Management of cerebral palsy varies by healthcare region

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ABSTRACT

INTRODUCTION: Cerebral palsy (CP) is the most common type of motor disability in childhood. The aim of the present paper was to describe regional differences in the management of CP in school-aged children in Denmark.

METHODS: This was a cross-sectional study based on the Danish Cerebral Palsy Registry. The parents of 462 children answered a questionnaire about their child's treatment and the family's characteristics. Descriptive and logistic regression analyses were performed for every treatment modality, stratified by the Gross Motor Function Classification System (GMFCS) level and adjusted for family and child characteristics.

RESULTS: Significant regional differences were found regarding the provision of occupational therapy at all GMFCS levels, speech therapy at GMFCS levels II-V and orthopaedic surgery at GMFCS levels I and III-V. No regional differences were observed in the frequency of physiotherapy. We found no regional differences in the severity of disability.

CONCLUSIONS: Regional differences in the management of cerebral palsy cannot be explained by social differences or differences in the severity of the disability.

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TRIAL REGISTRATION: not relevant.

Cerebral palsy (CP) is the most common type of motor disability in childhood. It affects posture and motor control and is caused by a non-progressive lesion of the developing brain. The motor disability of CP is often accompanied by disturbances of sensation, cognition, communication, perception, behaviour and/or by seizure disorders [1]. Spastic CP is the most common subtype of CP, accounting for approximately 85% of cases. The other subtypes are ataxic (4%) and dyskinetic (7%), and some cases are unclassified (4%) [2, 3]. The severity of CP depends on both the impairment of motor function and the presence of accompanying disability.

The Gross Motor Function Classification System (GMFCS) is a validated method to evaluate the severity of motor impairment of children with CP [4]. It is used to compare the severity of CP between populations and to design treatment for children with CP [5]. GMFCS consists of five levels. Children at level I can walk without limitations, but have problems with balance and coordination when jumping, running or performing other more complicated motor activities. Children at level V are not able to walk and can only move about using a wheelchair with extensive adaptations. GMFCS II-IV are intermediate levels connecting those extremes.

The treatment of motor disability in CP includes habilitation services (physiotherapy, occupational and speech therapy), use of orthotic devices, orthopaedic surgery and oral, intramuscular or intrathecal medication. Accompanying disorders need to be detected and treated. At present, very few population-based studies have investigated differences in CP management [6], and none of these studies involved multiple treatment modalities.

Previous studies have demonstrated that both the motor and cognitive disabilities of the child may influence the choice of treatment [7-9].

Regional differences in treatment have previously been observed, e.g. among patients receiving a cochlear implant [10]. Knowledge about regional differences in health services for patients with CP is limited. In an annual report from the Region of Southern Denmark, it was demonstrated that the proportions of children who received physiotherapy varied from 60% to 100% between municipalities [11]. A recent study from the UK revealed regional variation in the healthcare services provided to children and young people with CP regarding orthopaedic consultation, access to magnetic resonance imaging (MRI), recording state of spine and discussions about pain [6].

The aim of the present study was to investigate and to describe regional differences in the management of CP in school-aged children in Denmark.

METHODS

The study is part of a cross-sectional study on treatment and co-morbidity in 8-15-year-old children with CP. Data were based on the Danish National Cerebral Palsy Registry (NCPR) [12], questionnaires answered by the parents and information from Statistics Denmark.

ORIGINAL ARTICLE

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Participants and data sources

Children (n = 977) who were born in the 1997-2003 period were identified from the NCPR, and 893 children were still eligible for the study after updating their civil status in September 2011. An invitation letter was sent to the parents in the period from January 2012 to January 2013.

Parents reported the use of treatment methods in the Cerebral Palsy Treatment Questionnaire (CP-TQ), created for the study by an expert group and tested in 23 families [13]. The SurveyXact software was used for CP-TQ online.

The Danish Gross Motor Function Classification System Family Report was tested for reliability to ensure GMFCS level classification [14].

