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Effect of therapist-delivered task-oriented training on functional mobility and balance in children with cerebral palsy: a systematic review and meta-analysis

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Abstract

AIM: This study is a systematic literature review and meta-analysis that aimed to explore and assess the effectiveness of physiotherapist-delivered task-oriented training on functional mobility and balance in children with cerebral palsy (CP).

METHOD: This is a systematic literature review in which the following electronic databases were searched in order to find and include relevant trials for the meta-analysis: CINAHL, Cochrane Library, EMBASE, MEDLINE, PEDro, PubMed and PsycINFO. Nine randomized clinical trials (RCT) were included in the study. Eight of the studies were included in a quantitative meta-analysis that was conducted on each measurement instrument using the RevMan 5.3 software. The included measurement instruments were Pediatric Balance Scale (PBS), Timed Up & Go (TUG), and Gross Motor Function Measure (GMFM) domains D & E. The standardised mean difference (SMD) and 95% confidence intervals (95%CI) were calculated and examined from pre- and post-test scores. The PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses statement) and the Cochrane Handbook for Systematic Reviews of Interventions were followed in order to ensure the best possible quality for this review.

RESULTS: A total of 253 children of 2 to 15 years old participated in eight RCTs that were included in the final meta-analysis. The experimental groups in each study received task-oriented training focusing on functional goal-directed tasks, while the control groups received physical therapy with a focus on facilitation and normalization of movement patterns, or passive stretching and range of motion exercises. The duration of the intervention varied from 4 weeks to 41 months, while the intensity range across the trials was between 6 times a week to approximately 3 times a month, single sessions varying from 45min to 1 hour. A significant effect of task-oriented training was observed from the scores in Pediatric Balance Scale (P=0.0003, Mean D 3.80) and Timed Up & Go -test (P=0.02, Mean D 1.98), while no statistical or clinical significance was observed in the scores of Gross Motor Function Measure D & E.

CONCLUSION: The results from the meta-analysis implicate a significant effect of task-oriented training in children with cerebral palsy when assessed in Pediatric Balance Scale and Timed Up & Go -test, when compared to other treatment methods used in the included trials. Improvements in functional mobility and balance in experimental and comparison groups were observed in all of the studies.

Sammendrag

FORMÅL: Denne studien er en systematisk oversikt og meta-analyse som hadde som mål å utforske effekten av oppgaveorientert trening på funksjonell mobilitet og balanse hos barn med cerebral parese (CP).

METODE: Dette er en systematisk litteraturoversikt med meta-analyse. Følgende elektroniske databaser var søkt for å finne og inkludere relevante studier for meta-analysen: CINAHL, Cochrane Library, EMBASE, MEDLINE, PEDro, PubMed og PsycINFO. Åtte studier ble inkludert i kvantitativ meta-analysen som ble utført ved bruk av RevMan 5.3. Resultatene fra Pediatric Balance Scale (PBS), Timed Up & Go (TUG) og Gross Motor Function Measure (GMFM) ble utforsket og diskutert. Den standardiserte gjennomsnittsforskjellen (SMD) og 95% konfidensintervall (95%CI) ble beregnet av pre- og post-skårer. PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses statement) og Cochrane Handbook for Systematic Review of Interventions var brukt for å sikre best mulig kvalitet for denne studien.

RESULTATER: Totalt 253 barn i alderen 2 til 15 år deltok i åtte RCTs som ble inkludert i meta-analysen. Eksperimentgruppene i hver studie fikk oppgave-orientert trening med fokus på funksjonelle oppgaver, mens kontrollgruppene fikk fysioterapi behandling med fokus på fasilitering og normalisering av bevegelsesmønstre, eller passive tøynings- og bevegelsesutslagsøvelser. Intervensjonsmengden varierte fra 4 uker til 41 måneder, mens intensiteten varierte fra 6 ganger i uken til omtrent 3 ganger i måneden. Signifikant effekt av oppgave-orientert trening ble observert i resultatene fra Pediatric Balance Scale (P=0.0003, MD 3.80) og Timed Up & Go -test (P=0.02, MD 1.98), mens ingen statistisk eller klinisk signifikans ble observert i Gross Motor Function Measure D & E.

KONKLUSJON: Resultatene fra meta-analysen impliserer en signifikant effekt av oppgave-orientert trening hos barn med cerebral parese i Pediatric Balance Scale og Timed Up & Go-test. Forbedringer i funksjonell mobilitet og balanse i eksperimentelle grupper og kontrollgrupper ble observert i alle studiene.

