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Sport Activities for Children and Adolescents: Part 2. Joint Position Statement of Paediatric Societies on Physical Activity and Sport Recommendations for Children With Specific Chronic Disease Conditions

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ABSTRACT

Aim: To provide consensus-based recommendations on safe and effective physical activity and sports participation for children and adolescents with chronic health conditions.

Abbreviations: CAKUT, congenital abnormalities of the kidneys and urinary tract; CDC, centres for disease control and prevention; CKD, chronic kidney disease; DDH, developmental dysplasia of the hip; EAP, European Academy of Pediatrics; EIB, exercise-induced bronchospasm; FDEIA, food-dependent exercise-induced anaphylaxis; FEV1, forced expiratory volume in 1 s; HbA1C, glycated haemoglobin; IBD, inflammatory bowel disease; ICS, inhaled corticosteroids; MCDK, multicystic dysplastic kidney; MVPA, moderate-to-vigorous physical activity; NS, Nephrotic Syndrome; SCT, sickle cell trait; WHO, World Health Organization.

Methods: The Task Force of the European Academy of Pediatrics (EAP) reviewed English-language meta-analyses, systematic reviews, randomised clinical trials and observational studies published between 2000 and 2024 in major databases (Scopus, PubMed/MEDLINE, Cochrane Library, Science Direct, MEDLINE and EBSCO). Evidence from scientific organisations, including the WHO, was also considered. Recommendations were developed through expert consensus.

Results: The position statement provides tailored guidelines for children with juvenile idiopathic arthritis, congenital osteoarticular and musculoskeletal defects, haemophilia, asthma, cystic fibrosis, diabetes, sickle cell trait, hypertension, nephrotic syndrome, inflammatory bowel disease, epilepsy, a history of severe allergic reactions and reduced nephron number. Practical recommendations are summarised for each condition.

Conclusion: This consensus statement offers a structured, evidence-based framework for healthcare professionals, parents and caregivers to promote safe physical activity and sport participation in pediatric populations with chronic diseases, thereby supporting quality of life and long-term health outcomes.

1 | Background

An adequate level of physical activity is linked to numerous physiological and psychological health benefits throughout an individual's lifespan, including the prevention of various diseases such as metabolic disorders, cancer and mental health-related issues. Over recent decades, physical activity has garnered growing recognition as a fundamental component of maintaining good health and enhancing quality of life for individuals of all ages [1]. The World Health Organization (WHO) has issued physical activity guidelines designed for individuals across all age groups. For a paediatric population aged from 5 to 17 years, the guidelines recommend that children accumulate at least 60 min of moderate-to-vigorous physical activity (MVPA) daily, primarily of endurance or mixed forms of exercise, spread throughout the week. Additionally, children should engage in vigorous-intensity physical activities that promote muscle and bone strength on at least 3 days each week [2]. Physical activity can play a significant role in chronic disease management by preventing the onset of new chronic conditions, directly influencing the progression of existing diseases and aiding in the alleviation of symptoms related to chronic illnesses [3].

While healthy paediatric populations are generally advised to achieve 60 min of daily MVPA, prescribing the optimal amount of physical activity for children and adolescents with chronic health conditions necessitates a more tailored approach, taking into account the specific risks and benefits. The dosage of physical activity—including frequency, type, intensity and duration—can vary significantly based on factors such as the nature of the illness, the child's fitness level, physical disability, musculoskeletal pain, and any medications they may be taking. Consequently, clinicians may find themselves uncertain about the appropriate dosage and types of physical activity to recommend for their patients. The aim of this consensus paper, developed by the European Academy of Pediatrics (EAP), is to offer comprehensive guidance on participation in physical exercise and specific sports for children and adolescents with various chronic health conditions. Additionally, it seeks to propose tailored recommendations to support their involvement in physical activities.

2 | Methods

The evidence presented in this report was obtained through a comprehensive search of electronic databases, including Scopus, PubMed/MEDLINE, Cochrane Library, Science Direct, MEDLINE and EBSCO, covering the period from 2000 to 2024. The search utilised a range of keywords: exercise, physical activity, sports, physical effort, training, chronic disease, juvenile idiopathic arthritis, congenital osteoarticular defects, musculoskeletal defects, haemophilia, asthma, cystic fibrosis, diabetes, sickle cell traits, arterial hypertension, nephrotic syndrome, inflammatory bowel diseases, epilepsy, allergic reactions, reduced nephron number (e.g., due to renal and urological malformations, prematurity/small for gestational age, partial nephrectomy or history of cardiopathy or cancer with nephrotoxic treatments, obesity), chronic kidney disease, children, adolescents, youth and the paediatric population. To ensure a robust literature review, we focused on meta-analyses, systematic reviews, randomised clinical trials and observational studies from a global perspective. Additionally, we searched the websites of reputable scientific organisations, such as the World Health Organization (WHO). The articles selected for inclusion were mutually agreed upon by the authors, with particular emphasis on those that were meta-analyses and systematic reviews, as well as information deemed relevant for a paediatric medical readership.

3 | Results

3.1 | Juvenile Idiopathic Arthritis

Juvenile idiopathic arthritis refers to a type of arthritis with an unknown origin that begins before the age of 16, persists for over 6 weeks and is diagnosed after ruling out other potential causes. Arthritis in this context is identified by joint swelling or effusion, along with symptoms such as increased temperature, pain and restricted movement, with or without stiffness [4]. Additional constitutional signs may include anorexia, weight loss, growth failure and fatigue. Furthermore, extra-articular manifestations can involve the eyes, heart, lungs and haematopoietic system.

Summary

- This joint consensus statement provides practical, evidence-based guidelines for safe and effective physical activity in children and adolescents with chronic health conditions.
- Covering conditions such as juvenile idiopathic arthritis, asthma, cystic fibrosis, diabetes and others, the recommendations are primarily intended for paediatric healthcare professionals but are also accessible to parents and caregivers.
- They aim to improve quality of life, promote safe participation in sports and support long-term health outcomes.

