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Review Article

An integrative review of assessments used in occupational therapy interventions for children with cerebral palsy

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Abstract: Introduction: Children with cerebral palsy (CP) experience a wide range of deficits and symptoms. When undergoing occupational therapy (OT) interventions, it is essential that the OT select assessments that can accurately reflect the outcome measures of the targeted domains. Objective: To identify the assessment tools most frequently reported in research studies as measures for OT interventions when treating children with CP. Method: Pubmed and Ovid databases were systematically searched by using key terms "cerebral palsy," "assessments," and "occupational therapy". Assessment tools were explored and extracted from articles contingent on the following inclusion criteria: (1) children birth to 18 years diagnosed with cerebral palsy; (2) use of assessment(s) as a measure of OT intervention; (3) published in English between 2007 and 2017. In the preliminary search, Pubmed yielded 151 records and Ovid yielded 571. Out of these, only 76 met the inclusion criteria. From the remaining 76 articles, a total of 88 assessment tools were retrieved and included in this literature review. Results: Ten assessments were found to be of importance based on frequency of use. The Assisting Hand Assessment (AHA) and Pediatric Evaluation of Disability Inventory (PEDI) were the most commonly used. Conclusion: This study helps to determine which assessments are frequently used in OT practice with children with CP. The findings of this study play an important role in addressing the challenge of assessment selection faced by occupational therapists and provide a basis for future research to expand on with regards to treating children with CP.

Keywords: *Cerebral Palsy, Occupational Therapists, Assessments.*

Revisão integrativa de avaliações utilizadas em intervenções de terapia ocupacional para crianças com paralisia cerebral

Resumo: Introdução: Crianças com Paralisia Cerebral (PC) apresentam uma ampla gama de déficits e sintomas. Quando submetidos a intervenções de terapia ocupacional (OT), é essencial que as avaliações utilizadas reflitam com precisão as medidas de resultados dos domínios visados. Objetivo: Identificar os instrumentos de avaliação mais utilizados como medidas para intervenções no TO no tratamento de crianças com PC. Método: Bancos de dados Pubmed e Ovid foram sistematicamente pesquisados usando os termos-chave "paralisia cerebral", "avaliações" e "terapia ocupacional". Avaliaçoes foram exploradas e extraídas de artigos contingentes aos seguintes critérios de inclusão: (1) crianças de até 18 anos com diagnóstico de paralisia cerebral; (2) uso da(s) avaliação (ões) como medida de intervenção do TO; (3) publicado em inglês entre 2007 e 2017. Na pesquisa preliminar, foram encontrados 151 artigos em Pubmed e 571 em Ovid. Destes, apenas 76 foram inlcuidos devido aos critérios de inclusão. Dos 76 artigos restantes, um total de 89 avaliaçoes foram encontradas e incluídas nesta revisão da literatura. Resultados: Dez avaliações foram consideradas importantes com base na frequência de uso. A "*Assisting Hand Assessment*" (AHA) e o Inventário de Avaliação Pediátrica de Incapacidade (PEDI) foram os mais utilizados.

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Conclusão: Os achados deste estudo desempenham um papel importante no e do desafio de seleção de avaliação enfrentado pelos terapeutas ocupacionais e fornecem uma base para futuras pesquisas para expandir no que diz respeito ao tratamento de crianças com PC.

Palavras-chave: *Paralisia Cerebral, Terapeutas Ocupacionais, Avaliações.*

1 Introduction

Cerebral palsy (CP) is a non-progressive group of developmental motor disorders that may result in spasticity, paralysis, or abnormal posture (COKER-BOLT; GARCIA; NABER, 2015). CP affects motor skills, movement, and muscle tone and is the most common cause of physical disability in childhood with a consistent prevalence of 3.1 to 3.6 per 1000 births for over the last 20 years (LOWES et al., 2014; CHRISTENSEN et al., 2014). Because CP is a lifelong condition, all aspects of an individual's development and independence are impacted (STEULTJENS et al., 2004). Occupational therapy (OT) is one of many disciplines that provides treatment for children with CP with the goal of optimizing functional abilities and increasing independence (STEULTJENS et al., 2004). OT focuses on skill development to perform activities of daily living, addresses cognitive and perceptual deficits, promotes functional independence, and utilizes a wide variety of interventions and approaches during treatment (STEULTJENS et al., 2004). The American Occupational Therapy Association's centennial vision has caused a rising demand for practitioners to provide evidence-based treatment in order to maximize effectiveness of client care (AMERICAN..., 2017; SALEH et al., 2009). A major challenge in basing OT interventions on evidence-based practice is choosing the most appropriate assessment for individual clients (SALEH et al., 2009). Specifically, OTs report that standardized assessment, which are essential to OT practice, benefit clients and the OT profession as opposed to non-standardized assessments (PIERNIK-YODER; BECK, 2012). Considering the specific and complex deficits and needs of children with CP, it is essential that standardized assessments utilized to measure the unique skills and behaviors of this population accurately align with and reflect targeted outcomes when undergoing OT interventions. According to Wright and Majnemer (2014), if all clinicians in the rehabilitative community chose assessments from the same toolbox when treating children with CP, then a universal approach of measuring outcomes can be developed. While Wright and Majnemer (2014) discussed concepts that should be considered when choosing assessments to use with children with CP, they only provided examples of possible measures clinicians can utilize.

Other research that has been conducted to review the literature on assessment tools used for children with CP include Wagner and Davids (2012) systematic review study. Using the databases Health and Psychosocial Instruments (HaPI), US National Library of Medicine (PubMed), and Cumulative Index to Nursing and Allied Health Literature (CINAHL Plus) databases, they found twenty-one assessment tools and classification systems used specifically for upper extremity function and performance in children with CP (WAGNER; DAVIDS, 2012). Furthermore, a systematic review that searched MEDLINE, Embase, CINAHL, and PscyhINFO databases found eight assessments that were used to measure only activity limitation for children with CP (HARVEY et al., 2008). Functional motor abilities of children with CP represented another domain used to conduct a systematic literature review of assessment measures (KETELAAR; VERMEER; HELDERS, 1998). The study searched MEDLINE, Sportdisk, and PsychLIT databases and yielded seventeen instruments used in pediatric rehabilitation to evaluate functional motor abilities of children with CP (KETELAAR; VERMEER; HELDERS, 1998).

