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Functional tests assessing manual skills in children with cerebral palsy

Testy funkcjonalne oceniające zdolności manualne dzieci z mózgowym porażeniem dziecięcym

Agnieszka Strączyńska

Department of Physiotherapy, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University
in Torun, Poland

Abstract

Background

The aim of the study is to analyze and identify available functional tests assessing manual skills in children with cerebral palsy, as well as to describe and evaluate usefulness of the available tests in terms of qualitative and quantitative assessment of hand function.

Materials and methods

A review of all available functional scales assessing manual functions in children with cerebral palsy was conducted. Searches were made in the following electronic databases: Medline, PubMed and Cochrane Library. The analysis included all the researched scales related to the upper limb function and cerebral palsy.

Results

The content, methodology and application of 11 functional tests were compared. All available published research studies presented the reliability and validity of the assessment tools.

Conclusions

Scales used to assess manual functions in children with CP are to systemize child's abilities to complement the diagnosis, detect existing dysfunctions and to determine prognostic significance.

Key words: fine motor function, manual skills in children, cerebral palsy

Streszczenie

Wstęp

Celem pracy jest analiza oraz identyfikacja dostępnych testów funkcjonalnych oceniających zdolności manualne dzieci z mózgowym porażeniem dziecięcym. Ponadto, charakterystyka i ocena przydatności dostępnych testów pod względem oceny jakościowej i ilościowej funkcji ręki.

Material i metodyka

Przeprowadzone zostało badanie przeglądowe wszystkich dostępnych skal funkcjonalnych oceniających funkcje manualne dzieci z mózgowym porażeniem dziecięcym. Wyszukiwania dokonano w elektronicznych bazach: Medline, PubMed i Cochrane Library. Do analizy włączono wszystkie badane skale, które dotyczyły zagadnienia funkcji kończyny górnej i mózgowego porażenia dziecięcego.

Wyniki

Porównano zawartość metodologię i zastosowanie 11 testów funkcjonalnych. Wszystkie dostępne badania opublikowały badania nad ważnością i rzetelnością narzędzia oceniającego.

Wnioski

Stosowane skale do oceny funkcji manualnych u dzieci z CP mają za zadanie usystematyzowanie umiejętności dziecka jako uzupełnienie diagnozy, wykrycie istniejących dysfunkcji oraz znaczenie prognostyczne.

Słowa kluczowe: fine motor function, manual skills in children, cerebral palsy

Introduction

Cerebral palsy (CP) is defined as a permanent, non-progressive group of posture and movement disorders that cause activity limitation in children [1]. Almost 50% of children with CP have a reduced function of hands that affects functional independence and performance of daily activities [2] [3]. Due to the difficulties in maintaining and handling toys, they are also accompanied by deficits in experiencing and exploring the surrounding environment [4] [5]. According to the Gross Motor Function Measure (GMFM), general knowledge about the possibility of social participation of a child with CP is highly essential, but it is also of equal importance to assess the activity, functions and skills. A great number of available scales lack the assessment of manual skills, and if they do occur, they do not accurately evaluate the efficiency of hands[6-9]. Testing and assessment of hand function in children with CP is difficult, because there is no single method of assessment that would be universal.

Lots of methods are based on subjective judgment by the examiner, the assessment itself is often time-consuming or there has not been enough researches done on a given scale. Tools for assessing hand function in children with CP should be consistent so that clinicians and therapists can focus their rehabilitation efforts on a specific direction. The strongest predictors of manual dexterity and functional independence are manual dexterity and grip strength in both hands. In a fair qualifying assessment, the representation of these two components should be carefully investigated [10]. In addition, it is crucial to be aware that a developing child up to the age of 1 or 3 does develop manual skills dynamically regardless of the fact whether they have functional limitations. Therefore, each scale requires adaptation of its descriptions also depending on the age of the child with CP [11]. Disorders of hand function in children with CP are often secondary progressive and, therefore, the study of changes in the course of a child's development can help especially when choosing interventions, yet it can also determine the course of disorders over time, i.e. impact predictively [12].