Muscle atrophy, weakness and anaemia all play a role in diminished fitness; however, deconditioning resulting from reduced physical activity is likely the primary factor. Physical therapy is usually the first form of treatment to be carried out in the active phase of the disease. Once the acute phase of the disease has resolved and the condition is well-controlled, recreational sports are permitted. Recommended low-impact activities include swimming, cycling, Pilates, walking, table tennis and hiking. A progressive return to play in contact sports, including competitive sports, is also possible if the disease is in remission and the patient can tolerate physical exertion [5, 6]. For this reason, moderate exercise and strength-training activities are recommended for children with controlled juvenile idiopathic arthritis. Tailored training programmes should be provided, particularly for those with severe joint involvement, ideally in a group setting to enhance both physical and social benefits, provided their condition is well-managed and they have adequate physical capacity. Engaging in regular exercise can help increase range of motion, muscle strength, fitness and exercise capacity, while also reducing disability in adulthood and enhancing overall quality of life. Additionally, exercise offers notable anti-inflammatory benefits [5, 6].

3.1.1 | Recommendations for Children and Adolescents With Juvenile Idiopathic Arthritis

A multidisciplinary team comprising paediatric rheumatologists, physiotherapists and sports medicine specialists should collaborate to enhance physical activity levels and design individualised exercise programmes. This approach not only promotes general health benefits but also aids in the management of arthritis symptoms.

Sports participation should be tailored to the athlete's exercise tolerance and adjusted as needed in cases of significant illness or physical deficits.

During acute exacerbations, the primary objectives of physical activity are to maintain joint mobility and muscle strength. Once the disease is inactive, the focus shifts to progressively enhancing aerobic and muscular fitness.

Exercises with dynamic loading of a joint may provide better function. These exercises should focus on controlled, low-impact movements that strengthen surrounding muscles without exacerbating inflammation.

Water therapy and aquatic sports take advantage of the water's buoyancy and warmth, providing unique therapeutic benefits

Land-based exercises can provide similarly beneficial effects as aquatic activities.

Children may safely engage in competitive and impact sports if their condition is well-managed and they possess adequate physical capability.

Participation in organised sports programmes, typically lasting 3–4 months, is safe for children with controlled and stable juvenile idiopathic arthritis. These programmes should include regular assessments by healthcare providers to monitor progress and adapt activities as needed.

Athletes with systemic juvenile idiopathic arthritis should undergo a cardiological assessment prior to participating in sports.

Those with polyarticular or systemic juvenile idiopathic arthritis, along with cervical spine involvement, should have radiographic evaluations for C1–C2 instability before engaging in contact or collision sports. Ongoing monitoring of cervical spine health is also advised during regular follow-up.

Athletes experiencing inflammation of the temporomandibular joint must wear properly fitted mouthguards during activities with potential jaw and dental injury.

Athletes with visual impairments due to uveitis should utilise appropriate eye protection during activities with a risk of ocular injury and adhere to guidelines for one-eye athletes.

3.2 | Congenital Osteoarticular and Musculoskeletal Defects

Congenital osteoarticular and musculoskeletal deformities represent a diverse array of conditions arising from disruptions in the formation, growth or development of bone and cartilage structures within joints. These abnormalities can significantly impair joint function, leading to challenges in mobility and daily activities. Most of these deformities have a genetic basis. They can be categorised based on their localisation within the bone or joint into epiphyseal, metaphyseal, diaphyseal and epiphyseal cartilage deformities. While congenital osteoarticular defects are uncommon, the most prevalent congenital malformation is developmental dysplasia of the hip (DDH).

The incidence of DDH is estimated at 11.5 cases per 1000 live births, as determined through meta-analysis protocols and multiple logistic regression [7]. DDH is characterised by insufficient acetabular coverage of the femoral head. Since many symptoms may not be apparent at birth, the term 'developmental' more accurately reflects the biological nature of the condition than 'congenital' [8]. Patients often face significant obstacles in their daily activities, such as walking, running, standing and prolonged sitting, due to persistent pain and reduced physical function. Additionally, individuals with DDH tend to show lower strength

of hip flexor and abductor muscles [9]. Evidence suggests that progressive resistance training may serve as a promising exercise approach to alleviate pain and enhance functional abilities [10]. Strengthening hip abductors and incorporating gentle stretching exercises can also help improve hip stability during ambulation [11].

3.2.1 | Recommendations for Children and Adolescents With DDH

Engage in moderate exercise and strengthening activities to promote muscle balance, ensuring minimal stress on the hip joint.

Moderate-intensity activities such as rowing, cycling and tennis may be suitable options.

Swimming is highly recommended, as it effectively enhances cardiovascular fitness and upper body strength while providing low-impact hip exercises.

Running and other high-impact sports may not be recommended for most children with congenital osteoarticular and musculoskeletal defects. Decisions should be made on an individual basis by healthcare professionals, considering the patient's clinical status and physical abilities.

3.3 | Haemophilia

Haemophilia is a recessively inherited bleeding disorder linked to the X chromosome, arising from the absence, deficiency or dysfunction of coagulation factors VIII or IX in plasma. Children with severe haemophilia, characterised by having less than 1%–2% of normal factor levels, may experience spontaneous bleeding even in the absence of trauma. Common issues include joint or muscle haemorrhages, easy bruising and prolonged bleeding after injuries, with potential complications affecting vital organs, the airway and intracranial areas. The disorder often leads to significant restriction in range of motion and may result in chronic pain. However, preventive physical exercise that strengthens the periarticular muscles has been shown to reduce bleeding frequency. The actual risk of muscular, articular and intracranial haemorrhage varies depending on the child's individual bleeding tendency, previous bleeding history, medical treatment and type of sports [12].

Evidence suggests that patients with haemophilia should engage in at least 30 to 60 min of daily physical activity to maintain sufficient muscle strength and minimise injury risk [13]. Additionally, participation in a resistance training programme can reduce the frequency of bleeding episodes [14].

