

<https://helda.helsinki.fi>

Prevalence and treatment of hip displacement in children with cerebral palsy in Finland

Jeglinsky, Ira

2022-04

Jeglinsky , I , Alriksson-Schmidt , A , Hägglund , G & Ahonen , M 2022 , ' Prevalence and treatment of hip displacement in children with cerebral palsy in Finland ' , Journal of Children's Orthopaedics , vol. 16 , no. 2 , pp. 128-135 . <https://doi.org/10.1177/18632521221089439>

<http://hdl.handle.net/10138/343720>

<https://doi.org/10.1177/18632521221089439>

cc_by_nc

publishedVersion

Downloaded from Helda, University of Helsinki institutional repository.

This is an electronic reprint of the original article.

This reprint may differ from the original in pagination and typographic detail.

Please cite the original version.

Prevalence and treatment of hip displacement in children with cerebral palsy in Finland

Journal of Children's Orthopaedics
2022, Vol. 16(2) 128–135
© The Author(s) 2022
DOI: 10.1177/18632521221089439
journals.sagepub.com/home/cho

Ira Jeglinsky¹, Ann I Alriksson-Schmidt², Gunnar Hägglund²,
and Matti Ahonen³

Abstract

Purpose: The aim was to study the prevalence of hip displacements, dislocations, and the hip surgeries performed in a Finnish cohort of children with cerebral palsy not followed up in a hip surveillance program and to compare these with previous studies performed in Northern European countries before and after the implementation of hip surveillance programs.

Methods: A cross-sectional study. A cohort including 480 children with cerebral palsy, born during the period 2000–2018, not enrolled in a hip surveillance program. Migration percentages were recorded from hip radiographs, age at first hip surgery and type of surgery was extracted from medical records. In a separate analysis, the inclusion criteria were adapted to fit two studies analyzing hip dislocation and hip surgery in Sweden, Norway, and Scotland before and after the implementation of a hip surveillance program. Chi-square tests were used to assess differences in proportions between the groups.

Results: In total, 286 children (60%) have had at least one hip radiograph. Of these, 10 (3.5%) developed hip dislocation, which is more than in children of countries with hip surveillance programs (Sweden 0.7%, Scotland 1.3%, $p < 0.001$). Initial surgery to prevent hip dislocation was performed at an older age ($p < 0.001$).

Conclusion: Children with cerebral palsy in Finland not participating in a surveillance hip program were more likely to undergo hip surgery at an older age and to develop hip displacements and dislocations. The results support the effectiveness of surveillance programs to prevent hip dislocation in children with cerebral palsy.

Level of evidence: III

Keywords: Cerebral palsy, hip dislocation, hip surgery, surveillance program, treatment

Introduction

The cerebral palsy follow-up program (CPUP) is a Swedish population-based national quality registry and follow-up program implemented nationwide for individuals of all ages with cerebral palsy (CP). It started in 1994 in the southern part of Sweden but currently involves approximately 95% of all children and young people in Sweden born in 2000 or later with CP.¹ The goal of CPUP was originally to prevent hip dislocations² but over the years, the program has expanded in both size and scope and now seeks to prevent secondary conditions more generally. The program was adopted by one region in Norway in 2006 and included children born during the period 2002–2005. In 2010, the Norwegian CPOP expanded to include all children born in 2006 and later,

covering more than 90% of all children and young people with CP.³ Scotland adopted the CP surveillance program (Cerebral Palsy Integrated Pathway Scotland; CPIPS) in 2012 enrolling children and adolescents born in 2002 and

¹Department of Health and Welfare, Arcada University of Applied Sciences, Helsinki, Finland

²Orthopedics, Department of Clinical Sciences, Skåne University Hospital, Lund University, Lund, Sweden

³Department of Pediatric Surgery, Helsinki Children's Hospital, Helsinki University Central Hospital and University of Helsinki, Helsinki, Finland

Date received: 27 May 2021; accepted: 1 December 2021

Corresponding Author:

Ira Jeglinsky, Department of Health and Welfare, Arcada University of Applied Sciences, Jan-Magnus Janssonin aukio 1, 00560 Helsinki, Finland.
Email: ira.jeglinsky@arcada.fi



later, covering more than 95% of all children and adolescents with CP.⁴ Denmark and Iceland adopted CPUP in 2010 and 2012, respectively, making Finland the only Nordic country that does not have a hip surveillance program.

