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The Impact of Physical Activity on the Quality of Life in Children and Adolescents with Juvenile Idiopathic Arthritis

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ABSTRACT

Title: The Impact of Physical Activity on the Quality of Life in Children and Adolescents with Juvenile Idiopathic Arthritis

Background: Currently, there are no guidelines on physical activity in children diagnosed with JIA. Implementing recommendations could assist in managing this pathology and improving the lives of patients with chronic conditions.

Aim: This thesis aimed to evaluate the level of physical activity in patients diagnosed with JIA compared to healthy individuals using a systematic review.

Primary objective: To assess the extent to which JIA patients practice physical activity.
Secondary objectives:
a) To assess the factors influencing physical activity in JIA patients
b) To assess the benefits and misconceptions of physical activity in JIA patients
c) To assess whether physical activity improves or worsens the outcomes of JIA patients

Methodology: The PubMed database was searched on January 7th, 2025. RCTs and non-RCTs were included in this review. Studies were included if available in English. The PA levels in patients with JIA were evaluated compared to those of healthy individuals. Patients were younger than 18 years old.

Results: This master's thesis involves 12 studies, of which 5 were conducted in Europe. From all the studies, 2 were RCTs. The mean ages of the participants ranged from 8.5 to 15.7 years. Studies investigated PA levels using accelerometers (n=3) and/or self-reported questionnaires (n=7). Results illustrated PA levels, PA outcomes, factors influencing, and benefits, as well as misconceptions.

Conclusion: This thesis illustrates that children with JIA exhibit lower PA than healthy peers. Research emphasizes that lower PA is associated with poorer physical fitness and health-related QoL. Factors impairing PA in JIA are mostly disease activity, fatigue, pain and weight-bearing joints.

Keywords: Juvenile idiopathic arthritis, physical activity, exercise, sports, physical inactivity, chronic diseases, rheumatologic, pediatrics, guidelines, sport recommendations

SANTRAUKA

Pavadinimas: Fizinio aktyvumo įtaka jaunatviniu idiopatiniu artritu sergančių vaikų ir paaugliu gyvenimo kokybei

Problematika: Šiuo metu nėra fizinio aktyvumo (FA) gairių vaikams, kuriems diagnozuotas JIA (juvenilinis idiopatinis artritas). Rekomendacijos ir jų įgyvendinimas pagerintų šia lėtine liga sergančių pacientų gyvenimo kokybę.

Tikslas: įvertinti pacientų, kuriems diagnozuotas JIA, fizinio aktyvumo lygį ir palyginti su sveikais asmenimis, naudojant sisteminę literatūros apžvalgą.

Pagrindinis tikslas: įvertinti, kiek JIA pacientai užsiima fizine veikla.
Antriniai tikslai: a) Įvertinti JIA sergančių pacientų fizinį aktyvumą įtakojančius veiksnius
b) Įvertinti JIA pacientų fizinio aktyvumo naudą ir vyraujančius mitus
c) Įvertinti, ar fizinis aktyvumas pagerina ar pablogina JIA pacientų ligos eigą ir išeitis.

Metodika: straipsnių paieška atlikta PubMed duomenų bazėje 2025 m. sausio 7 d. Į šią apžvalgą įtraukti atsitiktinės atrankos tyrimai (AAT) ir ne AAT. Buvo įtraukti tyrimai, kurie buvo paskelbti anglų kalba ir įvertino FA lygius pacientams, sergantiems JIA, palyginti su sveikais asmenimis. Pacientai buvo jaunesni nei 18 metų.

Rezultatai: magistro darbe išanalizuota 12 studijų, iš kurių 5 atliktos Europoje. Dvi studijos iš visų įtrauktų buvo atsitiktinės atrankos klinikiniai tyrimai. Vidutinis pacientų amžius į analizę įtrauktuose tyrimuose buvo nuo 8,5 iki 15,7 metų. Fizinis aktyvumas tirtas naudojant akcelerometrus (n=3) ir/arba pacientams užpildant klausimyną (n=7). Rezultatuose pateikti fizinio aktyvumo lygiai, su fiziniu aktyvumu susijusios išeitys, įtakojantys veiksniai, fizinio aktyvumo privalumai ir vyraujantys mitai, susiję su fiziniu aktyvumu, sergant JIA.

Išvados: Šio magistro darbo metu nustatyta, kad vaikų, sergančių JIA, fizinis aktyvumas yra mažesnis nei sveikų bendraamžių. Atlikti tyrimai teigia, kad mažesnis fizinis aktyvumas sąlygoja mažesnį fizinį pajėgumą ir blogesnę su sveikata susijusią gyvenimo kokybę. Sergant JIA, ligos aktyvumas, nuovargis, skausmas ir didžiausią krūvį patiriantys sąnariai turi didžiausią įtaką pacientų fiziniam aktyvumui.

Raktiniai žodžiai: Jaunatvinis idiopatinis artritas, fizinis aktyvumas, mankšta, sportas, fizinis neveiklumas, lėtinės ligos, reumatologija, pediatrija, rekomendacijos, sporto rekomendacijos

CONFLICT OF INTEREST

The author reports no conflicts of interest.

ETHICS

Permission issued by the Ethics Committee.

LIETUVOS SVEIKATOS MOKSLŲ UNIVERSITETO
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DĖL PRITARIMO TYRIMUI

LSMU Bioetikos centras, įvertinęs pateiktus dokumentus, moksliniam-tiriamajam darbui tema „The impact of physical activity on the quality of life in children and adolescents with Juvenile Idiopathic Arthritis.“ P R I T A R I A .

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** Pastaba: šis pritarimas neatleidžia tiriamąjį mokslinį darbą vykdančių asmenų nuo prievolės laikytis Bendrojo duomenų apsaugos reglamento nuostatų ir nuo atsakomybės gauti nacionalinio arba regioninio bioetikos komiteto leidimą, jei toks leidimas būtinas pagal LR Biomedicininių tyrimų etikos įstatyme numatytus reikalavimus.*

ACRONYMS

6MWD: 6-Minute Walk Distance
ACR: American College of Rheumatology
AET: aerobic exercise training
ANA: antinuclear antibody
aPAQ: Physical activity questionnaire for adolescents
APARQ: adolescent physical activity recall questionnaire
C-HAQ: Childhood Health Assessment Questionnaire-disability index
C-HAQ38: Childhood Health assessment questionnaire
CASE: Childhood arthritis self-efficacy
CHAQ: Childhood Health Assessment Questionnaire
CHD: chronic heart diseases
CHQ-PF50: child health questionnaire parent form 50
CI: confidence intervals
cJADAS-10: Juvenile Idiopathic arthritis disease activity score in 10 joints
cPAQ / PAQ-C : Physical activity questionnaire for children
CRP: C-reactive protein
DMARD: non-biological disease-modifying anti-rheumatic drug
EC: exercise capacity
EMG: electromyography
ERA: enthesitis-related arthritis
ESR: erythrocyte sedimentation rate
FEV1: forced expiratory volume in 1 second
FMS: fundamental motor skills
FVC: forced vital capacity
GCs: glucocorticoids
HLA: Human leukocyte antigen
HOYVS: Health of Young Victorians Study
HR_peak: peak heart rate
HRQOL: health-related quality of life
HRR: heart rate reserve
IBD: inflammatory bowel disease
ILAR: International League of Associations for Rheumatology
IMT: inspiratory muscle training
JADAS: juvenile arthritis disease activity score
JCA: juvenile chronic arthritis
JIA: Juvenile idiopathic arthritis
JRA: juvenile rheumatoid arthritis
KiGGS: German Health Interview and Examination Survey for Children and Adolescents
LPA: light-intensity physical activity
MAS: macrophage activation syndrome
METs: metabolic equivalents
MPA: moderate PA
Mph: miles per hour
MVPA: moderate-to-vigorous-intensity physical activity
NPRD: National Paediatric Rheumatologic Database
NSAID: non-steroidal anti-inflammatory drug
OMPT: orthopedic manual physical therapy
ORs: Odds ratio
OT: occupational therapy
PA: physical activity
PAL: physical activity level
PE: physical education
PE_max: maximal expiratory pressure
PedsQL: Pediatric Quality of Life Inventory

PedsQl-MFS: Pediatric Quality of Life Inventory Multidimensional Fatigue Scale
PI_max: maximal inspiratory pressure
PRINTO: Pediatric Rheumatology Internation Organization
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PT: physical therapy
R@W : Rheumates@Work
RA: rheumatoid arthritis
RCT: randomized controlled trial
RET: resistance exercise training
RF: rheumatoid factor
SB: sedentary behavior
SLE: systematic lupus erythematosus
SoJIA: systemic-onset JIA
SPANS: Schools Physical Activity and Nutrition Survey
SWB: subjective well-being
TNFi: tumor necrosis factor inhibitor
triple DMARD therapy: methotrexate, sulfasalazine, and hydroxychloroquine
VAS : Visual Analog Scale
VO2_max / VO2_peak : peak oxygen consumption
VPA: vigorous PA
WHO: world health organization

INTRODUCTION

Juvenile idiopathic arthritis (JIA) is a chronic condition that not only affects the patient symptomatically but also poses significant challenges to a child's ability to engage in physical activity (PA). Although research has shown that physical activity benefits healthy individuals, current research lacks guidelines for children with JIA. Furthermore, children with JIA do not meet the minimum requirements of PA, preventing them from benefiting from their fitness level as it requires them to be active enough. It is crucial to further investigate the implementation of PA in children even more in JIA since childhood is a critical developmental growth to create motor skills and social interactions.