The National Hemophilia Foundation provides general guidance on sports participation for individuals with haemophilia, categorising certain activities as 'safe' (e.g., archery, aquatics, elliptical machine, stationary bike, fishing, frisbee, golf, hiking, Tai Chi, snorkelling, swimming and walking) and others as 'moderately risky' (e.g., recreational cycling, rowing, skiing, treadmills, circuit training, body sculpting classes, frisbee golf, Pilates and weight lifting) [15].

3.3.1 | Recommendations for Children and Adolescents With Haemophilia

Ensure that children with haemophilia receive appropriate factor prophylaxis to minimise bleeding risks during sports, while conducting a thorough evaluation of joint and muscle function prior to sport selection.

Avoid physical activity until any joint pain or swelling has completely resolved.

Young athletes with haemophilia should wear protective equipment.

If activity restrictions are necessary, physicians should guide children and families towards safe alternative options.

Prior to participating in contact or collision sports such as martial arts, hockey or football, consult with a sports medicine physician or paediatric haematologist.

Encourage participation in low-risk injury activities such as water polo, walking, cross-country skiing, golf and swimming; with adequate supervision, equipment and safety precautions, patients can also safely engage in various high-impact sports.

Avoid excluding children from organised physical activities in general.

Before returning to sports, ensure an appropriate examination and develop an individualised exercise programme.

3.4 | Asthma

Asthma is the most prevalent chronic disease in children, characterised by an inflammatory disorder of the airways that leads to hyper-responsiveness and reversible airflow limitation. Common symptoms include shortness of breath, coughing and wheezing, with exercise and emotional stress often triggering bronchospasm. Although exercise-induced bronchospasm (EIB) is rarely the sole trigger, it may be the initial presentation of asthma in children. In individuals with EIB, bronchoconstriction typically begins during exercise and peaks within 5–15 min after cessation of physical activity, usually resolving within an hour. Land-based endurance exercises, such as running or cross-country skiing, are common triggers, particularly in cold environments, while swimming rarely induces EIB. A 10%–15% drop in forced expiratory volume in 1 s (FEV_1) from baseline during the pulmonary function test, after vigorous exercise for approximately 6–8 min and a positive response to beta-2 agonist medication, confirms the diagnosis of EIB. Voluntary eucapnic hyperventilation tests are recommended in athletes with suspected EIB or unexplained exercise-related respiratory symptoms [16, 17].

Certain sports may expose individuals to dry, cold air, environmental allergens and pollutants, leading to exacerbation,

with runners and winter athletes reporting more symptoms. Although asthma-related fatalities in individuals under 20 years are uncommon, they have been documented in both competitive and recreational activities such as basketball and track running. Conversely, exercise can help mitigate the severity of EIB by raising the threshold for bronchospasm and swimming can enhance aerobic fitness and reduce asthma-related morbidity [18].

3.4.1 | Recommendations for Children and Adolescents With Asthma

Young athletes experiencing persistent symptoms or abnormal baseline pulmonary function tests should receive daily asthma treatment with inhaled corticosteroids (ICS), ICS/long-acting beta2 agonists, leukotriene receptor antagonists, or, in children aged ≥ 12 years on ICS/formoterol, an extra dose as needed before activity, to control bronchial inflammation, while avoiding the overuse of short-acting beta-2 agonists.

Children with well-controlled asthma can engage in any physical activity and should use inhaled beta-2 agonists 15–30 min before exercise.

Swimming is a safer option for those with EIB compared to running.

Children with asthma should refrain from scuba diving if they exhibit symptoms or have abnormal pulmonary function test results.

Keeping an accurate log of symptoms, triggers, treatments and recovery patterns is crucial for children and adolescents with asthma.

Quick-relief medications (rescue inhalers) should always be on hand during training sessions to manage potential flare-ups.

Outdoor training should be avoided when pollen or mould counts are elevated.

In cold environments, children should wear a scarf or ski mask during outdoor exercises and prefer breathing through their noses instead of their mouths.

Athletes with asthma competing at national or international levels must obtain a therapeutic use exemption, confirming their asthma and/or EIB to use certain medications; they should consult their sports federation for current documentation requirements as outlined by the World Anti-Doping Agency (www.wada-ama.org).

3.5 | Cystic Fibrosis

Cystic fibrosis is a genetic disorder caused by mutations that disrupt chloride transport, resulting in thick secretions in the pulmonary, gastrointestinal, endocrine and reproductive systems, as well as increased salt loss in sweat. The diagnostic 'sweat chloride test' remains the gold standard for detection. Pulmonary complications are the primary contributors to morbidity and mortality; however, early diagnosis and advancements in treatment have improved average survival rates [19]. Exercise limitations depend on the extent of lung disease and reduced ventilatory capacity, often resulting from bronchial narrowing (edema), bronchospasm, mucus accumulation and decreased alveolar ventilation. Additionally, significant ventilation–perfusion mismatch can lead to arterial oxygen desaturation, intrapulmonary right-to-left shunting or cor pulmonale with congestive right heart failure [20]. Chronic malnutrition can reduce muscle mass and strength (both respiratory and skeletal), adversely affecting physical performance. Cystic fibrosis may also lead to biliary cirrhosis and portal hypertension, which can result in oesophageal varices and splenomegaly. Children with splenomegaly or liver dysfunction face an increased risk of organ damage and should avoid contact or collision sports [21].

3.5.1 | Recommendations for Children and Adolescents With Cystic Fibrosis

Children with cystic fibrosis should be encouraged to participate regularly in a variety of physical activities suited to their abilities and disease severity.

Consultation with healthcare professionals, such as a sports medicine physician or paediatric pulmonologist, is recommended to individualise exercise programmes.

Structured training programmes can help improve respiratory muscle function, aerobic capacity and overall endurance.

Activities such as swimming, walking and cycling are often well-tolerated and beneficial.

Exercise-related coughing should not automatically lead to discontinuation of activity.

Scuba diving is not recommended.

