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Cerebral palsy in Norway: Prevalence, subtypes and severity

Guro L. Andersen[a,*], *Lorentz M. Irgens*[b], *Ivar Haagaas*[a], *Jon S. Skranes*[c], *Alf E. Meberg*[d], *Torstein Vik*[e]

[a]*Habilitation Center, Vestfold Hospital, Tønsberg, Norway*
[b]*Medical Birth Registry of Norway, Department of Public Health and Primary Health Care, University of Bergen, Norwegian Institute of Public Health, Norway*
[c]*Department of Laboratory Medicine, Children's and Women's Health, Norwegian University of Science and Technology, Trondheim, Norway*
[d]*Department of Paediatrics, Vestfold Hospital, Tønsberg, Norway*
[e]*Department of Public Health, Norwegian University of Science and Technology, Trondheim, Norway*

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ABSTRACT

Background/aim: To describe prevalence, subtypes and severity of cerebral palsy (CP) in Norway using criteria proposed by the Surveillance of Cerebral Palsy in Europe (SCPE) network.

Material: All children in Norway with CP born in January 1996–December 1998 were registered in the Cerebral Palsy Registry of Norway. The Medical Birth Registry of Norway provided the perinatal data.

Results: A total of 374 children with CP were identified with a prevalence of 2.1 per 1000 live births. Detailed information was obtained from 294 (79%) children. Median age at clinical assessment was 6.9 years (range: 1.9–10.2 years). Thirty-three percent of the children had spastic unilateral CP, 49% spastic bilateral, 6% dyskinetic, 5% ataxic CP and 7% were not classified. Severely impaired vision and hearing were present in 5% and 4% of the children, respectively. Active epilepsy was present in 28%, mental retardation in 31% and severely impaired or no speech in 28% children. The most severe impairments in gross motor function were observed in children with low Apgar scores, and the most severe impairments in fine motor function in children born at term, with normal birth weight and low Apgar scores.

Conclusion: Compared with other populations, the prevalence of CP as well as the proportions of subtypes and gross motor impairments were similar, whereas fine motor impairments and associated impairments were more common. The classification of children with mixed forms of CP is still a challenge. Children were more severely affected if Apgar scores were low, and if they were born at term.

*Corresponding author. Habiliteringssenteret, Sykehuset i Vestfold, Postboks 2168, N-3103 Tønsberg, Norway. Tel.: +47 33 30 82 59/ +47 97 07 01 58; fax: +47 33 31 22 76.
E-mail address: guro.andersen@siv.no (G.L. Andersen).

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1. Introduction

Cerebral palsy (CP) comprises a group of permanent and non-progressive disorders of movement and posture caused by a central nervous lesion, damage or dysfunction originating early in life (Surveillance of Cerebral Palsy in Europe (SCPE) 2000).[1]

Studies have reported that the prevalence of CP may vary between 1.5 and 3.0 per 1000 live births.[2–8] These differences in prevalence may reflect "true" differences but may also be the result of variations in ascertainment of CP cases or inconsistent definition and classification of CP. We are not aware of other studies comprising a complete national cohort.

Moreover, the subtypes and severity of CP as well as the proportion of patients with associated impairments vary between studies, and this variation is likely to be due to differences in diagnostic criteria and classification.[7,9–15] Recently, a European network, the Surveillance of Cerebral Palsy in Europe (SCPE), has agreed upon a definition of CP, and has suggested a revised classification in subtypes which may be less dependent on individual judgement.[1]

In 2002, the Cerebral Palsy Registry of Norway (CPRN), comprising data of all children with CP born in 1996 onwards, was established in Norway. As essentially all children with CP are diagnosed and treated at public hospitals or habilitation centres, Norway may be well suited for population-based studies. Moreover, the child neurologists who diagnose and are responsible for the medical follow-up are relatively few in number and have a well-established network enabling agreement on definitions and classification. Finally, the Medical Birth Registry of Norway (MBRN) established in 1967 provides essential perinatal data on risk factors for CP as well as perinatal survival.

In this article, we want to report the first results of CPRN. The aims are to describe (a) prevalence of CP in Norwegian children born in 1996–1998; (b) relative proportions of CP subtypes based on the SCPE classification system; (c) severity of CP; (d) occurrence of associated impairments and (e) associations between CP subtypes, severity and associated impairments on one hand and gestational age, birth weight and Apgar scores on the other.

2. Materials and methods

All Norwegian children with a diagnosis of CP born between January 1, 1996 and December 31, 1998 were eligible for registration. Data were collected between January 1, 2003 and March 31, 2006.

2.1. *Case ascertainment*

In Norway, all children with severe neurological disorders are treated in public hospitals, and each of the 20 counties has one habilitation centre caring for children with CP. All centres were invited to take part in the study providing summary and individual data. Summary data, based upon the habilitation centres' own data recording systems, were mainly the number of children with CP, including children who had died. These data were used to calculate the overall prevalence, and to validate case ascertainment. The diagnosis was confirmed when the children were at least 4 years.