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1 Introduction

This review aims to assess and examine the effect of a physical therapy intervention on functional mobility and balance in children with cerebral palsy. Cerebral palsy (CP) is the most common cause of childhood motor disability, the prevalence being of 2 to 2.5 per 1000 live births around the world and in the Nordic countries (Hollung et al. 2021; Oskoui et al. 2013) The diagnosis CP refers to a group of permanent neuromotor disorders that affect the individual’s movement, muscle tone and posture, causing limitations in physical activities and participation. Non-progressive disturbances occur in the developing fetal or immature brain. The motor disorders of cerebral palsy are often accompanied by a range of secondary conditions such as disturbances of sensation, perception, cognition, communication, and behavior, as well as epilepsy, and secondary musculoskeletal problems (Patel et al. 2020; Rosenbaum et al. 2006).

Variety of motor challenges and secondary conditions associated with CP often contribute to reduced functional abilities. Functional mobility is an individual’s physiological ability to move independently and safely around in a variety of environments. Movements such as rising from lying to sitting, standing, bending, walking, and climbing can provide a child with several opportunities to engage in physical activities in different environments (Bouça-Machado et al. 2018; Forhan et al. 2013). The fundamental components of mobility and movement are balance and upright postural control as they involve the ability to anticipate instability as well as recover from it (Liao et al. 1997; Rose et al. 2002). These core components allow a child to independently engage and participate in multiple levels of basic daily, social, and recreational activities in education, home and in the community (Chen et al. 2013; Franjoine et al. 2003).

The purpose of this review is to examine improvements in functional mobility and balance reactions that generally are poorer and impaired to a different degree in children with cerebral palsy when compared to typically developing children (Liao et al. 1997; Panibatla, 2017; Rose et al. 2002). The reduced functional balance capacity, and thus limited ability to move around independently, results from the neuromuscular impairments manifested in impaired muscle tone, selective motor control, and poor postural control mechanism, leading into significant limitations in activities of daily living and participation (Gan et al. 2008; Harbourne et al. 2010; Rose et al. 2002). Children with CP who have higher functional mobility participate more frequently and enjoy physical activities more when compared to children with lower functional abilities, which can contribute to further physical and mental health problems among the less active population of diagnosed children and adolescents (Alghamdi et al. 2017; Imms, 2008; Lauruschkus et al. 2017).

Functional mobility and balance contribute to health-related quality of life (Forhan 2013) by allowing an individual to engage in variety of tasks and activities, which furthermore is labelled as participation in the WHO's International Classification of Functioning and Disability (ICF) (World Health Organization, 2001). This review aims to discuss different ICF-CY domains in light of cerebral palsy in children, clinical reasoning, and task-oriented training in pediatric physical therapy. Furthermore, several factors that contribute to the individual's level of functioning among children with CP, as well as to clinical reasoning and decision making, are discussed in light of evidence-based practice (EBP) that consists of best research evidence, clinical expertise of the physical therapist(s), and patient preferences and values (Li et al. 2019).

In order to discuss evidence and draw conclusions about a treatment effect, the review explores and assesses task-oriented training as a primary intervention method. Motor impairments in children with CP are assumed to be static (non-progressive), but they can be improved with sufficient and extended practice and training over the course of development (Palisano & Orlin. 2017 p.87-91). Motor learning principles for most tasks require a period of skill acquisition, after which a motor behavior is retained and the newly acquired skill can be transferred to other similar tasks (Kleim & Jones, 2008). Therefore, for optimal efficacy, it is not simply practice of movements, but practice of movements embedded in tasks that are meaningful and challenging for the child, require progressively increased behavioral demands, and involve active participation (Kleim & Jones, 2008; Palisano & Orlin, 2017 p.87-91,). Modern motor learning theory provides the foundation for activity-focused rehabilitation methods used in physical therapy, such as task-oriented training, which is a contemporary intervention based on behavioral neuroscience and focuses on intensity, relevancy, repetitions, therapist-client collaboration, and feedback (Rowe et al. 2018; Valvano 2004).