Overall, these studies showed the types of assessments being used to measure specific domains (DIAS et al., 2017). However, there remains a lack of evidence on what assessments are currently being used to measure outcomes specifically for OT interventions for children with CP. In order to develop a toolbox of assessments utilized for children with CP, it is necessary to gain a cohesive understanding of the current assessments in use. The purpose of this study was to perform an integrative review of the literature to identify what assessments are being used to measure outcomes of OT interventions for children with CP.

2 Method

The study aimed to obtain a frequency count of each assessment used with the children with CP as reported the literature. An integrative review was performed and followed Arksey and O'Malley (2005) stages of methodological framework, which

include identifying the research question, identifying relevant studies, selecting studies, charting the data, and summarizing and reporting the results (Figure 1). The research team included three student investigators and a supervising professor. Pubmed and Ovid databases were systematically searched in January 2018 using the key terms "cerebral palsy", "assessment" and "occupational therapy". The following inclusion criteria were used: (1) children birth to 18 years old diagnosed with cerebral palsy; (2) use of assessment(s); (3) published in English between 2007 and 2017. Using these criteria, our search yielded a total of 383 articles that were imported to RefWorks. After eliminating duplicate articles, 307 articles remained and were allocated between three student researchers to be further reviewed by abstract and title. Based off the content found, further exclusion criteria were developed post hoc and included (1) articles lacking OT intervention; (2) systematic reviews. Assessments used in systematic reviews were not included in the frequency count to eliminate the possibility of duplicates. With the use of these post hoc criteria 76 articles were included for the analysis in this integrative review.

3 Results

The search yielded 76 articles that were synthesized and analyzed. In table 1, the list of the 76 articles and the assessments reported in each article are presented. The researchers found that there are 88 different assessments presented in these studies,

Of the 88 assessments, the ten most frequently reported in the studies are in descending order, including the Assisting Hand Assessment (AHA), Pediatric Evaluation of Disability Inventory (PEDI), Gross Motor Function Classification Scale (GMFCS), Canadian Occupational Performance Measure (COPM), Goal Attainment Scale (GAS), Manual Ability Classification System (MACS),

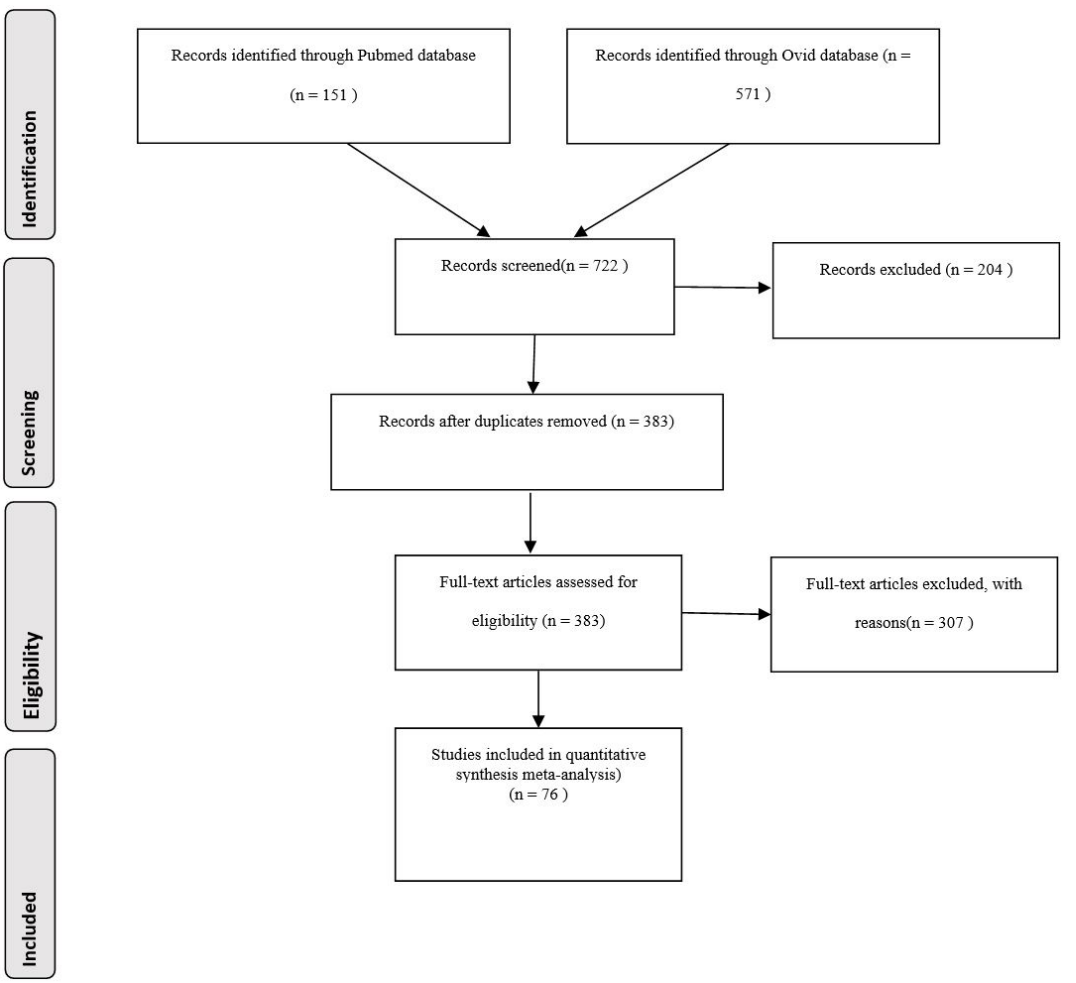

Figure 1. Flow chart of search process.

Table 1. Assessments Used for Children with CP as Found in Literature.

