Cerebral palsy (CP) is the most common physical disability in children, affecting approximately 2 per 1000 live births.\(^1,2\) In addition to motor impairment, the condition might affect sensation, perception, behaviour, communication, and cognition.\(^3\) Children with CP are at risk of developing problems with speech, language, and communication, including pragmatic ability.\(^4,5\) The physical disability can cause dysarthria, which limits the intelligibility of speech and may affect the ability to communicate via facial expressions and body language. A cognitive concurrent impairment will negatively affect language development,\(^4\) and is considered to be the strongest predictor of receptive language ability.\(^5\) Children with CP and communication impairments risk acquiring a passive role in communication, where the speaking partner takes responsibility for the conversation.\(^7\) In recent studies, about 50% of children with CP have been estimated to have some form of speech problems, and approximately 25% are classified as non-speaking.\(^8\)

Children with severe speech, language, and communication difficulties can use augmentative and alternative communication (AAC). Communication books, boards, and speech-generating devices are examples of aided AAC methods that may be considered. Unaided methods include manual signs, sounds, eye gaze, facial expressions, and pointing. The communication method chosen is influenced by the child’s motor, cognitive, and perception skills.\(^9\) In studies from different countries the percentages of children who use AAC methods varies between 32% and 54%.\(^8,10,11\)

For describing a child’s receptive and expressive communication ability, Virella et al.\(^12\) recommended the use of the Communication Function Classification System (CFCS).\(^13\) The CFCS focuses on activity and participation in everyday life and classifies children’s ability to communicate with familiar and unfamiliar partners.\(^13\) The CFCS consists of five levels, from level I (effective communication with all partners) to level V (seldom effective communication even with familiar partners; Table 1). Further, information about communication methods are provided using the categories: ‘speech’; unaided AAC such as ‘sounds’, ‘eye gaze, facial expressions, gesturing, and/or pointing’, and ‘manual signs’; or aided, such as ‘communication book, boards, and/or pictures’, ‘voice output device or a speech-generating device’, and ‘other’.

The CFCS is validated for children with CP aged 2 to 18 years and tested for reliability in several languages, indicating that the CFCS can be used as a reliable tool to classify the communication ability of children with CP.\(^10,11,13,14\) However, the inter-rater reliability is lower for children under the age of 4 years.\(^13\) Familiarity with
The Cerebral Palsy Surveillance Program (CPUP) is a Swedish national CP registry. More than 95% of the total population of children with CP are included, receiving regular follow-ups by local habilitation centres.\textsuperscript{22} As of 2017, 3773 children aged 0 to 18 years were registered.\textsuperscript{23} The aim of the CPUP was initially to prevent severe contractures and hip dislocations in children. Today, the CPUP includes data concerning, for example, gross motor function (GMFCS), fine motor function (mini-MACS or MACS), and communication ability (CFCS), the latter included in the CPUP since 2014.\textsuperscript{24} CPUP aims to increase knowledge about CP and improve collaboration between professions.\textsuperscript{22} CFCS level and communication methods are noted in the occupational therapy medical record form, with the recommendation to consult the speech language pathologist in classifying the CFCS level and communication methods of the child.\textsuperscript{25}

However, there is limited knowledge about the relationship between the child’s communication ability and the communication methods used, as well as about the relationship to age, sex, gross motor function, and manual ability. To plan and implement interventions it would be of interest to know if and how these variables interact.

The aim of this study, as shown in the data from the CFCS registry, was to investigate if communicative ability and communication method vary significantly with age, sex, gross motor function, or manual ability in children with CP.

### Method

This cross-sectional registry study was based on data reported to the CPUP. Data that were used and recorded by local occupational therapists, physiotherapists, or speech language pathologists in cooperation with the child or parent were used in the present study. Information from the CPUP concerning CFCS level I to V, communication method, MACS level I to V, mini-MACS level I to V, GMFCS level I to V, age, and sex were provided by the registry holder and data from the child’s most recent CFCS registration, year 2015 or 2016, were used.

