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Physiotherapy and physical activity in children with Perthes' disease

an international survey of recommendations from paediatric orthopaedic surgeons

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Aims

In the absence of clear and consistent clinical guidelines, this study aims to survey the current international consensus on recommendations for physiotherapy (PT), physical activity (PA), and weightbearing in patients with Perthes' disease. Additionally, the study seeks to identify factors influencing these recommendations, and to determine at which stage possible restrictions on physical activity are typically lifted.

Methods

An online international cross-sectional survey using a purpose-designed questionnaire with a general section, and three cases of Perthes' disease, was distributed to surgeons through paediatric orthopaedic societies and research groups.

Results

A total of 160 paediatric orthopaedic surgeons from 43 different countries (seven continents) participated. There was general agreement that impaired range of motion (ROM) and pain were important when prescribing PT, while the child's sex was not important. There was disagreement on whether age and Waldenström or Lateral Pillar classification were important factors in determining the need for PT. There was widespread agreement that stretching in the early stages of Perthes' disease was important, although Western and Southern Europe and the British Isles differed. There was considerable disagreement about strengthening exercises. 'Weightbearing as tolerated' in the early and fragmentation stages was generally recommended in the British Isles and Scandinavia (both > 90%), whereas other regions showed large variation. Regarding PA, there was broad agreement in allowing swimming and cycling, and discouraging high-impact activities including school sports in all stages.

Conclusion

Maintaining ROM was crucial for most participants, with strong consensus to discourage high-impact activities during initial and fragmentation stages. Swimming and cycling were often allowed, but no clear consensus emerged on weightbearing restrictions or when to resume full activities. Consensus within the British Isles, Scandinavia, and Eastern Europe was high for both for PT and PA, but recommendations differed between countries. Recommendations from the British Isles and Scandinavia were less restrictive than their Eastern European counterparts.

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Take home message

- This study highlights that orthopaedic surgeons prioritize range of motion and pain levels when recommending physical therapy and physical activity for patients with Perthes' disease.
- Case-based responses revealed general support for stretching, strengthening, and weightbearing as tolerated, although restrictions on high-impact sports remained common, particularly in early disease stages.
- International differences in recommendations were evident, emphasizing the need for clearer, consensus-based guidelines for managing Perthes' disease.

Introduction

Perthes' disease is an ischaemic necrosis of the femoral head's epiphysis in the growing child.[1] Recommendations for non-surgical treatment of Perthes' disease with a focus on physiotherapy (PT), physical activity (PA), or weightbearing restrictions vary,[2] both on a national basis and internationally. The common goal of all treatments of Perthes' disease is to maintain radiological congruency of the hip joint, and painless range of motion (ROM).

Perthes' disease typically passes through four stages: the initial stage, when the ischaemic event occurs and the femoral head weakens; the sclerosis stage, when the femoral head begins to flatten; the fragmentation stage, when the necrotic bone is removed and flattening of the cartilaginous femoral head continues; and the reossification stage, with boney regrowth.[3] In Perthes' disease, the hip becomes stiff, which is particularly pronounced in the early stage of the disease. While some studies found PT to be effective at maintaining or increasing ROM,[4] other studies could not confirm a positive effect on the long-term outcome.[5,6] At the same time, the femoral head is vulnerable to mechanical forces, especially in the early stages of disease.[1,7] It is controversial if restrictions for PA or weightbearing are effective in children, as well as whether children are likely to follow these restrictions. Another uncertainty is around defining when to return to both weightbearing and PA. PA is considered to be beneficial to preventing or postponing osteoarthritis and its related pain,[8] and to improving aspects of general health.[9]

This study aimed to identify current recommendations for PT, PA, and activity restrictions when treating children at different stages of Perthes' disease, drawing similarities and differences internationally.

The research questions were:

1. What are the current recommendations for PT, PA, and activity restrictions when treating children at different stages of Perthes' disease?
2. Which factors influence recommendations for PT, PA, and activity restrictions (e.g. age, sex, and clinical and radiological features)
3. Are there similarities and differences nationally and internationally, and to what extent?