Author, Year	Assessments
Aarts et al. (2007) https://doi.org/10.1002/oti.229	VOAA
Aarts et al. (2012) https://doi.org/10.1002/oti.321	AHA, ABILITHAND-Kids, COPM, GAS, VOAA, Melbourne
Auld et al. (2012) https://doi.org/10.3109/01942638.2011.572150	Disk-Criminator, Exteroception, Klingel's method, SIPT, SWMs, NSMDA
Bailes, Greve and Schmitt (2010) https://doi.org/10.1097/PEP.0b013e3181cbf224	GMFM-66, PEDI
Bailes et al. (2011) https://doi.org/10.1097/PEP.0b013e318218ef58	GMFM-66, PEDI
Barroso et al. (2011) https://doi.org/10.1016/j.clinbiomech.2011.05.006	JTTHF, Digital image acquisition system for range of motion
Berge et al. (2012) https://doi.org/10.1177/0269215511411936	GAS, House classification, MACS, VAS
Bleyenheuft et al. (2015) https://doi.org/10.1177/1545968314562109	ABILIHAND-Kids, ABILICO-kids, AHA, BBT, PEDI, LIFE-H, 6MWT, Pinch
Bleyenheuft et al. (2017) https://doi.org/10.1111/dmcn.13338	ABILIHAND-Kids
Brandão, Gordon and Mancini (2012) https://doi.org/10.5014/ajot.2012.004622	COPM, PEDI
Brandao et al. (2010) https://doi.org/10.1177%2F0269215510367974	JTTHF, PEDI
Buccino et al. (2012) https://doi.org/10.1111/j.1469-8749.2012.04334.x	Melbourne
Cameron et al. (2017) https://doi.org/10.1080/01942638.2016.1185500	COPM, PQRS
Case-Smith et al. (2012) 10.5014/ajot.2012.002386	AHA, QUEST, PMAL
Chen et al. (2014) https://doi.org/10.5014/ajot.2014.009860	PDMS-2, PMAL, WeeFIM
Cohen-Holzer et al. (2016) https://doi.org/10.3109/01942638.2014.990549	AHA, JTTHF
Coker-Bolt et al. (2015) 10.5014/ajot.2016.70S1-PO5115	CHUEQ, MA2, PEDI

Note: [6MWT = Six-Minute Walk Test; AHA = Assisting Hand Assessment; AIMS = Alberta Infant Motor Scale; AMPS = Assessment of Motor and Process Skills; APCP = Assessment of Preschool Children's Participation; BBT = Box and Block Test; BFMF = Bimanual Fine Motor Function scale; BOT = Bruininks–Oseretsky Test of Motor Proficiency; CAPE = Children's Assessment of Participation and Enjoyment; CBC = Child Behavior Checklist; CFUS = Caregiver Functional Use Survey; CHEQ; Children's Hand-Use Experience Questionnaire; CHQ = Australian Authorised Adaptation of the Child Health Questionnaire; CHUEQ = Children's Hand-Use Experience Questionaire; COPM = Canadian Occupational Performance Meausure; CPQOL-Child = Cerebral Palsy Quality of Life Questionnaire for Children; ENNAS = Einstein Neonatal Neurobehavioral Assessment Scale; ETCH = Evaluation Tool of Children's Handwriting; FES Family Empowerment Scale; fTORT = functional Tactile Object Recognition Test; GAS = Goal Attainment Scale; GMA = General Movements Assessment; GMFCS = Gross Motor Function Classification System; GMFM = Gross Motor Function Measure; GMFM- 66 = Gross Motor Function Measure – 66; GMFM-88 = Gross Motor Function Measure – 88; ICFI = International Classification of Functioning Interview; JTTHF = Jebsen-Taylor Hand Function Test; LIFE-H = Assessment of Life Habits; MA2 = Melbourne Assessment 2; MACS = Manual Ability Classification System; MAS = Modified Ashworth Scale; Melbourne = Melbourne Assessment of Unilateral Upper Limb Function; MHA = Minnesota Handwriting Assessment; NHDC = Neurological Hand Deformity Classification; NSMDA = Neurosensory Motor Developmental Assessment; PAC = Preferences for Activity of Children; PAFT = Pediatric Arm Function Test; PDMS-2 = Peabody Developmental Motor Scales II; PEDI = Pediatric Evaluation of Disability Inventory; PedsQL = Pediatric Quality of Life Inventory; PGMS = Peabody Gross Motor Scale; PMAL = Pediatric Motor Activity Log; PQRS = Performance Quality Rating Scale; PRT = Pediatric Reach Test; PSI-Short form = Parenting Stress Index-Short Form; QUEST = Quality of Upper Extremity Skills Test; ROM = Range of Motion; SAS = Sitting Assessment Scale; SIPT = Sensory Integration and Praxis Test; SPPC = Harter Self-Perception Profile; SSC = Sense and Self-Regulation Checklist; SWMs = Semmes Weinstein Monofilaments; TAUT = Toddler Arm Use Test; TCMS = Trunk Control Measurement Scale; THS-R = Test of Handwriting Skills–Revised; TIMP = Test of Infant Motor Performance; TIS = Trunk Impairment Scale; TVPS3 = Test of Visual Perceptual Skill -non-motor; VAS = Visual Analogue Scale; VMI = Beery–Buktenica Developmental Test of Visual–Motor Integration; VOAA = Video Observations Aarts and Aarts].

Table 1. Continued...

