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RESEARCH ARTICLE

Self-care and hand function in preschool children with unilateral or bilateral cerebral palsy: A cross-sectional study

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Abstract

Aims: To describe self-care capabilities among children with cerebral palsy (CP) and explore associations between self-care and hand function for children with unilateral cerebral palsy (UCP) and children with bilateral cerebral palsy (BCP) separately.

Method: Cross-sectional data on self-care capabilities (Pediatric Evaluation of Disability Inventory, PEDI), manual abilities (Manual Ability Classification System, MACS) and hand use during bimanual performance (Assisting Hand Assessment, AHA; Both Hands Assessment, BoHA) were retrieved from the Norwegian Quality and Surveillance Registry for Cerebral Palsy (NorCP). Eighty-seven children with CP (UCP, $n = 61$, mean age 4 years 1 month, SD 1 year 3 months, range 56) or BCP ($n = 26$, mean age 4 years 4 months, SD 1 year, range 41), classified at MACS level I ($n = 26$), II ($n = 40$) or III ($n = 21$), were included.

Results: No significant differences in self-care capabilities were found between children with UCP and children with BCP. Analysis of variance showed significant differences in self-care between MACS levels for the whole group. No significant differences in self-care between MACS levels were observed for children with UCP ($p = 0.36$), but significant differences were found for those with BCP ($p < 0.001$). Whereas a small correlation ($r = 0.3$) between PEDI and AHA scores was found for children with UCP, a large correlation ($r = 0.6$) was found for those with BCP. Children with BCP with symmetric hand use during bimanual performance (BoHA) had higher PEDI scores than children with asymmetric hand use.

Conclusion: Though children with UCP and children with BCP who were classified at MACS I–III exhibited similar self-care capabilities, the limited hand use seems to contribute differently between the two groups. The two different measures of hand use exhibit different associations with self-care capabilities for young children with UCP and BCP, respectively, and illustrate the need to treat UCP and BCP as two distinct groups, each requiring tailored interventions according to their specific needs.

KEYWORDS
bimanual performance, capabilities, cerebral palsy, children, hand function, manual abilities, self-care

1 | INTRODUCTION

Self-care activities are among the first activities of daily living (ADL) that children achieve, and most such activities are bimanual by nature (Eliasson, 2005; Henderson, 2006; Henderson & Eliasson, 2008). Self-care capability is a key component of independence, enables participation in everyday activities and may enhance self-esteem and self-confidence during childhood (Henderson, 2006; Henderson & Eliasson, 2008).

Cerebral palsy (CP) is the most common cause of permanent physical disability in children and may affect one side of the body (unilateral CP; UCP) or both sides (bilateral CP; BCP) (McIntyre et al., 2022). Children with CP often experience difficulties in the acquisition of self-care skills due to complex motor limitations and additional challenges such as impaired cognition, visual impairment and epilepsy (Burgess et al., 2019, 2021; Öhrvall et al., 2010; Østensjø et al., 2003; Stadskleiv et al., 2018). Approximately 80% of children with CP experience limited hand function (Arner et al., 2008; Imms et al., 2009; Klevberg et al., 2017). Individuals with CP form a heterogeneous group whose self-care capabilities range from complete independence in all ADL to full dependence on assistance for all everyday activities (Burgess et al., 2019; Öhrvall et al., 2010).

The five-level Manual Ability Classification System (MACS) is used for categorizing different levels of manual abilities (the overall ability to handle age-relevant objects, not each hand separately) in children with CP. MACS level I represents independent handling of objects with only slight disturbances, whereas level V indicates a profoundly limited ability to voluntarily handle objects (Eliasson et al., 2006). Although children with UCP are generally more capable of performing self-care tasks than children with BCP (Burgess et al., 2019; Kim et al., 2017; Kruijsen-Terpstra et al., 2014), we also know that children with BCP are classified across the whole range of MACS levels I–V, whereas children with UCP are predominantly classified at MACS I–III (Andersen et al., 2020; Arner et al., 2008; Himmelmann et al., 2006; Hollung et al., 2021; Klevberg et al., 2017). For the planning of tailored interventions, it is important to understand the differences in self-care capabilities between children with UCP and BCP, and the relationships between self-care capabilities and aspects of hand function for the two groups. When exploring self-care capabilities between the CP sub-groups, it may be appropriate to eliminate disparities in motor limitations by restricting comparisons to children at the same MACS levels (i.e., MACS I–III).

Several studies have shown positive correlations between self-care capabilities as measured with the Pediatric Evaluation of Disability Inventory (PEDI; Haley et al., 1992) and manual abilities (MACS) among children with CP (Burgess et al., 2019, 2020; de Brito Brandão et al., 2012; Kim et al., 2017; Kruijsen-Terpstra et al., 2014; Öhrvall et al., 2010; Phipps & Roberts, 2012; Smits et al., 2011). The wide variation in self-care capabilities within each MACS level has been demonstrated repeatedly; however, most studies include children with UCP and BCP who are not equivalent with respect to MACS levels. Moreover, the bimanual nature of most self-care activities (Henderson & Eliasson, 2008) illustrates the importance of examining the associations between self-care and more specific aspects of hand function, such as hand use during bimanual performance.

Key Messages

- Children with UCP or BCP classified at MACS levels I–III demonstrate similar self-care capabilities.
- MACS level can differentiate self-care capabilities for children with BCP but not for children with UCP in this young age group.
- Hand use during bimanual performance was strongly correlated with self-care capabilities for children with BCP, but not for children with UCP.
- Children with BCP with symmetric hand use during bimanual performance demonstrated higher self-care capabilities than children with asymmetric hand use.