The individual data were collected by a senior paediatrician in a standardised form. In principal, registration was based upon the definition and classification agreed upon by the Surveillance of Cerebral Palsy in Europe in 1999 (SCPE 2000).[1] A decision tree for inclusion and exclusion of cases and a hierarchical classification tree of CP subtypes developed by SCPE, translated into Norwegian, were distributed to each participating child neurologist in order to ensure consistency. In addition, a CD comprising a Reference and Training Manual, developed by SCPE (Krägeloh-Mann I 2003) was given to all participating professionals. The manual comprised detailed descriptions and definitions of CP and subtypes as well as videos of findings in typical cases. According to the guidelines, CP is divided into spastic, dyskinetic and ataxic subtypes. The spastic subtype is further divided into a unilateral (limbs on one side of the body are involved) and a bilateral (limbs on both sides of the body are involved) type. In this study, spastic unilateral CP was further subdivided into a right and left type depending on whether the right or left side limbs were affected (i.e. right or left hemiplegia). The spastic bilateral type was further subdivided into quadriplegia and diplegia.

2.2. *Gross and fine motor function*

Gross motor function was reported as walking and sitting ability. Walking ability was classified on a four-level scale ranging from normal walking without restrictions (level 0), walking with restrictions but without assistive devices (level 1), walking with assistive devices (level 2) and to children completely unable to walk (level 3).

Sitting ability was classified on a scale from zero to three, where zero indicated stable sitting, one indicated children sitting unstable but not in need of support, two indicated children in need of support, and three indicated children who where unable to sit even with support.

Fine motor function was described as hand function in each hand separately on a scale from zero to three. Zero indicated normal hand function, one minor motor signs, but nearly normal function, two obviously reduced function and three indicated severely reduced hand function (no useful function).

We used the recorded walking and sitting ability to assess gross motor function according to Gross Motor Function Classification System (GMFCS).[16–18] Walking ability zero or one corresponded to GMFCS levels I–II. Walking ability two corresponded to GMFCS level III. Walking ability three and sitting ability one or two corresponded to GMFCS level IV. Walking ability three and sitting ability three corresponded to GMFCS level V. Gross motor function was further dichotomised by defining GMFCS levels I–III as being "good" and GMFCS levels IV–V as being "poor" function.

We used the recorded information on hand function on each side to estimate Bimanual Fine Motor Function (BFMF) as indicated in Table 1.[13] Consistent with the dichotomisation of

Table 1 – Bimanual fine motor function estimated from recording of hand function in each hand separately

	Normal function left hand	Minor motor signs, but almost normal function in left hand	Obviously impaired function in left hand	Severely impaired function in left hand (no useful function)
Normal function right hand	BFMF I	BFMF I	BFMF II	BFMF III
Minor motor signs, but almost normal function in right hand	BFMF I	BFMF II	BFMF III	BFMF III
Obviously impaired function in right hand	BFMF II	BFMF III	BFMF IV	BFMF IV
Severely impaired function in right hand (no useful function)	BFMF III	BFMF III	BFMF IV	BFMF V

gross motor function, BFMF levels I–III was defined as "good" and BFMF levels IV–V was defined as "poor" function.

2.3. *Associated impairment*

Cognitive development was assessed by a cognitive test or by clinical judgement.

The results were described as normal (i.e. IQ level $\geqslant$85), general learning difficulties (i.e. IQ level 70–84), mildly retarded (i.e. IQ level 50–69), moderately to severely retarded (i.e. IQ level $<$50) or unknown. Mental retardation was defined as IQ below 70.

Feeding ability was classified on a scale from being independent (0), in need of some assistance (1), totally dependent on assistance (2), partly tube fed (3) to mainly tube fed (4). The presence of gastrostomy was also recorded.

Communication was recorded as verbal communication (i.e. speech), sign language and language understanding. Speech was classified on scale from zero to four where zero indicated normal speech, one indicated indistinct speech, two indicated obviously indistinct speech, three indicated severely indistinct speech difficult to understand and four indicated children without speech. For children using graphic communication, the type was recorded (writing, pictogram, pictures).

Vision was described as normal, impaired or severely impaired (i.e. no useful vision on the better eye, with correction, or when functional blindness occurred). Hearing was described as normal, impaired or severely impaired (i.e. the child considered functional deaf).

Epilepsy was defined as two unprovoked seizures, excluding febrile or neonatal seizures. Use of antiepileptic drugs was recorded and epilepsy was considered active when the child at the time of registration was taking an antiepileptic drug.

2.4. *Risk factors*

Obstetric and perinatal data were obtained from the MBRN.

2.5. *Ethics*

The study was approved by the Regional Ethical Committee (REC) for Medical Research in Mid-Norway, and by the Norwegian Data Inspectorate. The individual registration of data and the linkage of data to the MBRN required consent by the parents.

2.6. *Statistical methods*

The statistical package for social sciences (SPSS) for Windows version 12.0.1 (SPSS Inc., Chicago, IL) was used for data analysis, and a significance level of 0.05 was chosen. The χ^2-test or Fisher's exact test were used to analyse differences in proportions between groups. Correlations between severity of gross and fine motor impairment with perinatal data were analysed using Spearman's rank correlation coefficient. We used Kappa statistics to compare the classification of children with bilateral CP in being quadriplegic or diplegic with a classification of the same children based upon the severity of motor impairment in "poor" or "good". By convention, a kappa value of higher than 0.80 suggests excellent agreement, 0.60–0.80 good, 0.40–0.60 moderate, 0.20–0.40 fair and a kappa value below 0.20 suggests poor agreement.[19]

3. Results

In all, 374 children born in 1996–1998 were identified with CP corresponding to a prevalence of 2.1 per 1000 live births. Detailed data were recorded for 294 (79%) of these children, 149 (50.7%) boys and 145 (49.3%) girls. Fifteen (5%) children were born abroad and 19 (6%) had a postneonatal cause. Median age at diagnosis was 15 months (range: 0–100 months) and median age at clinical assessment was 6.9 years (range: 1.9–10.2 years).