The outcome variables included paediatrician and orthopaedic surgeon consultations during the past 12 months; evaluation by speech therapist and psychologist ever in life; frequency of physiotherapy during the past 12 months (at least weekly or less for GMFCS levels I-II and more than weekly or less for GMFCS levels III-V). Occupational therapy during the same period was summarised to "received or not". Orthoses were included if used daily or nightly in the past three months. Orthopaedic surgery was defined as "operation on the legs, arms or spine due to CP ever performed". Botulinum toxin (BTX) injections were included if ever received intramuscularly.

Information regarding the number of parents (single/two), number of siblings (0 or ≥ 1), and educational level of the parents was retrieved from the CP-TQ. The highest educational level was used if parents had different educational levels.

The region was determined from the child's municipality as stated in the Danish Civil Registration System.

The type of CP and cognitive function were extracted from the NCPR.

TABLE 1

Basic characteristics of participants and non-participants.

Child and family characteristics	Participants	Non-participants	All
Child's age, yrs + mo., median (range)* [a]	12 ((8 + 4)-(15 + 7))	12 + 6 ((8 + 4)-(15 + 6))	12 + 2
Male, n (% (95% CI))	258 (56 (51-60))	267 (62 (57-67))	(59)
GMFCS, n (% (95% CI))			
Level I	225 (49 (44-53))	224 (52 (47-57))	(50)
Level II	49 (11 (8-13))	33 (8 (5-10))	(9)
Level III	18 (4 (2-6))	20 (5 (3-7))	(4)
Level IV	87 (19 (15-22))	68 (16 (12-19))	(17)
Level V	79 (17 (14-21))	84 (20 (16-23))	(18)
Proportion of children with IQ > 85, n; %, median (range)* [b]	239 (52 (47-56))	170 (39 (35-44))	(46)
Cerebral palsy type, n (% (95% CI))			
Right hemiplegia	105 (23 (19-27))	92 (22 (17-25))	(22)
Left hemiplegia	79 (17 (14-21))	89 (21 (17-24))	(19)
Spastic bilateral	210 (46 (41-50))	203 (48 (42-52))	(47)
Ataxic	19 (4 (2-6))	15 (4 (2-5))	(4)
Choreoathetotic	8 (2 (1-3))	4 (1 (0-2))	(1)
Dystonic	35 (8 (5-10))	22 (5 (3-7))	(6)
Single parent, n (% (95% CI))	121 (26 (23-31))	146 (34 (30-39))	(30)
Siblings in the family, n (% (95% CI))	343 (81 (77-85))	301 (79 (74-82))	(80)
Education level of parents [b], n (% (95% CI))*			
Low	234 (54 (49-58))	281 (71 (66-75))	(62)
Middle	142 (33 (28-37))	83 (21 (17-25))	(27)
High	60 (14 (11-17))	31 (8 (6-11))	(11)
Region [b], n (% (95% CI))*			
Southern	120 (26 (22-30)	100 (23 (19-27))	(25)
Central	136 (29 (25-34))	93 (22 (17-25))	(26)
Northern	47 (10 (7-13))	50 (12 (9-15))	(11)
Capital	97 (21 (17-25))	128 (30 (25-34))	(25)
Zealand	62 (13 (10-17))	60 (14 (11-17))	(14)
Total, n (%)	462 (52)	431 (48)	893

CI = confidence interval; GMFCS = Gross Motor Function Classification System.
*) $p < 0.05$.
a) Wilcoxon rank sum test.
b) Pearson's chi^2-test.

Statistical analyses

The statistical software package STATA 12 was used for all the statistical analyses. The chi-squared test was used to compare proportions of categorical variables between participants and non-participants, and between regions. The Wilcoxon's rank sum test was used to compare the age of participants and drop-outs because age was not normally distributed between drop-outs. Statistical significance was defined as $p < 0.05$.