### Participants

A total of 3000 children aged 0 to 18 years (1739 males, 1250 females and 11 children without a sex registration) had a CFCS classification noted in the CPUP and were included in the study. Of these, 2771 children had one or more communication method noted.

### Procedure

The children were divided into age groups: 0 to 3 years (toddler), 4 to 6 years (preschooler), 7 to 12 years (school-aged child), and 13 to 18 years (adolescent). The communication methods were analysed using the categories: ‘speech’, ‘sounds’, ‘eye gaze, facial expressions, gesturing, and/or pointing’, ‘manual signs’, ‘communication book, boards, and/or pictures’, ‘voice output device or a speech-generating device’, and ‘other’. Comparable to the most widely used classification, the AAC methods were divided

### Table 1: The five levels of the Communication Function Classification System (CFCS), Gross Motor Function Classification System (GMFCS), and the Manual Ability Classification System (MACS)

| Level | CFCS | GMFCS | MACS |
|-------|------|-------|------|
| I     | Effective sender and receiver with unfamiliar and familiar partners | Walks without limitations | Handles objects easily and successfully |
| II    | Effective but slower paced sender and/or receiver with unfamiliar and/or familiar partners | Walks with limitations | Handles most objects with somewhat reduced quality and/or speed of achievement |
| III   | Effective sender and receiver with familiar partners | Walks using a handheld mobility device | Handles objects with difficulty; needs help to prepare and/or modify activities |
| IV    | Inconsistent sender and/or receiver with familiar partners | Self-mobility with limitations; may use powered mobility | Handles a limited selection of easily managed objects in adopted situations |
| V     | Seldom effective sender and receiver even with familiar partners | Transported in a manual wheelchair | Does not handle objects and has severely limited ability to perform even simple actions |

Adapted from Hidecker et al.\textsuperscript{13}
into unaided (‘sounds’, ‘eye gaze, facial expressions, gesturing, and/or pointing’, ‘manual signs’) and aided AAC (‘communication book, boards, and/or pictures’, ‘voice output device or a speech-generating device’). 9

### Statistical analysis

Data were analysed in SPSS Statistics version 24 (IBM, Armonk, NY, USA). Pearson’s $\chi^2$ test was used to test the significance of the associations between communication method and age group, sex, and levels of CFCS, MACS, and GMFCS. Spearman’s correlation ($r_s$) was used to analyse the correlations between CFCS and MACS and GMFCS levels, between presence of speech and CFCS, and between speech and age group. A $p<0.05$ was considered significant for all analyses.

### Ethics

The CPUP is a voluntary consent registry. The caregivers or patients are free to leave the registry and have their data deleted. The Research Ethics Committee at Lund University approved the study (LU-443-99). The data files received from CPUP were anonymized by the registry holder.

### RESULTS

#### Communication ability and communication methods

The distribution of children in relation to CFCS level and age group is reported in Table 2. Of the children, 45.0% were classified as effective senders and receivers with both unfamiliar and familiar partners.

The communication methods were distributed and used across all CFCS levels (Table 3). The most common method was speech, used by 72.2%. Sounds and eye gaze, facial expressions, gesturing, and/or pointing were also commonly noted, used by about a third of the children. In addition, manual signs were used by 9.9%. The aided communication methods used, exclusively or in combination, were communication books, boards, or pictures (11.0%), and voice output or speech-generating devices (3.0%). These were frequently used in combination with unaided methods. Four per cent had ‘other’ noted as the communication method. In this category, for example Bliss symbolics, iPads/tablets, writing, whistles, objects, and eye-controlled computers were found. iPad and Bliss symbolics, both defined as aided methods, were most commonly mentioned. Of the 2001 children who used speech, 1542 (55.6% of the total population) used speech as their only communication method. Sounds and/or eye gaze, facial expressions, gesturing, and pointing were the only communication methods used by 424 children (15.3% of total population).

