12 weeks of training [43].

Physiotherapeutic modalities: physical agents, electrotherapeutic, and mechanical modalities (N = 4)

Physiotherapeutic modalities, i.e. application of physical agents, electrotherapeutic, and mechanical modalities, were examined in four studies [44–47]. All studies had a high risk of bias, analysed a small number of patients (except one study), and reported a wide range of outcomes without specifying the primary outcome (data presented in Supplementary Data S1,

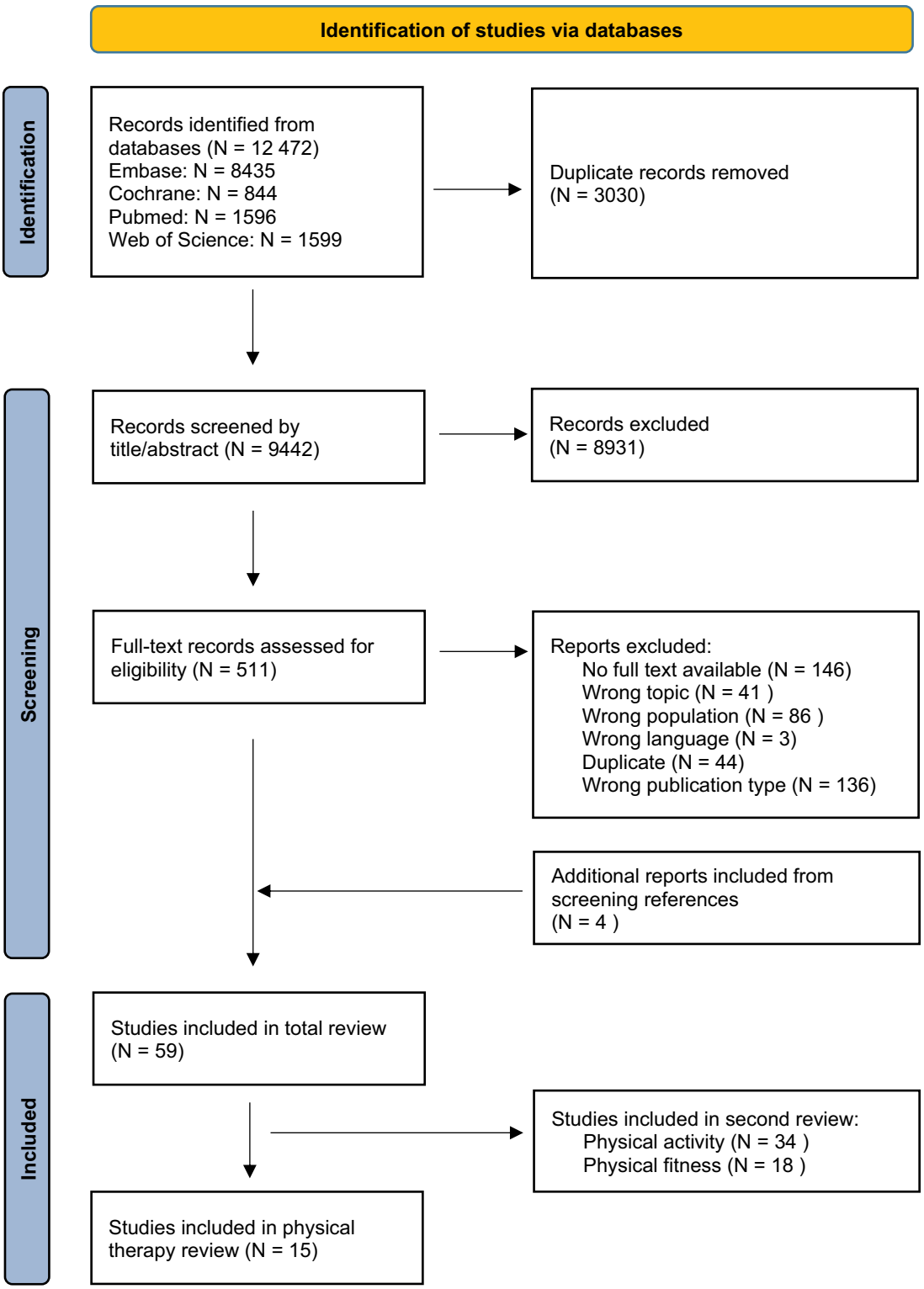

Figure 1. PRISMA flow diagram of the study selection process

available at *Rheumatology Advances in Practice* online). Two-week mud-bath therapy ($N = 18$) in addition to anti-TNF therapy (control group $N = 18$) was examined in patients with low to moderate disease activity (RCT, RoB: high) [44]. At 45 days, this therapy resulted in a significant improvement of musculoskeletal and skin disease activity, residual synovial inflammation on contrast-enhanced ultrasound, patient global, physical function, and quality of life (data presented in Supplementary Data S1, available at *Rheumatology Advances in Practice* online). Next, a 3-week add-on balneotherapy program ($N = 146$) in addition to sun exposure and bathing in the Dead Sea (control group $N = 20$) improved musculoskeletal and skin disease activity, hand grip strength, presence of pain in the cervical, thoracic and lumbar spine, mobility of the lumbar spine, and ADL (RCT, RoB: high, data presented in Supplementary Data S1, available at *Rheumatology Advances in Practice* online) [45].

Table 1. Summary of physical therapy interventions in PsA

Study design	Risk of bias	Patient characteristics	Study results						
		N *Disease activity (baseline)*	*Disease activity*	*Physical fitness*	*Pain*	*Function*	*Symptoms*	*Physical activity*	*Quality of life*
