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ASSESSMENT PROCEDURE

Reliability and validity of the Eating and Drinking Ability Classification System (EDACS) for children with cerebral palsy in Taiwan

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ABSTRACT

Purpose: The study was to assess the inter- and intra-rater reliability, construct validity and utility of the Eating and Drinking Ability Classification System (EDACS).

Methods: EDACS was translated into in Taiwan using an interactive process. Agreement between health professionals and teachers when using EDACS was assessed using Kappa and the Intraclass Correlation Co-efficient.

Results: Paired ratings of 4 (13%) health professionals (either speech or occupational therapists) and 26 (87%) teachers were obtained for 53 children with CP aged 6.7 years (SD 4.1 years), who worked in six education institutions. The raters used EDACS independently to classify children's eating and drinking ability and re-classified children's eating and drinking abilities after one month. Pairs of raters showed substantial agreement for the EDACS level at the first assessment ($k = 0.75$; absolute agreement = 81%; ICC = 0.94) and the second assessment ($k = 0.70$; absolute agreement = 77%; ICC = 0.95). The intra-rater reliability of EDACS level showed almost perfect agreement at rater 1 ($k = 0.87$; absolute agreement = 91%) and rater 2 ($k = 0.87$; absolute agreement = 91%).

Conclusions: We conclude that the Chinese version of EDACS is valid and reliable to be easily used by health professionals and teachers to classify functional eating and drinking abilities in children with cerebral palsy.

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KEYWORDS
Cerebral palsy; eating; drinking; swallowing; safety; efficiency; functional classification system

➤ IMPLICATIONS FOR REHABILITATION

- The Chinese version of EDACS is valid and reliable to be easily used.
- EDACS can be used by health professionals and teachers to classify functional eating and drinking abilities in children with cerebral palsy.
- The EDACS is analogous to other functional classification systems (i.e., GMFCS, MACS and CFCS) and specifically represents eating and drinking ability.

Introduction

People with cerebral palsy (CP) are affected by a range of activity limitations, attributed to non-progressive disturbances occurring in the developing fetal or infant brain [1]. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication, and behaviour; by epilepsy, and by secondary musculoskeletal problems [1]. People with CP experience eating, drinking and swallowing difficulties, frequently associated with malnutrition, dehydration, choking and compromised respiratory function linked to particles of food or fluid entering the lungs (i.e., aspiration) [2–5]. Activity limitations also affect bringing food and drink to the mouth. The degree to which a person with CP can control the posture and movement of the trunk and head has a direct impact on the efficient use of the muscle systems which support eating, drinking and swallowing and breathing [6,7].

Prevalence of eating/drinking/swallowing difficulties has been estimated to be as high as 85% [8] with anecdotal and emerging evidence that limitations increase with age [9,10]. Fatal consequences of choking and aspiration were evident in a UK study where 22% of identified deaths for people with CP resulted from solids or liquids in the lungs or windpipe [11].

The strongest modifiable risk factor for respiratory hospitalisations for young adults with CP is oropharyngeal dysphagia (i.e., eating, drinking and swallowing difficulties) [12,13]. Respiratory deterioration and premature death can be prevented by addressing underlying factors linked to eating/drinking/swallowing. The need to identify risk factors and evidence based preventative measures for the benefit of people with CP is recognized [14,15].

The Eating and Drinking Ability Classification System (EDACS) [16] is analogous and complementary to the Gross Motor Function Classification System (GMFCS) [17], the Manual Ability Classification System (MACS) [18] and the Communication Function Classification System (CFCS) [19]. Each of these Functional Classification Systems describe functional ability of people with CP using five distinct levels which are meaningful in

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daily life. They replace poorly defined, value laden terms such as mild, moderate and severe. Functional Classification Systems are considered to be useful in both clinical and research contexts because they can facilitate clear communication and planning at local and national level. Different Functional Classification System levels can be used to consider different clinical management options and enable clear reporting of research findings contributing to the clinical evidence base. In some cases, these Functional Communication Systems (FCS) enable prediction of future outcomes through the stability of the assigned FCS level [20].