A statistically significant association was found between CFCS level and the use of speech ($\chi^2$ [df 4, $n=2771$] = 1493.18; $p<0.001$), with presence of speech more frequent among the more functional levels of CFCS, as indicated by the statistically significant correlation ($r_s$ [df 2770] = 0.764; $p<0.01$). There were also significant associations between use of sounds and CFCS level ($\chi^2$ [df 4, $n=2771$] = 1307.69; $p<0.001$), as well as between eye gaze, facial expressions, gesturing, and/or pointing ($\chi^2$ [df 4, $n=2771$] = 1078.79; $p<0.001$).

#### Age

The distribution of children in relation to age group and CFCS level is reported in Table 2. There was a significant relationship between age group and CFCS level ($\chi^2$ [df 12, $n=3000$] = 98.43; $p<0.001$). The CFCS levels in the 0 to 3 years age group were evenly distributed across levels I, IV, and V, with only a few at levels II and III. In the older age groups, CFCS level I was most commonly noted.

### Table 2: Distribution of the Communication Function Classification System (CFCS), Gross Motor Function Classification System (GMFCS), and the Manual Ability Classification System (MACS) levels in different age groups

| Level | Instrument | Age group (y) | 0-3 | 4-6 | 7-12 | 13-18 | Row totals |
|-------|------------|---------------|-----|-----|------|-------|------------|
|       |            | n            | %  | n   | %    | n    | %     | n          | %   |
| I     | CFCS       | 72           | 22.9 | 277 | 41.9 | 621  | 49.8  | 1350       | 45.0 |
| II    |            | 36           | 11.5 | 87  | 13.2 | 148  | 11.9  | 355        | 11.8 |
| III   |            | 58           | 18.5 | 99  | 14.9 | 124  | 10.0  | 371        | 12.4 |
| IV    |            | 72           | 22.9 | 93  | 14.1 | 157  | 12.6  | 436        | 14.5 |
| V     | GMFCS      | 76           | 24.2 | 105 | 15.9 | 196  | 15.7  | 488        | 16.3 |
| I     |            | 119          | 38.1 | 309 | 46.8 | 549  | 44.1  | 1271       | 42.5 |
| II    |            | 42           | 13.5 | 102 | 15.5 | 218  | 17.5  | 504        | 16.9 |
| III   |            | 38           | 12.2 | 69  | 10.5 | 105  | 8.4   | 283        | 9.5  |
| IV    |            | 57           | 18.3 | 90  | 13.6 | 191  | 15.4  | 463        | 15.5 |
| V     | MACS       | 56           | 17.9 | 90  | 13.6 | 181  | 14.5  | 470        | 15.7 |
| I     |            | 59           | 19.0 | 210 | 32.1 | 431  | 34.8  | 927        | 31.2 |
| II    |            | 101          | 32.6 | 173 | 26.5 | 308  | 24.9  | 759        | 25.5 |
| III   |            | 42           | 13.5 | 104 | 15.9 | 168  | 13.5  | 451        | 15.2 |
| IV    |            | 43           | 13.9 | 70  | 10.7 | 132  | 10.7  | 352        | 11.8 |
| V     |            | 65           | 21.0 | 97  | 14.8 | 199  | 16.1  | 485        | 16.3 |

Communication Ability in Children with CP Emma Kristoffersson et al. 935
The distribution of level of GMFCS and MACS in relation to age group is presented in Table 2. The CFCS level correlated strongly and positively with GMFCS ($r_s$ [df 2991]=0.719; $p<0.001$) and with MACS level ($r_s$ [df 2974]=0.766; $p<0.001$). The different communication methods were spread and used across all levels of both GMFCS and MACS. Like with CFCS level, correlation analyses showed a positive relationship between speech and GMFCS and MACS level of the child ($r_s$ [df 2868]=0.605; $p<0.001$ and $r_s$ [df 2853]=0.617; $p<0.001$ respectively).

**DISCUSSION**

This study adds support to previous research suggesting that children with CP are at a high risk of developing communication problems. The results demonstrate a relationship between communication ability and communication method. The more functional CFCS level, the more likely the child was to use speech as a communication method. Children at less functional CFCS levels were more likely to use sounds, eye gaze, facial expressions, gesturing, and/or pointing. This is in accordance with previous research, as is the total percentage of children who used speech or were considered non-speaking. However, the results concerning the relationship between aided AAC, manual signs, and communication ability were not as clear, as these AAC methods were often used in combination with other communication methods and spread across all CFCS levels.