3.1. *Subtypes of CP*

Of the 294 children, 96 (33%; 95% CI: 28–39) had the spastic unilateral CP type, 143 (49%; 95% CI: 41–53) the spastic bilateral, 19 (6%; 95% CI: 4–10) the dyskinetic and 15 (5%;

95% CI: 3–8) the ataxic type. In 21 (7%; 95% CI: 4–11), the subtype could not be classified by the referring centre. These were recorded as non-classified.

3.2. *Gross and fine motor function*

Table 2 shows gross and fine motor function. Altogether, 161 (55%) children were able to walk independently. Median age when these started to walk was 22 months (range: 10–77 months). Another 46 (16%) children were able to walk with assistive devices and the median age when they started to walk was 36 months (range: 18–80 months). Eighty-three (29%) children were unable to walk, 17 of 19 children with dyskinetic and 54 (38%) of 141 children with bilateral spastic CP.

Severely impaired gross motor function (GMFCS: IV–V) was present in 1 (1%) child with unilateral CP compared with 53 (38%) children with bilateral ($p<0.01$) and 16 (89%) of children with dyskinetic CP ($p<0.01$ vs. unilateral).

BFMF was estimated to level IV or V in 97 (35%) children. In children with spastic bilateral CP 61 (44%) had level IV or V and in children with dyskinetic CP all except one had level IV or V ($p<0.01$). Among 61 children with BFMF level I 26 (42%) had normal function in both hands. Twenty-one of these 26 children had spastic bilateral CP, all spastic diplegia.

3.3. *Risk factors*

Table 3 shows the occurrence of CP subtypes according to birth weight, gestational age and Apgar scores. Informed consent to link the child's clinical data to the MBRN was obtained for all 294 children. Gestational age (GA) was recorded in the MBRN in 236 (80%) children, birth weight (BW) in 264 (90%) and Apgar score at 1 min in 261 (89%) and at 5 min in 256 (87%) children.

3.3.1. *Gestational age*

Of all children, 124 (53%) were born at term and 28 (12%) children were born before 28 weeks of gestation. In the general Norwegian population, 93% of children were born at term, and 0.9% were born before week 28 of gestation in 1998.[20] A lower proportion, 43/116 (38%), of children with spastic bilateral CP was born at term compared with 81/120 (68%) of the other subtypes ($p<0.01$), and a higher proportion of children with dyskinetic and ataxic CP were born at term ($p<0.01$ vs. other subtypes).

Table 2 – Gross and fine motor function in 294 children with cerebral palsy

	CP subtype					
	Unilateral N (%)	Bilateral N (%)	Dyskinetic N (%)	Ataxic N (%)	Not classified N (%)	Total N (%)
Walking ability						
Walks without restrictions	3 (3)	0	0	0	1 (5)	4 (1)
Walks without assistive devices	87 (92)	52 (37)	0	12 (80)	6 (29)	157 (54)
Walks with assistive devices	4 (4)	35 (25)	2 (10)	3 (20)	3 (14)	46 (16)
Unable to walk, in need of wheelchair	1 (1)	54 (38)	17 (90)	0	11 (52)	83 (29)
Total	95 (100)	141 (100)	19 (100)	15 (100)	21 (100)	290 (100)
Sitting ability[a]						
Sits stable	88 (94)	47 (31)	0 (0)	8 (53)	7 (33)	150 (52)
Mild impairment, sits a little unstable	6 (6)	50 (33)	1 (5)	7 (47)	3 (14)	67 (23)
Sits only with support	0	39 (26)	12 (67)	0	8 (38)	49 (17)
Unable to sit, even with support	0	15 (10)	5 (28)	0	3 (14)	23 (8)
Total	94 (100)	151 (100)	18 (100)	15 (100)	21 (100)	289 (100)
GMFCS level[b]						
GMFCS 1 or 2	90 (95)	51 (36)	0	12 (80)	7 (33)	160 (55)
GMFCS 3	4 (4)	36 (26)	2 (11)	3 (20)	3 (15)	48 (17)
GMFSC 4	1 (1)	38 (27)	11 (61)	0	8 (38)	58 (20)
GMFCS 5	0	15 (11)	5 (28)	0	3 (14)	23 (8)
Total	95 (100)	140 (100)	18 (100)	15 (100)	21 (100)	289 (100)
BFMF level[c]						
BFMF level I	29 (32)	29 (21)	0	1 (8)	2 (10)	61 (21)
BFMF level II	44 (48)	39 (28)	0	7 (54)	4 (19)	94 (33)
BFMF level III	18 (20)	10 (7)	1 (5)	0	3 (14)	32 (11)
BFMF level IV	1 (1)	30 (22)	4 (21)	4 (31)	5 (24)	44 (16)
BFMF level V	0	31 (22)	14 (74)	1 (8)	7 (33)	53 (19)
Total	92 (100)	139 (100)	19 (100)	13 (100)	21 (100)	284 (100)

[a] One unilateral unknown.
[b] Gross Motor Function Classification System levels estimated from walking and sitting abilities.
[c] Bimanual Fine Motor Function levels estimated from hand function in each hand separately.

