

# An addition to existing strength measures in children with cerebral palsy

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## **SUMMARY**



This dissertation mainly focuses on the clinimetric properties of the newly developed task-oriented strength measure, the TAAC. **Chapter 1** starts with a general introduction about children with CP, the importance of strength measures and the TAAC. CP accounts for being the largest diagnostic group treated in pediatric rehabilitation. The most common impairments of CP are random, uncontrolled body movements caused by muscle coordination problems. These muscle coordination problems exist of co-activation of agonist–antagonist muscles, spasticity, increased muscle tone, muscle weakness, and limited range of motion, which affect gross and fine motor function. Muscle weakness is a major disabling factor in the functioning of children with CP, especially in the upper limb. Muscle weakness is defined as the decreased ability to generate and control sufficient voluntary muscle force needed for an effective muscle performance.

Because of the impairments in arm-hand functioning, children with CP have limitations in performing activities of daily life (ADL). ADL are defined as “life tasks required for self-care and self-maintenance” and therefore fundamental to support the participation in society. As a result of the limitations in their execution of ADL, children with CP experience greater dependency, restricted social participation, and a decreased quality of life.

Rehabilitation is mainly aimed to improve motor function, so children with CP increase the ability to perform activities and become more independent. A framework that is often used during rehabilitation is the ICF-CY. It is divided in three levels, i.e. body functions and structures level, activity level and participation level. In the last decades, the focus of rehabilitation have shifted from the body function and structures level of the ICF towards the activity and participation level. Indicating the importance of functional therapy, wherein functional ADL activities are trained during therapy.

For clinicians it is common to measure strength. In standard approach strength is measured as muscle-based in two different ways: dynamic (isotonic and isokinetic) and static (isometric). Although, therapy principles have shifted towards functional therapy focusing on improving the performance of ADL, tests measuring the strength while performing ADL tasks are lacking. Functional strength represents the strength, which is necessary to perform an ADL task, such as lifting an object. Information about functional strength allows the therapist to make an adequate analysis about the performance of an ADL task. This information supports the

therapist to formulate an adequate treatment content and contributes to the assessment of treatment goals (diagnostic purpose). Furthermore, after a period of functional therapy, functional strength is assumed to be increased leading to a better performance of an ADL task (evaluative purpose).

Therefore, the TAAC was developed. The TAAC consists of a measuring unit and attachable ADL objects, such as a crate, pitcher and press button. The TAAC contains a sensor, which measures the force while the child lifts or pushes an ADL object. The TAAC instrument measures the maximal voluntary contraction (MVC), i.e. the isometric strength of the child, from the moment the ADL object is pulled up or pushed down until the task is completed.

When a new measure, such as the TAAC, is developed it is important that it is in line with the demand of the clinical practice and that it has sufficient clinimetric properties for its purposes. As the TAAC is developed for discriminative and evaluative purposes, the reliability, validity and responsiveness should be investigated.

The first aim of this dissertation was to check in the literature whether therapy that claims to be functional used the criteria of functional therapy to describe their intervention. These criteria also are the basis for the development of new measures investigating functional abilities, such as the TAAC. **Chapter 2** describes the results of a systematic review. The aim of this systematic review was to review definitions and elements of interventions in studies, which used the word "functional" to describe their intervention for children with cerebral palsy (CP), and to determine whether definitions and elements are similar to criteria of functional therapy described in the Dutch Guidelines. A total of 27 studies were included. Based on the results, the criteria "based on the activities/participation level of the ICF-CY", "goal-directed" and "context-specific" were referred to the most (40-59.3%). Descriptions of these criteria were less comparable to the suggested definition (43.8-69.2%). The remaining three criteria ("active involvement", "task-specific" and "focused on functionality instead of normality") were referred to less frequently (18.5-33.3%). The descriptions reported for these criteria were, however, the most comparable with the suggested definitions (80-100%). In conclusion, the included studies, in general have not used criteria of functional therapy. Future studies have to describe the elements of interventions in detail. Moreover, it is important to reach consensus on the definition and elements of functional therapy.

The second aim of this dissertation is to investigate the clinimetric properties, i.e. reliability, validity and responsiveness, of the different tasks of the newly developed TAAC in children with unilateral CP. The aim of **chapter 3** is to examine reproducibility of the arm-hand strength measured while performing the bimanual crate task and the unimanual pitcher task with the TAAC. For this study, 105 children diagnosed with unilateral CP, aged between 6-18 years, were included. The test-retest reliability of the force generated during bimanual crate task and unimanual pitcher task of the TAAC was investigated. The results showed good test-retest reliability for the crate and pitcher task with the non-affected hand for both age groups. The results of the pitcher task for the affected hand showed moderate test-retest reliability for both age groups. It was concluded that the TAAC is a reliable instrument to assess task-oriented strength in children with unilateral CP.