Methods

Study design

A web-based cross-sectional survey was created, which included general questions on clinical experience, country and city of clinical practice, a general section about the non-surgical management of Perthes' disease, and three patient cases.

The questionnaire was designed by the author (YDH), and included topics with conflicting findings in the literature, such as the type of and need for physiotherapy, weightbearing restriction, and sports activities with regard to the stage of the disease.[2,4,10-14] The questionnaire was tested through a pilot study with ten participants from Sweden and England with great expertise in Perthes' disease, and refined before being distributed internationally. Both quantitative and open questions were included in the survey to achieve a wider understanding of participants' views on the recommendations regarding PT and PA in children with Perthes' disease (Supplementary Material). Responses from the same IP address were blocked to prevent multiple participations.

Participants

The questionnaire was distributed to surgeons between March 2021 and December 2022 through paediatric orthopaedic societies, Perthes' disease research groups (International Perthes Study Group, Hip Hope Network), and personal contacts. Participants were asked to describe their recommendations for PT, including stretching, strengthening, weightbearing, and activity for children with Perthes' disease. The inclusion criteria for participants required that they be practising paediatric orthopaedic surgeons (consultants or attendings) who treat children with Perthes' disease and manage at least one newly diagnosed Perthes' disease patient per year.

Outcome measures

For the quantitative questions, a standardized rating scale was used that could be rated from 0 (not important) to 5 (very important), including age at onset, ROM, sex, pain, Lateral Pillar classification,[15] and disease stage. We added three patient cases to further explore decision-making, and to verify that participants' opinions were reflected in their practice recommendations. The patient cases presented Perthes' disease at three different stages according to the Waldenström classification (Figure 1): initial stage, fragmentation stage, and reossification stage.[3,16] The questions asked about recommendations for stretching exercises, strengthening exercises, weightbearing restrictions of the affected hip, and PA restrictions for each stage of the disease. The physical activities that the respondents could select included leisure and popular sports activities,[17–19] such as short (< 1 km) and long walks (> 1 km), swimming, cycling, horse riding, (cross-country) skiing, ball sports, gymnastics, trampolining, and school sports. For each activity, participants were asked to choose from five options: do not allow, allow with restrictions, allow, recommend, and abstain.

Ethical considerations

This study was approved by the Regional Ethical Review Board (Dnr 2021-07017-01; Sweden). All participants gave written informed consent before data collection began.

Statistical analysis

Data were collected via REDCap (Vanderbilt and National Institutes of Health, USA). We used means with SDs to describe parametric data, and medians with IQRs to describe non-parametric data. We summarized categorical variables using frequencies and percentages. To analyze which factors were