Cardiorespiratory exercises									
Thomsen (2018) [37]: HIIT *vs* control group									
RCT	Low	IG: 30 CG: 31 Low	NI	↑: **VO_2max** (3M and 9M) ↓: truncal fat% (3M) ns: truncal fat% (9M), HR, total fat%, BMI, lean muscle mass	NI	NI	NI	NI	NI
Thomsen (2019) [38]: HIIT *vs* control group									
RCT	High	IG: 32 CG: 35 Low	ns: **PGA (VAS)**, DAS-44, ASDAS-CRP, hsCRP	NI	ns: pain intensity (VAS)	NI	ns: fatigue-VAS	NI	NI
Thomsen (2023) [41]: HIIT *vs* control group									
RCT	High	IG: 32 CG: 35 Low	ns: US joint, US entheses, MRI BME SIJ, MRI BME spine	NI	NI	NI	NI	NI	NI
Chronaiou (2022) [40]: HIIT *vs* control group									
RCT	High	IG: 19 CG: 20 Low	ns: **MRI BME spine, MRI SPARCC scoring**	NI	NI	NI	NI	NI	NI
Chimenti (2014) [39]: home-based aerobic exercises									
Single-group intervention study	High	30 Low	ns: **PGA**	NI	↓: SF-36 bodily pain ns: Pain VAS	ns: SpA-HAQ	NI	Correlation: PA-level with SpA-HAQ and subdomains SF-36	ns: **global health, SF-36**
Resistance exercises									
Roger-Silva (2018) [42]: resistance exercises *vs* waiting list control group									
RCT	High	IG: 20 CG: 21 Active disease	↓: BASDAI ns: DAS28	↑: 1RM leg extension R ns: other 1RM	↑: SF-36 bodily pain	↓: **HAQS** ns: BASFI	NI	NI	↑: SF-36 general health ns: SF-36 other domains
Roger-Silva (2023) [43]: functional *vs* resistance exercises									
RCT	Some concerns	IG: 20 CG: 21 Active disease	ns: BASDAI, DAS28	ns: 1-RM	ns: SF-36 bodily pain	ns: **HAQS**, BASFI	NI	NI	ns: SF-36
Physiotherapeutic modalities: physical agents, electrotherapeutic, and mechanical modalities									
Cozzi (2015) [44]: mud-bath therapy *vs* control group									
RCT	High	IG: 18 CG: 18 Low to moderate	↓: **PASI, DAS28, SJC, TJC, VAS,** CEUS synovial washout rate ↑: CEUS synovial appearance time ns: **CRP**, other CEUS (peri)synovial	NI	NI	↓: HAQ	NI	NI	↑: SF-36 PCS, SF-36 MCS