EDACS classifies the eating, drinking and swallowing abilities of individuals with CP in five distinct levels, using the key features of safety and efficiency [16]. EDACS has strong evidence of content and construct validity, and excellent intra- and inter-observer reliability when used by speech and language therapists and parents. EDACS is now recognised as the gold standard measure of eating and drinking ability for people with CP [5,21–23]. The construct validity, content validity and usability of EDACS has been examined when translated into German [24] and Dutch [25].

The aim of this study was to undertake a programme of work to translate the EDACS into Chinese, including cross-cultural adaptations, following the methods set out by Eremenco et al. [26]. This was followed by an assessment of the inter- and intra- rater reliability, construct validity and utility of the Chinese EDACS when used by teachers and health professionals.

Our research questions were:

1. What is the translated content of the Chinese version of EDACS?
2. What is the inter- and intra-rater reliability of the Chinese version of EDACS when used by health professionals and teachers?
3. What is the association between EDACS and other Functional Classification Systems developed for people with CP i.e., GMFCS, MACS and CFCS?

Method

Stage 1 translation

The translation of EDACS was undertaken using an interactive process [26]. Firstly, two physical therapists independently translated the EDACS into Chinese. These two versions were examined and then combined into a single consensus version, by the first author. The consensus version was then translated back into English by the first author. The lead developer of EDACS (forth author) then checked the back translation in order to ascertain the accuracy and integrity of the content. The first and forth authors held a series of meetings to discuss potential misunderstandings, mis-translations, disagreements, cultural differences and areas of ambiguity. The Chinese version was amended following these discussions until all issues were addressed.

Results

The EDACS comprises two ordinal scales: someone's eating and drinking ability is described using one of five levels (I to V); someone's need for assistance in bringing food and drink to the mouth is described with one of three levels (Independent, Required Assistance, Totally Dependent). Following discussions between first and second authors, the following modifications were made to the Chinese translation of EDACS.

1. Use of medical terminology was reduced in order that EDACS be understood by parents, carers and non-health professionals
2. Following the ICF framework, all words and phrases which carried a value judgement or described a lack of ability were altered to neutral non-judgmental wording. ICF describes someone's function and ability.
3. The distinction between the two ordinal scales contained within EDACS was made clearer. The ability to eat/drink/swallow is different from the physical skills required to bring food and drink to the mouth. Therefore, someone who is unable to eat and drink safely and is able to bring food and drink to the mouth would be described as *EDACS Level V* and *Independent*. An individual who is able to eat and drink safely with some limitations to efficiency and who is dependent upon others to bring food and drink to the mouth would be described as *EDACS Level II* and *Totally Dependent*.
4. The translation of the food texture and fluid consistency types and descriptions represented a particular challenge because of the cultural difference in cooking and eating habits. Therefore, we went through a cross-cultural adaptation process for the content of food, for example, using "risotto" to replace "well cooked pasta."

The Chinese version of EDACS is comprehensible for all Chinese-speaking countries and has a strong convergence with the original English version. The Chinese version of EDACS manual is available to download from the EDACS website (www.EDACS.org) [27].

Stage 2: reliability and validity

A prospective cross-sectional psychometric study was carried out in Taiwan to examine the psychometric properties of EDACS. Children with cerebral palsy were recruited to the study *via* advertisements through the primary schools, related organizations, outpatient clinics and community newsletters. Children with cerebral palsy were eligible if they had been diagnosed with cerebral palsy, aged between 3 to 18 years. Children had a range of cognitive impairments and different degrees of limitations to communication including speech and language difficulties. First author recorded information about characteristics of participants (age, sex, type of cerebral palsy) and used the GMFCS, MACS, CFCS to classify their functional abilities in these domains. Details about the raters' sex, education status, profession, and number of years' experience working with children with cerebral palsy was recorded. The number of years they had known the participants, prior to their use of EDACS was also recorded. National Cheng Kung University Human Research Ethics Committee approval was given to conduct this study. Informed consent from parents or guardian of participants was obtained prior to data collection.

Data collection procedure

Two raters who knew each child, independently classified their eating and drinking abilities using EDACS from observations of their daily mealtime routines. This included use of the five level ordinal scale describing someone's eating and drinking ability, and the separate three level ordinal scale describing the level of assistance required at mealtimes. We identified the rater who knew the child the best at mealtimes and was most familiar with the child as rater 1; we identified the rater who observed the child's mealtimes occasionally as rater 2. All raters were familiar with the eating and drinking of participants. Raters were either therapists (occupational or speech therapists) or educators. All raters read the Chinese version of EDACS and were given the opportunity to discuss and clarify any questions with the first

Table 1. Characteristics of participants ($n = 53$).

