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Psychometric evaluation of the Clinical Assessment of Body Alignment items for children with cerebral palsy – a preliminary study.

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Abstract

Introduction: To evaluate construct validity, reliability and responsiveness of the Clinical Assessment of Body Alignment (CABA) items for children with cerebral palsy (CP).

Methods: Fifteen independent raters (physiotherapists) assessed 5 children with CP, GMFCS I – V, from photographs in supine, sitting and standing positions, using the Clinical Assessment of Body Alignment scale. Eleven therapists rescored one month later. Construct validity was evaluated based on one-way between subject ANOVA and Tukey HSD test for the raters' scores relative to GMFCS levels. Intra-class correlation coefficients (ICCs) with 95% confidence intervals (CI) evaluated Inter-rater and intra-rater reliability. Responsiveness was evaluated based on paired samples t-test evaluated scores with/without equipment. One physiotherapist who assessed 10 children with CP GMFCS IV (n=5) -V (n=5) aged 3 to 12 years (mean 5yr 4mth). Independent sample t-test compared between GMFCS IV and V.

Results: Construct validity showed significant differences in mean CABA values between GMFCS levels ($p< 0.001$). Excellent intra-rater and inter-rater reliability (ICC> 0.90), good responsiveness with/without equipment ($p<0.001$), and between GMFCS levels ($p<0.001$) was demonstrated.

Conclusion: The CABA items show strong psychometric properties for children with CP. It enables detection of postural alignment and is responsive to changes in this, thus has utility in supporting evaluation of postural equipment provision.

Introduction

Children with cerebral palsy (CP) have problems with movement and postural alignment (Carlberg & Hadders-Algra, 2005). Postural body alignment is an important component for functional movement, and the impact of this varies within the sub classification of CP (Rosenbaum et al, 2007). The Gross motor function classification system (GMFCS) grades children with CP; a child at level I is able to walk and function independently requiring little to no support for their postural alignment, whereas a child at level V is unable to maintain postural body alignment against gravity without the use of postural equipment (Palisano et al, 2008). Posture management interventions are typically utilised by therapists to correct body misalignment through use of positioning equipment to prevent deformities in alignment and support function (Rodby-Bousquet et al, 2013).

The use of observational assessment in assessing body alignment is part of everyday clinical practice (Hong, 2005). A consistent approach in total body alignment assessment is rarely reliable or reproducible between different raters, especially when used with individuals who have complex alignment such as children with CP (Fortin et al, 2011). There are limited standardised clinical assessments which enable therapists to monitor and detect changes in whole body alignment in children with CP (George et al, 2020a). Current measures of alignment are either sub-sections of developmental motor assessments or focus specifically on one body segment rather than the whole body. The Posture and Posture ability scale (PPAS) measures postural symmetry and is supported by psychometric properties (Rodby-Bousquet et al, 2016). Scoring is limited to a simple score of yes /no postural deviation from midline. As such, the responsiveness of this assessment to detect graded demarcation in alignment change is limited. Therapists need reliable and responsive assessment methods to easily quantify graded changes in body alignment to support clinical decisions about individual management and evaluate the impact of their postural interventions (Novak et al, 2020).

The recently developed Clinical Assessment of Body Alignment (CABA) is a clinical assessment tool designed to assess graded changes in total body alignment deviation, denoting left and right sides of the body across 3 positions; lying, sitting and standing (George, 2021). The CABA is based on clinically derived postural items which were developed and revised by the clinical expert opinion of 283 paediatric physiotherapists who specialised in postural assessment (George et al, 2020b). The CABA has shown good content validity (percentage agreement >70%), with clinician's overall agreement fair to good (k=.422) (Husted et al, 2000). As part of the initial development stage of this tool it was important to establish that the items and scoring system of the CABA were reliable and responsive to clinical change. In test development it is important to ensure the items and scoring system selected are reliable and relate to the construct in which the assessment is intended to be applied (Burton et al, 2000). Reliability reflects not only the correlation but also agreement between measures (Beaton et al, 2001). Ideally; if an assessment was totally reliable the therapist should be able to obtain the same score each time the assessment is undertaken within the exact same conditions. In reality, assessment results vary across administrations due to errors.

