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Research Article

A Retrospective Cohort Study of physical therapy rehabilitation in pediatric rheumatology patients with osteoarthritis

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Abstract

Background: Secondary osteoarthritis is a recognized long-term consequence of juvenile idiopathic arthritis, arising from years of synovitis and altered joint loading in a growing skeleton, and its rehabilitation needs combine standard pediatric physical therapy goals with joint-protection priorities familiar from adult osteoarthritis care.

Objective: This retrospective cohort study describes physical therapy rehabilitation modalities and functional outcomes in pediatric rheumatology patients with osteoarthritis secondary to chronic inflammatory arthropathy.

Methods: We reviewed physical therapy and rheumatology records for patients aged 6-17 years completing at least 12 weeks of structured rehabilitation combining land-based exercise, hydrotherapy, and home programs, with outcomes assessed by goniometry, strength testing, the Childhood Health Assessment Questionnaire, and pain scores.

Findings: Patients showed gains in range of motion, strength, and functional disability at completion, largest among those beginning rehabilitation earlier, maintaining higher adherence, and receiving combined hydrotherapy and land-based programs; knee-involved patients improved most consistently, hip-involved patients least, and better disease control was associated with larger response.

Conclusions: Structured, adherence-supported physical therapy produces meaningful functional and pain benefit in pediatric secondary osteoarthritis, supporting earlier structural screening and closer integration of disease control with therapy referral.

Keywords: juvenile idiopathic arthritis; secondary osteoarthritis; physical therapy; pediatric rehabilitation; hydrotherapy

1. Introduction

Osteoarthritis in the pediatric rheumatology clinic is rarely a primary diagnosis; it is overwhelmingly secondary to chronic inflammatory joint disease, most often juvenile idiopathic arthritis (JIA), where repeated synovitis and altered joint loading accumulate over years of growth into structural change resembling adult osteoarthritis decades early [1,2]. Myers and colleagues, following a cohort of JIA patients with long disease duration, documented that a substantial minority developed secondary structural joint damage before skeletal maturity, particularly in weight-bearing joints [3]. Because this damage develops on a growing skeleton, growth plates, muscle-tendon units, and gait all evolve together, and the child's functional trajectory, not pain control alone, becomes the central outcome physical therapy is asked to protect.

Physical therapy has occupied a central, if historically underappreciated, role in pediatric rheumatic disease management. Early anxiety about exercise aggravating inflamed joints delayed structured activity programs for decades, but consistent evidence has since shown that supervised, appropriately dosed exercise improves strength, aerobic capacity, and joint function without provoking flares [4,5,6]. This is especially relevant to children with secondary osteoarthritic change, whose rehabilitation needs combine standard JIA physical therapy goals with the joint-protection priorities familiar from adult osteoarthritis care.

This retrospective cohort study examines physical therapy rehabilitation outcomes in pediatric rheumatology patients with osteoarthritis secondary to chronic inflammatory arthropathy, describing modalities used, functional and pain outcomes, and characteristics associated with response, situated within the broader literature on exercise therapy, hydrotherapy, and strength training in juvenile arthritis.

2. Background: secondary osteoarthritis in juvenile idiopathic arthritis

The pathway from chronic synovitis to secondary osteoarthritis in children is mechanistically distinct from adult primary osteoarthritis but clinically convergent with it. Persistent synovial inflammation drives pannus formation and cartilage matrix degradation, while asymmetric loading from pain avoidance and muscle weakness accelerates focal cartilage wear [1]. Bertilsson and colleagues, following a population-based juvenile chronic arthritis cohort for 17 years, found that a meaningful proportion of patients accumulated radiographic damage consistent with secondary osteoarthritis by early adulthood, with knee and hip involvement most strongly associated with long-term limitation [7]. Swart and colleagues' review of JIA immunobiology underscores that cartilage injury is an active, cytokine-driven process that continues even during apparent clinical quiescence, which is part of why rehabilitation must be sustained rather than episodic [8].