The Assisting Hand Assessment (AHA) measures the spontaneous use of the affected hand during bimanual performance for children with UCP (Krumlinde-Sundholm & Eliasson, 2003). More recently, the Both Hands Assessment (BoHA) was developed from the same conceptual foundation as a measure to describe spontaneous hand use during bimanual performance in children with BCP (Elvrum et al., 2017). Both the AHA and BoHA are measures designed for children classified within MACS levels I–III. Burgess et al. (2021) found a strong positive correlation between self-care capabilities and bimanual performance for 74 children (aged 8–12 years) with UCP and BCP, for children classified with MACS I–III. The strongest correlations were found among children with BCP, and this finding was further supported by the results of a cross-sectional study of children aged 2–12.5 years by Elvrum et al. (2022).

There remains a paucity of knowledge regarding the relationship between limited hand use and self-care capabilities for children within separate CP sub-groups. Whereas children with UCP generally have one well-functioning hand and one affected hand (Arner et al., 2008), children with BCP have two affected hands that may be limited to various extents (Elvrum et al., 2017). Given these differences, we would expect that children with UCP possess greater self-care capabilities than children with BCP, even when they are classified at similar MACS levels. We would also assume that there are close associations between hand use during bimanual performance and self-care capabilities for both groups.

The primary purpose of this study was to describe self-care capabilities among children with CP and compare self-care between children with UCP and BCP with comparable levels of manual abilities (MACS I–III). In addition, the study aimed to explore the associations between self-care capabilities and manual abilities or hand use during bimanual performance separately for children with UCP and BCP, in order to generate knowledge needed for tailoring interventions to specific needs.

2 | METHODS

2.1 | Participants

A cross-sectional study design was used, and data from the Norwegian Quality and Surveillance Registry for Cerebral Palsy (NorCP) were included. All Norwegian children with CP are invited to participate in the NorCP, and the registry includes more than 90% of the population of Norwegian children with CP (Andersen et al., 2020). Only children with CP who had been assessed using both the PEDI and either the AHA or BoHA before the age of 6 years were included in the study. Children were excluded if the assessment (i.e. AHA or BoHA) that had been used was not a suitable match for the child's CP subtype, or if the time between the PEDI interview and the AHA or BoHA assessment was longer than 6 months.

2.2 | Measures and classification

The PEDI is a standardized assessment tool developed to measure children's capabilities within three domains of the Functional Skills Scale: self-care, mobility and social function (Haley et al., 1992). The PEDI is based on parental report from a structured interview (Haley et al., 1993) and has strong psychometric properties, and the Norwegian version has been validated for children aged 1 to 6 years (Berg et al., 2016). In this study, interval-level scaled scores from the Norwegian version of the Functional Skills Scale in the self-care domain (PEDI FSS) were used, because comparisons with typically developing children were not part of the aim of this study. The PEDI FSS is criterion-referenced and measures a child's capabilities along a continuum of item difficulty, with a possible range of scores from 0 to 100, where higher scores reflect higher levels of functioning (Haley et al., 1993). For simplicity, the term 'PEDI' will be used hereafter to refer to results from the PEDI FSS.

The MACS and Mini-MACS represent a five-level ordinal classification system developed to classify how children with CP handle age-relevant objects during everyday activities (Eliasson et al., 2006, 2016). The MACS has shown excellent psychometric properties and is stable over time for children aged 4 to 18 years (Eliasson et al., 2006; Öhrvall et al., 2014), and the Mini-MACS is shown to be reliable for use with children aged 1 to 4 years (Eliasson et al., 2016). The term 'MACS' will be used to refer to both MACS and Mini-MACS hereafter.

The AHA is a standardized, criterion-referenced test developed to measure and describe how effectively children with unilateral CP spontaneously use their affected hand during bimanual performance (Krumlinde-Sundholm & Eliasson, 2003). The more recently published BoHA was based on the same construct as the AHA, and it was developed to measure and describe hand use during bimanual performance for children with BCP at MACS levels I–III (Elvrum et al., 2017). The AHA is shown to be a valid and reliable tool for children with UCP aged 18 months to 18 years (Holmefur et al., 2009; Holmefur & Krumlinde-Sundholm, 2016; Krumlinde-Sundholm et al., 2007; Louwers et al., 2016), and there is growing evidence in support of the BoHA's reliability and validity for children aged 18 months to 12 years (Elvrum et al., 2017, 2022). In this study, the logit-based 0–100 unit scales were used for both AHA and BoHA results, where a higher score indicates superior performance (Krumlinde-Sundholm, 2012). The asymmetry index from the BoHA was also used in this study, where a difference of ≥20% between the unimanual sum scores for each hand indicated asymmetry (Elvrum et al., 2017). Additional challenges (cognition, epilepsy, vision) were retrieved from the NorCP medical protocol but were not included in the analyses because of a large number of missing data (Table 1).

2.3 | Data analysis

The data were examined for normal distribution and homogeneity of variance, and parametric or non-parametric statistics were chosen accordingly. Continuous variables from the PEDI, AHA and BoHA are represented in terms of mean (M), standard deviation (SD) and 95% confidence interval (CI) for normally distributed data, and median (MD) and range (interquartile range, IQR) for skewed data. Categorical variables are represented by frequencies (*n*) and percentages (%). An independent samples *t*-test was used to compare age at assessment with the PEDI between UCP and BCP, and the Mann–Whitney U-test was used for all other two-group comparisons. One-way analysis of variance (ANOVA) was conducted to analyse the effect of MACS levels on mean PEDI scores, and the Games–Howell test and Tukey's HSD test were used for post hoc analyses. Person's *r* was used to calculate correlations between PEDI scores and AHA or BoHA units. The coefficient of determination was determined by squaring the *r* value. The strength of the correlation between the variables was interpreted using the criteria suggested by Cohen (1988) (0.1 = small, 0.3 = medium, 0.5 = large). Analyses were performed using SPSS version 26 for Windows (IBM Corporation, 2017), and the statistical significance level was set at $p < 0.05$.