Tabel 3 – Children with CP born in Norway 1996–1998 according to CP subtype by gestational age (GA), birth weight (BW) and Apgar score

	Unilateral N (%)	Bilateral N (%)	Dyskinetic N (%)	Ataxic N (%)	Not classified N (%)	Total N (%)
GA						
GA <28 weeks	7 (10)	18 (16)	1 (6)	1 (7)	2 (5)	29 (12)
GA 28–32 weeks	6 (9)	29 (25)	1 (6)	0	3 (16)	39 (17)
GA 32–36 weeks	10 (15)	26 (22)	2 (11)	2 (15)	4 (21)	44 (19)
GA ⩾37 weeks	45 (66)	43 (38)	14 (81)	11 (79)	11 (58)	124 (53)
Total	68 (100)	116 (100)	18 (100)	14 (100)	20 (100)	236 (100)
Birthweight						
BW <1000 g	6 (7)	13 (11)	1 (6)	1 (7)	2 (10)	23 (9)
BW 1000–1499 g	10 (12)	28 (22)	1 (6)	0	2 (10)	41 (16)
BW 1500–2499 g	14 (17)	40 (32)	1 (6)	1 (7)	5 (24)	61 (23)
BW ⩾2500 g	53 (64)	45 (36)	16 (84)	13 (87)	12 (57)	139 (53)
Total	83 (100)	126 (100)	19 (100)	15 (100)	21 (100)	264 (100)
Apgar (1 min)						
Apgar 0–3	8 (10)	25 (20)	9 (50)	3 (21)	8 (40)	53 (20)
Apgar 4–6	10 (12)	34 (27)	5 (28)	1 (7)	4 (20)	54 (21)
Apgar 7–10	64 (78)	67 (53)	4 (22)	11 (73)	8 (40)	154 (59)
Total	82 (100)	126 (100)	17	15 (100)	20 (100)	261 (100)
Apgar (5 min)						
Apgar 0–3	3 (4)	11 (9)	5 (29)	1 (7)	4 (21)	24 (9)
Apgar 4–6	5 (6)	21 (17)	6 (35)	2 (13)	4 (21)	38 (15)
Apgar 7–10	74 (90)	91 (75)	6 (35)	12 (80)	11 (58)	194 (76)
Total	82 (100)	123 (100)	17 (100)	15 (100)	19 (19)	256 (100)

3.3.2. *Birth weight*

A birth weight ⩾2500 g was found in 139 (53%) children compared with 95% in the total population, and 23 (9%) had BW below 1000 g, against 0.9% in the total population.[20] A lower proportion of children with bilateral CP had birth weight ⩾2500 g compared with the other subtypes ($p<0.01$).

3.3.3. *Apgar scores*

A higher proportion of children with dyskinetic CP had low Apgar scores (0–3) at 1 and 5 min compared with all other subtypes ($p<0.05$). Among children with bilateral CP, low Apgar scores (0–3) at 1 min were more common than among children with the unilateral subtype ($p<0.05$).

Severity of impairments in gross motor function (Table 4) was not associated with gestational age or birth weight, but increased with decreasing Apgar score at 1 (Spearman's $\rho=-0.30$; $p<0.01$) and 5 min (Spearman's $\rho=-0.32$; $p<0.01$). The severity of impairments in fine motor function increased with increasing gestational age (Spearman's $\rho=0.34$; $p<0.01$) and birth weight (Spearman's $\rho=0.32$; $p<0.01$) and with decreasing Apgar score at 1 (Spearman's $\rho=-0.22$; $p<0.01$) and 5 min (Spearman's $\rho=-0.30$; $p<0.01$).

3.4. *Associated impairments (Table 5)*

Cognitive development was assessed by a cognitive test in 85 (29%) children or based upon clinical judgement in 161 (54%) children. In 28 (9%), cognitive development was unknown, in 12 (4%) children, it was not known if a test was performed and in 11 (4%) data on cognitive development were missing. Seventy-five (31%) of the children who had their cognitive development assessed were considered mentally retarded. The proportion of children with mental retardation was higher among children with spastic bilateral than among children with spastic unilateral CP ($p<0.01$).

A higher proportion of children with bilateral spastic CP had severely impaired vision compared with children with unilateral CP ($p<0.05$), whereas there were no differences between the CP subtypes in hearing impairment.

Active epilepsy was found in 18 (19%) children with unilateral CP compared with 8 (42%) with dyskinetic ($p=0.07$) and 42 (30%) children with spastic bilateral CP ($p=0.05$).

Among all children, 201 (72%) had normal or impaired, however, understandable speech. Thirty-one (11%) children communicated with the help of pictures or pictograms, but only 28 (34%) of 82 children with severely or no speech used these communication forms. In children with spastic unilateral CP, 85 (90%) had normal speech, whereas 17 of 19 with dyskinetic CP had severely impaired or no speech ($p<0.01$). However, in the latter group, language understanding was assessed as normal or only slightly impaired in 14 children.

Only one child had all of these associated impairments (i.e. mental retardation, severely impaired vision, severely impaired hearing, impaired speech and active epilepsy).