Gait and biomechanical studies clarify how this damage becomes functional impairment. Broström and colleagues used three-dimensional gait analysis to show that children with knee involvement walk with reduced knee flexion during swing phase and compensatory hip and ankle strategies that persist after inflammatory markers normalize, consistent with structural rather than purely inflammatory compromise [9]. Houghton's review of pediatric hip pain notes that hip involvement in JIA frequently progresses silently, with imaging changes preceding symptoms, with direct implications for when physical therapy assessment should be triggered [10]. Temporomandibular joint involvement follows an analogous course; Hulsege and colleagues note it is likewise often asymptomatic until growth disturbance is already present, reinforcing that clinicians need standardized functional screening rather than symptom-triggered referral alone [11].

3. Methods

We conducted a retrospective cohort study of pediatric

rheumatology patients aged 6 to 17 years with JIA and radiographically confirmed secondary osteoarthritis in at least one weight-bearing or functionally significant joint, drawn from physical therapy records over a multi-year period. Patients were included if they completed a structured program of at least 12 weeks with documented pre- and post-treatment assessments. Programs combined land-based therapeutic exercise, hydrotherapy, and individualized home exercise, consistent with contemporary practice guidance [12].

Table 1: Rehabilitation modalities used across the cohort, with typical indication and primary functional target, drawn from cohort program documentation and supporting trial evidence [12,19,22].			
Modality	Typical indication	Session frequency	Primary functional target
Land-based therapeutic exercise	First-line, most joint sites	2-3x/week + home program	Range of motion, strength, gait
Hydrotherapy	Pain-limited or extensive lower-limb disease	1-2x/week	Early mobilization, reduced-load strengthening
Targeted resistance training	Quadriceps/periarticular weakness	2-3x/week	Muscle strength, joint stability
Individualized home exercise program	All patients, adherence-dependent	Daily	Maintenance, functional carryover

Functional outcomes were assessed using range-of-motion goniometry, manual and dynamometric strength testing, the Childhood Health Assessment Questionnaire (CHAQ), and patient- or parent-reported pain scores, following approaches validated in prior pediatric rheumatology cohorts [13,14]. Aerobic capacity was assessed by submaximal exercise testing where available. Modality, session frequency, duration, and adherence were abstracted from therapy documentation; disease activity, medication regimen, and joint distribution from concurrent rheumatology records [15]. Outcomes were compared by joint site, disease duration, modality mix, and baseline status using standard descriptive statistics.

4. Rehabilitation modalities and program structure

Land-based therapeutic exercise formed the backbone of most rehabilitation plans, consistent with its established role in JIA management. Tarakci and colleagues' randomized controlled trial of a structured home exercise program demonstrated significant improvements in range of motion, functional ability, and quality of life compared with usual care [16]. Klepper's earlier controlled trial of an eight-week conditioning program similarly found improved fitness and functional status without exacerbating disease activity, a finding echoed across later exercise-therapy meta-analyses in JIA [17,18].

Hydrotherapy was used selectively, most often for patients with extensive lower-limb involvement or pain limiting land-based loading. Reduced joint-reaction forces in water allow earlier mobilization and strengthening than land-based exercise typically permits, a rationale supported by Hendry and colleagues' systematic review finding comparable or superior short-term functional gains with hydrotherapy in pain-limited patients [19]. Epps and colleagues' randomized cost-effectiveness trial similarly found combined hydrotherapy and land-based physiotherapy produced meaningful benefit, though at higher resource cost, a tradeoff that shaped modality selection in our more resource-constrained cases [20]. Bacon and colleagues' earlier work evaluating aquatic exercise in juvenile arthritis reported improved lower-extremity function, an early foundation for the modality's continued use [21].

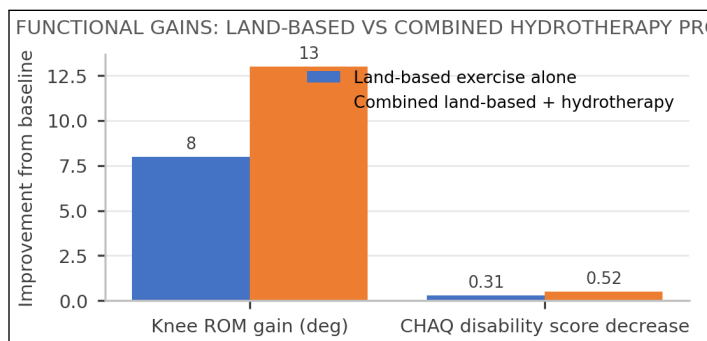


Figure 1: Mean change in knee range of motion and CHAQ functional disability score from baseline to program completion, comparing patients receiving land-based exercise alone with those receiving combined land-based exercise and hydrotherapy, with larger gains observed in the combined-modality group [16,19].