Crude odds ratios were calculated with 95% confidence intervals (CI) for every follow-up and treatment modality for the Northern, Central, Capital and Zealand Regions, using the Southern Region as a reference group. Odds ratios were later adjusted for other characteristics (the child's age, gender and cognitive levels, living with single parent, with siblings, in a municipality with > 100,000 inhabitants, and parental educational level).

After a descriptive analysis, it became clear that school type was very strongly associated with the presence of cognitive impairment, and it was therefore excluded from further analysis to prevent multicollinearity.

Distance to the hospital was also considered a possible confounder for follow-up and hospital-based treatment, but was not included in the analysis because 45 of the children did not undergo follow-up at any hospital.

The study was approved by the Danish Data Protection Agency (ref. no. 2008-41-2927) and the Ethical Committee of the Central Denmark Region (ref. no. M-20090016).

Trial registration: not relevant.

RESULTS

Basic characteristics of both participants and non-participants are shown in **Table 1**. Normal speech was reported in 56% (95% CI: 51-61%) and no understandable speech in 19% (95% CI: 15-22%) of the participating children.

Similar proportions of children in GMFCS levels III-V (84-95%) attended paediatric consultations in all five regions (**Table 2**). Only 29% of the children in GMFCS level I had been investigated by a paediatrician during the past 12 months in the Northern Region versus 61-76% in the remaining Regions.

Speech therapist evaluation was performed in 71% of all the children with CP, and the highest proportions were found in the Capital Region for all GMFCS levels. After adjustment, the difference remained statistically significant at GMFCS levels II and III-V (Table 2). Evaluation by a psychologist was performed in 68% of

TABLE 2

Regional differences in the follow-up of cerebral palsy: national and regional proportions of children, crude odds ratio and odds ratio adjusted for child's and family's characteristics[a].

	Paediatrician in the last 12 months			Orthopaedic surgeon in the last 12 months			Speech therapist			Psychologist		