Table 4 – Severity of impairments in gross and fine motor function in children with CP by gestational age (GA), birth weight (BW) and Apgar score

	Estimated GMFCS[a]				Estimated BFMF[b]			
	I–II *N* (%)	III *N* (%)	IV–V *N* (%)	Total *N* (%)	I–II *N* (%)	III *N* (%)	IV–V *N* (%)	Total *N* (%)
GA								
GA <28 weeks	15 (54)	5 (18)	8 (29)	28 (100)	19 (70)	3 (11)	5 (19)	27 (100)
GA 28–31 weeks	17 (44)	10 (26)	12 (31)	39 (100)	24 (63)	4 (11)	10 (26)	28 (100)
GA 32–36 weeks	24 (57)	8 (19)	10 (24)	42 (100)	23 (54)	7 (16))	13 (30)	43 (100)
GA ⩾37 weeks	68 (55)	16 (13)	39 (32)	123 (100)	50 (42)	14 (12)	55 (46)	119 (100)
BW								
BW <1000 g	14 (64)	3 (14)	5 (23)	22 (100)	15 (71)	3 (14)	3 (12)	21 (100)
BW 1000–1499 g	20 (49)	11 (27)	10 (24)	41 (100)	26 (65)	4 (10)	10 (25)	40 (100)
BW 1500–2499	32 (53)	10 (17)	18 (30)	60 (100)	39 (64)	5 (8)	17 (28)	61 (100)
Vekt ⩾2500 g	79 (58)	19 (14)	39 (29)	137 (100)	58 (44)	18 (14)	57 (43)	133 (100)
Apgar (1 min)								
Apgar 0–3	16 (31)	10 (19)	26 (50)	52 (100)	17 (33)	3 (6)	31 (61)	51 (100)
Apgar 4–6	27 (51)	8 (15)	8 (34)	53 (100)	30 (57)	7 (13)	16 (30)	53 (100)
Apgar 7–10	100 (66)	25 (16)	27 (18)	152 (100)	89 (60)	20 (14)	39 (26)	148 (100)
Apgar (5 min)								
Apgar 0–3	4 (17)	5 (22)	14 (61)	23 (100)	3 (13)	1 (4)	19 (83)	23 (100)
Apgar 4–6	15 (40)	7 (18)	16 (42)	38 (100)	16 (44)	5 (11)	16 (44)	36 (100)
Apgar 7–10	123 (64)	30 (16)	38 (20)	191 (100)	114 (61)	25 (13)	49 (26)	188 (100)

[a] GA was available in 232 children, BW in 260, Apgar 1 in 257 and Apgar 5 in 252 children who had their GMFCS assessed.
[b] GA was available in 227 children, BW in 255, Apgar 1 in 252 and Apgar 5 in 247 children who had their BFMF assessed.

In contrast, 81 (28%) children had solely a motor impairment. A higher proportion of children with unilateral CP (43/96 (45%)) had motor impairment only compared with 35 (24%) of 143 children with bilateral CP ($p<0.01$), 2 (13%) of 15 children with ataxic ($p<0.05$) and 1 (5%) of 21 children with non-classified CP ($p<0.01$). No children with dyskinetic CP had motor impairment only. Sixty-six (82%) of these 81 children without associated impairment had GMFCS levels I–II, 8 (10%) had level III and 6 (7%) had level IV. An even stronger association was found for fine motor function with 71 (87%) children with BFMF levels I–II, 4 (5%) with level III and 3 (4%) with level IV.

A total of 101 (34%) children were unable to eat independently and needed help from a care taker, either for oral feeding ($N=66$), or for tube feeding partly or mainly ($N=35$). Among children with dyskinetic CP, 8 (40%) of 20 had gastrostomy, compared with 26 (19%) of 139 children with spastic bilateral CP ($p<0.05$).

There were no differences in the distribution of associated impairments by gestational age except for epilepsy being present in a higher proportion of children born at term ($p<0.01$ vs. children born <32 weeks) (data not shown).

3.5. CP subtypes

3.5.1. *Unilateral spastic CP*

Among the 96 children with unilateral spastic cerebral palsy, the extremities on the right side were affected (right-sided hemiplegia) in 52 (54%) and on the left side (left-sided hemiplegia) in 44 (46%) children. There were no major differences in right and left unilateral CP in cognitive development, speech abilities, vision, hearing, epilepsy or feeding. Fine motor function of the non-affected hand was normal in all children classified as right unilateral CP. However, in the children classified as left unilateral CP, the function in the non-affected hand was impaired in six (14%) ($p<0.05$ vs. right unilateral).

3.5.2. *Bilateral CP*

Among children with bilateral spastic CP, more severe impairments in gross motor function were associated with increasing birth weight (Fig. 1a; Spearman's $\rho=0.20$; $p<0.05$) and decreasing Apgar score at 5 min (Spearman's $\rho=-0.20$; $p<0.05$), however not with gestational age (Fig. 2a; Spearman's $\rho=0.16$; $p=0.09$) or with Apgar score at 1 min (Spearman's $\rho=-0.10$; $p=0.25$).

More severe impairments in fine motor function were associated with increasing birth weight (Fig. 1b; Spearman's $\rho=0.32$; $p<0.01$) and gestational age (Fig. 2b; Spearman's $\rho=0.34$; $p<0.01$), with decreasing Apgar score at 5 min (Spearman's $\rho=-0.20$; $p<0.05$), but not with Apgar score at 1 min (Spearman's $\rho=-0.07$; $p=0.44$).