Materials and methods

In August and September 2020, an analysis was carried out in the following electronic databases: Medline, PubMed and the Cochrane Library. Keywords or mesh terms (if applicable) used in the search included "fine motor function in cerebral palsy", "manual skills in children with cerebral palsy" or "manual ability in cerebral palsy". The analysis included all the investigated scales that were primarily concerned with the upper limb function and cerebral palsy. After gathering all available tools, further searches were conducted in the databases which referred to individual tools. All shared systematic reviews as well as studies of the reliability and validity of each scale were identified. Summaries and a full text of all studies were reviewed. Then, a list of functional scales was prepared that listed each tool with information about the age limit of the study, purpose of the scale, time of the study, date of the first publication and some basic methodological research. Scales assessing overall child development, which included subscales assessing motor skills, were not taken into account as these are often non-specific.

Results

The analysis identified 11 tools, scales and / or classifications assessing mainly or only manual skills in children with cerebral palsy [Tab. 1].

Table 1. Selected functional scales assessing manual skills in children with cerebral palsy.

ScaleName	Age Limit	Purpose	Duration	Date of Publication	Training /Cost
BFMF (Bimanual Fine Motor Function)	3-8 years	Describes manual functions classifying a child's ability to grasp, hold and manipulate objects in each hand separately	A few minutes	2002	Self-study/ payment required
MACS (Manual Ability Classification System)	4-18 years	Evaluates how children use the upper limbs in activities of daily living	2 min	2006	Self-study/no charge
AHA (Assisting Hand Assessment)	12 months - 12 years	Assesses the activity of the upper limbs in unilateral dysfunction	10-15 min	2007	Training and payment required
MULL (Melbourne Assessment of Unilateral Upper Limb Function - MA)	5-15 years	Describes the movement patterns of the upper limb	30 min	1994	Self-study/ payment required
B+B (Box and Blocks Test)	>6years	Assesses unilateral manual skills	< 10 min	1985	Self-study/ payment required
CHEQ (Children's Hand-use Experience Questionnaire)	6-18 years	Describes the use of a supporting hand in two-handed activities	15-30 min	2011	Self-study/no charge
ABILHANDS-KIDS	6-15 years	Assesses manual activities of children with dysfunctions in the area of the upper limbs	15-30 min	1998	Self-study/no charge
QUEST (Quality of Upper Extremity Skills Test)	18 months- 8 years	Determines the quality of upper limb movement on the basis of neurodevelopmental therapies	Approx. 45 min	1992	Self-study /no charge
SHUEE (Shriners Hospitals for Children Upper Extremity Evaluation)	3-18 years	Specifies the spontaneous activity and dynamics of the upper limbs	Approx. 15 min	1996	Self-study /no charge
HAI (Hand Assessment for Infants)	3-12 months	Provides qualitative and quantitative measurement of the use of both hands together as well as separately. Assesses the risk of CP	15-30 min	2014	Training required/ no charge
JTHFT (Jebsen-Taylor Hand Function Test)	6-18 years	A test of aneffective use of hands in everyday activities in children with CP	15-30 min	2019	Self study/pa yment required

Discussion

One of the systems that determines the proper operation of both hands is the BFMF (Bimanual Fine Motor Function) scale. The available studies indicate that the BFMF scale may complement the MACS scale, especially if a child demonstrates remarkable motor skills [13]. The MACS scale (Manual Ability Classification System) [14] is currently the most common tool for describing functions of hands in everyday activities. It was created on the basis of GMFCS and it classifies children with CP at five different levels. At level I a child can use objects easily and quickly, while at level V a child has a severely limited predisposition to simple everyday activities. In addition, it is based on a detailed interview with a child's guardian regarding their manual skills. The test is designed to reflect performance of a typical child in everyday situations. Psychometric properties of the scale were analyzed in numerous scientific publications in terms of structure, content, assessment criteria, reliability and credibility [14-18]. The MACS scale is available in an electronic version in 19 different languages. Its application does not require any specialized training. Both BFMM and MACS scales are used to provide subjective assessment of hand function, yet they have been thoroughly constructed so that they objectively assess the performance of a child with MPD. The BFMM provides complementary information on the potential differences between manual skills and the actual use of hands in everyday life classified by the MACS. It primarily illustrates the differences in motor skills between both hands [19].