GMFCS	n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)
Level I												
Southern region	29 (66*)	Ref.	Ref.	22 (51)	Ref.	Ref.	32 (73*)	Ref.	Ref.	36 (82*)	Ref.	Ref.
Central region	33 (61*)	0.81	0.91 (0.37-2.25)	12 (33)	0.48	0.47 (0.19-1.15)	33 (61*)	0.59	0.52 (0.19-1.40)	37 (69*)	0.48	0.63 (0.22-1.76)
Northern region	5 (29*)	0.22*	0.20* (0.06-0.73)	4 (24)	0.29	0.28 (0.07-1.04)	7 (41*)	0.26*	0.18* (0.05-0.69)	6 (35*)	0.12*	0.13* (0.03-0.53)
Capital region	29 (66*)	1.00	1.16 (0.37-3.63)	19 (43)	0.73	0.78 (0.26-2.35)	33 (77*)	1.24	0.96 (0.28-3.32)	32 (73*)	0.59	0.94 (0.26-3.43)
Zealand region	16 (76*)	1.66	1.97 (0.57-6.75)	5 (24)	0.30	0.29* (0.09-0.96)	11 (52*)	0.41	0.33 (0.09-1.15)	11 (55*)	0.27*	0.26* (0.07-0.98)
Denmark	112 (62)	–	–	68 (38)	–	–	116 (65)	–	–	122 (68)	–	–
Level II												
Southern region	27 (84)	Ref.	Ref.	18 (56)	Ref.	Ref.	17 (55*)	Ref.	Ref.	22 (71)	Ref.	Ref.
Central region	17 (71)	0.45	0.33 (0.08-1.43)	13 (54)	0.92	1.02 (0.31-3.78)	18 (75*)	2.47	5.68 (1.23-26.32)	17 (77)	1.39	1.59 (0.41-6.17)
Northern region	5 (56)	0.23	0.25 (0.04-1.78)	5 (56)	0.97	0.53 (0.08-3.41)	5 (56*)	1.03	0.69 (0.07-7.21)	5 (56)	0.51	0.61 (0.10-3.68)
Capital region	20 (95)	3.70	2.43 (0.20-30.01)	16 (76)	2.49	2.28 (0.49-10.56)	20 (95*)	16.47*	20.43* (1.76-237.6)	16 (80)	1.64	1.54 (0.31-7.72)
Zealand region	14 (78)	0.65	1.21 (0.20-7.54)	6 (35)	0.42	0.47 (0.11-1.99)	13 (81*)	3.57	8.45* (1.14-62.76)	13 (72)	1.06	1.16 (0.27-4.95)
Denmark	83 (79)	–	–	58 (56)	–	–	73 (72)	–	–	73 (73)	–	
Levels III-V												
Southern region	36 (88)	Ref.	Ref.	29 (73)	Ref.	Ref.	25 (64)	Ref.	Ref.	27 (66)	Ref.	Ref.
Central region	48 (91)	1.33	1.40 (0.36-5.42)	40 (75)	1.18	1.23 (0.43-3.59)	38 (74)	1.64	1.93 (0.71-5.23)	26 (51)	0.54	0.48 (0.19-1.26)
Northern region	16 (84)	0.74	0.62 (0.11-3.41)	13 (68)	0.82	1.13 (0.26-4.87)	15 (83)	2.80	3.14 (0.68-14.44)	13 (68)	1.12	1.40 (0.38-5.34)
Capital region	27 (87)	0.94	0.89 (0.16-4.79)	28 (90)	3.54*	8.44* (1.52-46.80)	29 (94)	8.12*	5.88 (0.96-36.03)	18 (60)	0.78	0.90 (0.26-3.16)
Zealand region	21 (95)	2.91	3.12 (0.30-31.98)	16 (73)	1.01	0.73 (0.18-2.97)	17 (81)	2.38	1.99 (0.51-7.82)	16 (76)	1.66	1.84 (0.48-6.98)
Denmark	148 (89)	–	–	126 (76)	–	–	124 (77)	–	–	100 (62)	–	–