Age (yr), mean (SD)	6.7 (4.1)
Sex, n females (%)	19 (36)
Type of cerebral palsy, *n* (%)	
Diplegia	14 (26)
Hemiplegia	5 (10)
Quadriplegia	34 (64)
GMFCS, *n* (%)	
Level I	1 (2)
Level II	10 (19)
Level III	5 (9)
Level IV	19 (36)
Level V	18 (34)
MACS, *n* (%)	
Level I	1 (2)
Level II	6 (11)
Level III	9 (17)
Level IV	13 (16)
Level V	15 (18)
CFCS, *n* (%)	
Level I	3 (6)
Level II	7 (13)
Level III	6 (11)
Level IV	19 (23)
Level V	15 (28)

GMFCS: Gross Motor Function Classification System; MACS: Manual Ability Classification System; CFCS: Communication Function Classification System.

author about use of EDACS to classify children's eating and drinking ability. Training was given to each rater to ensure they understood how to use EDACS including the two ordinal scales; each rater practiced using EDACS on 2 or 3 children who were not included in the research sample with the first author.

The second assessment (intra-rater reliability) took place one month after the first one in order to reduce memory bias (i.e., remembering the classification level chosen). Two raters classified the children according to the EDACS levels again by observing the children's performance in daily eating and drinking.

Statistical analysis

Descriptive statistics were used to characterize the participants and raters. Following the original study design [16], the inter-rater reliability of the Chinese version of EDACS, when used by paired independent observers was calculated using Cohen's unweighted Kappa (k): absolute agreement and extent to which agreement exceeded chance. Intra-rater reliability was calculated using Cohen's unweighted Kappa (k) from paired observations made by the same raters at two time points. Intraclass Correlation Coefficient (ICC) (two-way random effects single measures consistency) was calculated to assess reliability across all raters and all time points. The following criteria for the degree of agreement were used for the Kappa coefficient interpretation: fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80) and almost perfect (0.81–1.0) [28]. Kendall's tau-b was used to verify the associations between the EDACS, and the GMFCS, MACS and CFCS. A score of 1 indicates a perfect positive correlation and −1 indicates a perfect negative correlation.

Results

Characteristics of participants

The study population comprised 53 children with cerebral palsy from six education institutions aged 6.7 years (SD 4.1 years), of which 19 (36%) were female, (Table 1). Fourteen (26%) had diplegia, 5 (10%) had hemiplegia and 34 (64%) had quadriplegia. The majority were classified as GMFCS Level IV or V (70%), MACS Level III, IV or V (51%) and CFCS Level IV or V (51%).

Table 2. Characteristics of raters ($n = 30$).

Experience (yr), mean (SD)	5.3 (6.3)	
Sex, *n* females (%)	30 (100)	
Education status, *n* (%)		
Tertiary	27 (90)	
Master	3 (10)	
Profession, *n* (%)		
Regular teacher	26 (87)	
Speech therapist	3 (10)	
Occupational therapist	1 (3)	
Acquaintance of participants (yr)	Rater 1 *n* (%)	Rater 2 *n* (%)
<1	27 (51)	26 (49)
1 ~ 2	8 (15)	24 (45)
2 ~ 3	16 (30)	3 (6)
>3	2 (4)	0 (0)

Characteristics of raters

Thirty raters working in six education institutions used EDACS to classify children's eating and drinking performance (see charateristics of raters in Table 2). Raters had different levels of experience in working with children with CP: ranging from less than 1 year to 22 years, with a mean 5.3 years (SD 6.3 years). All 30 raters were female. Twenty-seven (90%) had a tertiary degree and 3 (10%) had a masters degree in a related discipline. The majority of raters had known participants for less than 1 year. (Table 2).

EDACS inter-rater agreement and disagreements

Agreement at first assessment between independent raters (Table 3) was substantial for the EDACS level ($k = 0.75$; absolute agreement = 81%; ICC = 0.94, 95%CI = 0.90–0.97) and level of assistance ($k = 0.68$; absolute agreement = 81%; ICC = 0.84, 95% CI = 0.72–0.91).