(continued)

Table 1. (continued)

Study design	Risk of bias	Patient characteristics	Study results						
		N *Disease activity (baseline)*	*Disease activity*	*Physical fitness*	*Pain*	*Function*	*Symptoms*	*Physical activity*	*Quality of life*
Sukenik (1994) [45]: balneotherapy (IG) + sun exposure and bathing in the Dead Sea (IG and CG)									
RCT	High	IG: 146 CG: 20 NI	No between-group analysis						
Walker (2006) [46]: interferential current treatment									
Single-group intervention study	High	9 Moderate	↓: physician global, morning stiffness, TJC ns: PGA, SJC, ESR, CRP, radiographs, MRI, bone scan	NI	↑: SF-36 body pain ns: VAS	NI	NI	NI	ns: SF-36 MCS, SF-36 PCS
Elkayam (2000) [47]: balneotherapy (IG) + sun exposure and bathing in the Dead Sea (IG and CG)									
RCT	High	IG: 23 CG: 19 Moderate	↓: TJC, SJC ns: morning stiffness, PGA, PASI, ESR	ns: grip strengths	↓: presence of neck and back pain	ns: Schober test, bending forward	NI	NI	NI
Mixed rehabilitation exercises									
Patrascu (2018) [48]: standard therapy + physical therapy *vs* standard therapy									
RCT	High	IG: 60 CG: 60 NI	NI	NI	NI	↓: HAQ-DI (24 W)	↑: FACIT-fatigue (vitality) (16 W-24W)	NI	↓: DLQI-physical pain (16 W-24W) ↑: SF-36 PCS (16 W) ns: SF-36 MCS
Bilberg (2022) [49]: weight-loss treatment with very low energy diet + individual physical activity counselling									
Single-group intervention study	High	Cases: 41 Controls: 42 (non-PsA) Low to moderate	NI	↓: **timed stand test;** body weight; BMI; waist circumference; total fat mass; total, arm, and leg lean mass ↑: VO_2 (ml/kg/min) ns: **hand grip strength**, VO_2 (l/min)	ns: hand pain	NI	NI	↑: Saltin-Grimby physical activity scale	↑: SF-36 PCS

Summary of outcome measures: significant increase (↑), significant decrease (↓) or non-significant difference (ns) of parameters according between-group analysis for RCTs or within-group analysis for single-group intervention studies. Primary outcome measures are presented in **bold**.
%: percentage; 1 RM: one repetition maximum; ASDAS-CRP: AS Disease Activity Score with CRP; BME: bone marrow oedema; CEUS: contrast-enhanced ultrasound; CG: control group; DAS28: Disease Activity Score 28; DAS-44: Disease Activity Score 44; DLQI: Dermatology Life Quality Index; ESR: erythrocyte sedimentation rate; FACIT-fatigue: Functional Assessment of Chronic Illness Therapy—Fatigue Scale; HIIT: high intensity interval training; HR: heart rate; hsCRP: high sensitivity CRP; IG: intervention group; kg: kilogram; l: litres; M: months; min: minutes; ml: millilitres; *N*: number; NI: no information; PA: physical activity; PASI: Psoriasis Area Severity Index; PGA: patient global assessment; R: right; RCT: randomized controlled trial; SF-36 MCS: 36-item Short Form Health Survey mental component summary; SF-36 PCS: 36-item Short Form Health Survey physical component summary; SF-36: 36-item Short Form Health Survey; SIJ: sacro-iliacal joint; SJC: swollen joint count; SPARCC scoring: Spondyloarthritis Research Consortium of Canada; TJC: tender joint count; US: ultrasound; VAS: visual global assessment; VO_2max: maximal oxygen uptake; W: weeks.