Several studies in recent years (Ko et al. 2020; Kumar & Ostwal, 2016; Madhumati et al. 2020; Ogwumike et al. 2019; Rajalaxmi et al. 2021; Sah et al. 2019; Shaju, 2016) have reported positive effects in their assessment of the effect of task-oriented training in children with CP with focus on lower extremity function, balance, and mobility. Improvements have been observed in functional mobility and balance among children with different levels of Gross Motor Function Classification System (GMFCS) and subtypes of the diagnosis when assessing the skills in standardized clinical tests such as Pediatric Balance Scale (PBS), Timed Up & Go (TUG), Pediatric Evaluation of Disability Inventory (PEDI), and Gross Motor Function Measure (GMFM) (Ko 2020; Kumar & Ostwal, 2016; Ogwumike et al. 2019; Rajalaxmi et al. 2021; Salem et al. 2009). Furthermore, Badaru et al. 2021 observed a positive effect of task-oriented intervention in the quality of life of children with the diagnosis CP. However, the clinical significance of the effect of task-oriented training compared to other physical therapy interventions has not yet been systematically assessed. Therefore, detailed assessment of task-oriented training and discussion of the results from several clinical trials examining the intervention is significant in light of evidence-based practice in physical therapy, which is ought to rely on systematically developed evidence in clinical decision making, integrating the patient and family's values (Jewell, 2018).

Systematic reviews of clinical trials together with meta-analysis are considered as the most reliable evidence on the effect of interventions in health care practice (Akobeng, 2005; Craig et al. 2002). A systematic review of task-specific gross motor skills training for ambulant school-aged children with cerebral palsy was conducted by Toovey et al. in 2017. In addition to randomized clinical trials, the review included comparative studies, one repeated-measures study, and one single subject design study. Meta-analysis was not conducted by the research group (Toovey et al. 2017). As per October 2021 there has not been published a systematic review and meta-analysis of impact of task-oriented training on functional mobility and balance in children with cerebral palsy. To fill this research gap, a systematic review with meta-analysis of chosen randomized clinical trials was conducted with the purpose to examine the effectiveness of task-oriented training in functional balance and mobility in ambulant children with CP.

2 Theoretical background

This chapter provides theoretical background of the diagnosis cerebral palsy, ICF-CY framework for measuring health and disability, as well as an insight into philosophical approach in clinical reasoning and evidence-based practice. The topics are discussed in an effort to gain wider understanding of the results from individual studies as well as from the meta-analysis.

2.1 Cerebral Palsy

2.1.1 Definition and relevance

Cerebral palsy (CP) is a heterogeneous condition, which refers to a group of permanent, non-progressive, neuromotor disorders that manifest in the developing fetal or infant brain. The diagnosis CP comes with multiple clinical types; multiple patterns of neuropathology; multiple associated developmental pathologies; and multiple rare pathogenic genetic variations (mutations). Various pre-, peri-, and post-natal etiologies in CP result each in different types of impairments in the development of movement, muscle tone and posture (Graham et al. 2016; Hallman-Cooper & Rocha Cabrero. 2021; MacLennan et al. 2015; Oskoui et al. 2012). Despite the initial neuropathologic lesion being non-progressive in CP, children with the diagnosis can develop a wide range of secondary conditions over time that will variably affect their functional abilities. These conditions can, for instance, include intellectual disabilities, musculoskeletal problems such as muscle and tendon contractures, autism, epilepsy, spinal deformity, and visual impairments (Hallman-Cooper & Rocha Cabrero 2021; Palisano & Orlin, 2017; Patel et al. 2020). In this thesis, the heterogeneity of the diagnosis CP and the secondary conditions is discussed further as it is significant when evaluating the effect of an intervention for an individual, as well as when assessing the procedures and evidence of clinical trials in which groups and individual participants do not represent only one subgroup of the diagnosis. Moreover, characteristics of the diagnosis and secondary conditions play an important role in clinical reasoning and interventions, such as task-oriented training, for an individual child.

A systematic review and meta-analysis on the overall prevalence of cerebral palsy by Oskoui et al. (2013) included a total of 49 studies. Study locations varied and included several countries from Europe, Asia, Africa, Northern America, and Oceania. The analysis concluded an estimated prevalence of CP being 2.11 per 1000 live births. The highest pooled overall prevalence was in children weighing 1000 to 1499g at birth, and in children who were born before 28 weeks' gestation. A multidisciplinary CP-North study by Hollung et al. (2021) collected data from researchers from CP surveillance programs or registries in Nordic countries and Scotland. Children and adolescents with CP aged 6 to 19 years old were included in the study. The results from this study show that the overall point prevalence of CP in the Nordic countries and Scotland range from 2.13 to 2.32 per 1000 residents. According to the study, GMFCS level I had the highest proportion of individuals. These observations make it relevant to assess, examine and discuss the possibilities and effect of dynamic task-oriented training in ambulant children with CP.