Agreement at second assessment between independent raters (Table 3) was substantial for the EDACS level ($k = 0.70$; absolute agreement = 77%; ICC = 0.95, 95%CI = 0.91–0.97) and almost perfect for the EDACS level of assistance ($k = 0.90$; absolute agreement = 94%; ICC = 0.84, 95% CI = 0.91–0.97).

EDACS intra-rater reliability

Agreement between first and second assessments by rater 1 (Table 4) was almost perfect for the EDACS level ($k = 0.87$; absolute agreement = 91%) and substantial for the EDACS level of assistance ($k = 0.71$; absolute agreement = 83%). Agreement between first and second assessments by rater 2 was moderate for the EDACS level ($k = 0.58$; absolute agreement = 68%) and substantial for the EDACS level of assistance ($k = 0.74$; absolute agreement = 85%). The ICC for the EDACS level and the level of assistance was 0.97 (95%CI = 0.95–0.98) and 0.94 (95% CI = 0.91–0.96) respectively.

Comparisons between EDACS and GMFCS, MACS or CFCS

There was a statistically significant but only low to moderate positive correlation between the EDACS level and the GMFCS (0.41, $p < 0.01$), the MACS (0.58, $p < 0.01$) or CFCS (0.22, $p < 0.01$). There was a statistically significant but only low to moderate positive correlation between the EDACS level of assistance and the GMFCS (0.54, $p < 0.01$), MACS (0.60, $p < 0.01$) and CFCS (0.30, $p < 0.01$). Distribution of EDACS level and the level of assistance compared with GMFCS, MACS and CFCS is presented in Table 5.

Table 3. EDACS Inter-rater agreement and disagreements.

	Rater 2					
Rater 1	I	II	III	IV	V	Total
First assessment						
I	5	0	1	0	0	6
II	0	9	1	0	0	10
III	0	4	16	0	0	20
IV	0	0	1	11	3	15
V	0	0	0	0	2	2
Total	5	13	19	11	5	53
Second assessment						
I	5	0	0	0	0	5
II	2	9	2	0	0	13
III	0	1	14	4	0	19
IV	0	0	2	11	1	14
V	0	0	0	0	2	2
Total	7	10	18	15	3	53

	Rater 2			
Rater 1	Independent	Required assistance	Dependence	Total
First assessment				
Independent	4	1	1	6
Required assistance	0	17	3	21
Dependence	1	4	22	26
Total	5	22	26	53
Second assessment				
Independent	7	1	0	8
Required assistance	0	14	1	15
Dependence	1	0	29	30
Total	8	15	30	53

Table 4. EDACS intra-rater reliability.

	Second assessment					
First assessment	I	II	III	IV	V	Total
Rater 1						
I	5	0	1	0	0	6
II	0	10	0	0	0	10
III	0	3	17	0	0	20
IV	0	0	1	14	0	15
V	0	0	0	0	2	2
Total	5	13	19	14	2	53
Rater 2						
I	5	0	0	0	0	5
II	2	7	4	0	0	13
III	0	3	12	4	0	19
IV	0	0	2	9	0	11
V	0	0	0	2	3	5
Total	7	10	18	15	3	53

	Second assessment			
First assessment	Independent	Required assistance	Dependence	Total
Rater 1				
Independent	5	0	1	6
Required assistance	3	14	4	21
Dependence	0	1	25	26
Total	8	15	30	53
Rater 2				
Independent	5	0	0	5
Required assistance	2	15	5	22
Dependence	1	0	25	26
Total	8	15	30	53

Discussion

This study found that the Chinese version of the EDACS levels and the level of assistance had almost perfect or substantial inter- and intra-rater reliability when used by health professionals and educators. There was only moderate intra-rater reliability when EDACS was used by Rater 2 over 2 different time points. Raters who were either therapists (occupational or speech therapists) or educators only observed the child's mealtimes occasionally. When the Chinese version of the EDACS levels and the level of assistance was compared with other functional classification scales (i.e., GMFCS, MACS, CFCS), there was only low to moderate positive correlation.

Table 5. Distribution of EDACS level compared with other classification scales.