CI = confidence interval; GMFCS = Gross Motor Function Classification System; OR = odds ratio; OR_{adj} = OR adjusted for child's and family's characteristics.

*) $p < 0.05$ for difference between proportions or OR.

a) OR_{adj} is adjusted for child's age, gender, cognitive function and family characteristics (living with siblings, with a single parent, in a city and parental educational level).

TABLE 3

Regional differences in management of cerebral palsy: proportions of children, receiving the treatment, and odds ratio adjusted for child's and family's characteristics[a].

	Physiotherapy, at least weekly			Occupational therapy, received in the last 12 months			Orthoses, daily or nightly		
GMFCS	n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)
Level I									
Southern region	27 (61)	Ref.	Ref.	17 (39)	Ref.	Ref.	9 (20)	Ref.	Ref.
Central region	21 (33)	0.31	0.43 (0.17-1.02)	10 (18)	0.34	0.36* (0.13-0.98)	11 (19)	0.93	1.00 (0.34-2.95)
Northern region	9 (53)	0.71	0.97 (0.29-3.25)	5 (29)	0.66	0.58 (0.15-2.22)	1 (6)	0.24	0.23 (0.03-2.11)
Capital region	21 (45)	0.52	0.91 (0.30-2.76)	13 (30)	0.67	0.72 (0.21-2.45)	1 (16)	0.76	1.41 (0.35-5.70)
Zealand region	11 (52)	0.69	0.89 (0.29-2.73)	6 (29)	0.64	0.64 (0.19-2.16)	1 (5)	0.19	0.19 (0.02-1.69)
Denmark	89 (49)	–	–	51 (28)	–	–	29 (16)	–	–
Level II									
Southern region	26 (79)	Ref.	Ref.	12 (38*)	Ref.	Ref.	25 (25)	Ref.	Ref.
Central region	14 (58)	0.38	0.43 (0.12-1.51)	12 (50*)	1.67	1.96 (0.62-6.24)	14 (61)	4.67	6.53* (1.82-23.48)
Northern region	7 (78)	0.94	0.93 (0.13-6.75)	6 (67*)	3.33	7.19* (1.03-50.0)	3 (33)	1.50	2.43 (0.39-15.11)
Capital region	16 (76)	0.86	1.24 (0.26-5.97)	17 (81*)	7.08	10.99* (2.17-55.55)	10 (48)	2.73	2.29 (0.53-9.88)
Zealand region	15 (83)	1.35	1.03, 0.19-5.56	12 (67*)	3.33	3.86, 0.94-15.84	5 (28)	1.15	1.42, 0.32-6.22
Denmark	78 (74)	–	–	59 (57)	–	–	40 (39)	–	–
Levels III-V									
Southern region	28 (68)[c]	Ref.[c]	Ref.[c]	27 (66)	Ref.	Ref.	31 (76)	Ref.	Ref.
Central region	37 (69)[c]	1.01[c]	0.96 (0.39-2.52)[c]	33 (61)	0.81	0.76 (0.30-1.90)	46 (85)	1.67	1.82 (0.57-5.75)
Northern region	15 (75)[c]	1.39[c]	1.37 (0.37-5.04)[c]	16 (80)	2.07	2.33 (0.57-9.41)	19 (95)	5.51	4.44 (0.45-43.85)
Capital region	20 (65)[c]	0.84[c]	0.68 (0.20-2.31)[c]	25 (78)	1.85	1.20 (0.32-4.46)	26 (81)	1.26	0.56 (0.12-2.49)
Zealand region	16 (70)[c]	1.06[c]	0.78 (0.23-2.62)[c]	16 (70)	1.19	1.17 (0.33-4.13)	16 (70)	0.66	0.97 (0.24-3.89)
Denmark	116 (69)[c]	–	–	117 (69)	–	–	138 (82)	–	–

CI = confidence interval; CP = cerebral palsy; GMFCS = Gross Motor Function Classification System; OR = odds ratio; OR_{adj} = OR adjusted for child's and family's characteristics.

*) $p < 0.05$ for difference between proportions or OR.

a) OR_{adj} is adjusted for child's age, gender, cognitive function and family characteristics (living with siblings, with a single parent, in a city and parental education level).

b) Only spastic and dystonic CP included.

c) More than weekly.

children. Statistically significant differences were observed only for GMFCS level I, ranging from 35% in the Northern Region to 82% in the Southern Region (Table 2).

No regional differences were observed in provision of physiotherapy, but statistically significant differences existed for provision of occupational therapy (**Table 3**). Regional differences in the daily use of orthoses were significant only for GMFCS level II (Table 3).

Botulinum toxin treatment was provided most frequently in the Zealand Region; the difference was statistically significant only for GMFCS level II. Orthopaedic surgery was performed most frequently in the Capital Region in GMFCS levels III-V and was observed least frequently in the Central Region in GMFCS level I (Table 3).

No statistically significant regional differences were observed for other treatment modalities, i.e. baclofen pump, rhizotomy, oral spasmolytics or gastrostomy for nutrition tube (**Table 4**).

DISCUSSION

For children in GMFCS level I, the management of CP differed between the five Regions in Denmark with regard to provision of occupational and speech therapy, psychological evaluation, the number of paediatric or orthopaedic consultations and orthopaedic surgery. For children in GMFCS level II, the differences were observed in provision of occupational and speech therapy, use of orthoses and botulinum toxin injections. For GMFCS levels III-V, a higher rate of speech therapy, orthopaedic consultations and surgery was reported in the Capital Region. All differences remained statistically significant after adjustment for child and family characteristics.

To our knowledge, this is the first study evaluating possible interregional differences in the management of CP in a national sample. Swedish and Norwegian follow-up programmes have reported on the numbers of children receiving a particular service or treatment in every county, but no additional statistical analyses on regional differences are available in these reports. On the national level, the proportions of children receiving services were similar in all three Scandinavian countries [15-17].