Overall, the literature describes JIA patients as less physically active. Indeed, Bourdier et al. found that JIA patients engage in less PA and spend more time in sedentary activities compared to healthy individuals [1].

A previous systematic review by Kuntze et al. found interesting results about the efficacy of structured programs like aquatic and strengthening exercises, particularly in improving functional abilities and quality of life in JIA patients [2]. Another systematic review by Iversen et al. [3] analyzed multiple randomized controlled trial (RCT) studies and showed that most PA interventions including strengthening exercises three times per week, lead to improved function and mitigate symptoms, without side effects. Also, it was noticed that adherence was higher when they engage in low-intensity programs [3]. These results align with another systematic review where a structured exercise program improves physical function like range of motion as well as reducing pain [4].

Nonetheless, in 2023, a Cochrane Review describes that very low evidence is in favor of that physical activity reduces pain intensity and mitigates disability when compared to usual management. Also, quality of life was not significantly improved when participants were engaging in PA [5].

This master thesis aimed to evaluate the physical activity level of patients diagnosed with JIA compared to healthy individuals and address the effects of sports on JIA patients and factors limiting the practice, as well as misconceptions and biases.

LITERATURE REVIEW

I- Description of Juvenile idiopathic arthritis

1. Definition of JIA

JIA is the most common form of chronic arthritis in pediatrics. It primarily affects the joints but can present with a multitude of clinical presentations, including joint pain and stiffness, inflamed joints, rash, fever, and vision problems. JIA is a diagnosis of exclusion, meaning other conditions must be ruled out before the diagnosis is confirmed. Symptoms typically manifest before the age of 16 and persist for at least six weeks, except in the case of the systemic JIA subtype, where symptoms may last for two weeks [6]. When left untreated, it leads to significant joint damage, including cartilage destruction. The accumulation of synovial fluid and the formation of an abnormal growth, called pannus, is created within the joints. In more severe cases, JIA can also be associated with lung pathologies, negatively impacting the prognosis [6].

2. Different types of JIA

According to the 2004 revised version of ILAR, JIA is subdivided into six categories: systemic arthritis, oligo-arthritis (persistent or extended), polyarthritis (rheumatoid factor positive or negative), psoriatic arthritis, enthesitis-related arthritis, and undifferentiated arthritis [7]. Clinically, it is essential to test for antinuclear antibodies (ANA) as the positivity of ANA markers indicates a higher risk for uveitis and may provide insights into disease prognosis [8].

3. Etiology

Despite extensive studies, the exact cause of JIA remains unclear, although genetics, immunology, and environmental factors play a role in the pathogenesis. Some genes like the human leukocyte antigen (HLA) region have been described in the literature to increase the likelihood of triggering JIA manifestations [6]. Located on chromosome 6, the HLA region forms part of the major histocompatibility complex (MHC), and it houses many alleles associated with JIA. However, HLA genotypes are found in only 8-13% of JIA patients [9]. Palman et al. published a study in 2018 suggesting that genetic factors contribute to up to one-third of the overall susceptibility to JIA [9]. Patients with a family history of autoimmune diseases have a higher likelihood of developing JIA, particularly in the psoriatic and ERA subtypes [9].

4. Epidemiology

JIA is the most common rheumatologic disease in pediatrics [7]. Overall, the estimated incidence of JIA ranges from 1.6 to 23 cases for 100,000 children [9]. Most epidemiological studies have been conducted in Europe and North America, which has influenced major guidelines issued by organizations like the American College of Rheumatology (ACR), the European League Against Rheumatism (EULAR), and the ILAR. This focus on Western populations creates a selection bias, potentially leading to an overestimation of JIA risk in these regions compared to less-studied populations. Until now, no apparent environmental factor has increased the risk of developing JIA [9]. The predominant JIA subtype with the highest incidence is oligoarthritis, with 4.5 per 100,000 children [9]. The probability of remission fluctuates depending on the JIA subtype. Oligoarticular JIA has the highest remission rate, at 50%, whereas polyarticular JIA has the lowest rate, at 15% [9]. Key factors impacting physical health-related quality of life in JIA are pain, physical disability, fatigue, general well-being, and social living allowances [9].

II- Recommendations for physical activity

1. Description of PA

The 2020 WHO Guidelines highlight the importance of regular PA for individuals across all age groups (from 5 years old), including those with chronic conditions or disabilities [10]. Even though the terms may appear as synonyms, it is essential to redefine them appropriately. PA is a broader term for any movement performed by the body using the musculoskeletal system measured by the amount of energy burned, known as the energy expenditure [11]. Exercise is, on the other hand, a more specific form of PA, which intends to improve or at least maintain one or more components of physical fitness (cardiovascular fitness, morphological health, muscular strength, metabolic function, and motor skills) [11]. Research typically evaluates exercise based on frequency, intensity, time, type, and training mode [11].

2. The benefit of PA in chronic diseases

Most studies regarding PA are conducted in adult patients, showing that PA benefits those diagnosed with chronic and/or rheumatological conditions by improving cardiovascular function [12], and mitigating oxidative stress and inflammation to combat chronic inflammatory conditions [13]. On

the spectrum of pediatric rheumatological conditions, physical activity is a key component in managing children diagnosed with systematic lupus erythematosus (SLE) by improving health-related quality of life (HRQOL) [14]. However, further research with larger samples is needed to investigate those findings and even less information is regarding patients diagnosed with JIA.

3. Guidelines for PA

WHO Guidelines recommend that children (5-17 years), including those with chronic conditions, practice as close as possible to 60 minutes per day of moderate-to-vigorous intensity (mainly aerobic) throughout the week. Three sessions per week of vigorous-intensity aerobic activities are also recommended to reinforce bone and muscle [10].

It is essential to highlight the scarcity of recommendations for chronic diseases, particularly chronic rheumatologic ones. The most developed ones are those for children diagnosed with chronic heart disease. The latter condition has been attributed to PA guidelines, which are stratified risk categories based on comorbidities: low, moderate, or high risk [15]. Across all risk categories, a combination of aerobic exercise training (AET) and resistance exercise training (RET) is recommended. However, the intensity of these exercises is adjusted according to the patient's risk classification: moderate-to-vigorous intensity for low-risk patients, low-to-moderate for moderate-risk patients, and low intensity for high-risk patients [15].

Similarly, a consensus published by Blaess et al. [16] considered different aspects of SLE manifestation in the adult population. This allows a personalized approach of PA to patients with chronic diseases [16].

III- Physical activity in JIA

1. Current knowledge about PA in JIA

Despite limited research, PA has shown benefits for JIA patients in improving joint range of motion, muscle strength, functional status, and overall quality of life for JIA patients when structured physical activities (cardio-karate, aquatic exercises, pilates, and strength training) are applied [17]. Notably, adapted exercise programs do not exacerbate the condition, illustrating the benefit and feasibility of practising PA as a JIA patient [18,19]. Moreover, inactivity is seen as a risk factor for energy imbalances and cardiovascular risk in JIA patients [20]. Unfortunately, JIA patients show lower physical activity levels and reduced overall physical fitness compared to their healthy peers [21].

Nonetheless, it is crucial to comprehend their specific barriers to physical activity, such as symptoms, being under pressure, and lack of enjoyment, which significantly limit the ability of children with JIA to participate in regular physical activity [22]. On the other hand, facilitators such as effective symptom management, motivation, and robust social support systems play a crucial role in improving adherence to exercise programs [22,23].

Regarding the role of PA in JIA, the findings suggest that children with JIA tend to be less active than their healthy counterparts; despite variability in inclusion criteria, sample size, and measurement techniques [24]. Studies show benefits from pilates that positively impacted quality of life [25]. Similarly, studies reported improvements in functional capacity [26,27], reducing pain intensity [28], enhancing bone mineral density [29], improving aerobic capacity [30,31], improving strength capacity [32], and better balance ability [27]. Overall, it is reported that children with JIA demonstrated lower VO2peak compared to healthy peers, highlighting the need for maintaining an active lifestyle to prevent declines in aerobic fitness [33]. Exercise programs also play a key role in enhancing muscle strength and aerobic capacity, such as core stability exercises in JIA patients [34]. A randomized controlled trial by Ibrahim et al. [35] shows the effect of sport on JIA by acting on aerobic abilities and muscle reinforcement [35]. While the literature generally supports the positive effects of physical activity on children with JIA, other findings have been inconsistent. Some studies reported no significant differences in functional ability, pain, and quality of life [36].