Author, Year	Assessments
DeLuca et al. (2012) https://doi.org/10.3233/PRM-2012-0206	AHA, QUEST, PMAL Shriners Hospital
Ferre et al. (2017) https://doi.org/10.1111/dmcn.13330	AHA, BBT, COPM
Gelkop et al. (2015) https://doi.org/10.3109/01942638.2014.925027	AHA, QUEST
Georgiades et al. (2014) https://doi.org/10.1111/1440-1630.12150	NHDC
Golomb et al. (2010) https://doi.org/10.1016/j.apmr.2009.08.153	BOT, JTTHF, Dynamometer, Pinch
Gordon et al. (2007) https://doi.org/10.1111/j.1469-8749.2007.00830.x	AHA, Accelerometry, BOT, CFUS, JTTHF
Hamil, Washington and White (2007) https://doi.org/10.1080/J006v27n04_03	GMFCS, GMFM, SAS
Hansen et al. (2012) https://doi.org/10.1177%2F2156587211430833	CBC, GMFM-66, ICFI
Hoare et al. (2013) https://doi.org/10.1111/dmcn.12054	AHA, COPM, GAS, QUEST, PEDI
Hoare et al. (2010) https://doi.org/10.1186/1471-2377-10-58	AHA, COPM, GAS, QUEST, PEDI, MAS, Modified Tardieu Scale, PMAL
Houwink et al. (2013) https://doi.org/10.1111/j.1469-8749.2012.04442.x	VOAA
Howcroft et al. (2011) https://doi.org/10.1111/j.1469-8749.2011.04078.x	AHA
Huang et al. (2014) https://doi.org/10.1097/PEP.0000000000000001	PEDI
Imms et al. (2017) https://doi.org/10.1111/dmcn.13302	CAPE, PAC
James et al. (2015a) https://doi.org/10.1111/dmcn.12705	AHA, AMPS, COPM, JTTHF, Melbourne, TVPS-3
James et al. (2015b) https://doi.org/10.3109/01942638.2015.1076555	AMPS
Kara et al. (2015) https://doi.org/10.1111/dmcn.12583	BOT, BFMF, GMFM, GMFCS, MACS, WeeFIM

Note: [6MWT = Six-Minute Walk Test; AHA = Assisting Hand Assessment; AIMS = Alberta Infant Motor Scale; AMPS = Assessment of Motor and Process Skills; APCP = Assessment of Preschool Children's Participation; BBT = Box and Block Test; BFMF = Bimanual Fine Motor Function scale; BOT = Bruininks–Oseretsky Test of Motor Proficiency; CAPE = Children's Assessment of Participation and Enjoyment; CBC = Child Behavior Checklist; CFUS = Caregiver Functional Use Survey; CHEQ; Children's Hand-Use Experience Questionnaire; CHQ = Australian Authorised Adaptation of the Child Health Questionnaire; CHUEQ = Children's Hand-Use Experience Questionaire; COPM = Canadian Occupational Performance Meausure; CPQOL-Child = Cerebral Palsy Quality of Life Questionnaire for Children; ENNAS = Einstein Neonatal Neurobehavioral Assessment Scale; ETCH = Evaluation Tool of Children's Handwriting; FES Family Empowerment Scale; fTORT = functional Tactile Object Recognition Test; GAS = Goal Attainment Scale; GMA = General Movements Assessment; GMFCS = Gross Motor Function Classification System; GMFM = Gross Motor Function Measure; GMFM- 66 = Gross Motor Function Measure – 66; GMFM-88 = Gross Motor Function Measure – 88; ICFI = International Classification of Functioning Interview; JTTHF = Jebsen-Taylor Hand Function Test; LIFE-H = Assessment of Life Habits; MA2 = Melbourne Assessment 2; MACS = Manual Ability Classification System; MAS = Modified Ashworth Scale; Melbourne = Melbourne Assessment of Unilateral Upper Limb Function; MHA = Minnesota Handwriting Assessment; NHDC = Neurological Hand Deformity Classification; NSMDA = Neurosensory Motor Developmental Assessment; PAC = Preferences for Activity of Children; PAFT = Pediatric Arm Function Test; PDMS-2 = Peabody Developmental Motor Scales II; PEDI = Pediatric Evaluation of Disability Inventory; PedsQL = Pediatric Quality of Life Inventory; PGMS = Peabody Gross Motor Scale; PMAL = Pediatric Motor Activity Log; PQRS = Performance Quality Rating Scale; PRT = Pediatric Reach Test; PSI-Short form = Parenting Stress Index-Short Form; QUEST = Quality of Upper Extremity Skills Test; ROM = Range of Motion; SAS = Sitting Assessment Scale; SIPT = Sensory Integration and Praxis Test; SPPC = Harter Self-Perception Profile; SSC = Sense and Self-Regulation Checklist; SWMs = Semmes Weinstein Monofilaments; TAUT = Toddler Arm Use Test; TCMS = Trunk Control Measurement Scale; THS-R = Test of Handwriting Skills–Revised; TIMP = Test of Infant Motor Performance; TIS = Trunk Impairment Scale; TVPS3 = Test of Visual Perceptual Skill -non-motor; VAS = Visual Analogue Scale; VMI = Beery–Buktenica Developmental Test of Visual–Motor Integration; VOAA = Video Observations Aarts and Aarts].

Table 1. Continued...

Author, Year	Assessments
Kirkpatrick et al. (2016) https://doi.org/10.1111/dmcn.13109	ABILIHANDS-kids, AHA, MA2
Kruijsen-Terpstra et al. (2016) https://doi.org/10.1111/dmcn.12966	APCP, COPM, GAS, GMFCS, GMFM-66, MACS, PEDI-CAS, PEDI-FSS, Nijmeegse Ouderlijke Stress Index- Kort
Law et al. (2011) https://doi.org/10.1111/j.1469-8749.2011.03962.x	APCP, GMFCS, GMFM-66, PEDI, ROM, Family Empowerment Scale
Lidman et al. (2015) https://doi.org/10.1111/dmcn.12739	AHA, COPM, ROM
Lin et al. (2011) https://doi.org/10.1016/j.ridd.2011.01.023	BOT, CFUS, PDMS-2, PMAL, PSI
Louwers et al. (2011) https://doi.org/10.1111/j.1469-8749.2010.03849.x	AHA, GMFCS, MACS, Zancolli classification, House classification
Luna-Oliva et al. (2013) https://doi.org/10.3233/NRE-131001	AMPS, GMFCS, GMFM, JTTHF, PRT
Mackey et al. (2008) https://doi.org/10.1111/j.1468-1331.2008.02271.x	MAS, Melbourne, 3-D Kinematics
Mclean et al. (2017) https://doi.org/10.5014/ajot.2016.024968	AHA, BBT, COPM, GAS, fTORT, Sense-Assess kids, Wrist position test
Man and Wong (2007) https://doi.org/10.5014/ajot.61.3.355	Assessment of Comfort, WinFitts
Matusiak-Wieczorek et al. (2016) https://doi.org/10.5604/15093492.1205024	GMFCS, SAS
McConnell, Johnston and Kerr (2014) https://doi.org/10.3109/01942638.2013.866611	Melbourne
McGarry, Moir and Girdler (2012) https://doi.org/10.3109/17483107.2011.637283	Powered Mobility Program Assessment Battery, GMFCS
Millard, Benore and Mosher (2013) https://doi.org/10.1037/cpp0000005	GMFCS, WeeFIM
Novak, Cusick and Lowe (2007) http://doi.org/10.5014/ajot.61.4.463	GAS, PEDI, QUEST
Ostensjø, Oien and Fallang (2008) https://doi.org/10.1080/17518420802525500	COPM, GAS
Palsbo and Hood-Szivek (2012) https://doi.org/10.5014/ajot.2012.004556	ETCH, THS-R, Print tool, VMI