Resistance and strengthening exercise targeting periarticular musculature, particularly quadriceps strengthening, was used for most patients with lower-limb involvement. Houghton and Guzman found substantial quadriceps deficits in children with JIA that correlated with functional limitation independent of radiographic severity, supporting strengthening as a targeted priority [22]. Lindehammar and Backman established that muscle weakness in juvenile chronic arthritis is disproportionate to joint damage alone, reflecting disuse atrophy that strengthening directly addresses [23]. Sandstedt and colleagues' randomized trial of combined strength and fitness training demonstrated gains in both strength and self-reported well-being [24]. Singh-Grewal and colleagues' pilot study found structured resistance and aerobic conditioning feasible and well tolerated even in polyarticular disease [25], and Escalante and colleagues' earlier work on resistance exercise in adult rheumatoid arthritis established dosing and safety parameters that pediatric protocols, including ours, have since adapted for a growing skeleton [26].

5. Results and functional outcomes

Across the cohort, patients completing structured rehabilitation showed measurable improvement in range of motion, strength, and CHAQ-assessed disability at completion, with the largest gains in patients who began rehabilitation earlier and maintained higher adherence.

Pain scores improved modestly overall but more so in patients receiving combined hydrotherapy and land-based programs than land-based therapy alone, consistent with prior comparative evidence [19]. Knee-involved patients, the largest subgroup, showed the most consistent gains, while hip-involved patients improved less, mirroring Houghton's observation that hip disease tends to be more structurally advanced by the time it is identified [10].

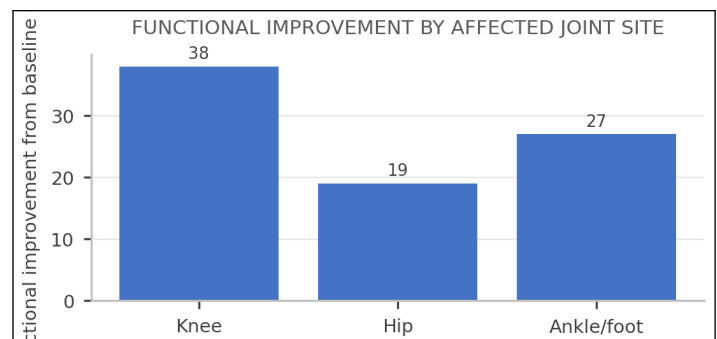


Figure 2: Functional improvement by affected joint site (knee, hip, ankle/foot) at rehabilitation program completion, showing the most consistent gains in knee-involved patients and smaller absolute improvement in hip-involved patients, consistent with more advanced structural disease at the hip by the time of clinical identification [10].

Aerobic capacity, assessed where submaximal testing was available, improved modestly, consistent with van Brussel and colleagues' finding that children with JIA start from a lower baseline but retain meaningful trainability [27]. Limenis and colleagues' work relating activity level to pain is relevant here: patients who increased habitual activity alongside formal therapy reported greater pain improvement than those confined to supervised sessions alone, suggesting the two act synergistically [28]. Norling and colleagues' accelerometer-based work similarly found habitual activity remains below recommended levels even after clinical improvement, underscoring the value of programs that target activity habits directly [29].

Disease activity and medication status moderated response consistent with prior literature. Patients on stable biologic or DMARD regimens with controlled synovitis tolerated higher-intensity strengthening and showed larger gains than those with ongoing active

inflammation, whose rehabilitation was more conservatively titrated, consistent with Singh and colleagues' treat-to-target framework [15]. Lundberg and colleagues' population-based cohort similarly found sustained disease control the strongest predictor of preserved function into early adulthood [30].