Special precautions are necessary for those with cystic fibrosis-related diabetes or splenomegaly and high-contact sports should generally be avoided in these cases.

3.6 | Diabetes

Recommendations for physical activity can differ based on the type of diabetes. Type 1 diabetes, which accounts for 5%–10% of cases, is an autoimmune disorder that results from the destruction of pancreatic β-cells, resulting in insufficient insulin production and hyperglycaemia. In contrast, type 2 diabetes mellitus, comprising 90%–95% of cases, is a metabolic condition characterised by peripheral insulin resistance and an inability of β-cells to adequately compensate, also leading to hyperglycaemia [22]. Maintaining consistent physical activity is essential for managing blood glucose levels and promoting overall health in children and adolescents with either type of diabetes.

The evidence supporting the benefits of physical activity for type 2 diabetes is robust, as it has been shown to reduce glycated haemoglobin (HbA1C), triglycerides, blood pressure and insulin

resistance [23], while also potentially delaying the onset of the disease [24]. However, evidence regarding type 1 diabetes is less clear; although it is widely accepted that exercise can lower insulin requirements [25], studies on its effect on glycaemic control yield mixed results [26]. The impact of physical activity on blood glucose levels depends on various factors such as duration, intensity and type of exercise [27]. Generally, aerobic exercise can lower blood glucose levels when performed after meals with the usual insulin dosage [28]. In contrast, prolonged physical activity may lead to significant decreases in blood sugar [29], while short, high-intensity or anaerobic activities tend to raise glucose levels [30, 31].

For safety, children and adolescents with diabetes should undergo a medical evaluation before initiating any training or sports activities to identify potential complications and establish appropriate exercise plans [32]. They are encouraged to adhere to the general physical activity recommendations for young people, which include at least 60 min of MVPA daily, along with vigorous and muscle- or bone-strengthening activities at least 3 days a week [27]. However, achieving these activity levels can be challenging due to the complexities of the disease, with a key barrier being the fear of hypoglycemia. To mitigate this risk, children must adjust their carbohydrate intake based on their insulin regimen, the timing and duration of exercise and the type of activity or modify insulin doses by reducing them by 10%–20% before and/or during exercise [33]. Frequent blood glucose monitoring is essential to implement these adjustments effectively. If exercise is planned, it is recommended to administer insulin in a less active area, such as the anterior abdominal wall. Given that physical activity among young children tends to be spontaneous, it is often difficult to apply this guidance consistently. To address unanticipated bursts of energy expenditure, extra snacks (10–15 g of carbohydrates per 30 min of MVPA, tailored to the child's age) can be provided before and possibly during extended physical activity [34]. Table 1 outlines specific recommendations for children and adolescents with diabetes participating in physical activity.

3.6.1 | Recommendations for Children and Adolescents With Diabetes

Prior to commencing any physical training, children and adolescents with diabetes should undergo a thorough medical evaluation to assess potential complications related to physical activity and to tailor exercise and sport options accordingly.

These individuals should be encouraged to adhere to the same physical activity guidelines recommended for the general paediatric population, which advocate for at least 60 min of MVPA each day.

Children must adjust their carbohydrate intake based on their insulin dosing regimens, the timing and duration of physical activity, and the specific type of exercise, or modify insulin doses by adapting insulin levels before, during and/or after physical activities.

3.7 | Sickle Cell Traits

Sickle cell traits (SCT) refer to a genetic condition marked by the presence of the HbS gene, which alters haemoglobin production and reduces the effectiveness of red blood cells. SCT is relatively common in some populations, and most individuals remain asymptomatic throughout life. The HbS gene affects only a portion of red blood cells, resulting in a limited number of sickle-shaped cells. However, under extreme physical stress such as intense athletic exertion, particularly in professional or high-intensity sports, sickling can occur and may lead to complications such as ischaemic rhabdomyolysis. In rare cases, this has resulted in sudden death. Sickling may be precipitated within minutes of vigorous activity and is exacerbated by heat, dehydration, altitude and comorbidities like asthma [37].

The Centres for Disease Control and Prevention (CDC) guidance cited above applies primarily to competitive and professional athletes. These recommendations should be interpreted with caution when applied to children who do not participate in high-intensity or elite-level sports. Physical examinations for individuals with SCT are typically normal because they are usually asymptomatic. The 2021 position paper from the American Society of Haematology and the American Heart Association also emphasises that SCT should not in itself preclude participation in sports and that risk must be assessed in the context of other factors [38].

3.7.1 | Recommendations for Children and Adolescents With SCT

Be aware that physical exams are usually normal, as individuals with SCT are generally asymptomatic.

Provide education for staff, coaches and athletes regarding the potentially severe risks associated with SCT.

Implement a gradual preseason conditioning regimen, progressively increasing training intensity while allowing ample time for rest and recovery between repetitions, particularly during high-intensity activities.

Children and adolescents with SCT should not undergo high-intensity performance tests, such as timed mile runs or repeated sprints, without careful medical evaluation and close supervision.

Instruct athletes to discontinue activity at the first sign of symptoms, including muscle spasm, pain, swelling, unusual weakness, tenderness, breathlessness or excessive fatigue.

Ensure athletes remain well-hydrated at all times, particularly in hot or humid conditions.

Advise against high-caffeine energy drinks and other stimulants, as they can exacerbate dehydration.

TABLE 1 | Examples of recommendations for children and adolescents with diabetes who engage in physical activity (adapted from [35, 36]).