Note: [6MWT = Six-Minute Walk Test; AHA = Assisting Hand Assessment; AIMS = Alberta Infant Motor Scale; AMPS = Assessment of Motor and Process Skills; APCP = Assessment of Preschool Children's Participation; BBT = Box and Block Test; BFMF = Bimanual Fine Motor Function scale; BOT = Bruininks–Oseretsky Test of Motor Proficiency; CAPE = Children's Assessment of Participation and Enjoyment; CBC = Child Behavior Checklist; CFUS = Caregiver Functional Use Survey; CHEQ; Children's Hand-Use Experience Questionnaire; CHQ = Australian Authorised Adaptation of the Child Health Questionnaire; CHUEQ = Children's Hand-Use Experience Questionaire; COPM = Canadian Occupational Performance Meausure; CPQOL-Child = Cerebral Palsy Quality of Life Questionnaire for Children; ENNAS = Einstein Neonatal Neurobehavioral Assessment Scale; ETCH = Evaluation Tool of Children's Handwriting; FES Family Empowerment Scale; fTORT = functional Tactile Object Recognition Test; GAS = Goal Attainment Scale; GMA = General Movements Assessment; GMFCS = Gross Motor Function Classification System; GMFM = Gross Motor Function Measure; GMFM- 66 = Gross Motor Function Measure – 66; GMFM-88 = Gross Motor Function Measure – 88; ICFI = International Classification of Functioning Interview; JTTHF = Jebsen-Taylor Hand Function Test; LIFE-H = Assessment of Life Habits; MA2 = Melbourne Assessment 2; MACS = Manual Ability Classification System; MAS = Modified Ashworth Scale; Melbourne = Melbourne Assessment of Unilateral Upper Limb Function; MHA = Minnesota Handwriting Assessment; NHDC = Neurological Hand Deformity Classification; NSMDA = Neurosensory Motor Developmental Assessment; PAC = Preferences for Activity of Children; PAFT = Pediatric Arm Function Test; PDMS-2 = Peabody Developmental Motor Scales II; PEDI = Pediatric Evaluation of Disability Inventory; PedsQL = Pediatric Quality of Life Inventory; PGMS = Peabody Gross Motor Scale; PMAL = Pediatric Motor Activity Log; PQRS = Performance Quality Rating Scale; PRT = Pediatric Reach Test; PSI-Short form = Parenting Stress Index-Short Form; QUEST = Quality of Upper Extremity Skills Test; ROM = Range of Motion; SAS = Sitting Assessment Scale; SIPT = Sensory Integration and Praxis Test; SPPC = Harter Self-Perception Profile; SSC = Sense and Self-Regulation Checklist; SWMs = Semmes Weinstein Monofilaments; TAUT = Toddler Arm Use Test; TCMS = Trunk Control Measurement Scale; THS-R = Test of Handwriting Skills–Revised; TIMP = Test of Infant Motor Performance; TIS = Trunk Impairment Scale; TVPS3 = Test of Visual Perceptual Skill -non-motor; VAS = Visual Analogue Scale; VMI = Beery–Buktenica Developmental Test of Visual–Motor Integration; VOAA = Video Observations Aarts and Aarts].

Table 1. Continued...

Author, Year	Assessments
Pham et al. (2016) https://doi.org/10.3109/01942638.2015.1127867	GMFCS, GMFM-66, TCMS, TIS
Phipps and Roberts (2012) https://doi.org/10.5014/ajot.2012.003921	GMFCS, MACS, PEDI
Psychouli and Kennedy (2016) https://doi.org/10.1097/PEP.0000000000000227	Melbourne, QUEST
Robert et al. (2013) https://doi.org/10.1111/dmcn.12219	MACS, Melbourne, SWMs, UE PROM
Rostami et al. (2012) https://doi.org/10.3233/NRE-2012-00804	BOT, MAS, PMAL
Ryan, Rigby and Campbell (2010) https://doi.org/10.1111/j.1440-1630.2009.00831.x	GMFCS, MHA
Ryll, Bastiaenen and Eliasson (2017) https://doi.org/10.1080/01942638.2016.1185498	AHA, CHEQ, MACS
Sakzewski et al. (2011) https://doi.org/10.1177/1545968311400093	AHA, COPM, JTTHF, LIFE-H, MAS, Melbourne
Sakzewski et al. (2012) https://doi.org/10.1111/j.1469-8749.2012.04272.x	CPQOL, MACS
Sakzewski et al. (2015) https://doi.org/10.1111/dmcn.12702	AHA, MACS
Schneiberg et al. (2010) https://doi.org/10.1111/j.1469-8749.2010.03768.x	CSI, Disk-Criminator, Light touch/position, Melbourne, SWMs
Schrank (2013) https://doi.org/10.1097/PEP.0b013e31827abaf4	GMFM-88, WeeFIM
Silva et al. (2012) https://doi.org/10.5014/ajot.2012.003541	PGMS, SSC
Snider et al. (2008) https://doi.org/10.1016/j.earlhumdev.2007.07.004	AIMS, ENNAS, GMA, TIMP
Steenbeek et al. (2010) https://doi.org/10.1177/0269215511407220	GAS, GMFCS, GMFM-66, MACS, PEDI
Storvold and Jahnsen (2010) https://doi.org/10.1097/PEP.0b013e3181dbe379	AHA, Dynamometer, GAS, GMFCS, GMFM-66, PEDI
Thompson et al. (2015) https://doi.org/10.1097/PEP.0000000000000111	Dynamometer, QUEST, PEDI, ROM