2.1.2 Etiology

The etiology behind CP is often multifactorial in an individual child. Approximately 90% of cases CP results from a static destructive process or injury in a healthy brain tissue rather than from abnormalities in brain development (Hallman-Cooper & Rocha Cabrero, 2021; Graham et al. 2016).

Prenatal injuries causing CP can include congenital brain malformations, intrauterine infections, intrauterine stroke, and chromosomal abnormalities. The group of perinatal causes consists of hypoxic-ischemic insults, infections in the central nervous system (CNS), stroke, and kernicterus. CNS infections and stroke can also occur in postnatal period, in addition to accidental or non-accidental trauma, and anoxic insults (Hallman-Cooper & Rocha Cabrero, 2021; MacLennan et al. 2015; Nelson, 2008). Children who are born preterm (especially before 28 weeks of gestation) and have low birthweight are at higher risk for developing CP and additional neurodevelopmental comorbidities (Hafström et al. 2018, Demesi-Drljan et al. 2016, Trønnes et al. 2014). Furthermore, in their systematic review, McIntyre et al. (2012) identified 38 additional risk factors for CP. The primary findings consist of 10 statistically significant risk factors in term-born infants; lacental abnormalities, birth defects, low birthweight, meconium aspiration, Caesarean delivery, birth asphyxia, neonatal seizures, respiratory distress syndrome, hypoglycaemia, and neonatal infection. However, despite the wide range of various risk factors, multiple studies have also reported that half of the children who developed cerebral palsy were born at term without any identified risk factor (Graham et al. 2016; Novak et al. 2017; Stavsky et al. 2017).

2.1.3 Clinical classifications

In order to contribute to the clinical diagnosis of cerebral palsy, a careful assessment of the child’s possible asymmetry, involuntary movements, abnormal primitive reflexes, and the late development of postural responses is important together with necessary follow-up (Palisano & Orlin, 2017). CP can be clinically classified and described topographically either as unilateral or bilateral cerebral palsy (Graham et al. 2016; Palisano & Orlin, 2017). Furthermore, the diagnosis is categorized into six different subtypes, each of which come with different types of distributions of motor and tone abnormalities (Graham et al. 2016; Hallman-Cooper & Rocha Cabrero, 2021):

Spastic diplegic	Spasticity and motor difficulties affect the legs generally more than the arms
Spastic hemiplegic	Spasticity and motor difficulties affect one side of the body; the arms are primarily involved more than the legs
Spastic quadriplegic	All four extremities are affected with often greater involvement of the upper extremities than the legs
Dyskinetic	Excessive, involuntary movements are characterized as combination of rapid, dance-like contractions of muscles and slow writhing-type movements
Dystonic	Involuntary, sustained muscle contractions cause twisting and repetitive movements
Ataxic	The child has unsteadiness and incoordination, and is often hypotonic

Children with different types of cerebral palsy can demonstrate a significant variation in functional abilities (Palisano & Orlin, 2017). The Gross Motor Function Classification System (GMFCS) was developed in 1997 to provide an objective clinical classification system in order to describe the severity and gross motor functions in children with the diagnosis (Palisano et al. 2008; Wood et al. 2000). The GMFCS is a reliable, functional five-point scale (level I presenting the best gross motor functions, and level V the least function), with emphasis on the child's typical performance and movement abilities in different settings. The universal classification system is widely used to not only describe motor activities of children with the diagnosis, but also to clinically predict outcome, set goals and plan rehabilitation, as well as to measure any change with an innovative intervention: the GMFCS level might change over time if rehabilitation and therapy has been helpful and effective. The scale is also useful in the situations where parents wish to understand the severity of the condition and the prognosis of their child's mobility (Gorter et al. 2008; Reid et al. 2011; Wood & Rosenbaum, 2000).

The GMFCS classification is discussed in this review due to it providing standardized evaluation of the functional levels in children with CP. Acknowledging the strengths and limitations in the functional abilities of the participants in the included trials contributes to more comprehensive understanding of the results as the GMFCS levels may provide explanations to, for example, a child's response to the intervention. Levels of the GMFCS scale together with the expected gross motor functions (Palisano et al. 2008) are described below.