Before physical activity	
Assess metabolic control	If blood glucose is < 5.0 mmol/L and levels are decreasing, additional carbohydrate may be needed. If blood glucose is 5 to15 mmol/L additional carbohydrate may not be needed, depending on the duration of exercise and the individual responses to exercise. If blood glucose is > 15 mmol/L and urine or blood ketones are present, delay exercise until levels are normalised with insulin administration.
Hydration	Consider fluid intake to maintain hydration (approximately 250 mL 20 min before exercise).
During physical activity	
Aerobic activity	Consume additional carbohydrate and/or adjust insulin when exercise lasts 45 min or more. Estimate energy expenditure and determine whether insulin or additional carbohydrate will be needed based on the peak insulin activity. If the insulin dose is to be changed for long duration of MVPA, try a 50% premeal reduction 1 h prior to exercise. If carbohydrate intake is to increase, try 1.0 g/kg body mass/h of moderate to high intensity exercise performed during peak insulin activity.
Anaerobic activities	Check blood glucose levels to assess responses to exercise. If activity lasts longer than 45 min, consume carbohydrates during exercise for fuel and adjust insulin according to the blood glucose response.
Team sport	Monitor blood glucose levels during and after activity. If within the maximum action of insulin, consider reducing insulin doses. Consume a proper snack and fluid at half-time and, if competition stress increases blood glucose levels, consider a small corrective dose of insulin.
After physical activity	
Post-exercise	Consume carbohydrate snacks or meals with fluids after exercise. If blood glucose levels are elevated post-exercise, treat with caution, that is, administer no more than a 50% correction dose, or replace the missing basal insulin if the exercise is completed with the insulin pump off. Consume a pre-bed snack whenever the duration of exercise is 60 min or more. If exercise is to be performed the next day, reduce the amount of basal insulin on the injected therapy.

3.8 | Arterial Hypertension

In children under 16 years of age, arterial hypertension is defined as an average blood pressure at or above the 95th percentile for age, sex and height on two or more occasions. For adolescents aged 16 and older, hypertension is defined as a blood pressure of 130/85 mmHg or higher [39]. While observational and interventional studies indicate that regular physical activity significantly lowers blood pressure in adults [40, 41], the evidence is less conclusive among children [42]. Research suggests that engaging in 40 min of MVPA at least 3–5 days a week can lead to an average reduction in systolic blood pressure of 6.6 mmHg and prevent vascular dysfunction in children and adolescents [42]. Exercise has also beneficially impacted cardiac structure in adolescents [43]. It is generally recommended that children and adolescents participate in at least 60 min of MVPA daily through activities, such as jogging, cycling or swimming, as increased physical activity correlates with improved overall health outcomes. In children and adolescents, physical activity should predominantly consist of active play, recreational games and sports, which inherently integrate aerobic and muscle-strengthening components. A combination of muscle-strengthening activities and aerobic exercise is highly recommended for patients with arterial hypertension due to favourable prognostic benefits [44]. Additionally, sedentary behaviour should be limited to no more than 2 h per day. For individuals with stage two hypertension, it is advisable to refrain from participating in competitive sports [39]. A meta-analysis showed that various forms of aerobic exercise, including walking, jogging and cycling, positively impact health outcomes, with cycling demonstrating particularly notable effectiveness [45]. A recent large-scale pairwise and network meta-analysis of 270 randomised controlled trials revealed that various modes of exercise training significantly improve resting blood pressure in adults, with isometric exercise showing particularly notable effects. Pairwise analyses indicated significant reductions in resting systolic blood pressure and diastolic blood pressure after various exercise modalities: aerobic training (−4.49/−2.53 mmHg), dynamic resistance training (−4.55/−3.04 mmHg), combined training (−6.04/−2.54 mmHg), high-intensity interval training (−4.08/−2.50 mmHg) and

isometric training (−8.24/−4.00 mmHg). The network meta-analysis ranked specific forms of isometric training as the most effective for systolic blood pressure reduction, followed by combined training, dynamic resistance training, aerobic training and high-intensity interval training. Additionally, sub-analyses identified isometric wall squats and running as the most effective exercises for reducing systolic blood pressure and diastolic blood pressure, respectively [46]. These findings observed in adults may also hold relevance for the paediatric population, suggesting that exercise could play a beneficial role in managing arterial hypertension in children.

3.8.1 | Recommendations for Children and Adolescents With Arterial Hypertension

Blood pressure measurements should be conducted during preparticipation examinations for all athletes.

Athletes with prehypertension should be encouraged to adopt lifestyle modifications while still being eligible for competitive athletics. Their participation in physical activity should not be restricted, but regular blood pressure monitoring and follow-up every 6 months is recommended.

Athletes with stage one hypertension, provided there is no target organ damage (e.g., left ventricular hypertrophy or underlying heart disease), should not face restrictions for competitive sports.

Although adolescents without evidence of target organ damage should not be restricted from sports, it is advisable to limit participation in sports with a high-static component (such as weightlifting, boxing, martial arts, sport climbing, water skiing, snowboarding, skiing, decathlon, rowing, speed skating and triathlon) until blood pressure is normalised through lifestyle changes or medication.

Athletes diagnosed with hypertension should undergo evaluations including blood chemistries, lipid profiles, haematocrit tests, urinalysis and electrocardiograms to check for potential organ damage and other health issues linked to elevated blood pressure. If cardiac involvement is suspected, cardiac ultrasound (echocardiography) should be considered.

Athletes with abnormal lab results or suspected secondary causes of hypertension should be referred for a comprehensive evaluation. For cases with suspected cardiac involvement, this may include echocardiography, while suspected endocrine or renal causes should prompt referral to an endocrinologist or nephrologist to address the underlying aetiology.

Any athlete with sustained hypertension should receive an echocardiogram to assess left ventricular structure and function, with results interpreted by a cardiology expert to differentiate between physiological adaptations and pathological changes.

In children with established arterial hypertension, renal ultrasounds are recommended, particularly in paediatric athletes with diabetes or renal issues that correlate with blood pressure values above the 90th percentile.

When arterial hypertension is associated with other cardiovascular diseases, eligibility for competitive sports should be determined based on the type of activity and severity of those conditions.

Generally, antihypertensive medications should be maintained during training and competitive events. New medications should be initiated at least a week prior to competition to mitigate unforeseen complications.