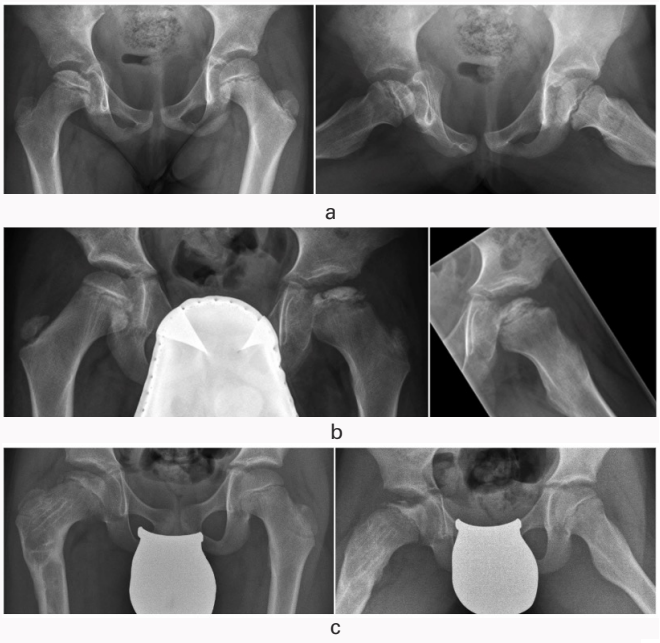

Fig. 1
Description of the patient cases. a) Case 1: A six-year-old female who experienced pain in the right groin for three months. Perthes' disease was diagnosed six weeks ago. Range of motion (ROM), right/left: flexion 120°/120°, extension 0°/15°, abduction 35°/45°, adduction 15°/15°, internal rotation 20°/40°, external rotation 30°/80°. b) Case 2: an eight-year-old male who experienced pain in the left groin once or twice a week. Perthes' disease was diagnosed one year ago. Positive Trendelenburg left hip. ROM, right/left: flexion 130°/90°, extension 15°/0°, abduction 50°/30°, adduction 20°/15°, internal rotation 55°/45°, external rotation 45°/-5°. c) Case 3: a nine-year-old male who was not in pain. Perthes' disease was diagnosed two years ago. A varisation osteotomy was performed 1.5 years ago. Positive Trendelenburg right hip. ROM, right/left: flexion 110°/120°, extension 0°/15°, abduction 25°/45°, adduction 15°/15°, internal rotation 10°/40°, external rotation 10°/80°.

considered important when recommending PT or PA, we calculated the T-ratio in a linear regression model to indicate the predictive power of each factor. The participant's ID was included as a random effect variable. p-values for fixed effects in the mixed effects linear regression models were obtained using the Wald test. Missing data were assumed to be completely random and were addressed using listwise deletion in the analysis. Additional analyses were conducted using mean imputation, but this approach did not alter the results. The threshold for statistical significance was set at $p \leq 0.05$. All statistical analyses were performed using R statistic software v. 4.3 (R Foundation for Statistical Computing, Austria). We analyzed the free-text responses using thematic analysis. The CROSS guidelines were used to report on the findings.[20]

Results

A total of 168 paediatric orthopaedic surgeons from 43 different countries (ten geographical regions, as per the Nations Online Project)[21,22] answered the questionnaire (Table I). For the present study, we excluded eight participants who saw less than one newly diagnosed patient with Perthes' disease per year. The mean length of work experience as a paediatric orthopaedic surgeon was 18 years (SD 10).

Table I. Demographic data of the participants.

Variable	Value
Participants, n	160
Mean years in practice (SD)	17.76 (9.97)
Region, n (%)	
Africa*	3 (1.9)
Asia and Middle East†	11 (6.9)
Australia	2 (1.2)
British Isles	39 (24.4)
Eastern Europe‡	9 (5.6)
North America	14 (8.8)
Scandinavia§	29 (18.1)
South America¶	1 (0.6)
Southern Europe**	20 (12.5)
Western Europe††	32 (20.0)

*Egypt, Morocco.
†China, Israel, India, Lebanon, Republic of Korea, United Arab Emirates.
‡Ukraine, Poland, Romania.
§Norway, Sweden, Iceland, Denmark, Estonia.
¶Brazil.
**Italy, Spain, Portugal, Greece, Cyprus, Turkey, Croatia.
††Austria, Germany, France, Switzerland, Netherlands, Belgium.

Which factors do orthopaedic surgeons consider important for recommending physiotherapy for patients with Perthes' disease?

Most participants (n = 111, 71%) agreed that ROM is very important for recommending PT. Pain was another factor considered very important or important for recommending PT (n = 107, 68%). Mixed effects linear regression analysis revealed that ROM was rated as more important than pain (Table II). The sex of the patient was not considered an important factor when recommending PT (n = 104, 66%) (Figure 2).

Which factors do orthopaedic surgeons consider important for recommending physical activity for patients with Perthes' disease?

Overall, 53% of the participants (n = 83) considered ROM very important, and 26% (n = 40) important, when recommending PA. A total of 49% (n = 75) considered pain as very important. Mixed effects linear regression analysis revealed that ROM was more important than pain (Table III). The sex of the patient was not considered an important factor by 55% of the participants (n = 84).