Aims

The purpose of this study was to evaluate construct validity, inter-rater and intra-rater reliability and responsiveness of the CABA scoring system in children with CP. Ethical Approval was obtained from the Ethical Review Board of York St John University, UK

Methods

A clinical measurement design was used to examine the inter and intra-rater reliability, construct validity and responsiveness of the CABA.

Participants

A convenience sample was recruited via the Association of Paediatric Chartered Physiotherapists (APCP) mailing list, a special interest group within the field of paediatric physical therapy, to evaluate inter-rater and intra-rater reliability and construct validity. Participants were invited if they worked within the field of posture or postural management with children with CP. Participation was voluntary and consent was gained through participants clicking on the survey link and consent question.
To describe the participant sample, four questions relating to APCP region, years of experience, place of work and area of speciality were asked at the start of the survey. This allowed for analysis of how representative the sample was of the targeted users, paediatric physiotherapists.

A single participant was involved in the responsiveness evaluation: one physiotherapist, the primary researcher, evaluated a random stratified sample of (n=10) children with CP GMFCS Level IV (n=5) and V (n=5) who attended the same school, using the CABA assessment form. The primary researcher was the sole physiotherapist within the school, thus the children were both used to the environment and the lead researcher, therefore, the evaluation had minimal impact on the children's mood, wellbeing and clinical presentation. The primary researcher was also familiar with the CABA assessment, having been the initial developer of the assessment. This meant that random errors related to misreading items or misinterpreting the scores were limited.

Description of children evaluated

A stratified random sample of children with CP (4-16 yrs in age) were recruited from a local special school. All children had a confirmed diagnosis of CP and GMFCS level by a consultant paediatrician, no surgical procedures within the previous 6 months, and no injection of botulinum toxin type A within the previous 6 months. Invitation letters and written information was given to the children's families through the schools' communication system. Agreement to participate in this study was indicated by families who returned the written consent form to the research team. Children who met the inclusion criteria and had consented to participate were then grouped into GMFCS levels. A child from each group was then randomly selected and invited consecutively until there was the desired number at each GMFCS level, for each part of the study as outlined below.

A sample of (n=5) children with CP, one at each GMFCS level, was selected for evaluating reliability and validity. A separate sample of (n=10) children with CP GMFCS Level IV (n=5) and V (n=5) was used to examine responsiveness. The responsiveness sample focused on GMFCS IV and V as children at these classifications require support to maintain body alignment against gravity across all their positions (Rosenbaum et al., 2008).

The sample sizes selected for each element of the study equated to three independent observations per child giving a total of 142 scores from each rater, sufficient enough to have the required power value when analysing the data (Bujang and Baharum, 2017). In total fifteen children were recruited for this study (n=5) for reliability and validity and (n=10) for responsiveness.

Instrument

The CABA assessment form is a clinical assessment tool developed to measure body alignment, with established content validity (George et al, 2020b). The CABA is designed to score deviations in body alignment in sitting, standing and lying. Body alignment is graded across 20 items head, trunk, pelvis, legs, arms and feet across all positions and left and right sides of the body. The CABA posture classifications uses a 0-3 scoring system to rank the alignment with 0 indicating a position within 5 degrees, either side of optimal alignment, and three indicating the most significant deviation away from optimal alignment. All CABA items are based on this scoring system with the exception of three items, which score on a 0-2 scale due to the limited joint range from optimal. The CABA has strong clinical utility properties, can be carried out online or on paper, making it highly applicable to everyday clinical practice (George, 2021).
The CABA was used in an electronic questionnaire to evaluate reliability and validity, and in paper form for responsiveness.