Studies show that barriers like pain and other symptoms related to JIA mitigate participation in physical activities. Nørgaard and Herlin show that children with JIA have reduced participation in sports, like club sports, leisure time, and school education, compared to healthy controls [37]. Indeed, pain intensity and functional impairment inherited from the disease lead to reduced sports activity. Daily activity observed with accelerometry shows that JIA patients, when engaged in sports, are more likely to choose individual, less intense, and weight-bearing sports, like badminton, swimming, and horse riding [37]. Adherence to exercise therapy varies widely (29-99%) [22], highlighting the need for future research on creating strategies that promote exercise adherence for children with JIA.

METHODOLOGY

Design: The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The literature review (described above) allowed the identification of criteria to investigate the impact of physical activity in children with JIA.

Search strategy: The PubMed database was searched on 07th January 2025 to identify all peer-reviewed studies in English from 2015 to 2025. This specific database was selected because of its extensive catalog to include as many papers as possible efficiently. Papers published later than 10 years old were excluded to prevent outdated information. Studies published not in English were excluded. Search terms were selected based on the previous literature review. The search strategy can be found in *Appendix 1*.

Eligibility criteria: Randomized Controlled trials (RCTs) and non-RCTs (Retrospective studies, Prospective studies, Cross-Sectional studies, Case-control studies, Clinical trials, and Cohort studies) were included in this review. Articles were eligible to be included if they were (i) published in English, (ii) evaluating the level of physical activity (exposure) on patients with JIA compared to healthy individuals (outcome), (iii) participants younger than 18 years old.
Studies were excluded from the review if (i) < 50% of study participants were not diagnosed with JIA, (ii) no full abstract and text were accessible, or (iii) it was a review article (literature review, meta-analysis, or systematic review).

Study selection and data collection: **Figure 1** shows the PRISMA flow diagram outlining the review process. No duplicates were identified using the Mendeley reference manager software. Titles and abstracts were independently screened for eligibility in January 2025, adhering to predefined criteria. Interrater reliability was assessed using a percentage of agreement (97.6%). Full texts of studies deemed potentially eligible were subsequently reviewed in detail. Data extraction focused on study design and outcomes, particularly related to physical activity. The results were reported through a narrative synthesis.

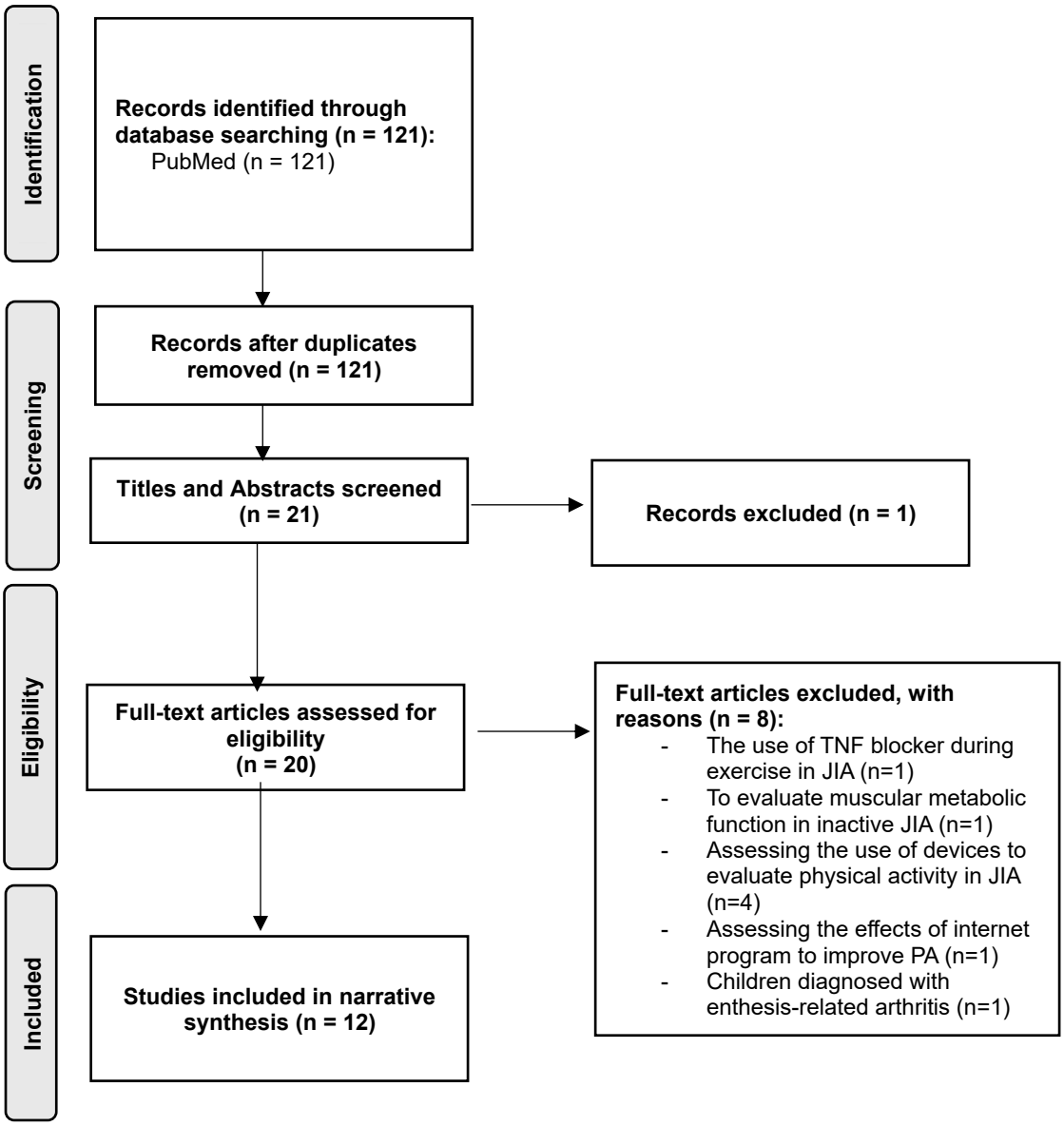

Figure 1: PRISMA 2020 flow chart [38].

RESULTS

1. Study characteristics

A total of 121 articles were identified in the search process. Twelve of them met the inclusion criteria. Characteristics from all 12 studies are summarized in Table 2 (Appendix 2). A total of 29,908 JIA patients and 16,810 healthy controls were included. The mean ages of the participants ranged from 8.5 to 15.7 years.

Among these articles, five studies were conducted in Europe (n=1 in the Netherlands [39], n=2 in Germany [40,41], n=1 in Norway [42], n=1 in Denmark [43]). Among the twelve articles, eleven were mainly quantitative studies [39–41,43–50] and one was an equal mix of quantitative and qualitative methodology [42]. From all the studies, n=2 were RCTs [44,46]; however, one of them does not specify whether the participants, researchers, or both were blinded to group assignments [44].

Overall, three of the twelve studies adopted an accelerometer to measure PA level [39,42,43]. In the quantitative research, a self-report questionnaire survey generated numerical data from scales and instruments, with seven studies adopting this method. Most articles examined physical activity levels through questionnaires, indicating that it is the most common method to quantify PA. Besides, the two RCTs did not adopt surveys or accelerometers, but measured lung capacity for PA and aerobic exercise fitness [44,46].

Other notable parameters were explored like pain (n=6) [39,40,42,43,46,50], fatigue (n=4) [39–42], disease activity (n=9) [39–45,47,50], functional ability (n=6) [42–44,47,48,50], quality of life (n=4) [44,46,47,49], aerobic exercise capacity (n=2) [44,46], muscle strength (n=2) [44,49], lung capacity (n=2) [46,49], self-efficacy (n=1) [39], well-being (n=3) [41,48,50]. The analysis revealed that most articles addressed pain, disease activity, and functional ability, while only 3 addressed the well-being (Table 1).