Case scenarios

In the presented case scenarios, stretching was recommended by 77% of participants for case 2 (eight-year-old male during the fragmentation stage with impaired ROM). Strengthening was recommended to a higher extent in case 3 (nine-year-old male with a positive Trendelenburg sign). Weightbearing restrictions were mostly advised in cases 1 and 2, but the

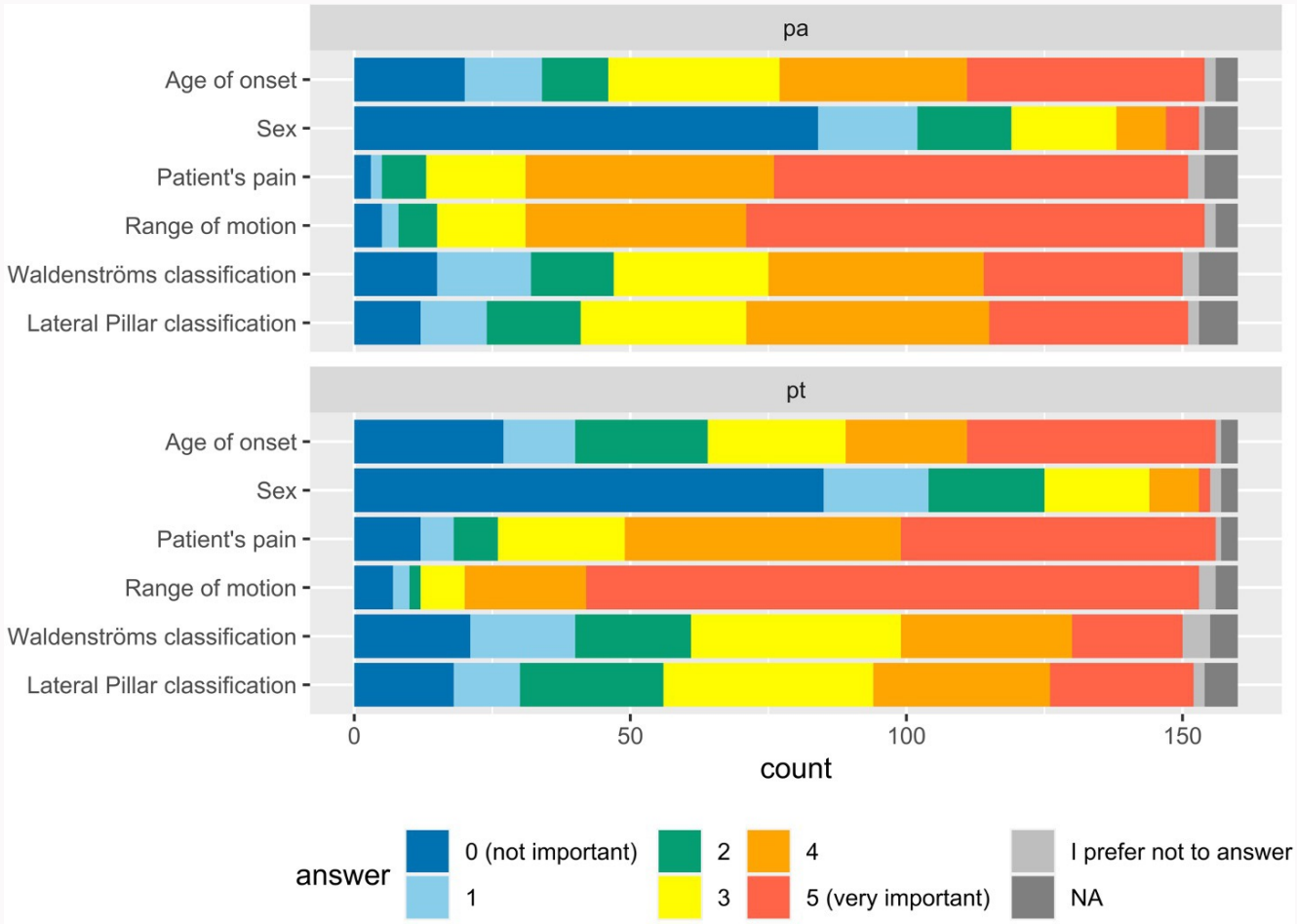

Fig. 2
Factors for recommending physical activity (pa) and physiotherapy (pt).

vast majority recommended weightbearing as tolerated in all scenarios (Table IV).