3 | RESULTS

3.1 | Sample characteristics

A total of 87 children (59% males) with unilateral ($n = 61$) or bilateral ($n = 26$) CP, with a mean age of 49.49 months, were included in the study (Table 1). The children were distributed across MACS levels I (30%), II (46%) and III (24%). Ninety-two percent of the PEDI and AHA or BoHA assessments were completed within a time frame of 0–3 months. There was no significant difference between age for children with UCP and BCP ($p = 0.091$), and the distribution of age according to the MACS levels shows that the majority of children in all three MACS levels were between 3 and 4 years of age (Table 1).

TABLE 1 Demographic characteristics of the participating children.

		Total ($n = 87$)	Unilateral CP[a] ($n = 61$)	Bilateral CP[b] ($n = 26$)
Age[c,d] (months) Mean (SD; range)		49.49 (14.69; 56)	48.15 (15.50; 56)	52.65 (12.32; 41)
Gender, *n* (%)				
Male		51 (58.62)	34 (55.7)	9 (34.62)
Female		36 (41.38)	27 (44.3)	17 (65.38)
MACS[e], *n* (%)				
I	1–2 years	5 (19.23)	5 (31.25)	-
I	3–4 years	14 (53.85)	6 (37.50)	8 (80)
I	5–6 years	7 (26.92)	5 (31.25)	2 (20)
	Total	26 (29.9)	16 (26.2)	10 (38.5)
II	1–2 years	8 (20)	7 (21.21)	1 (14.29)
II	3–4 years	21 (52.50)	18 (54.55)	3 (42.86)
II	5–6 years	11 (27.50)	8 (24.24)	3 (42.86)
	Total	40 (46.0)	33 (54.1)	7 (26.9)
III	1–2 years	4 (19.05)	2 (16.6)	2 (22.22)
III	3–4 years	11 (52.38)	7 (58.33)	4 (44.44)
III	5–6 years	6 (27.57)	3 (25.00)	3 (33.33)
	Total	21 (24.1)	12 (19.7)	9 (34.6)
GMFCS[f], *n* (%)				
I		2 (2.3)	2 (3.3)	-
II		56 (64.4)	52 (85.2)	4 (15.4)
III		12 (13.8)	7 (11.5)	5 (19.2)
IV		10 (11.5)	-	10 (38.5)
V		7 (8.0)	-	7 (26.9)
Time in months between assessments, *n* (%)[g]				
10		54 (62.07)	33 (54.10)	21 (80.77)
1–3		26 (29.89)	23 (37.70)	3 (11.54)
4–5		7 (8.05)	5 (8.20)	2 (7.69)
Additional challenges, *n* (%)				
Cognitive impairment[h]	Yes	28 (32.18)	17 (27.87)	11 (42.31)
	No	54 (62.07)	39 (63.93)	14 (53.85)
	Missing	5 (5.75)	5 (8.20)	1 (3.85)
Epilepsy	Yes	11 (12.64)	9 (14.8)	2 (7.69)
	No	7 (8.05)	6 (9.8)	1 (3.85)
	Missing	69 (79.31)	46 (75.4)	23 (88.46)
Vision impairment	Yes	25 (28.74)	13 (21.3)	12 (46.15)
	No	55 (63.22)	43 (70.5)	12 (46.15)
	Missing	7 (8.05)	5 (8.20)	2 (7.69)

[a]Unilateral included spastic unilateral CP.
[b]Bilateral included spastic bilateral CP ($n = 25$); and ataxic CP ($n = 1$).
[c]Age at assessment of the Pediatric Evaluation of Disability Inventory (PEDI).
[d]Difference in age is calculated with independent samples *t*-test (CI −11.32, 2.31, $p = 0.19$).
[e]Manual Ability Classification System (MACS) and Mini-MACS according to distribution of age.
[f]Gross Motor Function Classification System (GMFCS).
[g]Time between assessment with PEDI and Assisting Hand Assessment (AHA) or Both Hands Assessment (BoHA).
[h]Includes children with IQ < 70 and learning difficulties.

3.1.1 | Differences in self-care capabilities between children with UCP and BCP

In the comparison of self-care capabilities between children with UCP (MD = 54, IQR 45.80–68.10) and BCP (MD = 50, IQR 43.38–61.78), no significant differences were found ($U = 670$, $z = -1.14$, $p = 0.26$, $r = -0.12$) (Figure 1).

3.1.2 | Associations between self-care capabilities and manual abilities

The ANOVA indicated a significant effect of MACS levels on mean PEDI scores (F [2, 84] = 5.93, $p = 0.004$) when including global data where both CP subtypes were included ($n = 87$). Post hoc analysis with Tukey's HSD revealed a significant difference only between MACS levels I and III ($p = 0.005$). When investigating the effect of MACS levels on PEDI scores for children with UCP separately, the results from the ANOVA showed no significant effect (F [2, 58] = 1.04, $p = 0.36$) (Table 2).