Children enrolled in the CPUP program undergo regular assessments with hip radiograph examinations.⁵ The frequency of assessment varies depending on the child's age and Gross Motor Function Classification System (GMFCS) level.⁶ Hip radiographs are conducted once a year for children aged 2–8 years in GMFCS levels III–V, whereas children in GMFCS level II undergo radiograph at age 2 and 6 years. Children in GMFCS I are not examined radiographically provided they have a normal, pain-free range of hip motion.⁵ Ten years after the initiation of the Swedish CPUP surveillance program, the incidence of hip dislocations had been reduced from 9.0% to 0.4%.⁷ The results from the 20-year follow-up showed that the number of hip dislocations had remained stable at 0.3%.¹ In Finland, all children with CP aged 0–16 years receive multidisciplinary examinations (health and motor function) and intervention planning in hospital clinics or special care units every 1–2 years. However, hip radiographs are performed following the onset of symptoms (i.e. reactively), such as pain or reduced range of hip motion. The follow-ups are non-systematic and how monitoring is handled differs throughout the country,⁸ potentially resulting in health disparities. Hip displacement or dislocations in children with CP often cause severe pain and everyday problems like difficulties in sitting, standing, reduced mobility, and are associated with reduced quality of life.⁹

The aims of this study were to report (1) the prevalence of hip displacements and dislocations, (2) the mean age when the first radiographic hip examination and first hip surgery were performed, and (3) the number and type of hip surgeries performed in a cohort in Finland. In addition, we compared the results to those of earlier studies on hip dislocations and types of hip surgeries performed in Sweden, Norway, and Scotland. It was hypothesized that the number of hip dislocations would be statistically significantly higher in the Finnish cohort than in countries with surveillance programs and that the children in Finland would have undergone surgeries at a later, more advanced, stage and, therefore, would have undergone more complicated surgeries.

Methods

Design, study population, and procedure

This cross-sectional study included data from Helsinki University New Children's Hospital (HUH). Those eligible for inclusion in the study were children with CP, born from 1 January 2000 to 31 December 2018, treated at HUH during the years 2002–2018 and examined at the hospital in 2017–2018. In Finland, all children with CP,

with the exception of children with severe intellectual disabilities, attend neuropediatric outpatient clinics at a central or university hospital once or twice per year. The visits include health and motor function assessments, rehabilitation planning, and consultations regarding the potential need for spasticity treatment and surgery. The children are examined by a pediatric neurologist, a physical therapist, an occupational therapist, and, if needed, other professionals. The hips are evaluated as part of the pediatric neurologists' and physical therapists' examinations. In the event of an incipient hip dislocation, a pediatric orthopedist is consulted.¹⁰ Children with severe intellectual disabilities are cared for at special health care units in the municipalities and are not generally patients at HUH. However, if children with severe intellectual disabilities experience hip or other musculoskeletal-related problems, need surgery or other medical treatment, for example, for epilepsy, they are referred to HUH and are thus included in this study cohort.

HUH serves 22 municipalities with a total population of 1,686,669 inhabitants, which corresponds to 31% of the total Finnish population. Of these, 327,039 individuals are younger than 18 years old. Given that Finland does not have a CP registry, and the follow-ups are performed across several organizations (university hospitals and special health care units), the total number of children with CP in the catchment area is unknown. However, there is no reason to assume that the incidence of CP and the GMFCS distribution in Finland differ from those of other western developed nations.^{11,12} Using a conservative estimate of two children with CP per 1000 live births, a minimum of 654 children with CP are assumed to reside in the catchment area.