I	The child can walk indoors and outdoors. She/he climbs stairs without limitations. The child performs gross motor skills including running and jumping. Speed, balance, and coordination are reduced.
II	The child walks indoors and outdoors. She/he can climb stairs by holding onto a rail, and in addition experiences limitations in walking on uneven surfaces and inclines, as well as in crowds or confined spaces. The child has at best only minimal ability to perform gross motor skills such as running and jumping.
III	The child uses an assistive mobility device to walk indoors or outdoors. She/he may climb stairs holding onto a rail. The child is either transported in a wheelchair, or she/he propels a wheelchair manually, when travelling for long distances or outdoors on uneven terrain.
IV	The child may maintain levels of function achieved before the age of 6 years, or rely more on wheeled mobility at home, school, and in the community. She/he may achieve self-mobility using a powered wheelchair.
V	The child's voluntary control of movements, as well as the ability to maintain antigravity head and trunk postures, is restricted by physical impairments. All areas of motor function are limited. Functional limitations in sitting and standing are not fully compensated for through the use of adaptive equipment and assistive technology. The child has no independent mobility and is transported (pushed by another person). Some children achieve self-mobility using a powered wheelchair with extensive adaptations.

While the GMFCS scale is used to describe the performance in different gross motoric settings, the Manual Ability Classification System (MACS) aims to classify the child's manual ability. Manual ability refers to an individual's capability to manage daily activities that require the use of the upper limbs in order to handle objects with whatever strategies involved. It mainly focuses on the collaboration of the left and right upper limb, rather than assessing their function separately. The level of function in the upper limbs is observed and assessed through appropriate and relevant everyday activities in which the child handles different objects; for example, in eating, dressing, writing, and playing (Eliasson et al. 2006; Morris et al. 2006). Even though it is suggested that upper limb function and movements can indeed have a significant impact on mobility through, for example, impaired balance strategies and difficulties in coordination caused by impairments in one or both arms (Johansson et al. 2014; Rafsten et al. 2019), the MACS classification of the children was not considered in the inclusion criteria in this review. This is due to lack of information of the MACS levels in several studies, but also because the overall assessment of gross motor functions in GMFCS is considered more appropriate and relevant in the light of the statement of the problem as well as the purpose of this study. However, MACS levels of participants, when available in the included studies, are discussed in this paper as they can contribute to further understanding and qualitative evaluation of the individual characteristics, thereby affecting the heterogeneity of the groups and results in the clinical trials.

2.2 Functional mobility and balance in cerebral palsy: ICF-based methodology

'Functioning' can be referred to as an umbrella term that describes what an individual with a health condition does or is able to do in everyday life (Schiariti & Mâsse, 2014). The International Classification of Functioning, Disability and Health (ICF), found by the World Health Organization (WHO), is a framework for describing and understanding functioning and disability comprehensively from a bio-psychosocial perspective in four components (Figure 1): body functions and structures, activity and participation, personal, and environmental factors (Schiariti & Mâsse, 2014; WHO, 2001). ICF-CY, which is the pediatric version of the ICF, records the characteristics of the developing child and the influence of the child's surrounding environment (WHO, 2007). This chapter explicates the ICF domains in the light of cerebral palsy in children, clinical reasoning and task-oriented intervention in pediatric physical therapy.