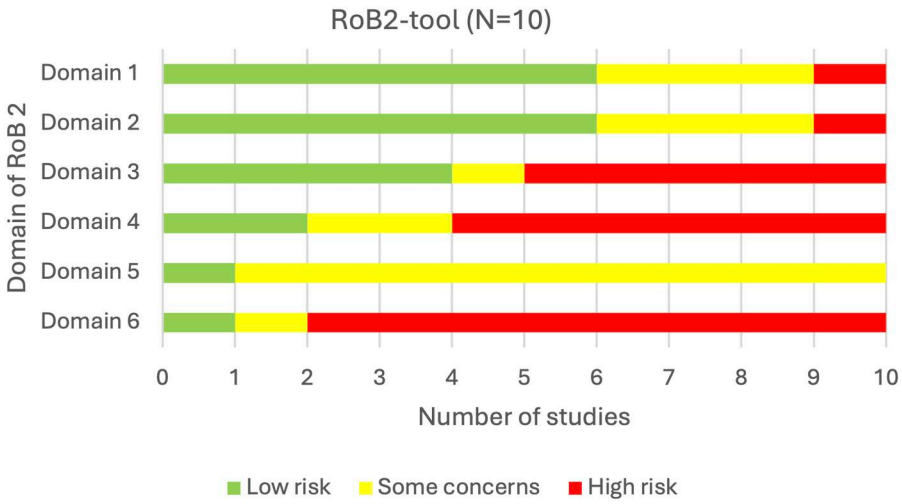

Figure 2. Risk of bias assessment using the RoB2-tool of the included RCTs ($N = 10$). Domain 1: randomization process; domain 2: deviations from intended interventions; domain 3: missing outcome data; domain 4: measurement of the outcome; domain 5: selection of the reported result; domain 6: overall bias

Although inclusion of a small control group, between-group analysis was not performed. Another add-on balneotherapy program during 4 weeks ($N = 23$) in addition to sun exposure and bathing in the Dead Sea (control group $N = 19$), examined in patients with moderate disease activity, resulted in a significant improvement in tender and swollen joint count, and presence of neck and back pain (original quantitative data only presented in graphs, RCT, RoB: high) [47]. Lastly, a 16-week interferential current treatment in nine patients with moderate disease activity suggested beneficial effects on physician assessed disease activity, duration of morning stiffness, tender joint count, and pain (data presented in Supplementary Data S1, available at *Rheumatology Advances in Practice* online) [46]. A control group was not included in the study protocol (single-group intervention, RoB: high).

Mixed rehabilitation programs (N = 2)

Physical therapy combined with pharmacological TNFα-inhibition treatment (adalimumab, $N = 60$) had beneficial short-term effects (<6 months) on physical function, pain, and fatigue in patients with PsA compared with TNFα-inhibition treatment (adalimumab) alone (control group $N = 60$, original quantitative data was only presented in graphs, RCT, RoB: high) [48]. However, the content of the physical therapy treatment was not specified. The effect of a weight-loss treatment of 12 months with very low-energy diet combined with individual physical activity counselling in obese patients with PsA with low to moderate disease activity ($N = 41$) was examined (single-group intervention, RoB: high) [49]. The program resulted in significant beneficial effects on the timed stand test as the main outcome measure (*median (IQR)*: PsA-baseline 26.9 (22.1, 35.4), PsA-M12 23.2 (19.4, 30.4), $P < 0.001$), but no significant change in the second main outcome handgrip strength was observed. Secondary, after the diet and physical activity intervention, significant improvements on body composition, VO_2 divided by body weight, physical activity level, and quality of life were noted (see Supplementary Data S1, available at *Rheumatology Advances in Practice* online). The outcomes were not compared to a PsA control group, but to an obese non-PsA control group who received the same intervention.