Data Collection: Validity and reliability

An electronic questionnaire, using Qualtrics, was devised comprising of photographs of each child and the CABA scoring items. All children were photographed in 3 different positions sitting, lying and standing positions. Each separate set of photographs for each position had 5 views; anterior, posterior, left, right and transverse. Children wore vests and shorts to enable body alignment to be observed and their faces were blanked out to protect anonymity. Photographs of each child were placed alongside the corresponding CABA scoring items in an electronic questionnaire format. Each child had a CABA assessment for each of the three positions. The GMFCS level of each child was hidden to all but the primary researcher. The use of photographs of children with CP, instead of observation in a clinical setting, minimised the amount of random error likely to occur, thus increasing the likelihood of identifying any CABA items with limited reliability.

The devised survey was sent out electronically to all APCP members via their mailing list. Participants were asked to contribute if they worked within the field of posture / postural management with children with CP. Respondents were asked to observe each child's body alignment 3 times, once in sitting, once in lying and once in standing using the CABA scoring system. This produced three independent observations of each child. Instructions on how to score were given at the start and photographs were shown with the **corresponding CABA** assessment item making it quick and easy for participants to score. The specific body alignment component being observed for each photo and a description of how this is rated was given at the top of each question.

Participation was voluntary and consent was gained through participants clicking on the survey link and consent question. Participant information was also provided on a separate link on the same email giving clarity on what was expected and the use of the data. The initial survey was open to APCP members for one month (April 2019 – May 2019).

Respondents were given the opportunity to participate in a repeat of this survey one month later by leaving their contact email address. In this case they were informed that anonymity to the researcher was not possible due to the need to retain participant contact information to send the second survey. Respondent's data for the repeated scores were matched using an individual unique reference number. The repeat survey was open to respondents for one month from June 2019 – July 2019.

Data Collection: responsiveness

In evaluating responsiveness, two frames of reference were used: immediate change in and out of posture management equipment and positional criterion (Beaton et al, 2001; Husted et al, 2000). Internal responsiveness was determined by comparing the CABA scores for each child in and out of postural equipment across three contexts: 1) Ability to detect change across all positions and body segments, 2) The level of change detected and 3) Ability to detect change at both GMFCS IV and V.

In order to evaluate responsiveness of the CABA one physiotherapist, the primary researcher, scored each child's (n=10) body alignment with and without equipment across lying, sitting and standing in a clinical setting. Data was collected using the CABA assessment form, in paper format. This was selected as it was the only format the CABA assessment was available in at the time of this study.

The children's posture was assessed both in and out of their usual equipment as part of their therapy sessions. As the primary researcher knew the children well and interacted regularly within the clinical context of the research, the children were familiar with assessment of their body alignment in everyday practice. Some children required support to maintain positions such as sitting without equipment. Adult support was therefore given if required to support safety, but not to correct or change alignment. Each child was allowed 2 minutes within each position before measurements were taken in order to allow them to adopt a typical alignment representative of how the child's posture would be both with and without their equipment.

Data Analysis

Each participant was assigned a unique reference number and the questionnaire responses were extracted from Qualtrics into the IBM Statistical Package for the Social Science (SPSS version 25) for data analysis. Only responses from therapists who returned complete questionnaires were analysed. Mean scores and standard deviation for the overall ratings of each body segment, each child and each position are reported.

Reliability was evaluated using intra-class correlation coefficients (ICC) with 95% confidence interval examining inter-rater and intra-rater reliability to determine the level of absolute agreement. Based on Bujang and Baharum (2017) with each rater carrying out a minimum of 3 observations per child (n=5); we had a power value of greater than 0.80 to detect reliability and ICC greater than 0.90, for significance at a p value of 0.05. For interpretation of the results, we adopted the following assessment of the strength of the reliability. ICC values less than 0.5 were indicative of poor reliability, values between 0.5 and 0.75 indicated moderate reliability, values between 0.75 and 0.9 good reliability, and values greater than 0.90 indicated excellent reliability (Koo et al, 2016).

Specifically, inter-rater reliability was examined using ICC estimates and their 95% confidence intervals (CI), based on a mean rating (k=15), absolute-agreement using a 2-way random-effects model. Intra-rater reliability was examined using ICC estimates; 95% CI were calculated using SPSS based on a mean rating (k=11) at two time points, absolute-agreement, using a 2-way mixed-effects model.