For children with BCP, results from the ANOVA indicated a significant effect of MACS levels on PEDI scores (F [2, 23] = 12.58, $p = <0.001$). Post hoc analysis with Tukey's HSD revealed significant differences between MACS levels I and II ($p = 0.002$) and between levels I and III ($p < 0.001$), but not between levels II and III ($p = 0.96$). Children classified at MACS level I had the highest mean PEDI scores (Table 2).

3.1.3 | Associations between self-care capabilities and hand use during bimanual performance

For children with UCP, a small positive correlation was found between PEDI scores and AHA units ($r = 0.26$, $p = 0.04$), and the AHA units account for 6.7% of the variation in PEDI scores for children in this group.

For children with BCP, a large positive correlation was found between the PEDI scores and BoHA units ($r = 0.590$, $p = 0.002$), and the BoHA units explained 34.81% of the variance in the PEDI scores. A comparison of the PEDI scores between children with BCP who

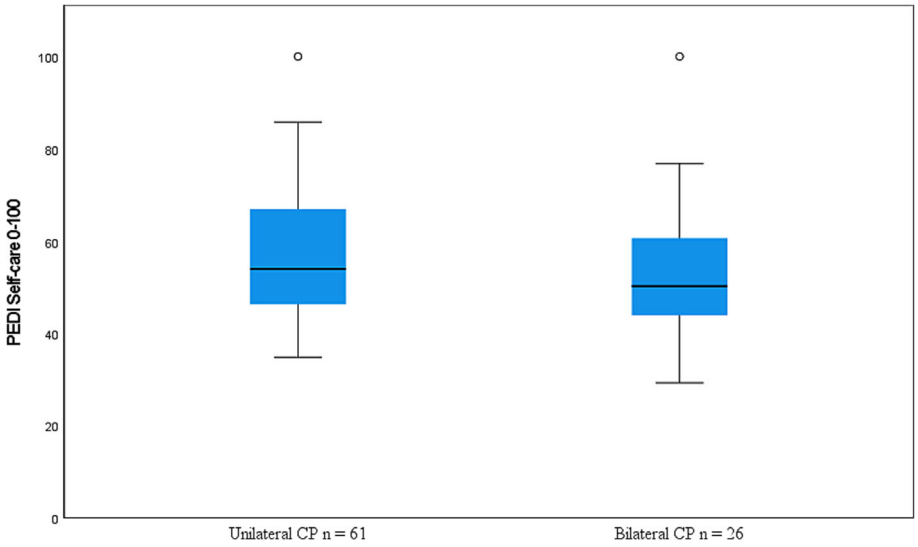

FIGURE 1 Distribution of the outcomes on the PEDI Functional Skills Scale for self-care among children with unilateral or bilateral CP. The figure illustrates the results from the Mann–Whitney U-test. Outliers represent two children aged 6 (UCP) and 4 (BCP) years, classified at Manual Ability Classification System level I.

TABLE 2 Results from the PEDI Functional Skills Scale for self-care according to CP subtype and levels of Manual Ability Classification System.

	Total ($n = 87$)					Unilateral cerebral palsy ($n = 61$)					Bilateral cerebral palsy ($n = 26$)				
	n	Mean	SD	F	*p*	*n*	Mean	SD	F	*p*	*n*	Mean	SD	F	*p*
MACS				5.93	.004[a]				1.04	.36				12.58	<.001[b]
Level I	26	61.97	17.33			16	59.17	18.71			10	66.44	14.64		
Level II	40	54.90	12.15			33	56.83	12.25			7	45.80	5.23		
Level III	21	48.53	9.63			12	51.64	9.93			9	44.38	7.90		

Note: SD = Standard Deviation, F = analysis of variance (ANOVA), and Mean PEDI FSS scores are measured on an interval scale of 0–100.
[a]Sig. difference between Mini-MACS/MACS levels I and III ($p = .005$) calculated with Welch from The Robust Test of Equality of Means.
[b]Sig. difference between Mini-MACS/MACS levels I and II ($p = .002$), and I and III ($p = <.001$).

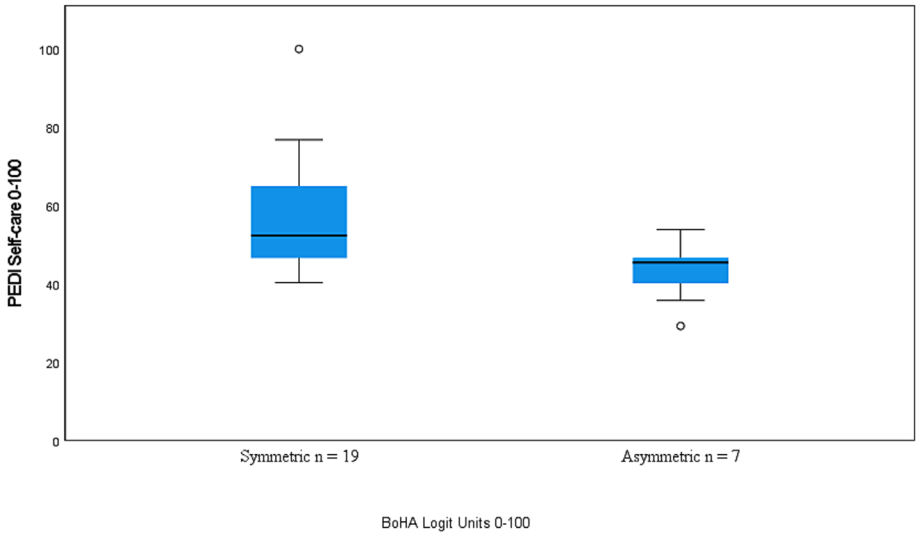

FIGURE 2 Distribution of scores on the PEDI Functional Skills Scale for self-care according to children who were classified with symmetric or asymmetric hand use on the Both Hands Assessment. The figure illustrates the results from the Mann–Whitney U-test. Outliers represent two children aged 6 (symmetric) and 2 (asymmetric) years, classified at Manual Ability Classification System levels I and III.

were classified with symmetric hand use and those with asymmetric hand use showed that PEDI scores were higher for children with symmetric (MD = 52.3, $n = 19$, IQR 43.80–65.00) than asymmetric (MD = 45.4, $n = 7$, IQR 35.70–47.00) hand use ($U = 30.5$, $z = -2.08$, $p = 0.036$, $r = -1.41$) (Figure 2).