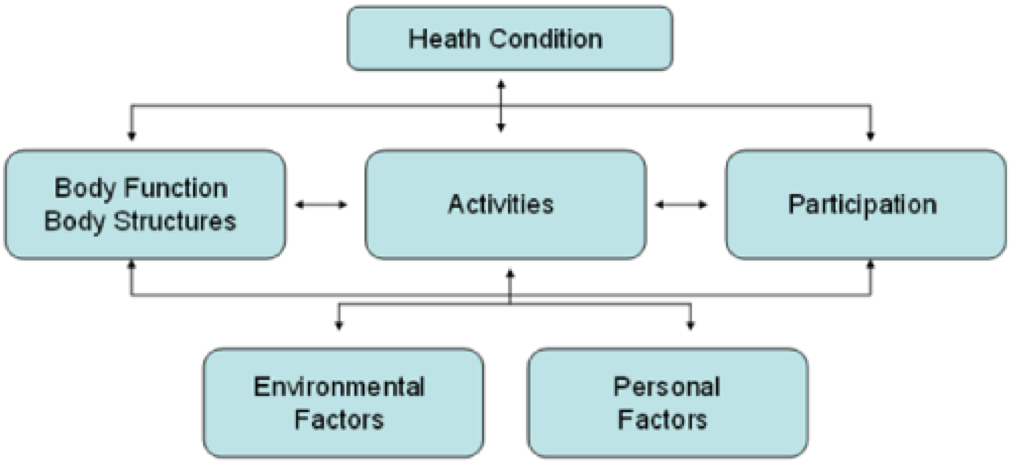

Figure 1 – Interactions between the components of ICF (WHO, 2007).

2.2.1 Body functions and structures

Body functions (the physiological functions of body systems) and structures (anatomical parts of the body) associated with functional mobility are related to posture, bones and joints, and neurocognitive functions (Forhan & Gill, 2013; WHO, 2007). Children with diagnosis CP suffer from multiple body function and structure impairments, which result primarily from the existing pathology, or secondarily from impairments such as skeletal malalignments, contractures, or abnormalities in muscle tone (Graham et al. 2017; Palisano & Orlin, 2017).

Upright postural control is a fundamental component of an individual's ability to anticipate instability and recover from it, and thereby, develop functional mobility and ability to move (Liao et al. 1997; Rose et al. 2002). Furthermore, postural control contributes to the child's ability to control the body's position in space for stability or orientation, balancing the center of mass over the base of support. In order to gain ability to move independently and safely (functional mobility), the child must have developed dynamic neural control which plays a crucial role in adapting quickly and effectively locomotion, and in contributing to reactive postural adjustments that provide strategies in recovering from unexpected external postural perturbations in changing environmental and task conditions (Forhan & Gill, 2013; Palisano & Orlin ,2017; Bouça-Machado et al. 2018). Impaired and disorganized neuromuscular responses in children with CP can result in widely disturbed muscle activity leading to abnormal anticipatory postural adjustments (expected internal postural perturbations), long-duration responses to balance threats, and inability to increase the muscle contraction amplitudes (Palisano & Orlin, 2017; Pavão et al. 2013; Shumway-Cook & Woollacott, 2005).

Children with the diagnosis of CP have a variety of decrease levels in muscle stem cell numbers, muscle body size, smaller-diameter fibers, and highly stretched sarcomeres, resulting in functional deficits such as decreased force production and range of motion (Mathewson et al. 2016). Joint contractures, in which the range of motion of a joint and ability to manually stretch the functionally “short” muscle is limited, is a common problem among children with CP (Cloodt et al. 2021; Mathewson & Lieber, 2016; Palisano & Orlin, 2017). Among ambulant children and children with moderate CP (level I-III), the most common and first contracture is often a flexion contracture in the gastrocnemius muscle which prevents an optimal dorsiflexion of the ankle and can also contribute to development of knee flexion contractures (Cloodt et al. 2021; Mathewson & Lieber, 2016). Furthermore, contractures in ankles and knees may increase the risk for additional contractures as they prevent normal movement patterns and emphasize abnormal forces around the joints. Lower limb contractures result often in structural and functional problems such as asymmetric posture, abnormal gait, and increased energy consumption especially among ambulant children with mild to moderate level (I-III) of CP (Cloodt et al. 2018, 2021).

Abnormalities in muscle tone, which is used to describe resting tension or resistance of muscle to passive movements, are common diagnostic features of CP. Most frequent abnormality among children with CP is hypertonia, which is characterized by increased resistance to an external force unlike hypotonia, which, on the contrary, is an abnormal decrease in the ability to generate voluntary muscle force (Cheng et al. 2012; Palisano & Orlin, 2017). Spasticity can clinically be defined as hypertonia in which neural resistance occurs to externally imposed movement of a joint, or alternatively, or as inappropriate involuntary muscle activity due to upper motor neuron paralysis (Palisano & Orlin, 2017; Sanger et al. 2003; Shamsoddini et al. 2014). It is a common impairment of the lower extremities among children with CP (Cheng et al. 2012), and often results in muscle imbalance, abnormal gait characteristics, disturbances in balance, and abnormalities in posture (Cheng et al. 2012; Liao, 1997; Palisano & Orlin, 2017; Panibatla et al. 2017).