Among children with spastic bilateral CP 25 (71%) of 35 children born before 32 weeks of gestation had normal IQ compared with 12 (34%) of 35 children born at term ($p<0.01$). Thirty-seven (84%) of 44 children born before 32 weeks had normal or only slightly impaired speech compared with 17 (40%) of 43 children born at term ($p<0.01$).

Among the children with spastic bilateral CP, 99 were diplegic and 44 were quadriplegic. Instead of using these

Table 5 – Associated impairments in 294 children with CP

	CP subtypes					
	Unilateral N (%)	Bilateral N (%)	Dyskinetic N (%)	Ataxi N (%)	Not classified N (%)	Total N (%)
Mental retardation[a]						
No	75 (89)	72 (61)	7 (47)	5 (56)	6 (43)	165 (69)
Yes	9 (11)	46 (39)	8 (53)	4 (44)	8 (57)	75 (31)
Speech						
Normal	85 (90)	78 (56)	0	9 (60)	7 (35)	179 (62)
Impaired, understandable	7 (7)	13 (9)	2 (7)	4 (27)	2 (10)	28 (10)
Severely impaired/no	2 (2)	49 (35)	17 (90)	2 (13)	11 (55)	82 (28)
Vision[b]						
Normal/impaired	91 (98)	120 (92)	19 (100)	15 (100)	16 (89)	261 (95)
Severely impaired	2 (2)	11 (8)	0	0	2 (11)	15 (5)
Hearing[c]						
Normal/impaired	90 (98)	128 (95)	17 (94)	14 (93)	19 (95)	268 (96)
Severely impaired	2 (2)	7 (5)	1 (6)	1 (7)	1 (5)	12 (4)
Active epilepsy						
No	76 (81)	96 (70)	11 (58)	11 (73)	13 (62)	207 (72)
Yes	18 (19)	42 (30)	8 (42)	4 (27)	8 (38)	80 (28)
Feeding						
Independent	87 (92)	80 (57)	1 (6)	12 (80)	7 (33)	188 (65)
Dependent	8 (8)	59 (42)	17 (94)	3 (20)	14 (67)	101 (35)
Gastrostomi						
No	89 (98)	113 (81)	12 (60)	14 (93)	16 (76)	244 (85)
Yes	2 (2)	26 (19)	8 (40)	1 (7)	5 (24)	42 (15)

[a] Mental status was unknown in 42 children, 8 of these had unilateral, 19 bilateral, 3 dyskinetic, 6 ataxic and 6 unclassified CP.
[b] Vision was unknown in 13 children, 1 had unilateral, 10 bilateral and 2 unclassified CP.
[c] There were 1 unknown in the unilateral, 8 in the bilateral and 1 in the dyskinetic group.

terms, SCPE has proposed to further describe children with bilateral CP by their gross (GMFCS) and fine (BFMF) motor abilities. According to our definition, 87 of the children with spastic bilateral CP had "good" gross motor function, 76 had "good" fine motor function, 53 had "poor" gross motor and 63 had "poor" fine motor function. Kappa values suggested good agreement in the classification of children as diplegic or quadriplegic and "good" or "poor" gross ($\kappa = 0.69$) or fine ($\kappa = 0.72$) motor function.

4. Discussion

In this study, we found that the prevalence of CP as well as the proportions of subtypes and severity were essentially the same as in other populations.[1,2,7,9,12] However, fine motor function may be more severely impaired and associated impairments may be more common in Norway than in some other populations.[7,14,15] The different proportions of dyskinetic CP reported in other studies are probably due to differences in classification. The severity of gross motor function was not associated with gestational age or birth weight. In contrast, the severity of fine motor impairment increased with increasing gestational age and birth weight. The impairments of both fine and gross motor function increased with decreasing Apgar scores.

To standardise the recordings as much as possible, the reporting clinicians were thoroughly informed of the SCPE guidelines on definition and subclassification in a number of meetings and by receiving the R&T Manual. It may thus be considered a strength of the study that the assessments of the children were done by these clinicians who themselves examined the patients. The prospective recording of perinatal data is another strength of the study making information or recall bias unlikely. It may be considered a limitation of the study that we received individual data on only 79% of the children. However, only six (2%) parents refused to let details of their child be recorded. Lack of data was mainly (67%) due to poor response from 4 of the 20 counties. Thus, selection bias is less likely and we consider the data on distribution of subtypes and severity to be representative of the total CP population in Norway.

The prevalence of CP has been reported to vary between 1.5 and 3 per 1000 live borns, and our results are consistent with this.[1,2,7,9,12] Due to the public and homogenous organisation of the care for handicapped children in Norway, we consider the ascertainment of cases to be complete, however, we cannot rule out that we have missed a few cases.