4 | DISCUSSION

The findings of this study, which included children classified at MACS levels I–III (mean age 4 years and 1 month), show similar self-care capabilities between children with UCP and BCP. In addition, the results illustrate a significant association between self-care and MACS levels for the whole cohort of included children. For children with UCP, however, no significant association between self-care capabilities and MACS levels was found, and the correlation between self-care and hand use during bimanual performance was small. By contrast, the association between self-care and MACS levels was significant for children with BCP, and the correlation between self-care and hand use in this group was large. Children with a symmetric performance pattern on the BoHA achieved significantly higher PEDI scores than those with asymmetric hand use.

The finding that children with UCP and BCP did not significantly differ in terms of their self-care capabilities was somewhat surprising and in contrast to previous findings that children with BCP show lower capabilities of self-care than those with UCP (Burgess et al., 2019; Kim et al., 2017; Kruijsen-Terpstra et al., 2014). Given that the majority of the participants in the previous studies were also preschool children, our differing finding is most likely explained by the fact that, for both sub-groups, our study included only children classified at MACS levels I–III, whereas all MACS levels were included in the cited studies. In addition, the cited studies did not aim to describe self-care between the sub-groups but found UCP as a determinant factor for capabilities of self-care. The results of our study indicate that children with UCP or BCP who are classified at comparable MACS levels also show similar self-care capabilities, hence suggesting that the ability to handle objects in everyday activities may be more important for self-care capability than whether one or two hands are affected.

When exploring the association between self-care and MACS levels for the whole cohort of children, our results confirmed the positive associations found in previous studies (Burgess et al., 2019; Öhrvall et al., 2010). Children who handle objects independently and easily (MACS I) had the highest PEDI scores, whereas children who may need assistance or adaptations in the handling of objects (MACS III) had lower PEDI scores. Surprisingly, this association between PEDI and MACS levels was not significant for the sub-group of children with UCP in our study, in contrast to the findings of previous publications (Burgess et al., 2019, 2020; de Brito Brandão et al., 2012; Öhrvall et al., 2010; Phipps & Roberts, 2012; Smits et al., 2011). The small correlations between PEDI and AHA scores for children with UCP were also surprising, given the large correlations reported by Burgess et al. (2021). Two major reasons for this discrepancy may be the inclusion of older children (8–12 years) in the study by Burgess et al. (2021) and their use of PEDI-CAT, which has a wider range of items and a more discriminative response scale (Fragala-Pinkham et al., 2020). Moreover, the small correlations between the PEDI and AHA scores in our study may also be a consequence of the different nature of the two instruments. The self-care domain of the PEDI measures capability in activities that require both hands for the most successful results (e.g. pulling up pants and buttoning/unbuttoning shirts), yet also includes items that do not require hand use (e.g. eating foods with a variety of textures) and items that are typically performed only with the dominant hand (e.g. brushing teeth or using a fork or spoon) (Burgess et al., 2019; Haley et al., 1992; Öhrvall et al., 2010). The AHA, on the other hand, measures the efficacy of the assisting hand when spontaneously used together with the dominant hand (16 items), as well as ratings of bimanual performance (4 items). One-handed strategies and the phenomenon of learned non-use of the affected hand may be evident even in young children with UCP (Eliasson et al., 2014; Ramey et al., 2013), and such strategies will reduce their AHA score, but not necessarily influence their score on the PEDI.

For children with BCP, significant differences in self-care capabilities were found between MACS levels I–II and levels I–III. The large positive correlation was therefore expected, and this result is consistent with the findings of Burgess et al. (2021). The content of the BoHA moderately aligns with the self-care tasks included in the PEDI (Elvrum et al. 2022), and increasingly strong correlations are to be expected with higher ages. Nevertheless, the BoHA scores explained only 34.81% of the variation in the PEDI scores for children with BCP in our study, indicating that other individual and environmental factors are important and should be included in future studies to investigate additional predictors of self-care capability in this group.

The negative association between asymmetric hand use and self-care capability among children with BCP was not surprising, given previous findings that children with asymmetric hand use scored significantly lower on the BoHA compared with those with symmetric hand use (Klevberg et al., 2017). Given the small correlation between self-care and hand use during bimanual performance for children with UCP reported in this study, it could be expected that a similar pattern would be observed on the BoHA for children with asymmetric performance. It is important to note, however, that both the test items and scoring criteria are vastly different between the AHA and BoHA, and results from the two tests should therefore not be compared but rather be used as separate measures of hand use in the two sub-groups. Furthermore, a key difference between the asymmetric hand use seen in children with BCP compared with those with UCP is that children with BCP have two affected hands, making it challenging to develop efficient one-handed strategies. Therefore, asymmetric hand use for children with BCP may affect the roles of the two hands, making it difficult to develop efficient strategies when learning and performing increasingly complex bimanual self-care tasks, as they grow older.