Test-retest reliability was examined using ICC and 95% CI to determine the level of absolute agreement between a rater's score on the first and second test of the same children. Overall rater agreement across GMFCS levels, positions and body segments was examined.

Construct validity was evaluated using a one-way between subjects ANOVA to compare raters' scores across position and GMFCS level to determine if scores differed by level of CP severity. Post hoc comparisons using the Tukey HSD test were used to examine differences between pairs of children to determine if the CABA could differentiate between each GMFCS level.

Responsiveness was evaluated using summed scores for all measurements with and without equipment across positional criterion, body segment and GMFCS level. The measurement taken without equipment was considered as the baseline measurement. Paired sample t-tests examined differences in scores across positions and body segments. Independent sample t-tests were used to compare differences in scores between GMFCS IV and V. As this examination involved comparison of four variables the α level was adjusted using a Bonferroni correction, to 0.012, to account for the possibility of type 1 errors. Values were deemed significant at $p < 0.01$ (Field, 2013).

Results

Fifteen independent raters (physiotherapists) assessed 5 children with CP (GMFCS I – V) from photographs in supine, sitting and standing positions, using the clinical Assessment of Body Alignment. Eleven therapists re-scored the same photographs one month later.

Inter-rater reliability

Overall inter-rater reliability was excellent across all positions of sitting, lying and standing (ICC [2,15] 0.93, 95% CI 0.918-0.941) and for all body segments (ICC [2,15] 0.93, (95% CI 0.918-0.941). The values given across individual positions and body segments showed excellent reliability for sitting, lying, head, trunk and pelvis. The ratings for standing, arm, leg and foot had reported lower range 95% confidence intervals from 0.847-0.933 (Foot) to 0.898-0.943 (Leg), demonstrating good to excellent agreement between raters (table 1).

Table 1: Inter-rater and intra-rater Reliability of the CABA Total score (N=355 ratings per rater) for different positions and body segments of children with CP.

	Inter-rater (K=15)		**Intra-rater (K=11)**	
Dimension	ICC(2,15)	95% CI	ICC(2,15)	95% CI
Position				
Standing	0.900	(0.868, 0.926)	0.902	(0.888, 0.914)
Sitting	0.931	(0.912, 0.942)	0.895	(0.864, 0.917)
Lying	0.953	(0.939, 0.966)	0.930	(0.920, 0.939)
Total	**0.930**	**(0.918, 0.941)**	**0.910**	**(0.895, 0.921)**
Body segment				
Head	0.947	(0.917, 0.968)	0.94	(0.929, 0.95)
Trunk	0.944	(0.917, 0.966)	0.924	(0.908, 0.937)
Pelvis	0.951	(0.926, 0.97)	0.936	(0.919, 0.949)
Arm	0.896	(0.847, 0.933)	0.891	(0.871, 0.908)

Leg	0.923	(0.898, 0.943)	0.876	(0.836, 0.904)
Foot	0.895	(0.847, 0.933)	0.903	(0.883, 0.919)
Total	**0.930**	**(0.918, 0.941)**	**0.910**	**(0.895, 0.921)**

The inter-rater and intra-rater ICC's when examining children classified by GMFCS levels were >0.910 (table 2). All of the ICC values for inter-rater reliability were excellent for GMFCS levels III to V, and good for Level II. The child at GMFCS I had an ICC (2,15) of 0.731, 95% CI 0.629-0.833 indicating moderate agreement.