Table 1: Summary of articles, sorted by lead authors

Lead author, Year	Type of study	Participants	Questionnaires for PAL	Accelerometers for PAL	Pain	Fatigue	Disease activity	Inflammation markers	Functional ability	Well-being	Quality of life	Self-efficacy	Exercise capacity	Muscle strength	Muscle endurance	Flexibility	Participation	Sports frequency/duration	Lung capacity	Active joints	Morning stiffness	Body composition	Treatment	Uveitis	Age at disease onset
Armbrust, 2016 [39]	Cross-sectional	N=80 JIA children (65% female, median: 9.8 years)		x	x	x	x	x				x					x	x							
Bohr, 2015 [43]	Cross-sectional	N=133 JIA children (female 74%, mean of 14 years)		x	x		x	x	x														x		
Fazaa, 2020 [50]	Cross-sectional	N=110 children (N=55 JIA and N=55 healthy) (female % not mentioned, mean age of 8.5 years)	x		x		x	x	x	x								x		x			x	x	
Hulsegge, 2015 [48]	Cross-sectional	N=28 JIA children (female 57%, mean age of 11.3 years) Healthy controls: SPANS: 11,108 participants (mean of 11.3 years, 49% female) HOYVS: 5,414 participants (mean of 11.6 years, 47% female)	x		x					x			x								x			x		
Kwon, 2017 [49]	Cross-sectional	N=51 children (N=26 with rheumatoid arthritis and N=25 controls)	x						x		x			x	x				x				x		

		Mean age JRA: 12.58 (42.3% female) Mean age control: 12.32 (40% female)																						
Milatz, 2019 [40]	Prospective observational cohort	N=23,016 JIA children Mean age : 7.4 years (in 2000) and 8.5 years (in 2012) Female from 61.4% (in 2000) to 65.4% (in 2015)	x		x	x	x	x	x								x	x		x			x		x
Milatz, 2024 [41]	Prospective observational cohort	N=6,297 JIA patients (67.5% female, mean age of 11.2 years)	x		x	x	x		x	x										x			x	x	x
Polat, 2024 [47]	Case control study	N=100 (50 children with oligoarticular in remission and 50 age and sex matched controls) Mean age: 11.8 years (oligo-JIA) and 11.6 years (control) Female percentage of 66% in both groups	x					x	x		x									x			x	x	x
Risum, 2018 [42]	Controlled cross-sectional study	N=120 children 60 JIA patients: 30 oligoarticular, 30 polyarticular (Mean age: 13.6 years; 83% female) Controls: 60 age and sex-matched healthy controls		x	x	x	x	x	x								x	x		x					

		(Mean age: 13.5 years; 83% female)																							
Sarac, 2024 [46]	RCT	N=33 JIA patients were randomized Exercise group: N=17 (mean age of 15.12, 29.4% female) Control group: N=16 (mean age of 15.7, 31.3% female)			x				x		x		x	x					x		x				
Sherman, 2018 [45]	Cross-sectional study	N=195 children JIA: 97 patients; Mean age of 11.8 years (68% female) Control group: 98 individuals; Mean age of 11.7 years (62% female)	x				x															x				
Sule, 2019 [44]	RCT	N= 33 JIA children Control group: N=16, mean age of 16.1 years (34% female) Exercise group: N=17, mean age of 14 years (36% female)			x	x	x		x		x		x	x					x	x		x	x		

The table displays the type of study and the characteristics of participants and summarizes all parameters studied in each of the twelve articles.

Abbreviations: JIA = Juvenile Idiopathic Arthritis, N = numbers, PAL = physical activity level, RCT = randomized controlled trial.

2. Physical activity levels

The studies collectively indicate that children with JIA engage in lower levels of PA compared to their healthy peers (Appendix 2). Bohr et al. [43] found that children with JIA exhibited significantly fewer activity counts per minute (cpm), averaging 475.6 cpm compared to 522.7 cpm in healthy controls [43]. This difference in cpm, although modest, is indicative of a significant reduction in physical activity levels. Furthermore, the study found that fewer children with JIA meet the recommended 60 minutes of PA daily compared to their healthy matched, with only 19% of girls and 45% of boys achieving these targets, compared to 39% and 61% in controls, respectively. This stark contrast points to an ongoing challenge in promoting PA in children with JIA [43]. Similar findings were reported by Fazaa et al. [50], who confirmed significantly reduced PA levels in JIA patients with a higher average of 10 hours spent sleeping and sitting. The sample population met 18.1% of general recommendations of at least 60 minutes of MVPA compared to 75% in controls [50]. Hulsegge et al. [48] noted no significant differences in fundamental movement skills (FMS) between JIA and control groups. Still, they observed a trend toward poorer physical fitness and PA levels among JIA children, possibly influenced by psychological barriers such as lower confidence and parental concerns [48].

Beyond PA participation, several studies underscore the significant physical fitness deficits in children with JIA. Kwon et al. [49] found that JIA patients exhibited lower levels of muscular strength, endurance, lung capacity, and overall physical fitness compared to healthy controls, possibly contributing to reduced PA engagement [49]. This comprehensive deficit in physical fitness suggests that the reduction in PA among JIA patients likely contributes to a vicious cycle, where decreased activity leads to lower fitness levels, which may further discourage engagement in physical activities. The need for interventions that improve physical fitness and encourage participation in PA is, therefore, critical to improving both the physical and psychological well-being of children with JIA [49].

Milatz et al. [40] reported a positive trend in school sports participation among children with JIA over 15-year period [40]. However, a significant proportion of JIA children remained exempt from participation, particularly those with active disease and functional limitations. While Milatz et al. [40] noted that some JIA subgroups met or exceeded WHO-recommended PA levels, a substantial proportion remained insufficiently active due to several factors: female gender, disease activity, RF-positive polyarthritis, systemic JIA, pain intensity, using glucocorticoids (GCs) and DMARDs. This highlights the ongoing challenges in ensuring that children with JIA, even with advances in treatment, are fully integrated into PA activities, particularly in school settings [40].

3. Physical activity outcomes

The impact of PA on health outcomes in JIA patients was assessed in several studies (Appendix 2). Kwon et al. [49] emphasized the relationship between reduced physical fitness and lower quality of life (QoL), with JIA children exhibiting poorer physical and functional capabilities. Polat et al. [47] found that children with oligoarticular JIA in remission reported lower PA levels and decreased school and social functioning scores, reinforcing the link between PA and overall health-related quality of life (HRQoL). It further reinforces the idea that encouraging PA may enhance physical improve psychological and social well-being [47].

The study about inspiratory muscle training (IMT) from Sarac et al. [46] demonstrated significant improvements in respiratory function (FVC, FEV1, PI_max, PE_max) and aerobic capacity (VO2_peak, METs) in JIA patients undergoing IMT interventions. These findings suggest that targeted PA interventions could have broader benefits for children with JIA regarding quality of life such as cardiorespiratory fitness and overall well-being.

4. Factors influencing the practice of physical activity

Several factors were identified as influencing PA levels in JIA patients. Fatigue emerged as a critical barrier, with Armbrust et al. [39] reporting higher fatigue scores among JIA children compared to healthy controls, leading to reduced energy and PA levels, self-efficacy, and associated with higher pain and disability. As shown by Milatz et al. [40,41] and Risum et al. [42], pain played a significant role in mitigating PA. In fact, those children with higher disease activity were found to be less likely to meet the World Health Organization's (WHO) recommended PA levels (>60min/day) [41]. These findings align with another study done by Bohr et al. about the negative association between active disease in weight-bearing and high-intensity PA [43].

The relationship between disease activity and PA also highlights the complexities of managing JIA. While Polat et al. [47] suggest that even during periods of remission, children with oligoarticular JIA experience reduced PA levels and lower quality of life (QoL) scores, it underscores that disease activity is not the sole factor. Hulsegge et al. [48] explored the differences in PA between JIA patients and healthy peers, where JIA patients were most affected by physical and psychosocial well-being. Questionnaires from parents revealed they perceived a higher difference in their child's behavior and emotional impact than other parents [48]. This implies that other factors—such as functional limitations, psychological well-being, and social participation—also significantly shape PA habits in these children. Sherman et al. [45] explored the relationship between disease activity, weight status, and PA levels,

finding no significant differences in obesity rates or screen time between JIA and control groups. However, they noted that early disease onset was associated with lower PA levels, emphasizing the importance of early intervention and aggressive treatment strategies to support active lifestyles in JIA children.

Regarding facilitators, social support and enjoyment of activities were identified as help in the engagement into sports. This suggests that structured interventions addressing both physical and psychosocial barriers could enhance PA participation.

5. Benefits and misconceptions of physical activity

Hulsegge et al. [48] highlight that children with JIA may face physical and psychosocial impairments [48]. Parents of children with JIA reported more difficulties in their emotions, combined with their child's behavior, compared to the parents of healthy controls. This suggests that, in addition to physical limitations, there are biopsychosocial components influencing PA practice, which may deter children from engaging in physical activities despite their ability [48]. Similarly, Risum et al. [42] highlight that pain represents the most substantial barrier to PA. At the same time, controls are impacted mainly by time, showing how patients with chronic diseases are disabled and inequality affected. An interesting finding indicates that both JIA and control groups were attracted to doing PA if this activity exerted enjoyment [42]. Thus, a comprehensive approach to promoting PA should not only address physical health but also consider mental health and social support [42].