Generally, participants recommended restrictions on high-impact sports activities such as trampolining, gymnastics, and ball sports in patient cases 1 and 2, where the children were in a more acute phase of Perthes' disease. All restrictions decreased somewhat in case 3, but were not lifted completely. Swimming and cycling were allowed or recommended in almost all case scenarios. A lack of consensus was seen in winter sports, table tennis, long walks, and horse riding (Figure 3).

International differences

Overall, 84% (n = 133) of respondents were not aware of any national guidelines for recommending PT or PA for patients with LCPD. National and international differences were seen in weightbearing restrictions: while respondents from Eastern Europe consistently recommended non-weightbearing in all case scenarios, respondents from Scandinavia and the British Isles consistently recommended weightbearing as tolerated. Wide variations were seen among respondents in Southern Europe and North America. A similar pattern in consistency was seen in recommending sports activities, with a more restrictive attitude in Eastern Europe and a more permitting attitude in Scandinavia and the British Isles.

Free-text responses

Two themes were identified when asking about whether or not PT should be included in the treatment: child-dependent factors (such as lacking compliance), and hip-dependent factors (such as pain and decreased ROM). Child-dependent factors were mentioned as a contributing factor, namely that children are difficult to guide in their behaviour:

> *"I've recently started to change my recommendations after speaking with our physios – we tell kids to avoid contact sports but they rarely listen to us and continue regardless. I'm becoming more pragmatic!"*

Some advocated physiotherapy for surveying the child:

> *"[…] refer to physiotherapy to guarantee supervision of the patient regarding beginning of an adduction contracture. Physiotherapy should aim at supervision of non-weightbearing by use of axillary crutches […]."*

> *"[…] all patients are referred to physio as they monitor the disease progression and highlight patients losing abduction."*

Hip-dependent factors for referring to physiotherapist were a decreased range of abduction:

> *"[…] I send all patients through to physio who have Perthes' and tell them that the ROM is the single most important thing about their management."*

> *"[…] when hinge abduction is present no physiotherapy can help."*

Table II. Comparison of factors that are considered when recommending physiotherapy. A high t-ratio (positive or negative) suggests that there is a substantial and meaningful difference between the factors.

Comparison	t-ratio	p-value*
Age - Lateral Pillar class	0.04	> 0.999
Age - Pain	-5.92	< 0.001
Age - ROM	-11.03	< 0.001
Age - Sex	13.16	< 0.001
Age - Waldenström	1.48	0.680
Lateral Pillar class - Pain	-5.91	< 0.001
Lateral Pillar class - ROM	-10.99	< 0.001
Lateral Pillar class - Sex	13.02	< 0.001
Lateral Pillar class - Waldenström	1.43	0.710
Pain - ROM	-5.15	< 0.001
Pain - Sex	19.06	< 0.001
Pain - Waldenström	7.33	< 0.001
ROM - Sex	24.10	< 0.001
ROM - Waldenström	12.38	< 0.001
Sex - Waldenström	-11.54	< 0.001

Mixed effects linear regression models were used to assess the importance of each factor, with t-ratios indicating their predictive strength. Participant ID was included as a random effect to account for repeated measures.
*Wald test.
ROM, range of motion.

Table III. Comparison of factors that are considered when recommending physical activity. A high t-ratio (positive or negative) suggests that there is a substantial and meaningful difference between the factors.