The results of this study show considerable variation in PEDI scores among our cohort of preschool-aged children with CP, a finding that mirrors the rapid development of both hand function and self-care capabilities during the early years, both among children with CP and their typically developing peers (Burgess et al., 2020; Elvrum, et al., 2022; Haley et al., 1992; Klevberg et al., 2018, 2021; Öhrvall et al., 2010; World Health Organization, 2007). Moreover, our results indicate that self-care capabilities for children with CP are multifaceted and can only partially be explained by hand function. Burgess et al. (2020, 2021) explored the role of additional challenges and found a significant effect of cognitive impairment on self-care capabilities when including children with UCP and BCP across a wider age span. Unfortunately, because of the amount of missing data in our study, it was not possible to obtain reliable results regarding the role of cognition and other additional impairments.

4.1 | Limitations and future directions

Despite recruitment from the national NorCP registry that included approximately 450 children below 6 years of age at the time, only 87 children were registered with results on both the PEDI and the AHA or BoHA within the defined period. Our findings may therefore not be generalizable to the whole population. There was a discrepant number of participants between the UCP and BCP groups, which may also have influenced the results. A strength to our study is the comparison between young children with UCP and BCP who were comparable in terms of MACS levels. However, the finding that the associations between PEDI scores and hand function were different for the two sub-groups indicates that the two groups experience different upper limb-related challenges despite their similar MACS levels. Our study did not intend to compare results from the AHA and BoHA between children with UCP and BCP, yet these measures were rather included to address the common construct of hand use for the two sub-groups separately. To tailor interventions to the specific needs of individual groups and individual children, more studies are needed to improve our understanding of various aspects of hand function (e.g. grasping and releasing ability, bimanual coordination, grip strength and speed) in relation to everyday life activities and participation among children with CP in general, and children with BCP in particular.

Future studies should also include more variables to explain the variations in self-care capabilities, and CP subtypes should be treated separately when exploring associations. More specifically, future studies ought to explore the role of cognition for self-care both between and within the sub-groups, and across more age groups. The Norwegian version of the PEDI-CAT (computer-adaptive version of the PEDI) was not available when this study was performed but is now included in NorCP. PEDI-CAT may be useful for future studies, because it includes a wider range of item difficulty and the scales are more discriminative.

5 | CONCLUSION

This study shows that preschool children with BCP or UCP who were classified at comparable levels of manual ability (MACS I–III) showed similar self-care capabilities as measured with the PEDI. The contribution of manual ability and hand use during bimanual performance differed between the two groups. The differing results between the two CP sub-groups may be explained by the distribution of the children's hand impairments (i.e. unilateral vs bilateral), how they use their hands during bimanual activities and self-care tasks, and not the least by the different measures used to explore the associations.

There were large variations in the results, and the findings have important clinical implications. The assessment of children with CP requires a multifaceted approach, and interventions should be tailored to the specific needs of sub-groups and individuals within the groups. The assessment of children's self-care capabilities is complex. Examining only manual abilities or hand use during bimanual performance does not provide sufficient information; thus, more variables should be included.

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CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

DATA AVAILABILITY STATEMENT

The data are not available due to privacy and ethical restrictions, researchers may apply for data from the NorCP registry for future studies.

ETHICS APPROVAL AND PATIENT CONSENT STATEMENT

Approval from the Regional Committee for Medical and Health Research Ethics of South-Eastern Norway (Reg.nr. 2017/2552) and the Data Protection Officer of Oslo University Hospital (case nr.17/21947) was obtained. Informed parental consents for their children's data to be used in the research were provided upon inclusion to the NorCP.

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REFERENCES

Andersen, G. L., Hollung, S. J., Klevberg, G. L., Jahnsen, R., & Kløve, N. (2020). Norsk kvalitets-og oppfølgingsregister for cerebral parese (NorCP). *Årsrapport for 2020 med plan for forbedringstiltak*.

Arner, M., Eliasson, A. C., Nicklasson, S., Sommerstein, K., & Hagglund, G. (2008). Hand function in cerebral palsy. Report of 367 children in a population-based longitudinal health care program. *The Journal of Hand Surgery*, *33*(8), 1337–1347. https://doi.org/10.1016/j.jhsa.2008.02.032

Berg, M., Dolva, A.-S., Kleiven, J., & Krumlinde-Sundholm, L. (2016). Normative scores for the pediatric evaluation of disability inventory in Norway. *Physical & Occupational Therapy in Pediatrics*, *36*(2), 131–143. https://doi.org/10.3109/01942638.2015.1050149

Burgess, A., Boyd, R. N., Chatfield, M. D., Ziviani, J., & Sakzewski, L. (2020). Self-care performance in children with cerebral palsy: A longitudinal study. *Developmental Medicine and Child Neurology*, *62*(9), 1061–1067. https://doi.org/10.1111/dmcn.14561

Burgess, A., Boyd, R. N., Chatfield, M. D., Ziviani, J., Wotherspoon, J., & Sakzewski, L. (2021). Hand function and self-care in children with cerebral palsy. *Developmental Medicine and Child Neurology*, *63*(5), 576–583. https://doi.org/10.1111/dmcn.14783

Burgess, A., Boyd, R. N., Ziviani, J., Ware, R. S., & Sakzewski, L. (2019). Self-care and manual ability in preschool children with cerebral palsy: A longitudinal study. *Developmental Medicine and Child Neurology*, *61*(5), 570–578. https://doi.org/10.1111/dmcn.14049