The proportion of children with various subtypes of CP in this study was essentially similar to the proportions reported in other studies.[7,12,14,21]

In children with unilateral spastic CP it may be noteworthy that children with paresis of the left side more often than

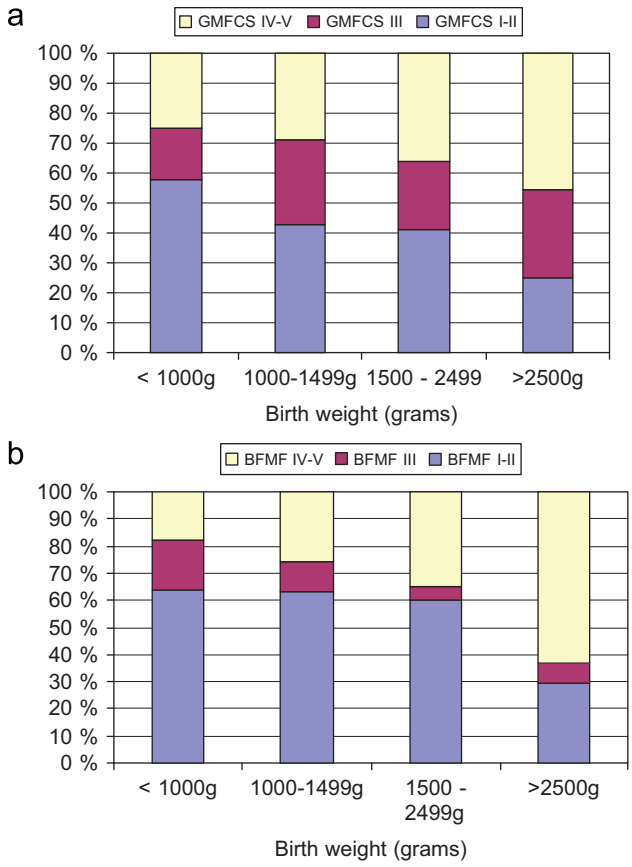

Fig. 1 – Severity of CP and birth weight. (a) Gross motor function classification (GMFCS) and birth weight (grams) in children with spastic bilateral CP. Birth weight is shown in four categories on the *x*-axis. The *y*-axis shows percent of children with estimated GMFCS levels I–II (less severe impairment), III (intermediate impairment) and IV–V (most severe impairment). (b) Bimanual fine motor function (BFMF) and birth weight (grams) in children with spastic bilateral CP. Birth weight is shown in four categories on the *x*-axis. The *y*-axis shows percent of children with estimated BFMF levels I–II (less severe impairment), III (intermediate impairment) and IV–V (most severe impairment).

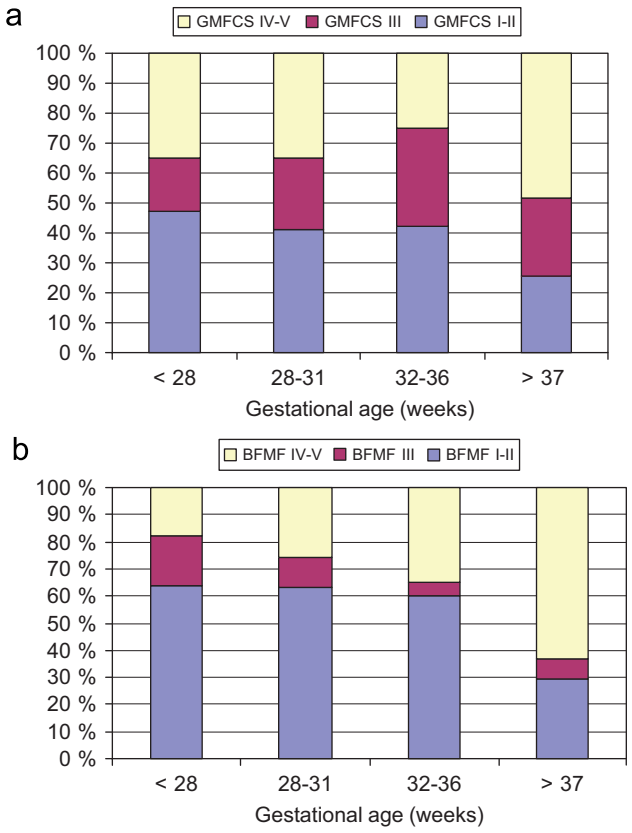

Fig. 2 – Severity of CP and gestational age. (a) Gross motor function classification (GMFCS) and gestational age (GA) in children with spastic bilateral CP. Gestational age is shown in four categories on the *x*-axis. The *y*-axis shows percent of children with estimated GMFCS levels I–II (less severe impairment), III (intermediate impairment) and IV–V (most severe impairment). (b) Bimanual fine motor function (BFMF) and gestational age (GA) in children with spastic bilateral CP. Gestational age is shown in four categories on the *x*-axis: $<$28, 28–31, 32–36 and $\geqslant$37 weeks. The *y*-axis shows percentage of children with estimated BFMF levels I–II (less severe impairment), III (intermediate impairment) and IV–V (most severe impairment).

children with paresis of the right side had impaired hand function on the non-affected side. Other authors have also reported that children with hemiplegia may have impairment in bimanual coordination beyond their unilateral impairments, although they did not report differences between paresis on the left- and the right side.[22] It may thus be questioned whether such children should indeed have been classified as bilateral CP; however, impairments of the non-affected side were mild in our study.