The main outcome variables were hip displacement and hip dislocation. For the purposes of this study, a migration percentage (MP) of 40%–99% was defined as displaced and MP 100% as dislocated hips.^{13,14} Hip surgery was classified into four categories: (1) adductor–iliopsoas lengthening (APL), (2) varus derotation osteotomy of the proximal femur (VDRO), (3) VDRO in combination with pelvic osteotomy (PO), and (4) salvage procedure. All hip surgeries conducted during the period 2002–2020 in the cohort were analyzed.

The medical records of the study participants were reviewed and the dates of the first and the most recent antero-posterior pelvic hip radiographs, laterality, and the total number of radiographs per participant were extracted. Additional information, such as mean age at follow-up, sex, and GMFCS level⁶ was collected. The MPs of the first and the most recent hip radiographs were measured and recorded by the last author who is an orthopedic surgeon. Hip surgeries were recorded and classified into the four categories (APL, VDRO, PO, and salvage).

We compared the prevalence of hip displacement/dislocation and the type of and age at hip surgery of the

participants not followed up in a hip surveillance program to those of children in other countries who are followed in a hip surveillance program. This was done by analyzing those members of this study cohort who met the inclusion criteria in two previously published studies.^{15,16} The 2011 study by Elkamil et al.¹⁵ compared a Norwegian cohort of children with CP not enrolled in a surveillance program to the children in a comparable Swedish cohort in the CPUP. This study included children 7–15 years of age in GMFCS levels III–V. Data on hip displacements/dislocation, hip surgeries, and radiographic examinations were collected from medical records in Norway and from the CPUP register in Sweden. The MPs of the most recent or preoperative anteroposterior pelvic radiographs were measured. The study by Wordie et al.,¹⁶ included all children 2–16 years of age in GMFCS levels I–V in Scotland who had a hip radiograph within 5 years of the inception of the Scottish hip surveillance program CPIPS (hereinafter called the Scotland CPIPS cohort). The MPs from the most recent radiographs were included in the data analysis. Surgical data on children who had undergone hip surgery after the inception of the CPIPS were analyzed. In the Scottish study, additional data from children at their first registration in the CPIPS were included for comparison with Scottish children who had a radiograph of the hip within 5 years of the inception of CPIPS (hereafter called Scotland “presurveillance”).

Data analysis

Descriptive statistics were summarized as means and standard deviations (SD) for continuous variables, and categorical variables were presented as absolute numbers and percentages. N-1 Chi-square tests¹⁷ were used to assess differences in proportions between the different variables (reported in percentages) in the studies by Elkamil et al.¹⁵ and Wordie et al.¹⁶ and the Finnish cohort. Difference in mean age at first surgery was calculated by independent *t*-test. A *p*-value of 0.05 was defined as statistically significant. SPSS Statistics for Windows, Version 27.0 (Armonk, NY: IBM Corp) and MedCalc (www.medcalc.org) were used for statistical analysis. Ethical approval for the study was obtained from the Helsinki University Ethics Committee (US/3640/2017).

Results

In total, 480 children with CP were examined at HUH during the years 2017–2018. Of these, 286 (60%) have had at least one hip radiograph. The dates of the first and the most recent radiographic examinations for the timeframe 2003–2020 were recorded for these 286 children. Characteristics of the children with radiographic examinations and the total cohort are presented in Table 1. Mean age at first radiographic examination was 4.1 years (SD=3.3, range

0–16 years). At the time of the first radiographic examination, 32 (11%) children had hip displacement (8 bilateral) and 6 (2%) had hip dislocations (4 bilateral; Table 2). At the most recent examinations, an additional 11 children (4%) had developed displacements (2 bilateral) and 4 (1%) dislocations (1 bilateral). In total, 43 (15%) children had displacements (11 bilateral) and 10 (3.5%) dislocations (4 bilateral).

Fifty (17%) children had undergone hip surgery during the period 2002–2020, on whom 15 operations were performed bilaterally (Table 2). Thirteen (5%) children underwent a second hip surgery and four children (1%) a third surgery during follow-up; three POs and one total joint arthroplasty. Mean age at first surgery was 9.3 years (SD=3.8, range 2–17 years). Most operations were performed on children in GMFCS levels IV and V.