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

de Brito Brandão, M., de Cássia Gonçalves, S., Carvalho, L. A., Crepaldi, P. V., Abrahão, L. C., de Melo Mambrini, J. V., & Mancini, M. C. (2012). Clusters of daily functioning and classification levels: Agreement of information in children with cerebral palsy. *Journal of Pediatric Rehabilitation Medicine*, *5*(3), 151–158. https://doi.org/10.3233/PRM-2012-0207

Eliasson, A. C. (2005). Improving the use of hands in daily activities: Aspects of the treatment of children with cerebral palsy. *Physical & Occupational Therapy in Pediatrics*, *25*(3), 37–60. https://doi.org/10.1300/J006v25n03_04

Eliasson, A. C., Krumlinde-Sundholm, L., Rösblad, B., Beckung, E., Arner, M., Öhrvall, A. M., & Rosenbaum, P. (2006). The manual ability classification system (MACS) for children with cerebral palsy: Scale development and evidence of validity and reliability. *Developmental Medicine and Child Neurology*, *48*(7), 549–554. https://doi.org/10.1017/S0012162206001162

Eliasson, A. C., Sjöstrand, L., Ek, L., Krumlinde-Sundholm, L., & Tedroff, K. (2014). Efficacy of baby-CIMT: Study protocol for a randomized controlled trial on infants below age 12 months, with clinical signs of unilateral CP. *BMC Pediatrics*, *14*(141), 1471–2431. https://doi.org/10.1186/1471-2431-14-141

Eliasson, A. C., Ullenhag, A., Wahlstrom, U., & Krumlinde-Sundholm, L. (2016). Mini-MACS: Development of the manual ability classification system for children younger than 4 years of age with signs of cerebral palsy. *Developmental Medicine and Child Neurology*, *59*(1), 72–78. https://doi.org/10.1111/dmcn.13162

Elvrum, A. K., Zethræus, B.-M., Vik, T., & Krumlinde-Sundholm, L. (2017). Development and validation of the Both Hands Assessment for children with bilateral cerebral palsy. *Physical & Occupational Therapy in Pediatrics*, *38*(2), 113–126. https://doi.org/10.1080/01942638.2017.1318431

Elvrum, A. K. G., Johansen, G. O., Vik, T., & Krumlinde-Sundholm, L. (2022). External validity of the Both Hands Assessment for evaluating bimanual performance in children with bilateral cerebral palsy. *Developmental Medicine and Child Neurology*, *64*, 586–592. https://doi.org/10.1111/dmcn.15127

Fragala-Pinkham, M., Miller, P. E., M.Dumas, H., & Shore, B. J. (2020). Development and validation of equations to link Pediatric Evaluation of Disability Inventory (PEDI) functional skills scores to PEDI-Computer Adaptive Test scores for youth with cerebral palsy. *Physical and Occupational Therapy in Pediatrics*, *40*(1), 106–120. https://doi.org/10.1080/01942638.2019.1628160

Haley, S. M., Coster, W. J., Ludlow, L. H., Haltiwanger, J. T., & Andrellos, P. J. (1992). *Pediatric Evaluation of Disability Inventory (PEDI): Version 1.0: Development, standardization and administration manual (Vol. 1)*. New England Medical Center Hospitals.

Haley, S. M., Ludlow, L. H., & Coster, W. J. (1993). Pediatric evaluation of disability inventory: Clinical interpretation of summary scores using Rasch rating scale methodology. *Physical Medicine and Rehabilitation Clinics*, *4*(3), 529–540. https://doi.org/10.1016/S1047-9651(18)30568-0

Henderson, A. (2006). Self-care and hand skill. In A. Henderson & C. Pehoski (Eds.), *Hand function in the child: Foundations for remediation* (2nd ed.) (pp. 193–216). Mosby. https://doi.org/10.1016/B978-032303186-8.50013-7

Henderson, A., & Eliasson, A. C. (2008). Self-care and hand function. In A. Eliasson & P. Burtner (Eds.), *Improving hand function in children with cerebral palsy: Theory, evidence and intervention* (pp. 320–338). Mac Keith Press.

Himmelmann, K., Beckung, E., Hagberg, G., & Uvebrant, P. (2006). Gross and fine motor function and accompanying impairments in cerebral palsy. *Developmental Medicine and Child Neurology*, *48*(06), 417–423. https://doi.org/10.1017/S0012162206000922

Hollung, S. J., Hägglund, G., Gaston, M. S., Seid, A. K., Lydersen, S., Alriksson-Schmidt, A., & Andersen, G. L. (2021). Point prevalence and motor function of children and adolescents with cerebral palsy in Scandinavia and Scotland: A CP-north study. *Developmental Medicine and Child Neurology*, *63*, 721–728. https://doi.org/10.1111/dmcn.14764

Holmefur, M., Aarts, P., Hoare, B., & Krumlinde-Sundholm, L. (2009). Test-retest and alternate forms reliability of the Assisting Hand Assessment. *Journal of Rehabilitation Medicine*, *41*(11), 886–891. https://doi.org/10.2340/16501977-0448

Holmefur, M., & Krumlinde-Sundholm, L. (2016). Psychometric properties of a revised version of the Assisting Hand Assessment (Kids-AHA 5.0). *Developmental Medicine and Child Neurology*, *58*(6), 618–624. https://doi.org/10.1111/dmcn.12939

IBM Corporation. (2017). *SPSS for windows*. IBM Corporation.