Table 2: Inter-rater and intra-rater Reliability of the CABA across GMFCS level

GMFCS Level	**Inter-rater (K=15)**		**Intra-rater (K=11)**	
	ICC(2,15)	95% CI	ICC(2,11)	95% CI
I	0.731	(0.629, 0.833)	0.784	(0.712, 0.833)
II	0.865	(0.825, 0.905)	0.86	(0.785, 0.913)
III	0.903	(0.856, 0.95)	0.825	(0.797, 0.849)
IV	0.907	(0.872, 0.942)	0.885	(0.865, 0.902)
V	0.932	(0.905, 0.959)	0.909	(0.885, 0.931)
Total	**0.930**	**(0.918, 0.941)**	**0.910**	**(0.895, 0.921)**

Intra-rater

Overall intra-rater reliability was good to excellent across all positions of sitting, lying and standing and for all body segments (ICC [2,11] 0.910, 95% CI 0.895-0.921). The ratings for positions sitting, standing and body segments arm, leg and foot had reported lower range 95% confidence intervals from 0.836-0.904 (leg) to 0.888-0.914 (standing), demonstrating good to excellent agreement between raters (table 1). The ICC's and 95% CI values given across lying, head, trunk and pelvis were >0.908, indicating excellent intra-rater reliability.

Examining inter-rater reliability for children classified by GMFCS levels the ICC values for were good to excellent for GMFCS levels II to V and moderate for Level I. On consideration of the 95% CI scores children at GMFCS IV and V demonstrated good to excellent reliability, whereas GMFCS level I to III demonstrated moderate to good reliability for (Table 2).

Test-retest reliability

In addition, ICC and 95% CI were used to determine the level of absolute agreement between a raters' score (k=11) on the first and second test of the same children, one month apart. Overall rater agreement across GMFCS levels, positions and body segments were excellent (ICC (2,11) 0.910 95% CI 0.895-0.921). Individual rater (K=11) ICC's across all measurements ranged from 0.858 to 0.933, with 6 of the 11 raters (55%) having an ICC > 0.9. This indicates that all raters had a high level of agreement in test and retest situation using the CABA.

Construct Validity

A one-way between subjects' ANOVA compared raters scores at each position and GMFCS level. There was a significant effect across the different GMFCS levels [$F(4, 350) = 137.4$, $p < 0.001$]. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for each of the severity levels was significantly different to other severity levels with the exception of Levels II and III (p=0.770) and Levels I and II (p=0.663, where no significant difference was detected (Table 3).

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We repeated the construct validity using the test-retest data set (K=11).. Values showed no change in significant effect at different GMFCS severity levels [F(4, 3900) = 799, p < 0.001], indicating that having experience of scoring with the CABA made no difference on construct validity.

Table 3: Construct validity pairwise comparisons between each GMFCS level based on raters scores at test 1 (k=15).

GMFCS Level	Paired comparisons between GMFCS Levels	Significance level	mean difference
I	II	0.663	-0.094
	III	0.023	-0.174*
	IV	0.000	-.872*
	V	0.000	-1.300*
II	III	0.770	-0.080
	IV	0.000	-.778*
	V	0.000	-1.205*
III	IV	0.000	-.697*
	V	0.000	-1.125*
IV	V	0.000	-.427*

* The mean difference is significant at the 0.05 level.

Responsiveness

Paired t-tests examined difference in scores with and without equipment across positions and body segments. Overall, the CABA's responsiveness to detect change in body alignment was statistically significant across all its postural body segments categorizations (t(9)=24.5, p<0.001 Table 4). Independent sample t-tests compared scores with and without equipment between GMFCS IV and V. The CABA demonstrated responsiveness to change in body alignment when equipment was used at GMFCS level IV (t(4)=20, p<0.001) and V (t(4)=44, p<0.001), indicating that the CABA was able to detect change accurately at both GMFCS IV and V.

Table 4: Internal responsiveness for paired and independent t tests of the CABA for positions, body segments and GMFCS level.