The reproducibility of the press button task is investigated in **chapter 4**. The aim is to explore relevant parameters and investigate their test-retest reliability within the scope of the press button task of the TAAC measured in children with unilateral CP. There were 118 children diagnosed with unilateral CP, aged between 6 and 18 years, included in this study. The test-retest reliability of the force generated during the press button task of the TAAC was investigated. The results showed moderate to good test-retest reliability of the parameters "mean peak force of all attempts", "overshoot of force", "number of successful attempts" and "time to complete four successful attempts". The parameters "mean peak force" and "number of successful attempts" are the most relevant parameters, as these parameters are task-specific and the most functional for clinical practice.

Besides the reliability also validity was investigated. **Chapter 5** aimed to investigate aspects of construct validity of peak force measurements of the crate and pitcher tasks using the TAAC in children with unilateral CP by comparing to outcomes of comparative measures using COSMIN guidelines. Children (N=105, mean age=12y 10mo, males=66), diagnosed with unilateral CP participated. Ten a priori hypotheses were formulated with peak force of the TAAC as index measure and compared to measures on body functions & structure and activity level of the ICF-CY. The results showed low to moderate positive correlations on body functions & structures level, and low negative and positive correlation on activity level, as hypothesized a priori. It can be concluded that the construct of peak force measurement of the TAAC is in line with the a priori hypotheses with comparators on body function & structures and

activity level, indicating a partial overlap of the construct of the TAAC with both ICF levels. The TAAC appears valuable as it measures functional strength that differs from the constructs of the comparators. However, more research with a larger population and more comparators is needed.

**Chapter 6** aims to investigate aspects of construct validity of the parameters “mean peak force” and “number of successful attempts” of the press button task using the TAAC in children with unilateral CP. Similar to the method in chapter 5, construct validity was investigated by comparing the outcomes of the parameters to outcomes of comparative measures using COSMIN guidelines. There were 118 children with unilateral CP (mean age 1y2mo, SD 3y5mo) included. Fourteen a priori hypotheses were formulated for each parameter of the TAAC. The results showed that 8/14 (57%) hypotheses could be supported for the parameter “mean peak force”, and 13/14 (93%) hypotheses for the parameter “number of successful attempts”. In conclusion, the hypothesized construct of the parameter “mean peak force” is only partially in line with our idea about the potential relationship of the compared constructs. The relationship needs to be reconsidered to some extent. The hypothesized construct of the parameter “number of successful attempts” is in line with our idea about the potential relationship of the compared constructs and can be considered to have good validity compared to the other measures. Thus the construct of this parameter adds new and meaningful information as an outcome measure for functional strength measurements.

Another clinimetric property investigated in this dissertation is the responsiveness, which is described in **chapter 7**. The aim is to explore responsiveness of measuring task-oriented strength of the crate, pitcher and press button task of the TAAC compared to the E-Link and AHA using a priori hypotheses. Forty-nine children with CP (mean age 11y, 6mo) participated. Data were collected before and after (16-weeks) task-oriented strength training. Responsiveness was determined using the construct-based approach and criterion-based approach between the TAAC and comparators. For the construct-based approach 6/15 hypotheses could be confirmed. The criterion-based approach showed that 13/72 values exceeded the 70%-threshold. Based on these results, the relationship of the constructs of change over time between the TAAC and the comparators as hypothesized should be reconsidered. The TAAC should be used for defining treatment purposes rather than evaluative purposes in clinical practice.

In **chapter 8** a general discussion of the main findings of the studies is provided. Based on the results found in this PhD trajectory, there is a need for a new measure and outcome with a theoretical construct that corresponds with the formulated criteria of functional therapy, such as the TAAC. The TAAC itself appears to be a reliable and valid instrument in a cross-sectional context within our study population of children with CP, as it adds new and meaningful information as an outcome measure, functional strength while performing an ADL task. Therefore, the TAAC is a valuable addition to strength measurements for diagnostic purposes. The TAAC should be measured next to the commonly used strength measurements, such as the grip- and pinch strength and HHD, as different constructs are measured. With the new information collected with the TAAC measurements, therapists can make a better assessment of the performance of ADL tasks, similar as the tasks of the TAAC, and can adjust the content of treatment based on this information. When considering the evaluative purpose of the TAAC, it can be concluded that the TAAC should not be used to evaluate therapy outcomes or progress developmental stages in clinical practice, yet.