In comparison with the cohort from Norway (without hip surveillance) and Sweden (with hip surveillance)¹⁵ (Table 3), the number of hip dislocations was lower in Finland (6.4%) than Norway (15%, *p*=0.06) but higher than the Swedish cohort with the hip surveillance program (0.7%, *p*<0.01). Mean age at first surgery was higher in Finland (9.2 years) than in both Norway (7.6 years, *p*<0.001) and Sweden (5.7 years, *p*<0.001). The proportion of children having undergone hip surgery was similar to that in Norway (44%–46%, *p*=0.78), but higher than that in Sweden (31.6%, *p*=0.04). More POs were performed in Finland (33%) than in Norway (8.4%, *p*<0.001) and Sweden (4.4%, *p*<0.001).

In comparison with the Scottish “pre-surveillance” and Scottish surveillance CPIPS cohorts¹⁶ (Table 4), the mean age of the children in Scotland was 1.5 years lower at follow-up than that of the Finnish children (*n*=253; *p*<0.001). The proportion of children with hip displacement in Finland (8.3%) was lower than in the Scottish “pre-surveillance” cohort (10%, *p*=0.41), but higher than in the Scottish CPIPS cohort (4.5%, *p*=0.009). The proportion with hip dislocation was higher in Finland (2.8%) than in the Scottish “pre-surveillance” cohort (2.5%, *p*=0.78) and the Scottish surveillance cohort (1.3%, *p*<0.06). Mean age at first surgery was 1.1 years lower in Scotland (*p*<0.001). Fewer APLs (0.5%, *p*<0.001) and POs (3.2%, *p*<0.001) were performed in Scotland than in Finland (4.0% and 12.6%, respectively). The total number of hip operations was lower in Scotland (8.4%, *p*<0.001). However, the data from Scotland only represent the surgeries performed during the 5 years during which a hip surveillance program has been in place.

Discussion

The prevalence of hip displacement (15%) and hip dislocation (3.5%) in the Finnish cohort was lower than what would be expected without treatment. In previous research reports, hip displacements have ranged from 25% to 60%

Table 1. Characteristics of the Finnish study cohort (n = 480).

	Total cohort	Children with hip radiographs	Children without hip radiographs	p-value
Total, n, (%)	480	286 (60)	194 (40)	
Age at follow-up ^a , mean (SD)	9.1 (4.8)	9.6 (4.7)	9.4 (4.6)	0.64
Sex, n (%)				
Boys	272 (57.0)	168 (59.0)	104 (54.0)	0.28
Girls	208 (43.0)	118 (41.0)	90 (46.0)	0.28
GMFCS ^b level, n (%)				
I	205 (43.0)	83 (29.0)	122 (63.0)	<0.001
II	103 (21.0)	66 (23.0)	37 (19.0)	0.29
III	45 (9.0)	37 (13.0)	8 (4.1)	0.001
IV	57 (12.0)	50 (17.5)	7 (3.6)	<0.001
V	63 (13.0)	50 (17.5)	13 (6.7)	0.001
Not classified	7 (2.0)	0 (0)	7 (3.6)	0.001
Cerebral palsy subtype, n (%)				
Spastic unilateral	226 (47.0)	91 (32.0)	135 (69.5)	<0.001
Spastic bilateral	129 (27.0)	110 (39.0)	19 (9.8)	<0.001
Ataxic	3 (1.0)	3 (1.0)	0 (0.0)	0.16
Dyskinetic	51 (10.0)	41 (14.0)	10 (5.2)	0.002
Not defined ^c	71 (15.0)	41 (14.0)	30 (15.5)	0.65

GMFCS: Gross Motor Function Classification System.

^aFollow-up at Helsinki University New Children's Hospital (HUH) 2017–2018.

^bGross Motor Function Classification System.