Note: [6MWT = Six-Minute Walk Test; AHA = Assisting Hand Assessment; AIMS = Alberta Infant Motor Scale; AMPS = Assessment of Motor and Process Skills; APCP = Assessment of Preschool Children's Participation; BBT = Box and Block Test; BFMF = Bimanual Fine Motor Function scale; BOT = Bruininks–Oseretsky Test of Motor Proficiency; CAPE = Children's Assessment of Participation and Enjoyment; CBC = Child Behavior Checklist; CFUS = Caregiver Functional Use Survey; CHEQ; Children's Hand-Use Experience Questionnaire; CHQ = Australian Authorised Adaptation of the Child Health Questionnaire; CHUEQ = Children's Hand-Use Experience Questionaire; COPM = Canadian Occupational Performance Meausure; CPQOL-Child = Cerebral Palsy Quality of Life Questionnaire for Children; ENNAS = Einstein Neonatal Neurobehavioral Assessment Scale; ETCH = Evaluation Tool of Children's Handwriting; FES Family Empowerment Scale; fTORT = functional Tactile Object Recognition Test; GAS = Goal Attainment Scale; GMA = General Movements Assessment; GMFCS = Gross Motor Function Classification System; GMFM = Gross Motor Function Measure; GMFM- 66 = Gross Motor Function Measure – 66; GMFM-88 = Gross Motor Function Measure – 88; ICFI = International Classification of Functioning Interview; JTTHF = Jebsen-Taylor Hand Function Test; LIFE-H = Assessment of Life Habits; MA2 = Melbourne Assessment 2; MACS = Manual Ability Classification System; MAS = Modified Ashworth Scale; Melbourne = Melbourne Assessment of Unilateral Upper Limb Function; MHA = Minnesota Handwriting Assessment; NHDC = Neurological Hand Deformity Classification; NSMDA = Neurosensory Motor Developmental Assessment; PAC = Preferences for Activity of Children; PAFT = Pediatric Arm Function Test; PDMS-2 = Peabody Developmental Motor Scales II; PEDI = Pediatric Evaluation of Disability Inventory; PedsQL = Pediatric Quality of Life Inventory; PGMS = Peabody Gross Motor Scale; PMAL = Pediatric Motor Activity Log; PQRS = Performance Quality Rating Scale; PRT = Pediatric Reach Test; PSI-Short form = Parenting Stress Index-Short Form; QUEST = Quality of Upper Extremity Skills Test; ROM = Range of Motion; SAS = Sitting Assessment Scale; SIPT = Sensory Integration and Praxis Test; SPPC = Harter Self-Perception Profile; SSC = Sense and Self-Regulation Checklist; SWMs = Semmes Weinstein Monofilaments; TAUT = Toddler Arm Use Test; TCMS = Trunk Control Measurement Scale; THS-R = Test of Handwriting Skills–Revised; TIMP = Test of Infant Motor Performance; TIS = Trunk Impairment Scale; TVPS3 = Test of Visual Perceptual Skill -non-motor; VAS = Visual Analogue Scale; VMI = Beery–Buktenica Developmental Test of Visual–Motor Integration; VOAA = Video Observations Aarts and Aarts].

Table 1. Continued...

Author, Year	Assessments
Uswatte et al. (2012a) https://doi.org/10.1097/PHM.0b013e318269ec76	MACS, PAFT, TAUT
Uswatte et al. (2012b) https://doi.org/10.1037/a0028516	MACS, PAFT, PMAL-R
Wallen et al. (2011) https://doi.org/10.1080/17518420701640897	AHA, COPM, GAS, MAS, PMAL, Tardieu Scale
Wallen, O'Flaherty and Waugh (2007) https://doi.org/10.1016/j.apmr.2006.10.017	COPM, CHQ, GAS, Melbourne, PEDI, QUEST, Tardieu Scale
Wallen et al. (2008) https://doi.org/10.1111/j.1469-8749.2011.04086.x	AHA, COPM, GAS, GMFCS, MACS, MAS, Melbourne, PMAL-R, Tardieu Scale
Wang et al. (2017) https://doi.org/10.1016/j.apmr.2017.01.024	BBT, BOT-2, MA2, PMAL-R
Yabunaka et al. (2011) https://doi.org/10.1097/PHM.0b013e3181fc7ddf	GMFCS, GMFM-66
Yasukawa and Uronis (2014) http://doi.org/10.1097/JPO.0000000000000022	Melbourne
Ziebell et al. (2009) https://doi.org/10.1111/j.1440-1630.2008.00775.x	BOT, GMFCS, SPPC