Comparison	t-ratio	p-value*
Age - Lateral Pillar class	0.06	1
Age - Pain	-4.70	< 0.001
Age - ROM	-8.77	< 0.001
Age - Sex	10.48	< 0.001
Age - Waldenström	1.25	0.810
Lateral Pillar class - Pain	-4.72	< 0.001
Lateral Pillar class - ROM	-8.77	< 0.001
Lateral Pillar class - Sex	10.36	< 0.001
Lateral Pillar class - Waldenström	1.18	0.850
Pain - ROM	-4.09	< 0.001
Pain - Sex	15.17	< 0.001
Pain - Waldenström	5.90	< 0.001
ROM - Sex	19.19	< 0.001
ROM - Waldenström	9.92	< 0.001
Sex - Waldenström	-9.14	< 0.001

*Wald test.
ROM, range of motion.

For allowing or restricting PA we identified three themes: disease stage, presence of pain, and type of activity.

"I do try to restrict impact activity during fragmentation phase."

"When the head is beginning to heal [case 3] I gradually reintroduce sport."

"I see no point in restriction in this stage. Head is nicely contained and the course of disease is not affected by activity."

"Pain is mentioned as an important factor for physical activity."

"Restrict according to pain. Patients/carers/school etc need to be aware that if a child with Perthes' gets pain then (s)he needs to be allowed to rest."

"Pragmatic approach – if makes pain and ROM worse then look to decrease. Aim to stop ROM worsening. Aim to avoid high-impact activity."

Most recommend adapting sport activities and avoiding high-impact activities:

"Only slow swimming, no racing against the clock, no jumping from the board."

"Avoiding impact in organized activities. I don't pretend we can stop the child running when they wish to, but we can reduce the risk in organized/controlled activities."

"All patients will be advised to avoid contact sports […] trampolining, and strenuous exercises at initial stages apart from cycling and swimming."

Discussion

This study revealed that PT is considered important as an (additive) treatment for children with Perthes' disease. In the present study, stretching exercises, to maintain or increase ROM, seemed to be considered particularly important in the initial and fragmentation stages, which is in line with the recently published study by Galloway et al.[23] While there is still a lack of evidence for whether PT is beneficial for the radiological outcome of Perthes' disease,[14] it seems to have a beneficial effect in maintaining or increasing ROM.[4,10] In the later stages of Perthes' disease, the respondents did not recommend stretching. A plausible explanation was that the femoral head has remodelled with or without congruency, and stretching might therefore not be considered as efficient for further remodelling. In these stages, strengthening exercises – to counteract the Trendelenburg sign – were considered to be more important. Daly et al[24] found that strengthening exercises for gluteus medius and maximus are effective in children with cerebral palsy, and therefore might also benefit patients with Perthes' disease.

Large variations existed in recommending or discouraging PA and weightbearing, which are closely associated. Many studies have shown the vulnerability of the femoral head in the early stages of Perthes' disease, and a slightly more favourable outcome when children with Perthes' disease