^cICD-10 codes G80.8 and G89.9.

and hip dislocations from 10% to 15% when not treated.^{7,20} The prevalence of hip dislocation in Finland was not statistically significantly different from that in Norway and Scotland prior to their implementation of hip surveillance. However, children with CP in Finland did have statistically significantly more hip dislocations than children with CP at comparable ages and GMFCS levels in Sweden and post-implementation of hip surveillance in Scotland. Children in Finland were statistically significantly older when undergoing their first surgery to prevent hip dislocation than children in Sweden and Scotland (post-implementation). Furthermore, a higher proportion of children was treated with reconstructive surgery (VDRO in combination with PO), which implies that more hip deformities had developed. Compared to Sweden and Scotland, which do have hip surveillance programs, more hip surgeries overall were performed in Finland. These findings are consistent with our hypothesis. However, comparing earlier studies from different countries with differences in health-care systems and practices, other than surveillance programs, may explain some of the differences observed.

In this study, mean age at first hip radiograph was 4.1 years in the Finnish cohort, which corresponds to the results from an earlier Finnish study scrutinizing the radiographic routines for children with CP at three university hospitals.⁸ These authors found considerably great inter-regional variation and that HUH was the only hospital with written instructions on radiographic follow-ups. Still, one-third of the children in that study had their first radiograph

at age 3 years or later. Part of the prevention in a hip surveillance program is based on standardized routines and systematic preventive examinations.⁷ For children enrolled in a surveillance program, regular radiographic examinations already start at 2 years of age, and are conducted yearly for children in GMFCS III–V up to the age of 8 years.⁵ Hip displacement > 40% can already be observed in children as young as 1 year of age and the median age for displacement with MP > 40% is 4 years.¹⁸

The mean age at first surgery to prevent hip dislocation was higher in the Finnish cohort than in the countries with surveillance programs, which is in line with our hypothesis. This is likely due to later detection of hip displacements. The first surgery in the Finnish cohort occurred at a mean age of 9.3 years, at which age soft tissue release is generally considered insufficient to achieve containment of the hip joint. In the study by Elkamil et al.,¹⁵ mean age at first surgery for the Swedish cohort was 5.7 years, and in a more recent study from Sweden mean age at first surgery with APL was 4.9 years and for VDRO 5.6 years.¹⁹ This indicates that surveillance programs are associated with earlier identification of displacement leading to earlier intervention.

It is likely that later detection of hip displacement and dislocation leads to more severe hip deformity, requiring reconstructive surgery, which is more invasive. More advanced reconstructions may have implications in terms of higher costs due to more complicated surgeries, longer in-hospital stays and post-surgery rehabilitation, although

Table 2. Hip displacement, hip dislocation, and hip surgery by sex and GMFCS-level.

	Hip displacement and dislocation at first radiographic examination (n = 286)		Total number of hip displacements and hip dislocations (n = 286)		First surgery (n = 50)			Second (n = 13) and third (n = 4) surgery ^a			
	Displacement MP 40%-99% n (%)	Dislocation MP 100% n (%)	Displacement MP 40%-99% n (%)	Dislocation MP 100% n (%)	APL n (%)	VDRO, n (%)	VRDO + PO n (%)	Salvage n (%)	VDRO, n (%)	VRDO + PO n (%)	Salvage n (%)
Sex											
Boys	20 (7.0)	3 (1.0)	28 (9.8)	7 (2.5)	10 (20.0)	2 (4.0)	21 (42.0)	1 (2.0)	1 (7.7)	6 (37.5)	4 (28.6)
Girls	12 (4.2)	3 (1.0)	15 (5.2)	3 (1.0)	2 (4.0)	1 (2.0)	11 (22.0)	2 (4.0)	1 (7.7)	4 (25.0)	1 (7.1)
GMFCS level											
I	0 (0.0)	0 (0.0)	1 (0.3) ^b	0 (0.0)	0 (0.0)	1 (2.0)	1 (2.0)	1 (2.0)	0 (0.0)	1 (6.2)	0 (0.0)
II	4 (1.4) ^c	0 (0.0)	5 (1.7) ^c	0 (0.0)	1 (2.0) ^d	1 (2.0)	3 (6.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (14.3)
III	2 (0.7)	0 (0.0)	2 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	4 (8.0)	0 (0.0)	1 (7.7)	0 (0.0)	0 (0.0)
IV	12 (4.2)	0 (0.0)	15 (5.2)	0 (0.0)	4 (8.0) ^d	1 (2.0)	14 (28.0)	0 (0.0)	0 (0.0)	3 (18.8)	0 (0.0)
V	14 (4.9)	6 (2.0)	20 (7.0)	10 (3.5)	7 (14.0) ^d	0 (0.0)	10 (20.0) ^e	2 (4.0) ^f	1 (7.7)	6 (37.5)	3 (21.4)
Total	32 (11.2)	6 (2.0)	43 (15.0)	10 (3.5)	12 (24.0)	3 (6.0)	32 (64.0)	3 (6.0)	2 (15.4)	10 (62.5)	5 (35.7)