The most commonly prescribed and well-tolerated medications for treating hypertension in athletes include vasodilators, particularly angiotensin-converting enzyme inhibitors and angiotensin receptor blockers, as these do not adversely affect energy metabolism or maximum oxygen uptake. However, it is essential to consider the potential for some antihypertensive drugs, such as beta-blockers and diuretics, to be classified as prohibited substances in certain sports by international federations due to their potential performance-modifying effects. Athletes should consult the World Anti-Doping Agency list and their sport's specific regulations to ensure compliance with anti-doping rules.

3.9 | Nephrotic Syndrome

Nephrotic syndrome (NS) is among the most prevalent kidney diseases in children, despite its relative rarity in the general population. About 90% of cases are steroid-sensitive, that is, showing complete remission by glucocorticoid treatment within 4 weeks, but relapses are common, and ongoing relapses were reported in up to 10% of cases in adulthood. The annual incidence of NS in the paediatric population varies globally, with rates ranging from 1.2 to 1.8 new cases per 100 000 children under 18 in Germany to 6.49 per 100 000 in Japan [47, 48]. NS is characterised by large proteinuria and hypoalbuminaemia, with or without edema, with the initial symptom often being facial swelling that subsequently spreads to the entire body [49]. A thorough evaluation is imperative before commencing corticosteroid treatment, including monitoring the patient's height, weight, blood pressure and atypical features suggesting genetic forms of NS or glomerulonephritis including genital malformation, arthritis and/or rash. Regular weight checks can help assess any changes in edema. A physical examination should also be conducted to identify potential infections and underlying systemic disorders [50]. The specific course of treatment for NS depends on its underlying cause, guided by the clinical practice recommendations from the International Paediatric Nephrology Association for the diagnosis and management of paediatric NS [51, 52].

In the acute phase of the disease and in case of ongoing relapses, patients should be educated on adhering to a low-salt diet to help mitigate fluid retention and edema [53]. There is no evidence supporting the benefits of bed rest or exercise restriction in NS management; instead, physical activity is favoured over sedentary behaviour to help prevent pulmonary thrombosis and embolism, with moderate exercise deemed acceptable [54]. It is important to monitor patients every 3 months in outpatient settings to identify potential side effects from steroid treatment, such as growth retardation and bone health, even though most

teams use steroid-sparing protocols as much as possible. Bone health should be emphasised, as steroid therapy but also chronic proteinuria may impact it, necessitating normal calcium intake for age and nutritional vitamin D supplementation [55].

Furthermore, paediatric patients with frequent-relapsing or steroid-dependent NS are at increased risk of declining physical function due to hospitalisation and steroid side effects. Thus, it is crucial to maintain a physical activity level in paediatric patients with NS through the early initiation of exercise therapy following hospitalisation.

Limited studies assess the effectiveness and safety of physical activity during the acute phase of NS. Therefore, structured exercise and sports participation should be postponed until remission is achieved. In patients with stable disease and under appropriate medical supervision, moderate-intensity aerobic exercise, resistance training and balance exercises can be safely introduced.

Research suggests that exercise therapy in chronic kidney disease patients does not significantly alter proteinuria but does lead to meaningful improvements in estimated glomerular filtration rate [56]. The primary objectives of resistance training include muscle hypertrophy and enhanced muscle strength. Furthermore, aerobic physical activity in children with NS can enhance exercise tolerance by improving oxygen supply and utilisation while preventing atrophy of type I muscle fibres [56, 57].

3.9.1 | Recommendations for Children and Adolescents With NS

Bed rest and/or exercise restrictions are not recommended for patients with stable or controlled NS, as there is no scientific evidence supporting their benefit and since there is an increased risk of thrombosis.

Physical activity should be encouraged for children and adolescents with NS who do not have contraindications and whose comorbidities are stable and well-controlled.

Paediatric patients with NS should engage in activities aimed at maintaining or improving physical fitness, focusing on muscle strength, balance and flexibility at least 2 days a week.

Exercise therapy for paediatric patients with NS should be tailored to the disease stage, such as during periods of remission.

The intensity of exercise should be monitored and adjusted based on the individual patient's functional capacity.

Exercises should be supervised by suitably trained professionals, such as physiotherapists, exercise professionals or rehabilitation specialists.

Activities including jogging, walking, jumping and swimming should be performed at a mild to moderate intensity.

3.10 | Inflammatory Bowel Diseases

Paediatric inflammatory bowel disease (IBD), encompassing Crohn's disease and ulcerative colitis, refers to chronic, recurrent inflammatory disorders of the gastrointestinal tract. The prevalence of IBD is on the rise, with approximately 25% of patients diagnosed before the age of 20 [58]. While the exact aetiology of IBD remains poorly understood, research indicates that genetic predisposition, environmental factors, alterations in gut microbiota, and immunological factors play significant roles in its pathogenesis. The clinical course of IBD varies widely; some patients experience mild symptoms, while others undergo aggressive disease progression [59]. IBD impacts physical health, functionality and quality of life through symptoms such as abdominal pain, diarrhoea, weight loss, growth retardation, malaise, fatigue, anaemia and fever. Additionally, treatment factors, hospitalisations, and psychological issues—such as anxiety, depression and misperceptions of exercise-related risks—can limit physical activity and promote sedentary behaviour [60, 61].

Physical activity is acknowledged as a vital component of promoting overall health in the paediatric population, including those with chronic illnesses [62]. Engaging in physical activity may help alleviate IBD symptoms, reduce disease activity and enhance health-related quality of life among paediatric patients with IBD [12, 63, 64]; however, comprehensive data on this topic remain limited [65]. Moreover, a sedentary lifestyle may pose a significant risk factor for the development of IBD [66], while more active patients with IBD in remission showed a significantly lower likelihood of experiencing disease flare-ups within 6 months [67].

Muscle strength and aerobic capacity are often diminished in paediatric IBD patients [68]. So far, no adverse effects of moderate-intensity physical activity on the clinical progression of IBD have been reported [69]. Evidence suggests that adolescents with Crohn's disease can participate in various forms of physical activity, including high-intensity intermittent exercises, without significantly exacerbating inflammation [70]. Therefore, it can be concluded that physical activity is a safe and beneficial approach for patients with IBD.