Despite the well-documented benefits of PA, the literature on misconceptions surrounding PA in JIA remains scarce. While several studies emphasize the importance of PA in improving QoL, physical fitness, and disease management [46,47,49], further research is needed to explore patient and caregiver perspectives on PA.

DISCUSSION

Children need to be active to improve their quality of life and positive outcomes on health. Recommendations from the WHO specify the minimum requirement of 60 minutes per day of PA [10]. On the other hand, certain aspects of chronic conditions may limit their practice due to pain, fatigue, and joint stiffness.

JIA is a chronic disease of the musculoskeletal system that impacts children's PA. In this review, we described that a significant number of JIA patients do not fulfill the minimum requirements of PA, thus preventing them from the physical activity benefits. Study analyses conclude that a variety of sports can improve both physical and psychological health in JIA patients. Moreover, we have identified several factors that influence PA in JIA patients and could be modified to improve the adherence and opinion of PA in chronic diseases.

Primary findings

Findings from the present research suggest that, overall, JIA patients are less engaged in PA compared to their healthy peers. This result is comparable to the study conducted by Bourdier et al., mentioning that JIA patients show lower physical activity levels compared to their healthy peers, besides exhibiting reduced overall physical fitness [21].

Similarly, it has been shown that JIA patients fail to meet the WHO recommendations of 60 minutes per day of PA, particularly in moderate-to-vigorous physical activity (MVPA). Due to the small number of studies available, generalizing results was impossible. Nonetheless, research tends to align with similar perspectives. Indeed, Milatz et al. [40] reported a positive trend in school sports participation among children with JIA over a 15-year period [40]. This change suggests that advancements in treatment options and better management of the disease have helped improve the functional abilities of children with JIA, enabling more of them to participate in school sports. While advances in treatment and disease management have improved PA participation in some cases, a substantial proportion of JIA patients remain insufficiently active, indicating a persistent challenge in promoting PA within this population.

To supplement these findings, the World Health Organization (WHO) states that approximately 80% of adolescents worldwide fail to meet the minimum recommended levels of physical activity [18]. Nonetheless, epidemiology data are hard to find for children with chronic diseases. A comprehensive review by West et al. reveals that exercise intolerance prevents children with chronic diseases from engaging in physical activity, which is why structured programs are needed to ensure safety and efficacy [51].

One of the main challenges in this field is the lack of standardized methods for assessing physical activity levels in JIA patients. Many studies exhibit considerable heterogeneity in design, by using various measurement tools, which complicates the development of clear recommendations for physical activity in JIA patients [17,19]. This leads to inconsistent findings and it is difficult to make a clear conclusions. For instance, Bourdier et al.'s meta-analysis points to significant discrepancies in research methodologies, which hinder the generalizability of results [21]. The lack of diversity and research scarcity enlightens the need to build a personalized approach toward JIA patients.

Secondary findings

Several factors contribute to reduced PA levels in JIA patients. Disease activity and functional limitations are primary determinants, with higher disease activity correlating with lower PA engagement. However, even in remission, some JIA children report reduced PA, suggesting that additional psychological and social factors influence participation. This result is comparable to that of previous groups, mentioning that reduced PA in children is multifactorial, primarily influenced by socioeconomic background [52], family support [53], demographic [53], and psychosocial factors [54].

Structured exercise programs, such as IMT, display beneficial effects on respiratory function, aerobic capacity, and overall well-being in JIA patients [46]. To supplement these findings, studies including children with other chronic conditions, illustrated that it improves heart movement [55], reduces cardiovascular risk factors [56], and perpetuates long-term benefits that enhance the quality of life [57]. This reinforces the positive impact of PA on health outcomes despite concerns about PA, which could potentially worsen symptoms. Currently, the evidence does not show that PA is detrimental. On the contrary, most of the parameters studied support the statement that PA enhances both physical and psychological health in JIA patients. A prospective study that randomized JIA patients to either Pilates or conventional exercise for six months measured health-related quality of life (HRQOL) as the primary outcome. The results demonstrated that Pilates positively impacted quality of life [25]. Similarly, two additional studies reported improvements in functional capacity following physical activity interventions [26,27]. Physical exercise in JIA has been linked to several benefits, including reductions in pain intensity [28], enhanced bone mineral density [29], improved aerobic capacity [30,31], ameliorated strength capacity [32], and better balance ability [27]. Additional studies have investigated the relationship between physical activity and cardiorespiratory fitness in children with JIA, focusing on peak oxygen consumption (VO2peak). In a controlled observational study, Takken et al. found that physical activity is more closely associated with physical fitness than body composition. Children with JIA demonstrated lower VO2peak compared to healthy peers, highlighting the need for maintaining an active lifestyle to prevent declines in aerobic fitness [33].

Exercise programs also play a key role in enhancing muscle strength and aerobic capacity. Elnaggar et al. conducted a randomized controlled trial examining bone mineralization and functional capacity, concluding that core stability exercises benefit bone health and functional capacity in JIA patients [34].

Effects and barriers

Physical Barriers

Pain, fatigue, and joint stiffness are major physical obstacles that hinder PA participation in JIA patients. Hoeksma et al. found that joint dysfunction could result in activity limitation in JIA subjects [58]. Also, Ioannou et al. show that fatigue and pain affect the child's ability to participate in PA [59]. Similarly, Ben Ouahma et al. assess that functional impairments and exemption from physical education are reported in many children, mitigating their PA opportunity from leisure and school time settings [60].

Overall, many children experience lower energy levels, reducing their ability to engage in sports and recreational activities [61]. Functional impairments, particularly in weight-bearing joints, further contribute to inactivity, creating a cycle of reduced PA and declining physical fitness [61–63].

Parental Concerns

Parents are crucial in shaping children's physical activity behaviors. In fact, children's perception of parental support is significant. Niermann et al. demonstrate that when a child views their parents as supportive, the likelihood of engaging in physical activity is higher [64]. Additionally, when parents believe in their ability to encourage their child's activity, they tend to provide even more support, thereby reinforcing the child's motivation [64]. Similarly, Wilk et al. demonstrate that parental influence, both direct (participating) and indirect (verbal encouragement), plays a role in children's PA [65]. However, it emphasizes even more the importance of the child's perception of their parental support as it is a limiting factor in their PA practice [65].

Mental Barriers

Psychological factors, such as low self-efficacy and psychosocial stress, can affect PA levels in JIA patients [39,66]. Self-perception can affect sports participation in many children by impairing their abilities in physical education, hence negatively interfering with their confidence and performance [67,68]. We can observe those traits not only in children with chronic disease but also in healthy subjects.

In fact, Rodriguez-Ayllon et al. show that psychological distress is associated with lower PA levels in children [69]. Cortis et al. described that self-efficacy, attitude, and perceived PA competence are predictors of PA adherence. Besides, motivation factors such as having fun, success, and challenges reinforce the likelihood of PA involvement. However, markers of unsafety and feelings of incompetence appear as psychological limits of PA [70].

In addition to that, fear and ignorance from parents, teachers, and health practitioners can generate apprehension in children and be detrimental to their physical practice [71].

Recommendations for clinical practice

A multidisciplinary approach should be adopted to enhance PA participation in JIA patients. First of all, it might be worth implementing a regular PA schedule and educating parents and children about the complexity of pain to encourage positive change [43]. Following the current guidelines, it is crucial to enhance the importance of practicing some sport at least 60 minutes MVPA, including three vigorous aerobic sessions weekly, which aligns with WHO recommendations [10].

Also, the implementation of structured PA programs based on disease activity, functional status, and pain severity to ensure safe and effective participation. This should also integrate a fun and social environment. This could be thought of as regular monitoring and individualized adjustments (flexible according to patient needs and capacity).

Moreover, education and counseling for patients and their parents might be essential to address misconceptions and give proper information. Psychological support should be integrated into their medical check-ups. Living with chronic diseases encompasses different challenges, like impacting self-confidence. That support might help build self-motivation and teach people how to live with chronic conditions. Furthermore, it is essential to highlight that some issues are universal for all children, regardless of their chronic status, about their PA practice, such as socioeconomic background [72,73], motivation [74], family support [73], and mental state [75].

Limitations

While this review provides valuable insights into PA participation in JIA patients, several limitations should be considered. Indeed, we can note the heterogeneity of study designs, as well as methods of PA measurements, which were most often self-reported, impacting the reliability and generalization of results. This might introduce recall bias and limit data accuracy. Despite a few long-term studies [40], longitudinal research has not been conducted enough. Long-term effects of PA interventions on JIA progression, physical health outcomes, biopsychosocial aspects of life, and overall

quality of life are extremely rarely investigated. By addressing these gaps and implementing targeted strategies, future studies might consider standardized assessments from the perspective of building clinical recommendations.