Children with bilateral spastic CP were further characterised by the severity of motor impairments and by using the traditional diagnoses of diplegia and quadriplegia. When we compared these two different ways of characterising children with bilateral CP, we found good agreement in the classification of children with less severe motor impairments (i.e. GMFCS or BFMF levels I–III) and diplegia, and between those with more severe motor impairments (i.e. GMFCS or BFMF levels IV–V) and quadriplegia. However, the proportion of children with quadriplegic CP in our study (15%) was lower than reported in one study from Australia (32%),[12] whereas it was higher than in two studies from western Sweden (6% and 10%, respectively).[7,9]

That different classifications explain the different proportions of quadriplegic and dyskinetic cases is also supported by the differences in proportions of unclassified cases, which was 7% in our compared with none in the Swedish studies.[6,9,11] Moreover, the children with non-classified CP in our study had gross and fine motor function and occurrence of associated impairments similar to children with spastic bilateral or dyskinetic CP. It is therefore likely that some of the children in the unclassified group are children with dyskinetic CP *and* spasticity, and that the reporting clinician had difficulties in deciding on the most dominating symptom in cases of mixed forms. Thus, our results suggest that the

discrimination between these two subtypes as proposed by SCPE is still a challenge to clinicians.

Only 8% of the children were not able to walk or to sit even with support, assessed as GMFCS V in our study. Other studies have reported higher proportions of children with GMFCS level V.[9,11,12]

Few studies have so far described fine motor function using BFMF. We found a somewhat higher proportion (35%) of children with BFMF levels IV and V than the 26% reported by Himmelmann et al.[7] This may mainly be due to differences in the recording of the data, since BFMF levels in our study were estimated from descriptions of fine motor function in each hand separately, whereas in the study of Himmelmann et al.,[7] the reporting physicians estimated BFMF levels directly. Moreover, our children were born in 1996–1998 while Himmelmann et al. covered the birth years 1991–1998.[7]

In the present study, the proportion of children without any associated impairment was 28%. Himmelmann et al.[7] reported 48% of children with CP to be without associated impairment; however, they did not include speech impairment. When we excluded speech impairments, we found that 34% of the children had no associated impairment, which is still lower than reported by Himmelmann et al.[7]

There are few reports on speech abilities and language understanding in children with CP. However, the proportion (28%) of children with severely impaired or no speech in our study was higher than the 20% reported in two previous studies.[14,15] Eleven percent of the children used graphic communication, a higher proportion than reported by Chan et al. (3%).[14] The age of the children and the distribution of subtypes is very similar to Chan, but in their study, parents were the informants, in contrast to health professionals in our study. Whereas health professionals may report children who have the necessary equipment, however using this equipment only in specific training sessions, parents are likely to report daily *use* of communication aids.[23] This may in part explain the differences. The severity of associated impairments increased with increasing gross and fine motor impairment, as observed by Himmelmann et al.[7]

Although children born before week 28 of gestation had a substantial increased risk of getting CP, they comprised only 12% of the total CP population. The major part of children with CP was born at term, consistent with most other studies.[11,21,24,27] However, a Swedish study reported that only 35% of children with CP born between 1991 and 1993 were born at term.[9]

More severe impairments in both fine and gross motor function were associated with low Apgar scores, consistent with Moster et al.[28] However, whether severe perinatal stress is the cause, or whether newborns with more severe brain damage tolerate the stress of birth less well, cannot be answered in this study. Moreover, the severity of gross motor impairment was not associated with gestational age or birth weight, whereas severity of fine motor impairment increased with increasing gestational age and birth weight. These findings could be due to variations in the timing and mechanisms of the insult leading to different subtypes of CP with different degrees of severity. However, similar results were observed when we restricted the analyses to children with bilateral CP. The findings may therefore, at least partly, be explained by the hypothesis of selective vulnerability of the periventricular regions of the brain in the 24–34 weeks of pregnancy (watershed areas), and by assuming that children with CP born prematurely have an injury to the brain limited to these areas and therefore have better gross and fine motor function and lesser degree of associative impairments.[25,26] The children with bilateral CP born at term with evidence of a peri- or neonatal hypoxic ischemic event, however, are at risk of more extensive brain injury including the grey matter, cortex and central nuclei and therefore more severe CP involving both upper and lower limbs.[25,26] Our results may thus be consistent with the current opinion that both perinatal stress as well as the timing of an insult play significant roles in determining the severity of impairments in motor function.[29]

We found no differences in the distribution of associated impairments by gestational age except for epilepsy being present in a higher proportion of children born at term. Also Himmelmann et al.[7] found that a higher proportion of children born at term had epilepsy, however, they found that children born <28 weeks of gestation had the highest proportion of all other accompanying impairments. However, when we restricted the analyses to children with the spastic bilateral subtype, we found that more children born at term had mental retardation and severely affected communicative abilities than children born <32 weeks of gestation, and that more severe gross and fine motor function impairment indicated increasing degree of severity of associative impairments. Again, this may be explained by different vulnerability of the immature and the mature brain.[25,26]

In conclusion, the prevalence of CP in Norway as well as the proportions of subtypes and severity were essentially the same as in other populations.[1,2,7,9,12] However, fine motor function may be more severely impaired and associated impairments more common in Norway than in some other populations.[7,14,15] The severity of gross motor function was associated with low Apgar score at 1 and 5 min but not with gestational age or birth weight. In contrast, the severity of fine motor impairment increased with increasing gestational age and birth weight, and with decreasing Apgar score at 1 and 5 min.

The classification of CP proposed by SCPE, supplemented by a description of gross and fine motor function, was a useful tool for recording and describing the panorama of CP in Norway, but the classification of children with mixed forms remains a challenge.

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