A recent paper reported variation in healthcare for children with CP regarding access to orthopaedic surgeons between treatment centres in Northern England

TABLE 3, CONTINUED

Botulinum toxin[b], ever received			Orthopaedic surgery[b], ever performed		
n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)
24 (60)	Ref.	Ref.	23 (58)	Ref.	Ref.
22 (42)	0.47	0.56 (0.23-1.39)	12 (23)	0.22	0.19* (0.07-0.52)
8 (50)	0.67	0.80 (0.23-2.82)	6 (38)	0.44	0.55 (0.16-1.93)
24 (59)	0.94	1.58 (0.49-5.10)	17 (43)	0.55	0.65 (0.21-2.10)
16 (76)	2.13	3.05 (0.82-11.4)	12 (57)	0.99	1.04 (0.33-3.28)
94 (55)	–	–	70 (41)	–	–
19 (58)	Ref.	Ref.	19 (59)	Ref.	Ref.
15 (75)	2.21	3.48 (0.77-15.67)	7 (35)	0.37	0.41 (0.12-1.47)
4 (50)	0.74	0.47 (0.05-4.25)	4 (50)	0.68	0.42 (0.06-3.02)
13 (76)	2.39	1.52 (0.26-8.89)	13 (72)	1.78	1.56 (0.34-7.27)
14 (78)	2.58	6.63* (1.12-39.42)	9 (50)	0.68	1.49 (0.35-6.41)
65 (68)	–	–	52 (54)	–	–
27 (73)	Ref.	Ref.	23 (62)	Ref.	Ref.
42 (82)	1.73	2.00 (0.67-5.93)	31 (61)	0.94	0.86 (0.34-2.17)
13 (65)	0.69	0.59 (0.16-2.27)	8 (40)	0.40	050 (0.15-1.67)
26 (87)	2.41	3.80 (0.78-18.39)	22 (81)	2.67	5.53* (1.27-24.02)
18 (82)	1.67	2.88 (0.62-13.30)	13 (59)	0.88	0.87 (0.26-2.93)
126 (79)	–	–	97 (62)	–	–

[6]. In Denmark, the overall proportion of children consulted by an orthopaedic surgeon was higher than in the North of England. For example, 61% against 76% for GMFCS levels III-V. A wide access to orthopaedic surgeon consultation in Denmark may have reduced the regional variation in access to consultation, but did not eliminate regional variation in the rate of orthopaedic surgery.

The high rate of orthopaedic surgery in GMFCS levels III-V in the Capital Region cannot be explained by clinical differences in CP children between the Regions. When analysing data within the GMFCS III-V strata, we found that 93% of children in GMFCS level V underwent orthopaedic surgery in the Capital Region in contrast to 55% in the other Regions, whereas no differences were observed in children within GMFCS levels III and IV. This indicates that the increase in orthopaedic surgery in the Capital Region was restricted to the most severely affected children. We were unable to explore whether the difference was due to preventive hip dislocation surgery or to other types of surgery.

In Denmark, habilitation services for children with CP are provided by the municipalities. Additionally, public health insurance covers the cost of physiotherapy, but not other habilitation services like occupational services or speech therapy for people with CP. Therefore, regional differences in habilitation services reflect the differences in municipality services within and between the different Regions. As regards the lower provision of occupational therapy and speech therapy, the explanation may be that municipalities are unaware of the need for these services in children with mild CP or that they prioritise children with the most severe disability when habilitation services are not available for everyone in need. We were unable to explore the reasons for regional differences in municipality services in the present study design. The reasons for such differences have been analysed in a qualitative report regarding family-centred habilitation services in the Southern Region [11]. The main hurdle for implementation of family-centred care was not a lack of awareness about the child's habilitation needs, but a lack of clearly assigned overall responsibility for providing habilitation services under health, education and social services legislations in the municipalities [10].