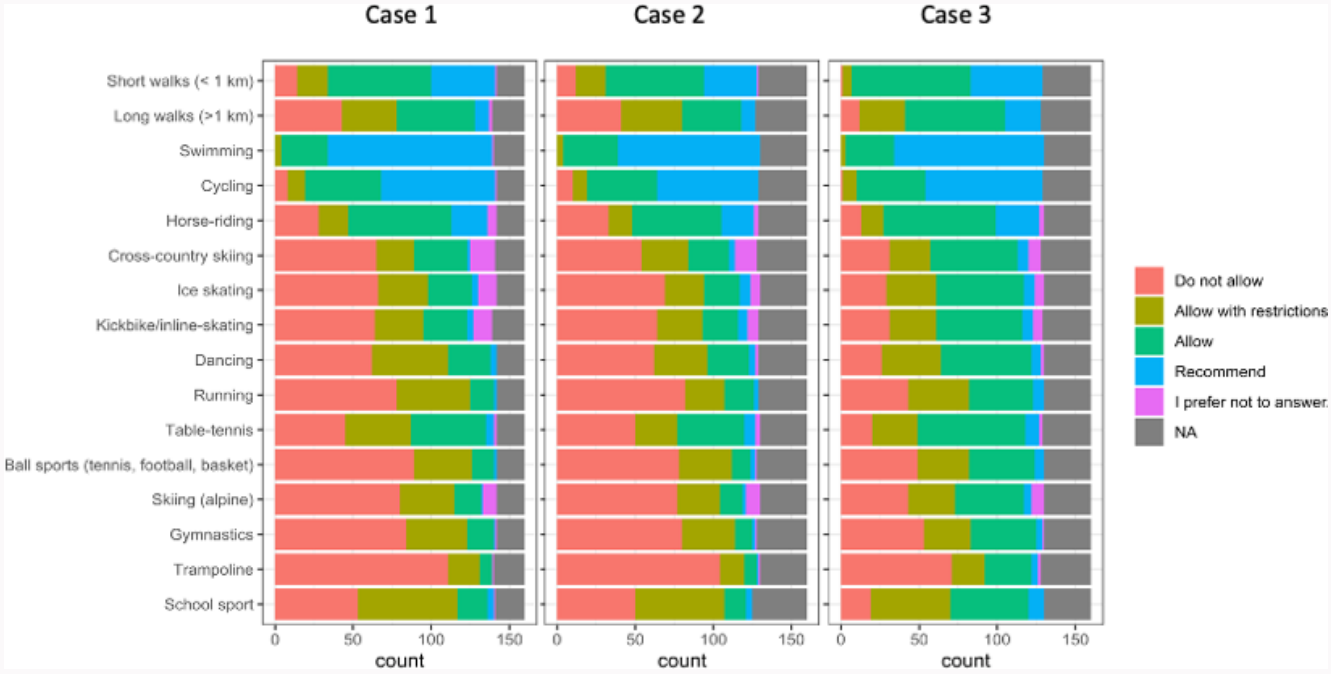

Fig. 3
Restrictions and recommendations of sport activities in three case scenarios. A "kickbike" refers to a kick scooter.

Table IV. Frequency of responses to questions related to the importance of stretching, strengthening and weightbearing in all three case scenarios. Missing answers, as well as answers of "I prefer not to say", are not included.

Response	Case scenario 1	Case scenario 2	Case scenario 3
N	160	160	160
Stretching, n (%)			
No	31 (21.5)	19 (14.5)	30 (23.3)
Only if…	11 (7.6)	11 (8.4)	11 (8.5)
Yes, always	102 (70.8)	101 (77.1)	88 (68.2)
Strengthening, n (%)			
No	78 (54.9)	54 (43.5)	39 (30.7)
Only if…	20 (14.1)	16 (12.9)	17 (13.4)
Yes, always	44 (31.0)	54 (43.5)	71 (55.9)
Weightbearing, n (%)			
No weightbearing	19 (13.4)	18 (13.7)	4 (3.1)
Restricted weightbearing	18 (12.7)	21 (16.0)	9 (6.9)
Weightbearing as tolerated	105 (73.9)	92 (70.2)	117 (90.0)

have restricted weightbearing; therefore, we expected a more confirmatory attitude towards a non-weightbearing regimen.[7,13,25,26] However, this was not the case in our study. More than one-third of the respondents allowed weightbearing as tolerated in all three patient examples. One could argue that age may have influenced their decisions, especially for the first patient case in the initial stage of Perthes' disease, because patient compliance is difficult at the age of six, and also the chance of a positive outcome is rather good. Regardless, even in the second case, in the fragmentation stage at the age of an eight-year-old, the vast majority did not entirely restrict weightbearing. There may be substantial drawbacks of weightbearing restrictions, including potential weight gain and the associated psychological burden. However, Novotny et al[27] did not find any excess weight gain of prolonged non-weightbearing in patients with Perthes' disease. The psychological burden of weightbearing restrictions, on the other hand, varies in different age groups,[28,29] but we still do not know if the risks – including the psychological burden – justify the benefit of weightbearing restrictions.[30] In addition, to our knowledge, no study has shown the minimal clinically important difference in all radiological outcome measurements such as Stulberg,[31] Sphericity Deviation Score,[32] or deformity index,[33] and its agreement with joint-specific or generic patient-reported outcome measures (PROMs) during the active disease or in adulthood.