GMFCS: Gross Motor Function Classification System; MP: migration percentage; APL: adductor-psoas lengthening/tenotomy; VDRO: varus derotational osteotomy proximal femur; PO: pelvic osteotomy.

^aNo child treated with APL as second or third surgery.

^bHemiplegia Winters, Gage, and Hicks gait classification (WGH) type IV.

^cTwo hemiplegia with WGH type IV.

^dAll cases with bilateral surgery.

^eTwo cases with bilateral surgery.

^fOne with bilateral surgery.

Table 3. Number of radiographs and surgeries in the Finnish cohort and the Norwegian and Swedish data in the study by Elkamil et al.¹⁸

Characteristics	Finland, n = 78	Norway, n = 119	p-value	Sweden, n = 136	p-value
Year of birth	2003–2011	1996–2003		1996–2003	
Follow-up year ^a	2018	2011		2011	
Mean age at follow-up, years, (range)	11.2 (7–15)	N/A (7–15)		N/A (7–15)	
Sex, n (%)					
Boys	54 (69.2)	73 (61.3)	0.25	74 (54.4)	0.03
Girls	24 (30.8)	46 (38.7)	0.25	62 (45.6)	0.03
GMFCS, n (%)					
III	15 (19.2)	28 (23.5)	0.40	36 (26.5)	0.22
IV	32 (41.0)	54 (45.4)	0.58	55 (40.4)	0.93
V	31 (39.8)	37 (31.1)	0.19	45 (33.1)	0.32
Mean number of radiographs/patient	7.0	5.0 (n = 28) ^b		9.0	
Hip dislocation, n (%) ^c	5 (6.4)	18 (15.1)	0.06	1 (0.7)	0.01
Mean age at first surgery, years (SD)	9.2 (3.8)	7.6 (2.9)	0.001	5.7 (2.3)	<0.001
Type of surgery, n (%) ^d					
Soft tissue release	9 (11.5)	28 (23.5)	0.04	16 (11.8)	1.0
VDRO	0 (0.0)	11 (9.2)	0.01	21 (15.4)	<0.001
Pelvic osteotomy	26 (33.3)	10 (8.4)	<0.001	6 (4.4)	<0.001
Salvage procedure	1 (1.3)	4 (3.4)	0.36	0 (0.0)	0.18
Total number of participants having undergone surgery	36 (46.2)	53 (44.5)	0.78	43 (31.6)	0.04

N/A: not applicable; GMFCS: Gross Motor Function Classification System; VDRO: varus derotational osteotomy proximal femur.

^aFollow-up at Helsinki University New Children's Hospital (HUH) 2017–2018, in Norway and Sweden 2010.

^bRadiographs from two Norwegian counties, covered 28 of the children in the cohort.

^cFrom the most recent exam.

^dFirst surgery.

Table 4. Number of radiographs and surgeries in the Finnish cohort and the Scottish data in the study by Wordie et al.¹⁹