Imms, C., Reilly, S., Carlin, J., & Dodd, K. J. (2009). Characteristics influencing participation of Australian children with cerebral palsy. *Disability and Rehabilitation*, *31*(26), 2204–2215. https://doi.org/10.3109/09638280902971406

Kim, K., Kang, J. Y., & Jang, D.-H. (2017). Relationship between mobility and self-care activity in children with cerebral palsy. *Annals of Rehabilitation Medicine*, *41*(2), 266. https://doi.org/10.5535/arm.2017.41.2.266

Klevberg, G. L., Elvrum, A. K. G., Zucknick, M., Elkjær, S., Østensjø, S., Krumlinde-Sundholm, L., Kjeken, I., & Jahnsen, R. (2018). Development of bimanual performance in young children with cerebral palsy. *Developmental Medicine and Child Neurology*, *60*(5), 490–497. https://doi.org/10.1111/dmcn.13680

Klevberg, G. L., Jahnsen, R., Elkjær, S., & Zucknick, M. (2021). Hand use development in children with unilateral cerebral palsy. *Developmental Medicine and Child Neurology*, *63*(12), 1462–1468. https://doi.org/10.1111/dmcn.14957

Klevberg, G. L., Ostensjo, S., Krumlinde-Sundholm, L., Elkjaer, S., & Jahnsen, R. B. (2017). Hand function in a population-based sample of young children with unilateral or bilateral cerebral palsy. *Physical & Occupational Therapy in Pediatrics*, *37*, 528–540. https://doi.org/10.1080/01942638.2017.1280873

Kruijsen-Terpstra, A. J., Ketelaar, M., Verschuren, O., Smits, D. W., Jongmans, M. J., & Gorter, J. W. (2014). Determinants of developmental gain in daily activities in young children with cerebral palsy. *Physical & Occupational Therapy in Pediatrics*, *18*, 265–279. https://doi.org/10.3109/01942638.2014.957429

Krumlinde-Sundholm, L. (2012). Reporting outcomes of the Assisting Hand Assessment: What scale should be used? *Developmental Medicine and Child Neurology*, *54*(9), 807–808. https://doi.org/10.1111/j.1469-8749.2012.04361.x

Krumlinde-Sundholm, L., & Eliasson, A. C. (2003). Developing the Assisting Hand Assessment: A Rach-built measure intended for children with unilateral upper limb impairments. *Scandinavian Journal of Occupational Therapy*, *10*(1), 16–26. https://doi.org/10.1080/11038120310004529

Krumlinde-Sundholm, L., Holmefur, M., Kottorp, A., & Eliasson, A. C. (2007). The Assisting Hand Assessment: Current evidence of validity, reliability, and responsiveness to change. *Developmental Medicine and Child Neurology*, *49*(4), 259–264. https://doi.org/10.1111/j.1469-8749.2007.00259.x

Louwers, A., Beelen, A., Holmefur, M., & Krumlinde-Sundholm, L. (2016). Development of the Assisting Hand Assessment for adolescents (Ad-AHA) and validation of the AHA from 18 months to 18 years. *Developmental Medicine and Child Neurology*, *58*(12), 1303–1309. https://doi.org/10.1111/dmcn.13168

McIntyre, S., Goldsmith, S., Webb, A., Ehlinger, V., Hollung, S. J., McConnell, K., Arnaud, C., Smithers-Sheedy, H., Oskoui, M., Khandaker, G., Himmelmann, K., & Global CP prevalence group. (2022). Global prevalence of cerebral palsy: A systematic analysis. *Developmental Medicine and Child Neurology*, *64*(12), 1494–1506. https://doi.org/10.1111/dmcn.15346

Öhrvall, A. M., Eliasson, A. C., Löwing, K., Ödman, P., & Krumlinde-Sundholm, L. (2010). Self-care and mobility skills in children with cerebral palsy, related to their manual ability and gross motor function classifications. *Developmental Medicine and Child Neurology*, *52*(11), 1048–1055. https://doi.org/10.1111/j.1469-8749.2010.03764.x

Öhrvall, A.-M., Krumlinde-Sundholm, L., & Eliasson, A. C. (2014). The stability of the Manual Ability Classification System over time. *Developmental Medicine and Child Neurology*, *56*(2), 185–189. https://doi.org/10.1111/dmcn.12348

Østensjø, S., Brogren, E., & K, N. (2003). Everyday functioning in young children with cerebral palsy: Functional skills, caregiver assistance, and modifications of the environment. *Developmental Medicine and Child Neurology*, *45*(9), 603–612. https://doi.org/10.1111/j.1469-8749.2003.tb00964.x

Phipps, S., & Roberts, P. (2012). Predicting the effects of cerebral palsy severity on self-care, mobility, and social function. *The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association*, *66*(4), 422–429. https://doi.org/10.5014/ajot.2012.003921

Ramey, S. L., Coker-Bolt, P., & DeLuca, S. C. (2013). *Handbook of pediatric constraint-induced movement therapy (CIMT)* (1st ed.) (pp. 19–54). American Occupational Therapy Association, Inc.

Smits, D. W., Ketelaar, M., Gorter, J. W., van Schie, P., Dallmeijer, A., Jongmans, M., & Lindeman, E. (2011). Development of daily activities in school-age children with cerebral palsy. *Research in Developmental Disabilities*, *32*(1), 222–234. https://doi.org/10.1016/j.ridd.2010.09.025

Stadskleiv, K., Jahnsen, R., Andersen, G. L., & von Tetzchner, S. (2018). Neuropsychological profiles of children with cerebral palsy. *Developmental Neurorehabilitation*, *21*(2), 108–120. https://doi.org/10.1080/17518423.2017.1282054

World Health Organization. (2007). *ICF-CY: International classification of functioning, disability and health: Children & youth version*. World Health Organization. Retrieved from https://www.who.int/classifications/icf/en/

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