3.10.1 | Recommendations for Children and Adolescents With IBD

Regular physical activity is strongly recommended for paediatric patients with IBD, as exercise can provide additional benefits, such as alleviating extraintestinal symptoms and enhancing mental health by reducing depression and anxiety.

In certain patients it can be needed that physical exercise interventions are supervised by a qualified specialist to ensure safety and effectiveness.

Given the unique course of the disease for each patient, individual clinical and functional evaluations are needed.

Personalised physical activity and exercise prescriptions as well as associated recommendations are necessary in some patients to minimise risks associated with IBD and improve outcomes.

When designing an exercise program, factors such as medical/functional limitations, disease status, medications, use of medical devices, and age must be thoroughly considered.

Moderate-intensity aerobic and resistance (strength) training are safe options that positively impact body composition.

Flexibility exercises, such as yoga, are recommended to enhance muscle elasticity and overall mobility.

Patients in remission or experiencing mild disease activity should aim to increase their physical activity levels, while those with moderate to severe disease activity should focus on low-intensity options, such as walking or gentle yoga.

3.11 | Epilepsy

Epilepsy is a chronic, non-communicable neurological disorder affecting the brain. In children, the incidence of epilepsy ranges from 41 to 187 per 100 000. The prevalence in developing countries is notably higher than in developed countries, showing rates of 3.6 to 44 per 1000 versus 3.2 to 5.5 per 1000, respectively [71]. Alongside recurrent seizures, epilepsy is associated with various comorbidities, including cognitive and psychological issues, as well as social isolation [72]. Engaging in physical activity can enhance self-esteem and facilitate social integration, ultimately improving overall quality of life [73].

Seizures can be triggered by multiple and varying factors, such as fatigue, emotional stress, fever, menstrual hormonal changes, alcohol or caffeine intake, heat, humidity and lack of sleep, while physical activity is only a rare trigger. According to Frucht et al., only two out of 400 individuals with epilepsy reported exercise as a precipitating factor for seizures [74]. Furthermore, it has been suggested that physical activity may actually reduce seizure frequency and improve cardiovascular and mental health among individuals with epilepsy [75]. Nevertheless, children with epilepsy are often advised by lay people and sometimes even physicians not to recommend participating in sports due to the fear that the activity will worsen seizures or cause injury, which might reflect a lack of education on this subject.

Evidence indicates that children with epilepsy—without motor or sensory impairments—exhibit lower participation levels in general sports and group activities compared to their healthy counterparts. Additionally, a correlation has been observed between higher seizure frequency and reduced physical activity [76]. A recent systematic review by Van den Bogard et al. concluded that physical exercise and sports correlate with a decreased frequency of comorbidities and offer beneficial psychosocial outcomes for persons with epilepsy, including improved quality of life, self-esteem, socialisation and long-term health. Despite the limited number of studies and varying results, there is growing evidence to suggest that not only physical activity does not exacerbate seizures, but it may help decrease their occurrence [77].

Capovilla et al. proposed a classification of sports based on the potential risk of injury or death in the event of a seizure. Group 1 includes low-risk sports where seizures do not pose additional risks for the athlete or bystanders, such as athletics (except certain events in Group 2), bowling, team contact sports (e.g., judo), ground-based team sports (e.g., baseball, basketball, football) and various racquet sports. Group 2 comprises moderate-risk sports that may pose a risk to the individual but not to others, including alpine skiing, gymnastics, cycling and swimming. Group 3 identifies high-risk sports for individuals with epilepsy, which may also pose risks to bystanders, including aviation, climbing, diving, parachuting and certain motorsports [75].

Hyperventilation, a known trigger factor in specific syndromes, for example, associated with absence seizures in Childhood Absence Epilepsy Syndrome, is a stimulation method included in the standard electroencephalographic evaluation. This allows the physician to give correct advice to the people with epilepsy—adapting physical exercise only to those patients who present seizures during hyperventilation, not yet controlled by medication.

3.11.1 | Recommendations for Children and Adolescents With Epilepsy

There is no rationale to support a general ban on sports for patients with epilepsy. Individuals with epilepsy should be encouraged to engage in regular physical activity.

Participation in specific physical activities or sports for those with epilepsy should be determined through an individual clinical assessment, taking into account the risk of seizures and associated implications.

Patients with well-controlled epilepsy should not face exercise restrictions, except for scuba diving, skydiving, high-altitude sports and activities involving motor vehicles.

For patients with uncontrolled epilepsy, a more comprehensive evaluation is essential; risk assessment should consider seizure types, frequency, patterns and triggers.

Sports such as horseback riding, motor sports and activities performed in a mountain environment can be evaluated, provided necessary safety precautions are in place, and participants are not alone, given the potential risks involved.

Swimming should take place in supervised settings, under the guidance of trained professionals familiar with the athlete's medical history. Life jackets are recommended for boating, water skiing and similar activities.

Contact sports are generally feasible, except for boxing, as consensus on its safety for patients with epilepsy has not been established.

Cyclists should also avoid busy roads to minimise potential hazards.

3.12 | History of Severe Allergic Reactions

A history of severe allergic reactions or anaphylaxis necessitates proactive emergency planning. The most common allergens encountered in athletic settings include ingested foods (33%), insect bites (19%) and medications (14%), as athletes often practise or compete outdoors, travel for events and eat in unfamiliar environments. Less frequent triggers comprise cats, latex, cleaning agents, environmental allergens and exercise [78]. The prevalence of food allergies is on the rise, impacting up to 8% of children [79]. The serious implications of allergies include anaphylaxis, diminished quality of life and increased economic burden. Cofactors—conditions that can exacerbate allergic reactions—may explain why anaphylaxis occurs in response to a food allergen that is otherwise tolerated or causes only mild reactions. In children and adolescents, the most frequently reported cofactors include exercise, concurrent infections, stress, menstruation and adverse weather conditions [80].