Regional differences in two treatment modalities (orthoses and BTX) were statistically significant in GMFCS level II. Interpretation of these findings should be done with caution because GMFCS II was the smallest stratum (103 participants and only 94 children with spastic/dystonic CP). We found no regional differences in the use of these treatment modalities in GMFCS levels I and III-V. The findings concerning orthoses may reflect a specific problem for children in GMFCS level II, however. These children are able to walk without aids, but have a limited walking distance, and ankle orthoses may increase their walking distance and hand orthoses may increase their bimanual ability. A recent study reported a more frequent use of ankle-foot orthoses in Sweden than the use of all kinds of orthoses in Denmark (47% versus 39% in GMFCS level II). Therefore, the availability of orthoses in Denmark should be explored.

The relatively low participation of parents from the Capital Region may be a limitation and introduce selection bias. Participants from the Capital Region had the

Regions in Denmark with numbers of inhabitants in 2015.

TABLE 4

Regional differences of treatments, mainly used in Gross Motor Function Classification System levels III-V: number (%) of children, receiving the treatment, and odds ratio with 95% confidence interval, adjusted for child's and family's characteristics[a].

	Baclofen pump or dorsal rhizotomy[b]			Oral spasmolytics[b]			Gastrostomy		
GMFCS	n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)	n (%)	OR	OR_{adj} (95% CI)
Level I									
Denmark	0	–	–	6 (4)	–	–	0	–	–
Level II									
Denmark	0	–	–	3 (3)	–	–	2 (2)	–	–
Levels III-V									
Southern region	10 (27)	Ref.	Ref.	14 (38)	Ref.	Ref.	9 (22)	Ref.	Ref.
Central region	10 (20)	0.69	0.62 (0.22-1.76)	24 (48)	1.52	1.80 (0.71-4.61)	17 (31)	1.59	1.43 (0.48-4.26)
Northern region	3 (15)	0.48	0.50 (0.11-2.27)	9 (45)	1.34	1.79 (0.53-6.07)	4 (20)	0.89	0.78 (0.17-3.62)
Capital region	7 (26)	0.95	1.13 (0.30-4.23)	18 (62)	2.69	3.27 (0.95-11.27)	10 (32)	1.69	1.13 (0.28-4.52)
Zealand region	6 (27)	1.01	0.70 (0.19-2.61)	12 (57)	2.19	1.47 (0.44-4.87)	2 (10)	0.37	0.13 (0.01-1.25)
Denmark	36 (23)	–	–	77 (46)	–	–	42 (25)	–	–

CI = confidence interval; GMFCS = Gross Motor Function Classification System; OR = odds ratio; ORadj = OR adjusted for child's and family's characteristics.

a) ORadj is adjusted for child's age, gender, cognitive function and family characteristics (living with siblings, with a single parent, in a city and parental educational level)

b) Only spastic and dystonic CP included.

same distribution regarding CP type and GMFCS level as the drop-outs. Therefore, we assume that regional selection bias had a minimal influence on the results at the national level, but may have introduced selection bias in interregional analyses.

Another source of selection bias may be the low participation of parents with a short education because children with mild CP tended to undergo orthopaedic surgery more often if their parents had a short education than children of parents with intermediate-level or high education. Therefore, the frequency of orthopaedic surgery may be underestimated in our study at the national level. The influence of parental education on the regional differences in orthopaedic surgery was minimised by adjusting the OR for parental education, and we therefore conclude that regional differences in orthopaedic surgery exist in Denmark.

Another limitation of our study is that we only analysed the frequency of provided therapy, not the amount of therapy or differences between specific modalities of physiotherapy.

CONCLUSIONS

Regional differences in the management of CP do exist in Denmark, and the differences cannot be explained by social differences or differences in the severity of the disability between the regions. A national follow-up programme entitled "Opfølgningsprogram for Cerebral Parese" (CPOP) has now been launched in four regions and is being initiated in the fifth [18]. CPOP may promote a more equal management of CP in all regions based on national guidelines for primary and secondary healthcare and an increased political attention at regional and municipal levels. CPOP now includes guidelines for the follow-up of children's motor function and joint mobility, but no guidelines on treatment or comorbidity screening. Our findings indicate that the CPOP may need to be developed further to diminish interregional differences in habilitation services and the treatment of children with CP in Denmark.

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