Another tool for assessing manual skills in children with cerebral palsy is the AHA (Assisting Hand Assessment) test. It is used/applied/implemented to assess hand function in children with difficulties who use one of their hands, i.e. mainly in the case of hemiplegia. The AHA specifies the extent/scope to which the paralyzed upper limb is used in a two-handed activity. The evaluation is performed by observing the spontaneous use of standardized toys. A properly trained therapist leads certain games and the entire session is recorded. The test consists of 22 components that describe the supporting hand with regards to general activities, use of the arm, grasp and release, coordination, pace and rhythm of movements. Each of them has a four-level scale (1 = does not do; 2 = ineffective; 3 = quite effective; 4 = effective). These results add up and at the end can be given/expressed as a percentage. The result of 22 means that the hand is not used at all, and the maximum score of 88 means that the hand is used effectively as a typical non-dominant [20].

Classification that determines the ability of one hand is MUUL (Melbourne Assessment of Unilateral Upper Limb Function, MA). It was designed for children at the age from 5 to 15 years both with cerebral palsy and other neurological disorders. This is a study grounded on a video recording which shows movements of the upper limb based on activities, such as reaching, grasping, releasing and manipulating. It contains 16 elements that are standardized tasks. All of these individual actions are evaluated in four main categories: range of motion, accuracy, fluency and quality of motion on a scale 0-3 or 0-4. The test has a comprehensive description of what is required during the task completion.

The result is converted to a percentage. The higher the percentage score, the higher the quality of movement of the upper limbs. Although detailed evaluation criteria are given in the scale manual, it does not specify the level of training required by the therapist using the MA test [21]. Independent studies by Cusick, Vasquez, Knowles and Wallen (2005) were conducted. They investigated the impact of therapist training on the reliability of the MA test performance, and found that training for novice users increases test knowledge and improves consistency in assessment. The Melbourne Assessment test has been validated and recognized as a reliable [22]. Publications reveal evidence on the content, design and validity of the criteria [23]. Unfortunately, in order to use the test, it is mandatory to pay a fixed fee and undergo an additional training which is the major drawback of this tool. The B+B test (Box and Block Test) is a time-based test implemented to assess unilateral manual skills. It was devised for patients both the youngest ones from 6 years of age and for adults that may have hand dysfunctions. The B+B utilizes a standardized set of instruments necessary to perform the test: a wooden box should measure 53.7 cm x 25.4 cm x 8.5 cm and 150 wooden blocks (cubes) each measuring 2.5 cm. A patient's task is to use the dominant hand at first and move the blocks from one side of the box through the center and then place them on the opposite side, all of this completed within 1 minute. The number of blocks transferred is recorded and a patient repeats the same process with the other hand. It is obvious that there are normative data for both people with disabilities and the blind. The test takes less than 10 minutes. The advantage of the test is both its duration and lack of any required specialist training. The psychometric properties of the test were assessed in terms of their reliability and credibility. The test was described in the eighties, but in recent years it has been applied as a complement to various functional tests [24] [25]. The CHEQ (Children's Hand-use Experience Questionnaire) is designed for children from 6 to 17 years of age with functional limitations in one hand. The test uses/includes activities or tasks in which a patient should use both hands. The questionnaire is completed in accordance with a four-point scale in which the following three components are assessed: the effectiveness of the grip, assistance of the supporting hand and time of task completion. The scale is primarily addressed to children with cerebral palsy, brachial plexus palsy or other disabilities within one hand. The test was reviewed in connection with its credibility and reliability. It is currently translated into 70 languages and it is also available on-line [26]. The ABILHANDS-kids questionnaire is very much alike. It is predominantly filled in by parents / guardians who describe their children's daily bilateral activities. The questionnaire was also designed/devised for children with CP aged 6 to 15 years. It contains 21 questions concerning activities of daily living, such as taking off a T-shirt, filling a glass with water or putting on a backpack. A parent determines whether a given activity is possible to perform, and also whether it is difficult or easy. All the elements are counted in the end regardless of the way they were completed. The analysis can be performed on-line. The ABILHANDS-kids is available in three language versions. There are also numerous publications confirming its accuracy and reliability [27]. The Quality of Upper Extremity Skills Test (QUEST) is a scale that defines quality movement patterns and