	EDACS level					
Rater 1	I	II	III	IV	V	Total
GMFCS						
I	1	0	0	0	0	1
II	2	5	1	2	0	10
III	1	0	3	1	0	5
IV	2	0	7	0	0	9
V	0	5	9	12	2	28
Total	6	10	20	15	2	53
MACS						
I	1	0	0	0	0	1
II	2	3	1	0	0	6
III	3	2	1	3	0	9
IV	0	5	12	2	0	19
V	0	0	6	10	2	18
Total	6	10	20	15	2	53
CFCS						
I	1	1	1	0	0	3
II	2	1	3	1	0	7
III	2	0	1	3	0	6
IV	0	6	9	6	1	22
V	1	2	6	5	1	15
Total	6	10	20	15	2	53

	EDACS level of assistance			
Rater 1	Independent	Required assistance	Dependence	Total
GMFCS				
I	1	0	0	1
II	3	7	0	10
III	1	2	2	5
IV	1	4	4	9
V	0	7	21	28
Total	6	20	27	53
MACS				
I	1	0	0	1
II	3	3	0	6
III	2	5	2	9
IV	0	10	9	19
V	0	2	16	18
Total	6	20	27	53
CFCS				
I	1	2	0	3
II	1	4	2	7
III	1	2	3	6
IV	1	10	11	22
V	1	3	11	15
Total	5	21	27	53

Inter- and intra-rater reliability

In terms of inter-rater reliability, when pairs of raters independently rated children's eating and drinking ability using the EDACS level and level of assistance, levels of agreement were substantial. Ratings of EDACS level of assistance were almost perfect at second assessment. The findings support use of EDACS by educators and health professionals to describe children's eating/drinking and swallowing abilities. Our findings are similar to those

reported by van Hulst et al. [25] where inter-rater reliability between parents and health professionals was examined. In addition, our findings contrasting observations made by raters who were familiar with the child with those made by raters unfamiliar with the child was similar to van Hulst's [25] observations from speech and language pathologists who were familiar or unfamiliar with the child. The professional backgrounds and training of our evaluators are markedly different from previous studies where raters were either parents or speech pathologists [16,24,25]. This supports use of EDACS with professionals from different backgrounds as the content of EDACS appears to be readily understood. EDACS provides a means to communicate the eating and drinking abilities of individuals with cerebral palsy between regular teachers and healthcare professionals.

There were differences in intra-rater reliability between Rater 1 s, who were more experienced and Rater 2 s who had less direct knowledge of working with the participants. Intra-rater reliability for all Rater 1 s was substantial to almost perfect for the EDACS levels, but the rater 2 was from moderate to substantial. This could be explained by the raters' familiarity with the participants. Rater 1 s who spent more time with participants in the organizations routinely observed participants through different meal times and were more likely to participate in decisions around suitable food textures and fluid consistencies, and management strategies. Rater 2 s were less familiar with usual mealtimes and had less knowledge of participants to draw upon, to support the mealtime observations made.

Each EDACS level describes the safety and efficiency of someone's eating and drinking ability using between 8 and 13 bullet points. The different domains include oral movements used, coordination between breathing and swallowing, food and fluid loss from the mouth, techniques used to eat and drink, and the food textures and fluid consistencies that someone can safely manage. In some settings, it is possible that children were not given food textures and fluid consistencies that demonstrated greater levels of skill. For example, if individuals are only offered smooth purees or well mashed food consistencies, they will not demonstrate biting and chewing skills linked to more challenging food textures. Less challenging food textures may by selected to reduce risks linked to choking and aspiration. This may lead raters to select an EDACS level indicating that an individual has more limitations to function than would be the case if more challenging food textures were available.

In a previous study, Sellers et al. [16] reported differences in ratings between parents and therapists that seemed to be linked to different mealtime objectives: parents were more willing to offer their children food textures and fluid consistencies that practiced skills at the edge of their children's abilities, whereas therapists aimed to reduce risks of choking and aspiration at mealtimes. This supports involvement of parents who are familiar with their children's skills to determine which EDACS level best describes their children's usual eating and drinking performance.