Characteristics	Finland (n = 253)	Scotland pre- surveillance (n = 1171)	p-value	Scotland post- surveillance (n = 1646)	p-value
Year of birth	2002–2016	N/A		N/A	
Follow-up year ^a	2018	2013		2019	
Mean age at follow-up, years, (range)	9.4 (2–16)	7.9 (2–16)	<0.001	7.2 (2–16)	<0.001
Sex, n (%)					
Boys	151 (59.7)	N/A		N/A	
Girls	102 (40.3)	N/A		N/A	
GMFCS, n (%)					
I	70 (27.7)	276 (23.6)	0.11	435 (26.4)	0.56
II	61 (24.1)	183 (15.6)	0.002	259 (15.8)	0.001
III	30 (11.8)	171 (14.6)	0.35	209 (12.7)	0.62
IV	47 (18.6)	202 (17.2)	0.54	277 (16.8)	0.53
V	45 (17.8)	336 (28.7)	<0.001	466 (28.3)	<0.001
Unclassified	0 (0)	3 (0.3)	0.38	0 (0.0)	
Hip displacement, n (%) ^b	21 (8.3)	117 (10.0)	0.41	74 (4.5)	0.009
Hip dislocation, n (%) ^b	7 (2.8)	29 (2.5)	0.78	21 (1.3)	0.06
Mean age at first surgery in years (SD, range)	8.7 (3.8, 2–15)	N/A		7.6 (N/A, 2–16)	<0.001
Type of surgery, n (%) ^c					
Soft tissue release	10 (4.0)	N/A		8 (0.5)	<0.001
VDRO	3 (1.2)	N/A		77 (4.7)	0.01
Pelvic osteotomy	32 (12.6)	N/A		53 (3.2)	<0.001
Salvage procedure	1 (0.4)	N/A		0 (0.0)	0.03
Total number of participants having undergone surgery	46 (18.2)	N/A		138 (8.4)	<0.001

N/A: not applicable; GMFCS: Gross Motor Function Classification System; VDRO: varus derotational osteotomy proximal femur.

^aFollow-up at Helsinki University New Children's Hospital (HUH) 2017–2018, in Scotland 2019.

^bFrom the most recent exam.

^cFirst surgery.

costs were not investigated in this study. However, a recent study evaluated the cost-effectiveness of surveillance programs to prevent hip dislocation in children with CP by analyzing three studies based on CPUP.²¹ The authors compared costs and quality-adjusted life-years to analyze the cost-effectiveness of hip dislocation prevention in children of countries with and without hip surveillance programs, including the Norwegian data from the study by Elkamil et al.¹⁵ and data from CPUP in Sweden. The results indicated that preventing hip dislocations in children with CP is cost-effective.²¹

This study has a number of limitations. The Finnish children in this study form a patient group identified from hospital records and this group is not population-based as in the CP registries used for comparison in this study. There may be children and young people with CP and severe intellectual disabilities in the catchment area whose displacement or pain has not been identified and who, therefore, do not appear in the HUH hospital records. Some of the children not examined with hip radiographs may have hip displacements/dislocations causing the true prevalence of hip displacement/dislocation in the non-surveillance cohorts to be underestimated. Similarly, those children with a hip radiograph may be a selection of children with a high proportion of hip displacement/dislocation and hence cause the prevalence to be overestimated.

In summary, the results from this study indicate that a CP hip surveillance program leads to earlier detection of hip displacement, reduces the need for reconstructive and salvage surgery and significantly reduces the number of children with hip dislocations. The results support the effectiveness of surveillance programs for the prevention of hip dislocation in children with CP.

Author contributions

All authors designed the study. I.J. and M.A. collected the Finnish data. I.J. drafted the article; and all authors read, critically reviewed, and approved the final article.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by Nordforsk (grant #82866) and Forte (grant #2018-01468). The findings and conclusions in this report are those of the authors and do not necessarily represent the official positions of the funders. No other funding source supported this project.

Ethical approval

This article does not include any studies with human participants or animals performed by any of the authors. Ethical

approval for the study was obtained from the Helsinki University Ethics Committee (US/3640/2017).