Of the children, 45% were classified as effective senders and receivers with both unfamiliar and familiar partners. This indicates that 55% were not fully effective communicators. The lack of access to aided AAC and manual signs for children with CP and communication impairment was discussed in a Norwegian study, where the results indicated that about 40% of the children who needed these AAC methods had no access to them. Research has shown the importance of introducing aided AAC and manual signs early when a delay is noted, regardless of the child's development of age or communication ability. In this study, older children used aided communication to a higher extent than younger children. At the same time the

### Table 3: Distribution of Communication Function Classification System (CFCS) level and communication method

| CFCS level | I | II | III | IV | V |
|------------|---|----|-----|----|----|
| n | % | n | % | n | % | n | % | n | % |
| Speech | 1218 | 90.2 | 324 | 91.3 | 282 | 76.0 | 157 | 36.0 | 20 | 4.1 |
| Sounds | 66 | 4.9 | 70 | 19.7 | 167 | 50.4 | 356 | 81.7 | 258 | 52.9 |
| Eye gaze, facial expressions, gesturing, pointing | 74 | 5.4 | 67 | 18.9 | 201 | 54.2 | 339 | 77.8 | 122 | 25.5 |
| Communication book, boards, pictures | 5 | 0.4 | 16 | 4.5 | 78 | 21.0 | 149 | 34.2 | 57 | 11.7 |
| Manual signs | 9 | 0.7 | 31 | 8.7 | 97 | 26.1 | 122 | 28.0 | 16 | 3.3 |
| Voice output device, speech-generating device | 3 | 0.2 | 5 | 1.4 | 24 | 6.5 | 41 | 9.4 | 11 | 2.3 |
| Other | 4 | 0.3 | 9 | 2.5 | 23 | 6.2 | 32 | 7.3 | 44 | 9.0 |

Note that each child may be included in more than one category. Total number of children is 2771. ‘Other’ category based on raw data.

### Table 4: Distribution of communication method in different age groups

| Communication method | 0–3 | 4–6 | 7–12 | 13–18 | n | % |
|----------------------|-----|-----|------|-------|---|---|
| Speech               | 160 | 56.5 | 455 | 74.1 | 855 | 74.5 | 531 | 73.0 |
| Sounds               | 186 | 65.7 | 240 | 39.1 | 360 | 31.4 | 234 | 32.2 |
| Eye gaze, facial expressions, gesturing, pointing | 149 | 52.7 | 215 | 35.0 | 349 | 30.4 | 227 | 31.2 |
| Communication book, boards, pictures | 12 | 4.2 | 55 | 9.0 | 134 | 11.7 | 104 | 14.3 |
| Manual signs         | 31 | 11.0 | 69 | 11.2 | 104 | 9.1 | 71 | 9.8 |
| Voice output device, speech-generating device | 2 | 0.7 | 11 | 1.8 | 41 | 3.6 | 30 | 4.1 |
| Other                | 8 | 2.8 | 25 | 4.1 | 48 | 4.2 | 31 | 4.3 |

Total number of children 2771. ‘Other’ category based on raw data.

Statistical significances were found between the use of communication boards and age groups ($\chi^2$ [df 3, $n=2771$] =25.42; $p<0.001$), and speech devices and age groups ($\chi^2$ [df 3, $n=2771$]=14.21; $p=0.027$), where more of the older children used these AAC methods than the younger children. In the 0 to 3 years age group, 0.7% of the children used a speech device, 4.2% a communication board, and 11.0% manual signs. A correlation analysis showed a positive relationship between the use of speech and age group ($r_s$ [df 2880]=0.119; $p<0.001$). In the youngest age group, 56.5% used speech versus ≥73.0% in the older age groups (Table 4). There was no statistical relationship between age groups and use of manual signs ($\chi^2$ [df 3, $n=2771$] =2.48; $p=0.479$).