Note: [6MWT = Six-Minute Walk Test; AHA = Assisting Hand Assessment; AIMS = Alberta Infant Motor Scale; AMPS = Assessment of Motor and Process Skills; APCP = Assessment of Preschool Children's Participation; BBT = Box and Block Test; BFMF = Bimanual Fine Motor Function scale; BOT = Bruininks–Oseretsky Test of Motor Proficiency; CAPE = Children's Assessment of Participation and Enjoyment; CBC = Child Behavior Checklist; CFUS = Caregiver Functional Use Survey; CHEQ; Children's Hand-Use Experience Questionnaire; CHQ = Australian Authorised Adaptation of the Child Health Questionnaire; CHUEQ = Children's Hand-Use Experience Questionaire; COPM = Canadian Occupational Performance Meausure; CPQOL-Child = Cerebral Palsy Quality of Life Questionnaire for Children; ENNAS = Einstein Neonatal Neurobehavioral Assessment Scale; ETCH = Evaluation Tool of Children's Handwriting; FES Family Empowerment Scale; fTORT = functional Tactile Object Recognition Test; GAS = Goal Attainment Scale; GMA = General Movements Assessment; GMFCS = Gross Motor Function Classification System; GMFM = Gross Motor Function Measure; GMFM- 66 = Gross Motor Function Measure – 66; GMFM-88 = Gross Motor Function Measure – 88; ICFI = International Classification of Functioning Interview; JTTHF = Jebsen-Taylor Hand Function Test; LIFE-H = Assessment of Life Habits; MA2 = Melbourne Assessment 2; MACS = Manual Ability Classification System; MAS = Modified Ashworth Scale; Melbourne = Melbourne Assessment of Unilateral Upper Limb Function; MHA = Minnesota Handwriting Assessment; NHDC = Neurological Hand Deformity Classification; NSMDA = Neurosensory Motor Developmental Assessment; PAC = Preferences for Activity of Children; PAFT = Pediatric Arm Function Test; PDMS-2 = Peabody Developmental Motor Scales II; PEDI = Pediatric Evaluation of Disability Inventory; PedsQL = Pediatric Quality of Life Inventory; PGMS = Peabody Gross Motor Scale; PMAL = Pediatric Motor Activity Log; PQRS = Performance Quality Rating Scale; PRT = Pediatric Reach Test; PSI-Short form = Parenting Stress Index-Short Form; QUEST = Quality of Upper Extremity Skills Test; ROM = Range of Motion; SAS = Sitting Assessment Scale; SIPT = Sensory Integration and Praxis Test; SPPC = Harter Self-Perception Profile; SSC = Sense and Self-Regulation Checklist; SWMs = Semmes Weinstein Monofilaments; TAUT = Toddler Arm Use Test; TCMS = Trunk Control Measurement Scale; THS-R = Test of Handwriting Skills–Revised; TIMP = Test of Infant Motor Performance; TIS = Trunk Impairment Scale; TVPS3 = Test of Visual Perceptual Skill -non-motor; VAS = Visual Analogue Scale; VMI = Beery–Buktenica Developmental Test of Visual–Motor Integration; VOAA = Video Observations Aarts and Aarts].

Melbourne Assessment of Unilateral Upper Limb Function (MUUL), Pediatric Motor Activity Log (PMAL), Quality of Upper Extremity Skills Test (QUEST), and Jebsen-Taylor Hand Function Test (JTHFT). Table 2 lists these ten assessments and their associated properties.

Additionally, a prominent trend was observed in which a majority of the articles utilized more than one assessment. Specifically, 66 out of the 76 articles used two or more assessments. Using more than one assessment shows the complexity and need of assessing the unique skills and behaviors of children with CP.

4 Discussion

This integrative review depicted the current trend of assessments used in research involving OT interventions for children with CP. The evidence determined the AHA, PEDI, GMFCS, COPM, GAS, MACS, MUUL, PMAL, QUEST, and JTTHF, to be the most frequently used ten assessments in research in descending order. Additionally, 66 out of 76 articles used a combination of two or more assessments. Since CP is a complex condition affecting several functional domains, using more than one assessment allowed the researchers to address the

Table 2. Top Ten Assessments and their Frequency of Use, Assessment Type, Purpose, Age Range, Psychometrics, Administration Time, and Price.

Assessment	Frequency	Type of Assessment	Purpose of Assessment	Age Range	Psychometrics	Administration Time	Price of Assessment
AHA (KRUMLINDE-SUNDHOLM et al., 2007; WAGNER; DAVIDS, 2012)	22	Skilled observation by clinician	Evaluates assisting hand in bilateral hand use activities using videotaped play session	18 months to 12 years old	Interrater reliability = 0.98 (two rater design) and 0.97 (20-rater design) Intra-rater reliability = 0.99	10-15 minutes play session of child Scoring time dependent on therapist's experience with AHA	USD $350 for test kit USD $260-$320 for 3-day training/ certification process
PEDI (ASHER, 2007; LIVINGSTONE; PALEG, 2016)	17	Behavior checklist/ rating scale completed via structured interview or professional observation	Examines functional capabilities and typical performance to detect functional delay, track progress after intervention, and assess intervention outcome	6 months to 7.5 years old; can utilize for older children if functional capabilities do not exceed those of 7.5 year old children with no disabilities	Inter-rater reliability = 0.84-1.00, 0.74-0.94; Internal consistency = 0.95-0.99; Good validity with children with CP	20-60 minutes depending on therapist's experience with PEDI	USD $115 for manual USD $35 for score forms (x25)
GMFCS (CANCHILD, 2018; WOOD; ROSENBAUM, 2000)	16	Family report questionnaire	5-Level system that classifies according to current gross motor abilities/ limitations, and level of need for assistive technology and wheeled mobility	0 to 18 years old	Inter-rater reliability = 0.93; Test-retest reliability = 0.79; Demonstrated face validity	< 5 minutes if familiar with child; 15-20 minutes if unfamiliar with child and require observation session	Free

Table 2. Continued...

Assessment	Frequency	Type of Assessment	Purpose of Assessment	Age Range	Psychometrics	Administration Time	Price of Assessment
COPM (ASHER, 2007; LIVINGSTONE; PALEG, 2016)	14	Semi- structured interview- based rating scale	Self-perception of identified occupational performance	7+ years old	Inter-rater reliability: performance = 0.63-0.89, satisfaction = 0.76-0.88; Internal consistency: performance = 0.73, satisfaction = 0.83; Demonstrated content/ construct/criterion validity; Responsive to change (able to detect medium sized effect size in children with hemiplegic CP)	30-40 minutes	COPM Manual and 100 Forms (e-book) = USD $29.51
GAS (ABILITYLAB, 2014; LIVINGSTONE; PALEG, 2016; STEENBEEK et al., 2010)	14	Patient reported outcome	Self-identified patient goals and measurement criteria	All ages	Inter-rater reliability = 0.82; Intra-rater reliability = 0.64 Criterion validity = 0.44; Content/convergent validity established for children with CP (77-88% of ratings met GAS criterion); Excellent responsiveness to change in goals of children with CP at all GMFCS levels	Variable	Free
MACS (ELIASSON et al., 2006)	13	Family/patient/ caregiver report questionnaire	System for classifying hand use in daily activities	4 to 18 years old	Interrater reliability between therapists = 0.97 (95% confidence interval 0.96-0.98); Interrater reliability between parents and therapists = 0.96 (95% confidence interval 0.89-0.98); Good validity	Variable	Free MACS chart and identification download Instructional DVD = USD $35.17

Table 2. Continued...