The same argument can be made for restrictions on PA. We can only assume that the paediatric orthopaedic surgeons found that the risks of preventing a child from enjoying the health and psychosocial benefits of exercise and sports participation are higher than the risk of excessive femoral head deformation.[34–36] The same phenomenon has been described in other paediatric medical conditions where guidelines for restricted PA were actively ignored by the treating physician.[37] Still, there is some uncertainty about when to allow the return to high-impact sports activities, as seen in the study of Li et al.[11]

To our knowledge, apart from the British Isles and Sweden, most countries do not have national guidelines. Recently, Galloway et al[23] published 'Clinical consensus recommendations for the non-surgical treatment of children with Perthes' disease in the UK', and one consensus

guideline document is available through a general internet search published by the Swedish Paediatric Orthopaedic Quality Register.[38] However, different parent organizations have published some generic guidelines on their home pages.

There was generalized agreement within countries in the British Isles, Scandinavia, and Eastern Europe both in terms of PT and PA; however, the recommendations differed between countries. The British Isles and Scandinavia were less restrictive in their approach, compared to Eastern Europe, in terms of weightbearing and PA. Wide variations were seen in Southern Europe and North America. In general, different countries have different minimum PA recommendations for children. However, due to the unequal number of participants across the various countries, these conclusions should be interpreted with caution. Further studies are needed to study the impact of physician/surgeon recommendations on PA for children with Perthes' disease.

It was not possible to determine the response rate, as the survey was distributed to members of different paediatric orthopaedic societies and study groups. A low response rate can introduce bias, as those who choose to participate may differ significantly from those who do not, affecting the study's representativeness. Nevertheless, the responses we received and analyzed were provided by experienced experts in treating patients with Perthes' disease, which suggests they are likely to be reliable. While we had representation from 43 countries in ten regions, responses were scattered geographically and not all countries were represented by the same number of participants. However, the majority of participants had substantial work experience, with only 12 participants having been in practice for less than five years. The study may further be affected by response bias, where participants may have provided answers that are in line with current recommendations at their hospital or country, or may not fully understand the questions, leading to inaccuracies in the data. Another important consideration is the selection of cases, which differed in several aspects, including age, sex, disease stage, and clinical presentation, as well as surgical interventions. Cases 1 and 2 in particular may have been misinterpreted as suggesting that surgical treatment was ruled out from the outset, leaving only non-surgical options available. However, this was not our intention and was not understood this way during the testing phase. Despite our intention to present typical cases, drawing definitive conclusions based on these examples may remain challenging. Furthermore, BMI was not included in the study, as we did not anticipate that it would significantly influence the recommendations for physiotherapy. The questionnaire was exclusively distributed to paediatric orthopaedic surgeons. Including the opinions of physiotherapists could have provided valuable insights, but this would have exceeded the scope of the study and should be investigated separately. This comparison was conducted on a national level within a single country;[12] however, an international comparison is therefore lacking.

This study highlights that practice variation exists both nationally and internationally. Nonetheless, maintaining ROM was very important for the vast majority of participants. Despite many studies showing a better radiological outcome of Perthes' disease in patients treated with non-weightbearing, many participants recommended pain as a tool for the guidance of weightbearing and PA rather than the stage or the severity of Perthes' disease. A high consensus was observed discouraging high-impact activities during the initial and fragmentation stages where swimming and cycling were widely recommended. However, there was no definitive consensus on the appropriate timing for resuming full activities. The present study provides a basis for international research collaborations, e.g. by planning studies with cluster randomization, with the final aim of elaborating evidence-based consensus guidelines for PT and PA in different stages of Perthes' disease, including its impact on both radiological measures and PROMs to understand if the benefits outweigh the potential risks.

Supplementary material

Questionnaire that was distributed to orthopedic surgeons through paediatric orthopaedic societies and research groups.

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Data sharing

The data that support the findings for this study are available to other researchers from the corresponding author upon reasonable request.

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Ethical review statement

This study was approved by the Regional Ethical Review Board (Dnr 2021-07017-01; Sweden). All participants gave written informed consent before data collection began.

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