### Sex

No significant results were found concerning CFCS level and sex ($\chi^2$ [df 4, $n=2989$]=0.95; $p=0.917$), or communication method and sex ($\chi^2$ [df 8, $n=2764$]=10.8; $p=0.211$).

### Gross motor function and manual ability

The distribution of level of GMFCS and MACS in relation to age group is presented in Table 2. The CFCS level correlated strongly and positively with GMFCS ($r_s$ [df 2991]=0.719; $p<0.001$) and with MACS level ($r_s$ [df 2974]=0.766; $p<0.001$). The different communication methods were spread and used across all levels of both GMFCS and MACS. Like with CFCS level, correlation analyses showed a positive relationship between speech and GMFCS and MACS level of the child ($r_s$ [df 2868]=0.605; $p<0.001$ and $r_s$ [df 2853]=0.617; $p<0.001$ respectively).
younger children were generally classified at a less functional CFCS level, i.e. they were seen as less effective communicators. These results indicate that many of the children in the study probably would have benefited from access to aided communication methods and manual signs earlier in life.

An unexpected result was that all communication methods were used across all MACS levels. This included manual signs, an AAC method highly dependent on manual ability. However, there was no specific information about the quantity or quality of the manual signs used. A previous study concluded that manual signs were indistinctly used by 56% of the children with CP who relied on them as their communication method. The study discussed if other AAC methods, less dependent on manual ability, would be more appropriate. Recent research has concluded that it is beneficial for the child’s development to use several AAC methods in combination (i.e. multimodal communication). Children with CP who only use manual signs would probably benefit from using aided AAC methods as well, but manual signs can still be introduced to and used by children with reduced manual ability.

The relationship between CFCS level and communication method causes concerns regarding the classifications made using CFCS. According to the descriptions of the CFCS levels in the manual, it seems unlikely that a child who uses only sounds, eye gaze, facial expressions, gesturing, and/or pointing is in CFCS level I. This alternative was noted for several children and were probably either registration errors or misinterpretations of the CFCS instructions.

Another weakness with the CFCS classification in this study is the interpretation of which and how many communication methods a child is using. Numerous children had more than one method noted, which is in accordance with the manual. However, this instruction seems to have been missed by many, who registered according to the communication method mostly preferred instead of all methods used. Also, although communication board and speech-generating devices have their own box to tick, these alternatives were more than once mentioned under ‘other’.

The inter-rater reliability of the CFCS has been considered high in previous studies. However, some of these studies concluded that the inter-rater reliability was high when two professionals were involved, but moderate when a professional and a parent did the rating. When developing the CFCS, it was also concluded that the inter-rater reliability was lower for children younger than 4 years of age. Of the children in the current study, 314 (10.5%) were younger than 4 years of age. Furthermore, CFCS is a fairly new system in the CPUP. The results of the present study confirm that it is harder to classify younger children. The CFCS levels in the group of children aged 0 to 3 years spread mainly between level I, IV, and V, unlike in the older age groups, where level I was most commonly noted, as expected. More surprising was the high number of children who were classified in CFCS level I at a time when children are considered to be in the beginning of their language development. In addition, some of the professionals seem to have misinterpreted the CFCS manual and noted children with no speech in CFCS level I, commenting that this was due to their young age, while research indicates that a 12-month-old with typically developing communication skills would be classified in CFCS level IV and a 48-month-old in CFCS level I. In the same study, it was concluded that over-rating younger children was a common mistake and that the number of correct classifications in the CFCS could be increased with an educational intervention in using the tool. The results in this study indicate a need for an educational intervention for some CPUP raters, with the aim of improving the understanding of the CFCS.

A weakness in the present study is that the CPUP does not include the amount of AAC intervention the child receives. Another limitation is that no CFCS users were interviewed to determine any perceived inconsistencies in the results.