Food-dependent exercise-induced anaphylaxis (FDEIA) results from physical activity of varying types and intensities, distinguishing it from typical food allergies. Symptoms of FDEIA generally include urticaria and severe allergic responses. Research indicates that physical activity can trigger the release of mediators from IgE-dependent mast cells, leading to FDEIA when a certain threshold is surpassed. Foods commonly associated with FDEIA include wheat, eggs, chicken, shrimp, shellfish, nuts, fruits and vegetables, with high-intensity and frequent physical activity being more likely to provoke an episode than low-intensity or infrequent activity [81].

Cholinergic urticaria presents as a skin rash triggered by elevated body temperature. The most prevalent subtypes of urticaria observed in young athletes are those induced by physical exertion, temperature changes, sunlight, water exposure or certain amounts of external pressure [82]. Cold urticaria, on the other hand, results from exposure to cold stimuli. Effective management of cold urticaria involves patient education, antihistamine use and avoidance of triggers, such as cold water immersion, intense physical exertion or prolonged activities. For paediatric patients with anaphylaxis, modifications of the type, duration, intensity and frequency of physical activity are commonly recommended [83].

3.12.1 | Recommendations for Children and Adolescents With a History of Severe Allergic Reactions

Athletes with food allergies or intolerances should strictly avoid specific trigger foods to minimise the risk of allergic reactions, especially during physical activity.

Any athlete who has experienced severe allergic or anaphylactic reaction should be required to have injectable epinephrine readily available on-site for immediate administration.

Coaches and medical personnel should receive comprehensive training on recognising and managing potentially life-threatening allergic reactions to ensure timely and effective intervention.

3.13 | Reduced Nephron Number

Children with reduced nephron number are at increased risk for progressive chronic kidney disease (CKD) and cardiovascular morbidity such as arterial hypertension and premature arteriosclerosis. Reduced nephron number may be due to congenital abnormalities of the kidneys and urinary tract (CAKUT) (including solitary kidney, multicystic dysplastic kidney (MCDK), renal hypoplasia or dysplasia), partial or total nephrectomy, low birth weight (weight <2.5 kg), prematurity, episodes of acute kidney failure, cancer treatment, arterial hypertension, congestive heart failure, systemic disease, nephrotoxic drugs or obesity [84].

In recent decades, advancements in cancer treatment for children and adolescents have significantly improved survival rates. Consequently, most children diagnosed with Wilms tumour or other renal tumours become long-term survivors who live with a single kidney post-surgery, but there is also a long-term risk of CKD in survivors of childhood cancer or leukaemia [85]. Another cause of having a single kidney is congenital absence, which occurs in approximately 1 in 2000 births. Patients with a single kidney should adopt lifestyles that minimise risks to their remaining kidney and avoid potentially harmful activities, especially those involving trauma [86].

Evidence indicates that severe kidney injuries are more commonly linked to road accidents or falls rather than to physical activity [87]. Moreover, sport-related kidney injuries are exceedingly rare, with an incidence of only 0.4 per million children annually for catastrophic kidney injuries associated with sports [88]. For instance, in American football, classified as a "collision" sport, kidney injuries occur significantly less frequently than head injuries [89]. However, the risk of kidney damage varies by sport. Available evidence suggests that cycling, nonmotorised sledding, downhill skiing/snowboarding and equestrian activities may pose higher risks compared to other sports [90]. In most European countries and the USA, kidney cancer survivors are generally encouraged to participate in sports, provided there are no other contraindications or individual limitations. Children with a single kidney who have recovered from cancer should also consider other factors when engaging in sports. These include the risk of cardiac and renal adverse events following treatment with anthracyclines, platinum compounds, ifosfamide and radiation therapy. Anyway, the benefits of physical activity for children with a single kidney likely outweigh the minimal risks of renal injury. In addition to physical activity, other nephroprotective lifestyle measures should be emphasised for children at risk of reduced nephron number. These include maintaining a diet controlled in protein and salt intake, avoiding nephrotoxic medications (e.g., nonsteroidal anti-inflammatory drugs), ensuring adequate hydration, avoiding tobacco use and

preventing overweight/obesity. For children with a single kidney, contact or collision sports should be individually evaluated and may require additional caution, and the use of appropriate protective gear is recommended to mitigate the risk of trauma to the remaining kidney [91].

3.13.1 | Recommendations for Children and Adolescents With a Reduced Nephron Number

Children with a reduced nephron number should not face restrictions on participation in physical activities.

Families should be educated about the potential, albeit rare, risks of serious kidney injuries during physical activity, enabling informed and shared decision making regarding suitable sports.

Some children with a reduced nephron number may require regular monitoring of blood pressure and renal function.

All children with single kidney should undergo an annual assessment of blood pressure.

An individual assessment is essential for participation in contact and collision sports to evaluate safety risks.

Utilising appropriate protective equipment can significantly reduce the risk of injury to the remaining kidney, allowing participation in most sports.

To promote optimal health, it is important to avoid dehydration and encourage regular fluid intake during physical activities.

4 | Conclusions

Children and adolescents with chronic health conditions show distinct pathophysiologic mechanisms that uniquely influence their tolerance during physical exertion. It is essential, considering medical and functional limitations as well as contraindications, to ensure that these young individuals engage in appropriately balanced, structured and adapted physical activity/exercise. To promote optimal health, it is important to avoid dehydration and encourage regular fluid intake during physical activities. Careful selection of activities is crucial to mitigate undue risks associated with specific disease-related factors that may contribute to exercise intolerance. Effective collaboration between paediatric subspecialists and primary care physicians is vital in providing families and young athletes with tailored physical activity recommendations [92]. The exercise recommendations presented in this article serve as a foundation for healthcare teams working with paediatric populations who have chronic illnesses, highlighting the potential benefits of regular physical activity. Ongoing research on physical activity, exercise and sport for chronic conditions in children is necessary to address existing knowledge gaps and should be prioritised globally, as physical activity is a powerful tool for enhancing overall health.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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