Moreover, due to the lack of literature, this review included non-RCTs, which lowered the quality of the reported results. Also, this review is subject to the limitations of potential errors or biases in searching, including and reading articles. To address those concerns, preliminary research was performed to ensure an adequate search strategy. Also, the interrater agreement was calculated where one supervisor worked on the thesis during inclusion criteria. Finally, it is important to consider the variability of studies included in this review, particularly the methodology to assess patients.

Despite the well-documented benefits of PA, the literature on misconceptions surrounding PA in JIA remains scarce. While several studies emphasize the importance of PA in improving QoL, physical fitness, and disease management [46,47,49], further research is needed to explore patient and caregiver perspectives on PA. In fact, most studies investigating the role of physical activity in JIA utilize case-control, cross-sectional, and cohort designs. The methods employed are often subjective, relying on daily diaries and questionnaires, though some studies incorporate objective tools like accelerometers to measure activity levels. Key priorities should include variability in inclusion criteria, sample size, and measurement techniques, using longitudinal and experimental study designs to track outcomes over time to collect extensive data about optimal activity levels for JIA patients. Researchers are also encouraged to explore how different types of physical activity, when accumulated, influence health outcomes in children with JIA. Finally, greater diversity within study populations is needed to ensure that findings are generalizable across various demographics and subgroups [24].

Addressing misconceptions (concerns about exacerbating symptoms) through education and tailored exercise programs could help mitigate barriers to PA participation. Future studies should investigate the psychosocial dimensions of PA in JIA, ensuring that interventions are both evidence-based and patient-centered.

CONCLUSION

The findings of this systematic review highlight the reduced physical activity (PA) levels in children with JIA compared to their healthy peers. Multiple studies link lower PA levels to decreased physical fitness and health-related quality of life. Various factors influence PA participation in patients with JIA, including disease activity, fatigue, pain, limited range of motion, weight-bearing joints, and psychological barriers. While some interventions, such as inspiratory muscle training, improve PA outcomes, adherence remains a significant challenge. Future research should focus on developing targeted and sustainable interventions that address both physiological and psychosocial barriers to PA, ensuring that children with JIA can achieve optimal health and well-being through regular physical activity.

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Appendix 1

Table 1: Search strategy on 07/01/2025, inspired by the template of the University of Tasmania [76].

	Search
#1	("juvenile idiopathic arthritis"[Title/Abstract]) OR ("JIA"[Title/Abstract]) OR ("juvenile rheumatoid arthritis"[Title/Abstract]) OR ("JRA"[Title/Abstract])
#2	Limit #1 to English language AND publication date from 2015
#3	(child*[Title/Abstract]) OR (adolescen*[Title/Abstract]) OR (teen[Title/Abstract]) OR (youth*[Title/Abstract]) OR (pediatric*[Title/Abstract])
#4	Limit #3 to English language AND publication date from 2015
#5	(physical activity[Title/Abstract]) OR (sport*[Title/Abstract]) OR (exercise[Title/Abstract]) OR (program*[Title/Abstract]) OR (fitness[Title/Abstract]) OR (training[Title/Abstract])
#6	Limit #5 to English language AND publication date from 2015
#7	("chronic disease*"[Title/Abstract]) OR ("pediatric*"[Title/Abstract]) OR ("rhumato*"[Title/Abstract]) OR ("rheumato*"[Title/Abstract]) OR ("paediatric*"[Title/Abstract])
#8	Limit #7 to English language AND publication date from 2015
#9	#2 AND #4 AND #6 AND #8
#10	Limit #9 to NOT ((systematic review[Title/Abstract]) OR (meta analysis[Title/Abstract]) OR (literature review[Title/Abstract]))
#11	Limit #10 to English language AND publication date from 2015

Appendix 2

Table 2: Summary of included studies, sorted by lead authors alphabetically (n=12)

Lead author (sorted by alphabetic order), year, study location	Study design with intervention (if any) Measure of PA	Participants (N, brief eligibility criteria, % female, mean age)	Key measurements 1) Primary aim 2) Secondary aims Method of follow-up (if any)	Statistical measures	Overall result / discussion
Armbrust, 2016, The Netherlands [39]	Cross-sectional study (3 pediatric rheumatology centers in The Netherlands) Part of R@W, (internet-based program) Quantitative study Accelerometer to record movement over 7 consecutive days	N= 80 children with JIA (65% girls, median: 9.8 years) Inclusion: JIA diagnosis, Dutch fluency, having a computer with internet Exclusion: physical disability due to other pathology than JIA, having cognitive behavioral therapy, >2cm out of 0 to 10 (physical global assessment)	1)Fatigue levels and its related factors 2)relationship of fatigue and disease-related factors 3)relation of fatigue and attendance of physical education classes (fatigue) PedsQl-MFS; (energy) VAS for energy levels (medication and disease activity), perceived health (disability and pain) : (patients characteristics) Data from medical charts; (disease activity) VAS physician global assessment (VAS-PGA); (disability) C-HAQ38; (pain) VAS; (PA level) accelerometer; (exercise capacity) treadmill	Spearman correlation between (gender, age, disease activity, use of medication, pain, disability, exercise capacity, PA level and self-efficacy) AND (fatigue and mean daily energy level) All factors correlated with p-value < 0.10 -> multivariate model Spearman correlation between (participation of sport, attendance, sport frequency) AND (disease activity, use of medication, pain, functional ability, fatigue, exercise	Mean energy level comparable in morning vs evening (highest in afternoon) Lower mean daily energy levels on all 7 days by 60% of children with JIA, by 78% on more than half the week Full attendance and no absence due to disease by 70% of patients // Full participation in sports by 66% Median sports frequency in free time = 1h/week High fatigue correlated with low energy levels Patients with higher fatigue -> higher disability, higher pain, lower EC, lower PAL, lower self-efficacy scores High energy levels correlated with low disability, low pain, higher PAL, being off medication High disability and low self-efficacy -> higher levels of fatigue

			(Self-efficacy) CASE scale	capacitiy, self-efficacy) Correlation with p-value < 0.10 -> logistic regression to predict sport frequency Significant p-value is <0.05	Lower PAL is a predictor of higher fatigue Higher sport frequency correlated with lower fatigue Predictors of full participation in physical classes are younger age, off medication, lower disability, less pain, higher fatigue and higher exercise capacity <u>Overall</u>: fatigue is impacting JIA patients, and self-efficacy is associated with fatigue =>promoting self-efficacy strategies in JIA for enhancing outcomes (perceived health like fatigue, physical healthy), hence improving physical activity and participation
Bohr, 2015, Denmark [43]	Cross-sectional study Measure and compare PA levels between moderate/severe JIA and healthy (comparable age and gender) Danish school children Participants assessed clinically by a pediatrician	N=133 JIA patients (female 74%, mean of 14 years) Inclusion: 7-20 years, JIA with DMARD (methotrexate, biologics, or frequent intra-articular injections of corticosteroids)	1)pattern of physical activity with moderate to severe JIA 2)association between PA and disease activity, disability, pain, functional ability, JIA subgrouping, duration of symptoms, medications, body mass (pattern of PA) accelerometer (disease activity) JADAS; (Global disease scoring) VAS; (disability) limits of articular motion; (functional ability) Danish version of CHAQ; (level of pain) VAS; (inflammatory markers) ESR	Summary stats to compare PA levels between JIA and healthy controls Distribution of level of PA compared to healthy children by Wilcoxon Signed Rank Test Dependence on disease related factors tested by analysis of variance (one way ANOVA), linear regression or by rank	Significant difference between PA distribution between JIA and their healthy matched in average activity and level of activity, where JIA patients do less Lower percentage of participants meeting The Danish Health Authorities' guidelines for daily PA of more than 60mn/day of moderate PA compared to their healthy matched: 45% vs 61% for boys And 19% vs 39 % for girls Negative association (-0.213, p-value 0.014) between active disease in weight-bearing joints and vigorous PA <u>Overall</u>: JIA patients are less physically active than healthy controls and also than Danish recommendations

	outside of investigation Quantitative study Accelerometers to record movement data for 7 days			correlations/Spearman's rho or t-test Significance: two-tailed and alpha as 0.05	=>implementing a schedule for regular physical exercise to medical treatment may be beneficial =>educating patients about complexity of pain to encourage a positive change in their life
Fazaa, 2020, Tunisia [50]	Cross-sectional study Measuring and comparing PA levels between JIA and healthy individuals (Tunisian school children) Physical activity questionnaire for children cPAQ and adolescents aPAQ Quantitative study	N=110 children (N=55 JIA children; and control N=55 healthy schoolchildren), mean age of 8.5 years, female % not mentionned Inclusion: JIA diagnosis Exclusion: high disease activity, physical handicap limiting exercise performance	1)assess PA in JIA compared to healthy age and gender controls 2)determine factors that affect PA levels (pain) VAS; (disease activity) JADAS-27; (functional ability) CHAQ; (PA assessment) Arab version of cPAQ and aPAQ	Descriptive stats to compare PA levels between children with JIA and healthy controls Independent-sample t test for difference in demographic and clinical features	<u>JIA compared to healthy group</u>: Lower PA levels; Significant lower time spent in PA questionnaire; Higher average for sleeping and sitting in 76% JIA (10h/day); Less time in MVPA and more time on sedentary activities; General recommendations (>60mn/day MVPA): 18.1% for JIA group (vs 75%), Significant lower MET/day and lower energy expenditure <u>Factors limiting PA level</u>: Main barrier: pain (81.5%), swollen joints (52.7%), joint deformities (25.4%) Association to lower PA level: longer duration of disease progression, JIA subgroup (systemic JIA and polyarticular JIA with positive RF), active disease