Dimension	Paired t -tests	Independent t-Tests	
		GMFCS Level IV	GMFCS Level V
Position			
Lying	p<0.001	(p<0.001)*	(p<0.001)*
Standing	p<0.001	(p<0.001)*	(p<0.001)*
Sitting	p<0.001	(p<0.001)*	(p<0.001)*
Body segment			
Head	p<0.003	(p=0.114)	(p<0.001)*
Trunk	p<0.001	(p<0.001)*	(p<0.001)*
Pelvic	p<0.001	(p=0.002)*	(p<0.001)*
Arm	p<0.001	(p=0.001)*	(p=0.04)
Leg	p<0.001	(p<0.001)*	(p<0.001)*
Foot	p<0.001	(p<0.001)*	(p=0.002)*
All measures			
Total:	p<0.001	(p<0.001)*	(p<0.001)*

*= Denotes significant result

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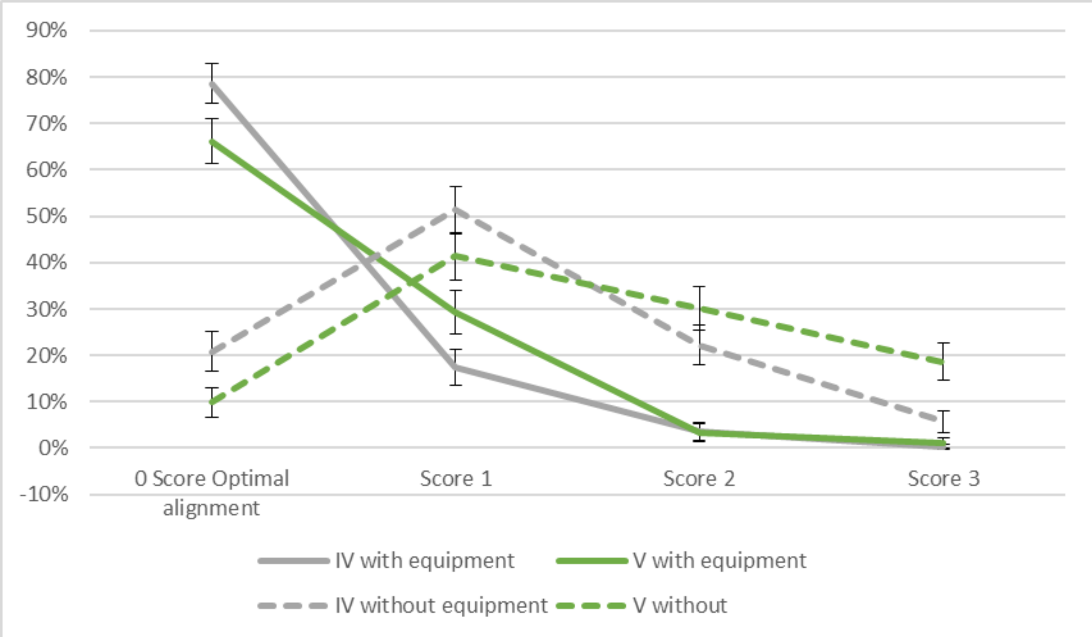
The mean scores of measurements of all children at each GMFCS level IV (n=5) and V (n=5) increased in line with the CABA scoring criteria towards more optimal alignment with equipment compared to without, across all positions and body segments (figure 1). This indicates that at GMFCS IV and V the CABA is responsive to immediate change in body alignment with equipment across posture categorisations and scoring criteria as set out in the CABA.

Figure 1: Percentage scores of all measures at GMFCS Level IV and V with and without equipment.



Discussion and Implications

The CABA shows excellent intra-rater and inter-rater reliability across all dimensions, demonstrating statistically significant construct validity to differentiate between GFMCS levels. The CABA is responsive to immediate change in body alignment when posture management equipment is used and demonstrates statistically significant ability to differentiate between changes in children with CP GMFCS IV and V.

Reliability

Our results showed excellent overall inter-rater and intra-rater reliability for the CABA for children with CP across all GMFCS levels, with the exception of GMFCS Level I, where moderate reliability was detected (table 2). The reason for this is unclear; there may be different explanations for this including the presentation and order of the ratings with the child at GMFCS Level I always being the first rated and as such, the benchmark case. This discrepancy could also be attributed to the child making an active postural adjustment prior to the photograph being taken. Children at GMFCS level I have good postural alignment and function in walking and postural adjustments (Rosenbaum et al, 2007). Although children were positioned in optimal alignment, it is possible small active postural movement may have occurred prior to the photo being taken. Also, it is possible that some raters expected to see misalignment, although overall rater variability was low. Therefore, reliability of the CABA in children at GMFCS level I may be slightly lower and is an important consideration when using the CABA in clinical practice.