movement of the upper limbs in children with CP on the basis of neurodevelopmental therapy. In its assessment it mainly focuses on four elements: the dissociation of movement, catching, defensive extension and shift of the center of gravity. The QUEST describes/specifies a child's ability to withdraw from pathological patterns while performing different tasks. The outcome is given as "yes" or "no" and is added up in all four elements to calculate the total score. Then they are converted into percentage results for further analysis. The higher the score, the better the movement quality. This test can be accessed on-line and it is free of charge. What is more, it does not require any additional training. Scientific publications recognize it as credible and reliable [21] [28] [29]. Another test that describes functions of the upper limb in children with CP is the Shriners Hospitals for Children Upper Extremity Evaluation (SHUEE). It relies on video analysis, which assesses activity of the upper limbs and the dynamics of particular segments engaged in all 16 tasks. The SHUEE is designed for children from 3 to 18 years of age and is administered in a standardized sequence. The SHUEE consists of two sections. The first section assesses passive and active range of motion in joints in the upper extremities, muscle tension, and activities of daily living. The latter section presents the findings based on the recording. The two above-mentioned tests can be accessed on-line and they are for free. The QUEST does not require/necessitate any additional training, while SHUEE offers workshops on video analysis. According to scientific publications, both are considered dependable and reliable [21] [30].

Recently, a new assessment of hand function has been developed in relation to infants aged 3 to 12 months who are at risk of developing cerebral palsy (CP). The scale developed by HAI Krumlinde-Sundholm et al. is an important tool in the assessment of unilateral CP. Early hand preference in infancy may be one of the first symptoms. Contrary to other tools, this scale takes into account an infant's ability to use each hand separately (right and left) as well as both hands together which makes it possible to assess the child's overall hand skills [31]. The HAI is based on 10 to 15 minutes play session which is recorded on video. An examiner interacts with a child while playing so as to provoke a great variety of hand and arm movements. Depending on the possibility of postural control of an infant, he or she sits in a baby bouncer or in a high chair at the table. The toys used for the test are specially selected to induce both one- and two-handed activities. [31] [32]. The use of HAI in infants at risk of bilateral CP is still unexplored. This scale can be useful for this group of children due to its structure measuring both one- and two-handed abilities. However, the assessment of the HAI in these infants still requires further studies on its accuracy and reliability [33].

The last analyzed test is the Jebsen-Taylor Hand Function Test (JTHFT). Likewise all previous scales, it is used to assess manual abilities. It consists of seven unilateral tasks which are administered using standard procedures and verbal instructions. First, the tasks are performed with the non-dominant hand and then with the dominant hand [34]. Tofani et al. conducted studies on the validity and internal consistency of the Jebsen-Taylor Hand Function Test (JTHFT) in children with CP. It was also aimed at providing clarification of the relationship between manual dexterity and manual skills. The results of the JTHFT and MACS tests were evaluated against one other. Correlations were found between the two tests.

Children who show a higher level of MACS need more time to complete the task of the JTHFT or cannot finish it at all. It is presumably because of the relationship between their cognitive level and manual skills [35]. The scale can be a tool to support assessment of hand function in children with CP, however, in this case it would be useful to perform an additional comparison, of specific manual abilities with neurological subtypes.

Conclusions

Majority of literature concerned with the matter described a great number of classifications assessing manual skills in children with cerebral palsy, yet they are not always characterized by high specificity and sensitivity in determining the level of abnormalities. At the same time all of the described tools included most of the elements in line with the ICF classification. Some of them as stand-alone tools are only used to assess the functional upper limb as a complement to the study. The knowledge of individual functional scales not only allows you to monitor the obtained findings of therapy, but it also perfectly helps in determining the reliability of selected physiotherapeutic methods.

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