Physical therapy uptake in real clinical practice (N = 2)

Physical therapy uptake in clinical practice has only been examined in two studies (for details, see Supplementary Data S1, available at *Rheumatology Advances in Practice* online) [50, 51]. In India, a cross-sectional survey carried out in multiple rheumatology centres revealed that only 14% of the patients with PsA (total: $N = 262$) had seen a physical therapist in the last 12 months and 64% had never seen a physical therapist (RoB: high) [50]. In Serbia, a retrospective analysis concluded that 100% of the studied PsA population (total: $N = 162$) followed physical therapy as part of their PsA treatment (RoB: high) [51].

Discussion

This study aimed to systematically review the effect and quality of physical therapy in the management of PsA. Despite physical therapy is largely recommended, only 15 studies fulfilled our inclusion criteria. Thirteen studies investigated different physical therapy interventions and two studies described physical therapy uptake in clinical practice. The studies have various study designs, heterogeneous outcome measures, and a high overall risk of bias, except one RCT assessing cardiorespiratory exercises [37]. A second RCT examining functional versus resistance training had minor concerns according to the RoB2-tool [43]. Consequently, conclusions about physical therapy management in PsA must be interpreted with caution.

Training programs consisting of HIIT, resistance and functional training hint on promising and clinically interesting results in patients with PsA. First of all, these training programs were safe and well tolerated, as there was no deleterious effects on peripheral and axial disease activity [37, 38, 40–43]. Good tolerance of moderate to high intense aerobic and resistance exercise programs was already demonstrated in patients with RA and axial spondylarthritis (axSpA) [52–56]. In PsA-patients with low disease activity, the increase in peak oxygen uptake after 11-week HIIT training was comparable and slightly higher compared with the ExeHeart trial and ESPA-study assessing HIIT in patients with RMDs and axSpA, respectively [54, 56]. The ExeHeart trial, in which

HIIT was performed in primary care setting, also evaluated a long-term increase on VO_2peak, but no effects on pain, fatigue, and body composition [56]. The ESPA study, combining HIIT with high intense resistance training, reported estimated VO_2peak values, which were higher at baseline, and did not include a long-term evaluation [54]. Similar to the short-term decrease in truncal fat percentage observed in the HIIT-study of Thomsen *et al.*, the ESPA-study showed a significant decrease in waist circumference [37, 54]. Moreover, a short-term significant improvement in fatigue was noted in the ESPA study, which was not confirmed in the HIIT-study of Thomsen *et al.* [38, 57]. However, the threshold for clinical relevance was reached [38].

Despite design peculiarities, resistance and functional training programs showed promising results with improvement of functional capacity, disease activity, pain, and quality of life after 12 weeks training [42, 43]. No significant effects were observed for the secondary outcome muscle strength, but the chosen resistance of 60% of one repetition maximum (due to inclusion of a sedentary population) might have been insufficient to increase muscle strength [42]. The interesting finding that using elastic bands was equally effective as weight machines facilitates the implementation of resistance training in clinical practice [43]. Compared with RA, a meta-analysis of moderate to high intense resistance exercise programs with a duration ranging between 3 and 104 weeks concluded reduction of disease activity, while no difference was observed in physical function assessed by HAQ [55]. The effect on muscle strength was not evaluated in this meta-analysis. Lastly, low methodological study quality hinders firm conclusions about physiotherapeutic modalities interventions and mixed rehabilitation programs in PsA.

This low methodological study quality was an important first concern. First of all, the recruitment process often facilitated the selection of motivated patients by using local advertisements or was left unreported. Secondly, due to the nature of rehabilitation programs, where blinding to group allocation is almost impossible, it is remarkable that few studies included a blinded assessor and the majority focused on patient-reported outcomes only. According to the principles of exercise physiology, it is unlikely that interventions with a duration of maximum 3 months and no boost session to support the maintenance phase can actually result in meaningful long-term clinical outcomes [58]. Last, trial design aspects such as appropriate sample sizes, inclusion of trustworthy control groups, and adherence to reporting guidelines (e.g. disease-related information) would improve generalizability of future results.