					(JADAS-27 > 6), active disease in weight-bearing joints, functional ability, patients under treatment <u>Overall</u>: JIA patients less physically active than healthy matched and than general health recommendations, some could lose benefit of PA due to lower practice, low PA associated with disease-related factors, control of disease may improve PA levels =>physician should recommend safe exercise for JIA patients
Hulsegge, 2015, Australia [48]	Cross-sectional study Evaluating and comparing the physical capabilities and activity levels of 2 groups Self-reported questionnaires completed by participants Quantitative study	N=28 JIA children, (female 57%, mean age of 11.3 years) Healthy controls: SPANS (mean of 11.3 years, 49% female) HOYVS (mean of 11.6 years, 47% female) Inclusion: age between 6 and 16 years, JIA diagnosis Exclusion: inability to follow instructions, inability to perform	1)compare parameters (FMS, physical fitness, PA) between groups 2)describe differences in physical and psychosocial well-being between groups (pain) VAS; (fundamental motor skills) assessed by pediatric physiotherapist; (aerobic capacity) mutistage 20-meter shuttle run test to predict VO2max; (PA) modified version of APARQ; (physical function) revised CHAQ; (physical and psychosocial well-being) CHQ-PF50;	Fisher exact test and independent t-test for SPANS and HOYVS groups Independent t-test: -differences in mean values of aerobic capacity between JIA and SPANS -differences in physical and psychosocial well-being (CHQ-PF50) between JIA and HOYVS Logistic regression: differences in FMS between JIA and SPANS	No difference in having FMS between JIA and healthy peers <u>JIA compared to healthy peers</u>: More likely to be advanced in kick and overhand throw Lower aerobic capacity compared to SPANS (significant in girls of year 8 and boys of year 10) Less PA during summer and winter school terms (significance for girls of year 6) In summer, 57.1% of JIA met PA reco (> 60mn) vs 35.7% (winter) (comparison to SPANS that report 78.7% met reco in summer and 72.3% in winter) Parents of JIA children have lower scores than HOYVS on 10/12 physical and psychosocial parameters of CHQ-PF50 -> main difference in child behavior and emotion impact on parent

		independently exercise	Recommendations of > 60mn/day or moderate to vigorous intensity		Overall:differences in aerobic capacity and level of PA compared to healthy individuals, No significant difference in FMS, Less physical fitness and PA, Affected physical and psychocosial well-being =>similar FMS – enough FMS to practice PA, =>small sample size
Kwon, 2017, South Korea [49]	Cross-sectional Comparison of physical fitness between groups Quantitative study	N=51 children (N=26 with rheumatoid arthritis and N=25 healthy controls) Mean age JRA: 12.58 (42.3% female) Mean age control: 12.32 (40% female) Inclusion: JRA diagnosis, ability to move independently, communicate, floow instructions Exclusion: unstable condition, unable to practice physical fitness	1)muscular strength and endurance, flexibility, lung capacity, body composition 2)functional ability, health-related quality of life (muscle strength) grasping power and back muscle - dynanometer; (flexibility of bending forward) digital trunk forward flexion meter; (lung capacity) FVC, FEV1	Kolmogorov-Smirnov Independent semple t-test (difference in physical fitness) Scheffe test (post hoc analysis) Statistical significance : p-value<0.05	FEV (excluding 14-16 years) and FEV1 were different in all age groups Body fat percentage difference for 14-16 years, skeletal muscle mass for all age groups
Milatz, 2019, Germany [40]	Prospective observational cohort	N=23,016 JIA children school-aged children and adolescents	1)prevalence of school sports participation 2)correlates of school sports abstenteeism	Analysed by 2-level random effect logit models	School sport attendance in JIA: Increase attendance over 15-year period (from 30.8% in 2000 to 63.6% in 2015): due to significant

	Analysing existing data from the German NPRD Self-reported participation in school sports Mainly quantitative study	Mean age ranging between 7.4 years (in 2000) and 8.5 years (in 2012) Female percentage ranging from 61.4% (in 2000) to 65.4% (in 2015) Inclusion: JIA diagnosis, enrolled in database between 2000-2015, school attendance Exclusion: not mentionned	3)attendance in school sports (pain) self-report (fatigue) self-report (coping) self-report (overall well-being) self-report (functional ability) German version of C-HAQ (disease activity) cJADAS-10 (frequency of PA in leisure time) five-point Likert scale	p-value < 0.05 (statistically significant)	decrease of full exemption (from 44.5% in 2000 to 16.1% in 2015) Decrease in exemption -> associated with more patient with inactive disease Largest decrease in exemption was RF-positive polyarthritis patients (from 67.3% in 2000 to 25.2% in 2015) and systematic (from 52.4% in 2000 to 16.7% in 2015) Factors associated with exemption in 2015 : female sex, disease actvity, RF-positive polyarthritis, systemic JIA, pain intensity, any form of GCs, DMARDs, physiotherapy Self reported pain, fatigue, copin and overall well-being -> associated to non-participation
Milatz, 2024, Germany [41]	Prospective observational cohort PA levels in JIA compared to control and associated factors Self-reported data	N=6,297 JIA patients (67.5% female, mean age of 11.2 years) Inclusion: JIA diagnosis, being in database in 2017 between 3 and 17 years Exclusion: not mentionned	1)PA levels between JIA and healthy matched controls 2)correlates of physical inactivity, risk groups of sedentary behaviour Comparision of self-reported PA between NPRD patients and KiGGS sample	Odds ratio (ORs) with 95%-confidence intervals (CI) p-value < 0.05 was significant	In 2017 <u>Comparison of PA in JIA compared to controls</u>: 35.7% JIA met minimun WHO reco (vs 20.2% in controls) Less difference with ageing (30% in 3-6 group year vs 6% in 14-17 group year) In general population, girls more likely to meet reco <u>Comparison of physical inactivity compared to controls</u>: Physical inactivity (<2/week for minimum 60min): comparable proportion

	Quantitative study				Girls more likely than boys in both population Group age of 14-17 years more impacted RF-positive polyarthritis and enthesitis-related arhritis Factors related to physical inability: Disease duration, age at JIA onset, disease activity and functional disability
Polat, 2024, Turkey [47]	Case control study Evaluate PA and HRQOL in children with oligoJIA in remmission with healthy peers Physical activity questionnaire for children PAQ-C General physical levels over the previous 7 days	N=100 (50 children with oligoarticular in remission and 50 age and sex matched healthy controls) Mean age: 11.8 years (oligo-JIA) and 11.6 years (control) Female percentage of 66% in both groups Control group randomly selected by matching age and gender Inclusion: not clearly mentionned	1)HRQOL, PA levels in children with oligoarticular JJIA in remission and healthy individuals 2)what affects PA levels: disease-related factors (disease activity) JADAS and Wallace criteria; (Functional ability) CHAQ; (pain) VAS; (PA practice) PAQ-C; (quality of life) PedsQL; Visit at 3 and 6 month follow-up	Kolmogorov-Smirnov/Shapiro-Wilk tests Student's T-test Mann-Whitney U test Chi-square, Fisher test ANOVA Kruskal-Wallis test Correlation analysis with Spearman's test p-value threshold <0.05	JIA patients characteristics compared to controls: Significant lower self-reported PedsQL scores (Oligoarticular JIA, domains: school functionnning and psychosocial) Physical activity was not correlated with pain experienced from previous week or well-being