Cognitive impairment is a strong predictor of communicative ability in children with CP. However, this was not a parameter researched in the current study. Cognitive function was recently added to the CPUP register, and in future research it would be of interest to study the relationship between communication ability, communication methods, and cognitive functions. Future studies are needed to explore the relationship between communicative ability and CP subtypes. Furthermore, longitudinal studies are needed to better capture the development of the relationship between communicative ability and communication method.

CONCLUSION

Given the high ratio of children who are registered in the CPUP database, our population is likely representative of children with CP in countries similar to Sweden. In summary, this study indicates the need for educational interventions for some raters who may need clarification on their interpretations of CFCS. More explicit instructions might be needed for the CFCS manual, particularly for classifying younger children. Reliable data on communication ability would be beneficial in providing children in need of AAC with adequate communication methods. The results indicate that children with CP should be presented to aided AAC and manual signs earlier and to a greater extent.

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CAPACIDAD DE COMUNICACIÓN Y MÉTODOS DE COMUNICACIÓN EN NIÑOS CON PARALÍSIS CEREBRAL

OBJETIVO
Investigar si la capacidad y el método de comunicación estaban relacionados entre sí y con la edad, el sexo, la función motora gruesa o la capacidad manual en niños con parálisis cerebral.

MÉTODO
Este estudio transversal utilizó datos registrados en el registro del Programa Sueco de Vigilancia de la Parálisis Cerebral, en el que participaron 3000 niños de 0 a 18 años. La prueba χ² de Pearson y la correlación de Spearman se usaron para probar las asociaciones entre variables.

RESULTADOS
La capacidad y el método de comunicación se relacionaron entre sí y con la edad, la función motora gruesa y la capacidad manual. Los métodos de comunicación asistida se utilizaron con mayor frecuencia entre los niños mayores. Cuanto más funcional era la comunicación, menos uso de la comunicación sin ayuda ocurrió. Se utilizaron diferentes métodos de comunicación en todos los niveles del Sistema de clasificación de funciones de comunicación (CFCS). El habla fue más común en los niveles más funcionales, utilizado por el 72% de los niños. Cuarenta y cinco por ciento fueron considerados comunicadores efectivos en todos los entornos. Para la clasificación del nivel y método de comunicación, los evaluadores cometieron algunos errores de registro recurrentes.

INTERPRETACIÓN
Algunos evaluadores pueden necesitar aclaraciones sobre las interpretaciones de las instrucciones de CFCS. Los resultados indican que los niños deben presentarse a la comunicación aumentativa y alternativa asistida y a los signos manuales antes y en mayor medida.

CAPACIDADE DE COMUNICAÇÃO E MÉTODOS DE COMUNICAÇÃO EM CRIANÇAS COM PARALISIA CEREBRAL

OBJETIVO
Investigar se a capacidade e os métodos de comunicação são relacionados um ao outro, e a idade, sexo, função motora grossa, ou habilidade manual em crianças com paralisia cerebral.

MÉTODO
Este estudo transversal usou dados registrados no registro do Programa Sueco de Acompanhamento da Paralisia Cerebral, envolvendo 3000 crianças com idades de 0 a 18 anos. Testes χ² de Pearson e correlações de Spearman foram usados para testar associações entre as variáveis.

RESULTADOS
A capacidade e o método de comunicação foram relacionados um ao outro, e também à idade, função motora grossa, e habilidade manual. Métodos de comunicação com auxílio foram mais frequentemente usados entre crianças mais velhas. Quanto mais funcional era a comunicação, menos uso de comunicação sem auxílio ocorreu. Diferentes métodos de comunicação foram usados ao longo dos níveis do Sistema de Classificação da Função da Comunicação (CFCS). A fala foi mais comum nos níveis mais funcionais, usada por 72% das crianças. Quarenta e cinco por cento eram considerados comunicadores efetivos em todos os ambientes. Para a classificação do nível e método de comunicação, alguns erros de registro recorrentes foram observados entre os examinadores.

INTERPRETAÇÃO
Alguns examinadores podem precisar de esclarecimento quanto à interpretação das instruções do CFCS. Os resultados indicam que as crianças devem ser apresentadas a comunicação aumentada e alternativa, e a sinais manuais precocemente, e em maior escala.