Another concern is the content of the studied physical therapy interventions. Today, the improved pharmacological treatment options are targeting disease activity more effectively which results in better control of symptoms, less severe structural damage and less disability in ADL [59]. However, residual (non-inflammatory) pain and remaining cardiometabolic risk factors in patients with PsA are still an unmet need in PsA and were not addressed in the reviewed interventions [6, 9–17, 60]. Despite the high prevalence of psychological comorbidities in PsA, limited attention was given to mental health comorbidities and outcomes in the included studies. For example, previous research in RMDs has already highlighted the importance of targeting fear of movement, injury beliefs and widespread pain to optimize patient outcomes [61–67]. We propose that future physical therapy research in PsA will further include physical activity and exercise programs, because of their known beneficial effects on cardiometabolic risk factors as well as on musculoskeletal pain in the general population and in RMDs [21, 54, 56, 68–70]. Furthermore, incorporating the biopsychosocial model of care is needed to address unmet needs in PsA, e.g. residual pain, mental health and cardiometabolic risk.

Two included studies reported real-life data of the uptake of physical therapy in the management of PsA with various numbers of physical therapy use and without description of the goals and content [50, 51]. EULAR, ACR and Group for Research and Assessment of Psoriasis and Psoriatic Arthritis treatment recommendations encompass several statements about non-pharmacological interventions [13–15]. Physical therapy is particularly advised to manage axial disease and enthesitis, but the exact content of the recommended treatment is not provided. Since high-quality evidence in patients with PsA is scarce, recommendations are mainly supported by evidence in patients with osteoarthritis, RA, and axSpA, or based on expert opinion. Occasionally, patients with PsA are part of the included mixed RMD-population, but the published results do not distinguish between different RMDs [71–74]. Distinction between the results of different RMDs is recommended. After all, PsA is a heterogeneous disease with specific disease characteristics that might impact the feasibility, safety, and outcomes of physical therapy interventions: e.g. skin lesions and inflammation; cardiometabolic risk profile already present in early disease or even before disease onset; presentation of enthesitis, peripheral and axial disease; and potential impact of mechanical loading in the pathogenesis of spondylarthritis [1, 2, 6, 8, 10, 12, 75, 76]. Further research should clarify if evidence in patients with other RMDs might be extended to patients with PsA. Additionally, future research on identification of patient profiles in PsA based on their dominant disease type, musculoskeletal and skin disease activity level, the presence and type of comorbidities, and the presence of psychosocial factors might be necessary. It will enhance the design of targeted interventions to address the management needs of each patient profile.

Some strengths and limitations of this systematic review should be discussed. We performed a broad search examining physical therapy, physical activity, and physical fitness in PsA to create a complete overview of the available literature. To discuss each topic thoroughly, only papers examining physical therapy in PsA were reported in this systematic review. Papers examining physical activity and fitness will be discussed in a separate review article. The broad search contributed to heterogeneous outcomes and interventions which complicated analysis and synthesis of the results. With a great interest in the management of patients with PsA, we have only included papers reporting results of PsA-patients separately. Consequently, interesting physical therapy studies might have been missed as study populations often consist of mixed RMD-populations. Nevertheless, we have strengthened the methodological quality of this systematic review by conducting and reporting according to the recommended guidelines and by prospectively registering the protocol at the PROSPERO database.

To conclude, high-quality evidence on physical therapy in PsA was scarce. Cardiorespiratory, resistance and functional exercises demonstrated promising results to positively influence cardiometabolic risk factors as well as disease-related outcomes in patients with PsA. Evidence for other physical

therapy modalities was inconclusive. Future physical therapy research in PsA with adequate methodological quality is needed to support clinical guidelines for PsA management.

Supplementary material

Supplementary material is available at *Rheumatology Advances in Practice* online.

Data availability

Data are available on reasonable request to the corresponding author.

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