Relationships between the EDACS and other functional classification systems

The relationship between the EDACS levels for the children in the study, and the GMFCS and MACS was similar to that observed in other studies [9,16,24]. There was a moderate positive correlation; close examination of differences reveals that in 20% of cases, there was a difference of more than two levels in either direction. That is to say that we cannot use the GMFCS or MACS level to predict someone's eating and drinking ability measured using EDACS. The population selected for study will affect correlations between FCS. Seventy percent of participants in this study were classified as GMFCS levels IV or V; the full range of eating and drinking ability EDACS I to V were recorded for these participants. Two participants were classified as EDACS Level V by Rater 1 and 2, and both were GMFCS Level V. There was some uncertainty about whether children with most limitations to eating and drinking ability are represented in this study. Children with most limitations to eating and drinking ability are likely to be dependent upon tube feeding in order to remain healthy, grow and stay alive. It is possible that some institutions cannot manage enteral feeds for children so they do not attend school; this would account for their under-representation in our study population.

There was a higher correlation between MACS levels and EDACS levels, than GMFCS, which is consistent with previous findings [24]. For example, when looking at the distribution of EDACS and MACS levels, 60% of participants who were classified as EDACS Level III were classified as MACS Level IV. Perhaps, both EDACS and MACS levels reflect the degree to which the upper body is affected by cerebral palsy; it is likely that greater head, neck and trunk control that will support greater selective motor control of the arms, hands, face, mouth and tongue. Participants classified as GMFCS Level IV or V may also have suitable adapted seating systems which support greater selective motor control for eating and drinking. Taken together, these findings support the current view that EDACS and other Functional Classification Systems are each needed to obtain a comprehensive picture of the functional abilities of the child with CP. Our findings support the view that each individual scale is distinct enough from the others to represent different functions of the motor system [16,24,29].

The correlation between either EDACS level or level of assistance and CFCS showed only low association in our study. Other studies have shown moderate associations, but always lower than between EDACS and GMFCS, or EDACS and MACS [16,24]. The CFCS classifies the effectiveness of communication between a sender and a receiver, and considers all forms of communication including speech, gesture, facial expression and Augmentative and Alternative Communication. It also considers familiarity of a person's communication partner. The CFCS does not describe the functional movements required to speak or communicate using the face. The EDACS describes the safety and efficiency of movements required for eating and drinking, including biting, chewing and swallowing. When looking at the distribution of CFCS and EDACS levels between our and Tschirren's studies [24], more than half of participants were classified as CFCS Level IV–V and I–II respectively as well as EDACS Level III-IV and I-II respectively. The children in our study population showed more limitations in both communication participation (CFCS) and eating and drinking (EDACS). It is possible that the lower correlation between CFCS and EDACS levels, was linked to the younger age of participants where communication skills including the use of AAC is still developing.

Limitations

One limitation of this study is that data collection was limited to professionals working in education institutions where selected groups of children with CP attend. Participants with fewest limitations to motor ability were not well represented in the study sample. Participants were mostly classified as having the greatest limitation to function across all classification systems (e.g., MACS and GMFCS levels III to V); all would receive individualized

adaptations for mealtimes if necessary. These adaptations could be seat adjustments, special tables, adapted tableware and cutlery to improve eating and drinking abilities. Secondly, there were 38 participants (72%) under 6 years of age in our study. There is currently only limited evidence to support stability of EDACS levels for children with cerebral palsy over 3 years old [9]. It is possible that food and fluid textures suitable for much younger children continue to be given to older children with CP regardless of biting, chewing and swallowing abilities; routine assessment of eating, drinking and swallowing by registered health professionals such as speech and language therapists is not commonplace in the education institutions included in this study. Lastly, all raters observed participants during mealtimes only in the institutions. We are unsure whether food texture and fluid consistency choices made in the education institutions were the same as those selected at home. It is possible that raters' observations around oral movements and safe swallowing would be limited if exposure to more challenging food textures was limited for each participant.

Conclusion

We confirmed that the Chinese version of EDACS is reliable and an easily applicable tool to classify functional eating and drinking abilities in children with cerebral palsy when used by experienced health professionals and regular teachers. It could be used to enhance the communication concerning eating and drinking abilities for children with cerebral palsy among professionals and regular teachers at schools. The EDACS is analogous to other functional classification systems (i.e., GMFCS, MACS and CFCS) and specifically represents eating and drinking ability in children with cerebral palsy.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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