Assessment	Frequency	Type of Assessment	Purpose of Assessment	Age Range	Psychometrics	Administration Time	Price of Assessment
MUUL (ASHER, 2007; THE ROYAL…, 2018)	12	Therapist observation scale	Uses video-based measurement to examine unilateral upper limb movements based on activities involving grasp, release, reach and manipulation	2.5 to 15 years old	Interrater reliability: total scores = 0.961, fluency correlation for test components = 0.902; ROM = 0.866, quality of movement = 0.683, Validity: clinically valid for children 2.5 years and older and positively correlated with Quality of Upper Extremity Skills Test scores	Total time = 50-60 minutes including 20-30 minutes to administer and 30 minutes to score	USD $1165.75 per assessment for orders outside Australia
PMAL (USWATTE et al., 2012a; WALLEN et al., 2009)	10	Parent report/semi-structured interview	Evaluates how often and how well the involved upper extremity is used in the natural environment	7 months to 8 years old	Revised PMAL by Uswatte et al. (2012a): Internal consistency = 0.93; Test-retest reliability = 0.89; Strong support for convergent validity Revised PMAL by Wallen et al. (2009): How Often Scale test-retest reliability = 0.94 with strong evidence of construct validity; How Well Scale test-retest reliability = 0.93 with strong evidence of construct validity	5-15 minutes to complete 3 minutes to score	Free
QUEST (ABILITYLAB, 2016; ASHER, 2007; LIVINGSTONE; PALEG, 2016)	9	Performance based checklist for therapist observation Criterion-referenced	Examines the quality of upper extremity movement associated with grasp, weightbearing, protective extension, and dissociated movement in a play context	18 months to 8 years old	Interrater reliability = 0.93; Test-retest reliability = 0.95; Excellent internal consistency; Validity = strong correlation with PDMS-FM scales	45 minutes	USD $99

Table 2. Continued...

Assessment	Frequency	Type of Assessment	Purpose of Assessment	Age Range	Psychometrics	Administration Time	Price of Assessment
JTTHF (ABILITYLAB, 2012; ASHER, 2007)	9	Performance test Norm-referenced	Timed test of effective hand use in daily activities	5 years old and older	Test-retest reliability = 0.98-0.99	15-20 minutes	USD $300+ for commercially sold test kit (instructions, test items, carrying bag, forms) If self-created kit, can cost as low as $0 to $10.

multiple needs of this population. Additionally, the use of assessments in clinical practice guides OTs not only during interventions, but also to establish therapeutic goals (BREWER; POLLOCK; WRIGHT, 2014)

The findings of this study have the following implications for OT practice:

- Because OT is a field striving towards evidence-based practice, OT practitioners working with children with CP can utilize the evidence from this article to aid their selection of assessments for use in clinical practice.
- With this growing focus on evidence-based practice, OT practitioners should conduct research that adds to the development of a universal toolbox to establish a standard approach of measuring OT intervention outcomes for children with CP.

Data from this study helped to establish the most frequently used assessments in research studies. Further investigation is needed to determine what assessments are currently used in clinical OT practices in order to develop a toolbox of assessments for children with CP. For instance, AHA, represents the only standardized tool of spontaneous play that measures bimanual hand use. This is a unique scope of use, which may have contributed to its frequent selection by researchers despite the high cost for the test kit and certification process (HOLMEFUR; KRUMLINDE-SUNDHOLM; ELIASSON, 2007; KRUMLINDE-SUNDHOLM et al., 2007). The second most frequented cited, the PEDI, allows a wide scope of use by researchers since it can be utilized as an initial, interim, discharge, and evaluation assessment for individual or group interventions, and rehabilitative and therapeutic programs (ASHER, 2007).

Possible factors that may have contributed to the selection of assessments in these research studies include attributes such as scope of use, affordability, feasibility with time, and psychometric properties. All of the top 10 assessments present fair to excellent psychometric properties, they are usually performed on average of 30-40 minutes, and five out of ten assessments (GMFM, COPM, GAS, PMAL, and JTTHF) cost $0 to $40. Measures that are accepted into a toolbox are expected to have demonstrated strong reliability and validity when use with children with cerebral palsy (STRATFORD; RIDDLE, 2005). As in these research studies, it is important for clinical OTs to also take into consideration the use of quality assessment measures to implement evidence-based practice. Therefore the use of a toolbox containing OT assessments specific for children with CP will ultimately enable a universal approach to guide clinicians in the rehabilitative community to measure outcomes and gauge effectiveness of their treatment.

5 Conclusion

These research studies showed the complexity of assessing children with CP. The clinical OTs must be aware of these complexities and that more than one assessment may be needed to capture the unique skills and behaviors of the children with CP.

As for study limitations, only two databases (PubMed and OVID) were used to search for articles that contain the targeted keywords. Utilizing more databases can widen the scope of search for studies that contain assessments and strengthen the evidence by increasing the frequency count. Additionally, even though a good portion of the articles originated from countries other than the United States, the reviewing of English-language only articles excluded data that could have provided a more accurate depiction of assessments used for children with CP on a global scale. Future research studies are needed to expand on the current study, to provide additional justifications for assessment use, and contribute to the development of an assessment toolbox for children with CP that is specific to measure outcomes for OT interventions.

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Author's Contributions

Carly Peters - took the leadership role in searching for the articles, organizing the result and discussion sections. Amy Chang - Assited with the articles search, result and discussion sections. Abigail Morales - Assited with the articles search, result and discussion sections. Karin Barnes - had a consultant role due to her expertise in pediatrics. Ana Allegretti - is the academic mentor of the students and principal investigator of the research study. All authors approved the final version of the text.