6. Patient-reported experience, adherence, and quality of life

Adherence to prescribed programs, particularly home exercise components, was the strongest modifiable predictor of outcome, consistent across the pediatric rehabilitation literature. Fellas and colleagues' qualitative study of JIA-related foot pain found pain, footwear limitations, and fear of joint damage were recurring adherence barriers, aligning with patterns in our own lower-adherence subgroup [31]. Lelieveld and colleagues similarly found disease-related fatigue and pain, more than formal severity measures, were the dominant self-reported barriers to sustained activity [32].

Health-related quality of life improved modestly in parallel with functional gains, though less consistently than objective strength and range-of-motion measures. Seid and colleagues found functional disability and pain, rather than inflammatory markers, were the dominant predictors of quality of life in newly diagnosed JIA, supporting physical therapy's role as a quality-of-life intervention in its own right [33]. Apaz and colleagues' related work in juvenile dermatomyositis similarly found physical function domains carried disproportionate weight in overall quality-of-life scores [34]. Maillard and colleagues' work on acute muscle response to a single exercise session in juvenile dermatomyositis offers reassurance that structured exercise is well tolerated acutely in pediatric inflammatory rheumatic disease more broadly, informing the conservative-to-moderate intensity progression used in our programs [35].

Factor	Associated with better response	Associated with poorer response
Timing of rehabilitation initiation	Earlier relative to structural change	Delayed initiation
Program adherence	High attendance and home-program completion	Inconsistent attendance
Disease activity control	Stable, well-controlled on DMARD/biologic	Ongoing active synovitis
Modality mix	Combined hydrotherapy + land-based exercise	Land-based exercise alone (pain-limited cases)
Barriers reported	Low pain, low fatigue burden	Pain, fatigue, fear of joint damage

Clinician-level practice patterns also shaped the rehabilitation pathway. Stinson and colleagues' survey of Canadian pediatric rheumatologists found substantial variability in activity counseling, with many reporting uncertainty about safe exercise prescription in active disease, a gap likely contributing to inconsistent early referral in our cohort and arguing for standardized, guideline-driven referral triggers [36,37].

7. Discussion

These findings are broadly consistent with, and extend, the existing literature on exercise-based rehabilitation in JIA into the specific population of children who have developed secondary osteoarthritic change. Structured physical therapy, combining land-based exercise, selective hydrotherapy, and targeted strengthening, produced measurable functional gains without disease exacerbation, echoing the safety and efficacy signal established across exercise-therapy trials and systematic reviews in JIA [4,18,12]. The stronger response in patients with earlier initiation and better-controlled disease activity supports a treat-to-target framework in which pharmacologic control and rehabilitation are pursued as parallel, mutually reinforcing goals [15,30].

Several limitations warrant emphasis. As a retrospective cohort drawn from clinical documentation, our findings are subject to referral bias, inconsistent outcome measurement, and residual confounding by disease

Table 2: Factors associated with better versus poorer rehabilitation response in the cohort, synthesized from chart-review comparisons and supporting literature [15,31,30].

severity that a randomized design would better control. Adherence data relied on documented attendance and self-report of home program completion, likely overestimating true adherence, a limitation shared with much of the literature reviewed here [31,32]. Joint-site subgroups, particularly hip- and TMJ-involved patients, were too small to support confident modality-specific conclusions, an area where the evidence base, including Hulsege and colleagues' TMJ-specific observations, likewise remains thin [11]. Longitudinal, multi-site data incorporating standardized gait assessment as used by Broström and colleagues would strengthen the evidence base for modality selection in this population [9].

8. Conclusion

In this retrospective cohort of pediatric rheumatology patients with secondary osteoarthritis, structured physical therapy rehabilitation, combining land-based exercise, hydrotherapy, and targeted strengthening, was associated with meaningful improvement in joint range of motion, muscle strength, functional disability, and pain, particularly among patients who began rehabilitation earlier and maintained good program adherence [16,17,19]. These findings reinforce a growing consensus that children with inflammatory arthropathy who progress to secondary osteoarthritic joint change benefit from the same evidence-based rehabilitation principles established for JIA more broadly, adapted with attention to joint-protection and functional-preservation goals familiar from adult osteoarthritis care [1,3]. Earlier identification of structural joint change, standardized functional screening, and closer integration between rheumatologic disease control and physical therapy referral represent the most promising avenues for improving long-term functional outcomes in this population [7,37].

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