In terms of inter-rater and intra-rater total reliability for the dimensions of position and body segments, the CABA demonstrated excellent reliability (ICC >0.910). Individual ICC's for both inter-rater and intra-rater were good to excellent for each of the specific positions and body segments, indicating that the CABA has substantial reliability across all its dimensions. A recent literature review found only two assessments which demonstrated good to excellent validity and reliability (George et al, 2020a). These were the Posture and Posture Ability Scale (PPAS)

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(Rodby-Bousquet et al., 2016; Rodby-Bousquet et al., 2014) and the Spinal Alignment and Range of Motion Measure (SAROMM) (Bartlett and Puride, 2005). This suggests that there has been limited research exploring this topic. Whilst aspects of psychometrics of these assessments have been investigated to some extent, neither of these assessments have reported measurement error, content validity, responsiveness or sensitivity (George et al, 2020a).

For assessments to be meaningful, relevant and effective they need to be standardised and demonstrate good performance in psychometric characteristics of validity, reliability and responsiveness (Finch et al., 2003; Terwee et al., 2003). The CABA's ability to quantify observational assessment of body posture enables changes to be determined accurately and quickly as an integral part of a child's day-to-day function, instead of in a one-off specific position, setting or task. The CABA thus provides a consistent method for physiotherapists to identify, describe and evaluate body alignment of a child at a particular point in time.

In terms of variability between the raters, overall scores were shown to be excellent ICC's (2,11) >0.90, indicating that all raters had a high level of agreement in inter-rater and intra-rater situations and the CABA is fit for purpose. Interestingly, all raters had high levels of intra-rater reliability, indicating that raters' clinical experience, their place of work and specialty had little impact on their ability to reliably use the CABA. A possible explanation for this is the extensive content validity process undertaken in the CABA's development, with contribution from over 280 paediatric physiotherapists (George et al, 2000b). The CABA was developed to be a clinically usable tool which can be easily applied to clinical practice, with low user demand.

Construct validity

Early identification and monitoring of body alignment asymmetry are important aspects of managing a child's posture and function (Gericke, 2006). The ability to determine changes in body alignment early can prevent the development of musculoskeletal complications (Hagglund et al, 2014; Porter et al, 2008; Scrutton, 2008) and assist in the effectiveness of posture management interventions (Hagglund et al, 2014; Pountney et al, 2009; Farley et al, 2003). The CABA is able to reliably detect changes in body alignment from optimal, providing a clinical assessment which is consistent in monitoring a child's postural alignment by either the same or multiple therapists.

Construct validity for the CABA scoring was evaluated through its ability to differ between known GMFCS levels in children with CP. Overall the CABA demonstrated statistically significant ability to differentiate between all GMFCS levels ($p < 0.001$) with the exception of GMFCS levels I and II, and levels II and III. The primary differences between children classified at GMFCS levels I, II and III pertain mainly to mobility (Palisano et al, 2008) with little differences described in terms of body alignment support (Rosenbaum et al, 2007). Whilst other postural assessments have only examined psychometric properties from GMFCS Level II (Rodby-Bousquet et al, 2013), the CABA examined body alignment across all GMFCS levels.

Responsiveness

The CABA demonstrated statistically significant differences in detecting changes in body alignment using the posture categorisations across all positions of lying, standing and sitting, and across all body segments ($p<0.001$). These results may be explained by the fact that postural equipment aims to provide a stable and energy efficient position from which a child can function (Gericke, 2006). The principles of this relate to maintaining an individual's centre of gravity within their base of support (BoS): support is provided to central body segments such as the head, trunk, pelvis and legs which form the BoS and improve stability and function (Dusing & Harbourne, 2010; Harris & Roxborough, 2005). Activity and participation are an integrated aspect of posture management, a collective aim is to prevent body alignment deformity whilst promoting functional skills (Gericke, 2006). Without support from postural equipment alignment can be significantly deviated from optimal, therefore a greater change in body alignment would be expected between alignment with and without equipment. These results further support the association between gravity and postural deviation and deformity in children with CP (Novak et al, 2020; Dewar et al, 2015).