	Mainly quantitative study	Exclusion: Patient < 9 years and > 14 years, no complete questionnaire, missing visits in the 6-month follow-up			
Risum, 2018, Norway [42]	Controlled cross-sectional study Compare levels and intensities of PA between JIA subgroups and factors Accelerometer for 7 consecutive days Questionnaires Mixed quantitative and qualitative study	N=120 60 JIA patients: 30 oligoarticular, 30 polyarticular Controls: 60 age and sex-matched healthy controls Mean age of JIA: 13.6 years (83% female) Mean age of controls: 13.5 years (83% female) Inclusion: age 10-16 years, disease duration > 6 months, oligoarticular or polyarticular JIA (RF +/-), living in South-Eastern Norwegian area	1)compare measured levels and intensities of PA across 2 JIA subgroups to age and sex-matched controls 2)differences in PA between JIA subgroups and associations 3)participation in PA and PE + barriers (volume and intensity of PA) accelerometers (PA, PE, facilitators, barriers) structured interview (disease activity) JADAS 71 (clinical inactivity) Wallace criteria (disease duration) CHAQ	Independent sample t test, analyses of covariance, Mann Whitnes U test, chi-square test : assess differences between 2 groups and between patient subgroups Linear regression: correlates of cpm, VPA, sedentary time Disease related variables ($p<0.15$) in univariate -> multivariate adjusted for age, sex, accelerometer wear time p-value < 0.05 as statistical significant Effect size for PA categories differences with Eta Squared value	Both JIA subgroups: moderate disease activity, no to mild functional limitation (CHAQ) 25% active joint disease (1-2 joints) 43% with DMARDs (mostly TNFi) 58% no biologics None on corticosteroids Barriers felt by 43% JIA (mostly pain) and 32% controls (mostly time) Facilitators for both: enjoyment and become fit <u>Overall</u>: Comparable PA level JIA spent less time on vigorous PA Use of biologics -> higher PA levels =>professionals should consider patient preferences (focus on enjoyment and consider symptoms like pain) to include more vigorous PA in JIA patients and act on their well-being

		Exclusion: comorbidities associated with impaired cardiopulmonary conditions, severe orthopedic, recent surgery or inability to walk		(small 0.2; medium 0.5; large 0.8)	
Sarac, 2024, Turkey [46]	RCT Cardiopulmonary exercise test Intervention: randomisation -> exercise group with IMT program (intensity 60% of PI_max) The control group pursues routine medical treatments for 8 weeks (nothing additional) Mainly quantitative study	N=33 JIA children were randomised 17 assigned to exercise group (mean age of 15.12, 29.4% female) 16 assigned to control group (mean age of 15.7, 31.3% female) Inclusion: JIA diagnosis, age 13-18 years, same frequency/dosage of biologic drugs the last 3 months, history of arthritis > 1 joint in lower extremity Exclusion: having a condition limiting performance of	1)effect of IMT on respiratory muscle strength 2)effect of IMT on pulmonary functions, aerobic exercise capacity, functional capacity, and QoL in children with JIA (Pulmonary functions: PI_max, PE_max, FVC, FEV1, FEV1/FVC) spirometer, respiratory pressure test (maximal aerobic exercise capacity: METs, VO2_peak, HR_peak, HRR, VO2_peak/HR_peak) treadmill and cariopulmonary exercise test CPET (lower extremity related functional capacity) 6MWD (QoL) PedsQL, Child Self-Report Patients were follow up every 2 weeks for 8 weeks	Shapiro-Wilk test, histograms, detrended-Q plot graphs, kurtosis, skewness Independent sample t-test (student) and Mann-whitney U test : group difference Paired sample t-test and Wilcoxon: significance of within-group over time Chi-square test and Fisher's exact test: compare categorical demographic data Effect size: Hedge's g Intention-to-treat analysis	Intervention group: Increased: FVC, FEV1, PI_max, PE_max No change within group: FEV1/FVC Increased: METs, VO2_peak, VO2_peak/body weight, VO2_peak/HR_peak No change: HR_peak and HRR Overall: Intervention (8-weeks of IMT) beneficial (inspiratory muscle strength, vital capacity, aerobic exercise capacity) compared to no intervention No improvement in the intervention group for lower extremity (functional capacity or QoL)

		assessments or affect results, physiotherapy the last 6 months, >3 times / week exercise, active disease status, involvement or cardiopulmonary organs, systemic JIA		p-value threshold of 0.05	
Sherman, 2018, Israel [45]	Cross-sectional study Assessing existing PA levels, screen time and obesity rates Quantitative study	N=195 JIA: 97 patients Mean age of 11.8 years (68% female) Control group: 98 individuals Mean age of 11.7 years (62% female) Inclusion: not mentioned Exclusion: not mentioned	1)screen-time information in JIA patients and disease-activity compared to control group 2)correlation with PA, weight and leisure time activity compared to control group (disease activity and remission) Wallace criteria, physician VAS (PA frequency and intensity) Modified Godin Leisure-Time Exercise Questionnaire (BMI) (daily screen time)	Normality distribution (Shapiro-Wilk test) Chi-square test: difference between qualitative data t-test or Mann-Whitney test: differences between patients and healthy controls Kruskal-Wallis non-parametric test: 3 groups comparison Pearson or Spearman correlations: associations between continuous variables	Comparison between JIA and controls: Similar for PA, obesity rates, screen time hours

				p-value threshold of 0.05	
Sule, 2019, USA [44]	RCT (blinded intervention is unclear) Intervention group: engaged in slow-speed resistance exercises with individualized instruction by a certified trainer, 1-2 times per week for 12 weeks Control group: performed home-based aerobic exercises 3 days per week for 12 weeks Monitoring of compliance with exercise regimen, adherence	N= 33 JIA patients Control group: N=16, mean age of 16.1 years (34% female) Exercise group: N=17, mean age of 14 years (36% female) Inclusion: age 10-18 years, polyarticular JIA diagnosed with stable therapy and steroid free > 1 month Exclusion: pregnant, breast feeding, active flares, cardiopulmonary pathologies, cognitive impairement Stratified by gender + Randomized to either exercise or control group	1)safety and feasibility of slow-speed resistance exercise program BMI (aerobic fitness) VO2_peak (isometric muscle strength) elbow extension and knee extension (pain) Wong-Baker FACE, kids fatigue severity scale (functional ability, QoL) CHAQ Follow up:	2-sided, paired student t-test : comparison of pre and post intervention Fisher's exact test : compare data between 2 groups Significance levels : p-value <0.05	Resistance exercise protocol: safe and well-tolerated for JIA, no serious adverse effects No significant improvements: no statistical improvement in pre and post exercise measure of : Body composition, aerobic fitness, muscle strength, quality of life either in exercise or control groups Both groups show difficulties in adhering to exercises protocol (consistency) Study cohort with abnormal body composition (high percentage of participants that do not meet guidelines recommended lean muscle mass and body fat)

	rates recorded for both groups Quantitative study				

Abbreviations from the table:
aPAQ (Physical activity questionnaire for adolescents); APARQ (adolescent physical activity recall questionnaire); C-HAQ (Childhood Health Assessment Questionnaire-disability index); C-HAQ38 (Childhood Health assessment questionnaire); CASE (Childhood arthritis self-efficacy); CHAQ (Childhood Health Assessment Questionnaire); CHQ-PF50 (child health questionnaire parent form 50); CI (confidence intervals); cJADAS-10 (Juvenile Idiopathic arthritis disease activity score in 10 joints); cPAQ / PAQ-C (Physical activity questionnaire for children); DMARDs (disease-modifying antirheumatic drugs) ; EC (exercise capacity); ESR (erythrocyte sedimentation rate); FEV1 (forced expiratory volume in 1 second); FMS (fundamental motor skills); FVC (forced vital capacity); GCs (glucocorticoids); HOYVS (Health of Young Victorians Study); HRQOL (health-related quality of life); HR_peak (peak heart rate); HRR (heart rate reserve); IMT (inspiratory muscle training); JADAS (juvenile arthritis disease activity score); JIA (juvenile idiopathic arthritis); JRA (juvenile rheumatoid arthritis); KiGGS (German Health Interview and Examination Survey for Children and Adolescents); METs (Metabolic equivalents); MPA (moderate PA); MVPA (moderate to vigorous PA); NPRD (National Paediatric Rheumatologic Database); ORs (Odds ratio); PA (physical activity); PAL (physical activity level); PE (physical education); PE_max (maximal expiratory pressure); PedsQL (Pediatric Quality of Life Inventory); PedsQl-MFS (Pediatric Quality of Life Inventory Multidimensional Fatigue Scale); PI_max (maximal inspiratory pressure); R@W (Rheumates@Work); RCT (randomized controlled trial); RF (rheumatoid factor); SPANS (Schools Physical Activity and Nutrition Survey); TNFi (Tumor necrosis factor inhibitor – a drug); VAS (Visual Analog Scale); VO2_max / VO2_peak (peak oxygen consumption); VPA (vigorous PA); 6MWD (6-Minute Walk Distance).