References

- Hägglund G, Alriksson-Schmidt A, Lauge-Pedersen H, et al. Prevention of dislocation of the hip in children with cerebral palsy: 20-year results of a population-based prevention programme. *Bone Joint J* 2014; 96-B(11): 1546–1552.
- Hägglund G, Andersson S, Düppe H, et al. Prevention of severe contractures might replace multilevel surgery in cerebral palsy: results of a population-based health care programme and new techniques to reduce spasticity. *J Pediatr Orthop B* 2005; 14(4): 269–273.
- Andersen GL, Hollung SJ, Jahnsen R, et al. Cerebral palsy registry of Norway and cerebral palsy follow-up program yearly report for 2019 (in Norwegian), https://www.kvalitetsregistre.no/sites/default/files/20_arsrapport_2019_cp.pdf (2020, accessed 20 April 2021).
- Gaston M. CIPIS: musculoskeletal and hip surveillance for children with cerebral palsy. *Pediatr Child Health* 2019; 29: 489–494.
- Markström A, Hägglund G, Alriksson-Schmidt AI. Hip pain in children with cerebral palsy: a population-based registry study of risk factors. *BMC Musculoskel Dis* 2019; 20: 62.
- Palisano RJ, Rosenbaum P, Bartlett D, et al. Content validity of the expanded and revised gross motor function classification system. *Dev Med Child Neurol* 2008; 50(10): 744–750.
- Hägglund G, Andersson S, Duppe H, et al. Prevention of dislocation of the hip in children with cerebral palsy. The first ten years of a population-based prevention programme. *J Bone Joint Surg* 2005; 87-B: 95–101.
- Löppönen T, Mäenpää H, Ahonen M, et al. Hip radiography of children and youth with cerebral palsy in Finland. *Lääkärilehti [Fin Med J]* 2018; 15: 931–936.
- Bagg MR, Farber J, Miller F. Long-term follow-up of hip subluxation in cerebral palsy patients. *J Pediatr Orthop* 1993; 13(1): 32–36.
- Mäenpää H, Autti-Rämö I, Varho T, et al. Multiprofessional evaluation in clinical practice: establishing a core set of outcome measures for children with cerebral palsy. *Dev Med Child Neurol* 2017; 59(3): 322–328.
- Hirvonen M, Ojala R, Korhonen P, et al. Cerebral palsy among children born moderately and late preterm. *Pediatrics* 2014; 134(6): e1584–e1593.
- Hollung SJ, Hägglund G, Gaston MS, et al. Point prevalence and motor function of children and adolescents with cerebral palsy in Scandinavia and Scotland: a CP-North study. *Dev Med Child Neurol* 2021; 63(6): 721–728.
- Reimers J. The stability of the hip in children. A radiological study of the results of muscle surgery in cerebral palsy. *Acta Orthop Scand Suppl* 1980; 184: 1–100.
- Hägglund G, Lauge-Pedersen H, Persson M. Radiographic threshold values for hip screening in cerebral palsy. *J Child Orthop* 2007; 1(1): 43–47.
- Elkamil AI, Andersen GL, Hägglund G, et al. Prevalence of hip dislocation among children with cerebral palsy in regions with and without a surveillance programme: a cross sectional study in Sweden and Norway. *BMC Musculoskel Dis* 2011; 12: 284.

16. Wordie SJ, Robb JE, Häggglund G, et al. Hip displacement and dislocation in a total population of children with cerebral palsy in Scotland. *Bone Joint J* 2020; 102-B(3): 383–387.
17. Campbell I. Chi-squared and Fisher-Irwin tests of two-by-two tables with small sample recommendations. *Stat Med* 2007; 26: 2661–2675.
18. Larnert P, Risto O, Häggglund G, et al. Hip displacement in relation to age and gross motor function in children with cerebral palsy. *J Child Orthop* 2014; 8(2): 129–134.
19. Kiapekos N, Broström E, Häggglund G, et al. Primary surgery to prevent hip dislocation in children with cerebral palsy in Sweden: a minimum 5-year follow-up by the national surveillance program (CPUP). *Acta Orthop* 2019; 90(5): 495–500.
20. Huser A, Mo M, Hosseinzadeh P. Hip surveillance in children with cerebral palsy. *Orthop Clin N Am* 2018; 49: 181–190.
21. Vallejo-Torres L, Rivero-Santana A, Martin-Saborido C, et al. Cost-effectiveness analysis of a surveillance program to prevent hip dislocation in children with cerebral palsy. *Gac Sanit* 2020; 34(4): 377–384.