In terms of responsiveness to change at GMFCS level for the dimension of body segments, individual GMFCS IV and V were statistically significant for each body segment with the exception of head GMFCS IV (p=0.114) and arm GMFCS V (p=0.04). These discrepancies could be attributed to specific body segments and CP classification. The head result could be attributed to the fact that children classified as GMFCS IV typically can maintain independent head alignment (Palisano et al, 2008); consequently change in CABA scores is lower for this classification group with equipment compared to without. In regards to arm alignment, the reason for this is unclear, but may relate to children at GMFCS IV having more active movement compared to GMFCS V (Palisano et al, 2008). Children at GMFCS IV may be more likely to be able to adjust arm position as a result of improved stability and improved body alignment (Carlberg & Hadders-Algra, 2005); consequently, change in CABA scores is higher for this classification group with equipment compared to without. However no comparable statistical significance was found between GMFCS IV and V at any individual body segment. Whilst these results suggest that the CABA is responsive to changes in alignment at GMFCS IV and V across all its dimensions, the adjusted p level may have resulted in type 2 errors. Therefore, these results need to be interpreted with caution.

Study Limitations

Whilst it is recognised that the CABA is designed to be used as a clinical observation tool the use of photographs may mean that the overall reliability may be lower in a clinical scoring session than reported in the current study. Clinical postural evaluation is a difficult task; the use of photographs in assessment of posture has been used in several studies (Fortin et al, 2011), with a consensus that measurement photographs may be the most comprehensive and rapid way to assess posture. The use of photographs can minimise measurement error and demonstrates merit for clinical based assessment (Do Rosario, 2014; Dunk et al, 2005).

The selection of photographs enabled raters to participate and score 5 children, each across 3 positions, twice. This meant that each rater made a total of 6 observations per child, across all positions at each GMFCS level. Had this study been conducted in a clinical setting it is highly unlikely that this number of raters and observations across the diversity of children would have been possible. It is recognised that in everyday clinical assessment sessions, scoring is likely to involve a smaller number of children across one or two positions. In this stage of the assessment's development, it was important to establish the reliability of CABA's scoring ability whilst minimising errors in measurement. Further studies examining the CABA's use in clinical settings would further our understanding of the relevance and use of the tool to guide health provision.

As part of the development of this new assessment we acknowledge that the relatively small sample of children with CP may have limited the generalizability of the findings. However, in the conduct of preliminary reliability studies, only a small sample size is required especially when a very high value of ICC is set for result significance (George et al, 2020b). Future studies examining reliability of the CABA against a larger sample of children with CP, and in children with other medical diagnoses and/or neurological disabilities, would further support the generalizability of the results of this study. Evaluation of the tool's use is on-going to assist with refinement of its clinical usability.

Conclusion

The findings from this preliminary study demonstrates that the CABA scoring system has excellent inter-rater and inter-rater reliability across all dimensions of body segments and positions; lying, sitting and standing. Whilst it demonstrates overall statistically significant construct validity to differ between all GFMCS levels, there are some limitations between lower levels. The CABA has demonstrated responsiveness to immediate change in body alignment when posture management equipment is used, and offers clinicians and researchers a rigorously developed clinical tool which has built a platform for further clinical based examination.

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Further studies examining the CABA's psychometric properties and role as a standardised outcome measure for alignment in clinical settings is already being undertaken. Further research examining the CABA's usability across a range of conditions, adults and children, would examine the CABA's role in posture management practices across wider clinical presentations.

Key points:

- The Clinical Assessment of Body Alignment items show high psychometric properties for children with CP.
- In a relatively small sample this study shows the CABA to be a standardised clinical assessment demonstrating excellent validity and reliability.
- Further studies to assess the CABA's responsiveness in response to postural therapeutic interventions are required.

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