Abnormalities in postural control in cerebral palsy includes difficulties in organizing compensatory postural adjustments (CPAs) and anticipatory postural adjustments (APAs). Anticipatory postural adjustments (APAs) have a significant role in the performance of many activities and tasks that require a sufficient maintenance of vertical posture (Girolami et al. 2010). APAs that are created by the central nerve system (CNS) are referred to as pretuning of sensory systems and activation of muscles prior to a goal-directed movement. Anticipatory control and activation of the muscles do not only contribute to generating the movement, but also to maintaining postural control in, for example, fast upper and lower limb movements, or in sudden translations of the support surface (Girolami et al. 2010; Gjelsvik & Syre, 2016).

In task-oriented training, body functions and structures are strongly related to individual treatment methods and goal setting. Restrictions, such as reduced postural control, muscle tone abnormalities, and contractures, can prevent a child from performing certain movement patterns that would make a functional task possible. Therefore, it is important to consider the individual characteristics of body functions and structures in clinical reasoning. Body functions and structures should also be considered when performing standardized tests for measuring a child's functional and motor abilities. Although a child can perform certain tasks and score high in different measure instruments, such as in PBS and TUG, the therapist should pay attention to how the given task is performed and achieved. A task may not be impossible for a child to perform despite the limitations in their body functions and structures, but these characteristics should be taken into account when assessing the scores and evidence from different outcome measures, as participants might have used a variety of strategies in order to score high in the test. For example, a child who has reduced selective control in truncus and increased spasticity in their right knee and ankle might use compensation strategies such as truncus rotation and circumduction (a combination of hiking and forward rotation of the pelvis and abduction of the hip) in order to walk as fast as another child with milder functional limitations, thereby scoring as high in the given test as the other participant. Despite the same score from a functional test, goals and focus on treatment interventions may significantly vary between these two individuals because of their body functions and structures.

2.2.2 Activity and participation

Social participation for children involves interactions with others in several varying environments, such as at home, school, and community. Through activities and participation, the child has an opportunity to form friendships, gain knowledge and learn new skills, express creativity, and determine purpose in life (Chen et al. 2003). In physical therapy, the focus with children who have CP is often on motor activities and how they affect the child's activity and participation in learning, general tasks and demands, mobility, self-care, and other domains of life (Palisano & Orlin, 2017; WHO, 2007).

Functional mobility is crucial as it allows the child to move independently and safely in a variety of environments and accomplish functional tasks and activities. Impaired functional mobility has been found to reduce participation and ability to engage in the activities of daily living, at home, school and in the community, as well as to be associated with a greater risk of loss of independence, and institutionalization (Bouça-Machado et al. 2018; Leonardi et al. 2009). Several fundamental components of one's functional mobility are often impaired to a different degree in children with CP (Liao et al. 1997; Panibatla et al 2017; Rose et al. 2002) and lead into significant limitations and restrictions in activities and movements such as rising from lying to sitting, standing, bending, walking, and climbing (Forhan et al. 2013; Gan et al. 2008; Harbourne et al. 2010; Rose et al. 2002). According to several studies (Alghamdi et al. 2017; Imms 2008; Lauruschkus et al. 2017), children with diagnosis of CP and lower functional abilities participate less frequently and enjoy fewer physical activities and are thus in risk for developing further physical and mental health problems.

In this review, task-oriented intervention and its effect is assessed and discussed. Task-oriented training aims to contribute to improvements in meaningful daily activities that consist of several different functional tasks. As functional training through different tasks aims to improve the child's ability to perform meaningful activities in their life, it is crucial for a pediatric physical therapist to consider in their clinical reasoning what activities and what kind of participation are important for the individual. This has an impact on the individual goal setting, which is a fundamental component of task-oriented intervention, and treatment plan. If we look into two individual children with cerebral palsy and consider the characteristics of their diagnosis, secondary conditions and body functions and structures to be somewhat similar, we still cannot assume the goals for treatment and individual tasks used in the intervention to be necessarily identical. Moreover, despite the two children possibly scoring alike in clinical tests, they might be limited by different activity levels and be driven by unsimilar interests within participation, thereby tolerating different levels of intensity in the intervention as well as being motivated by different goals.

2.2.3 Environmental factors

Lastly, environmental factors consist of the physical, social, and attitudinal environment in which children live and conduct their lives, and are coded from the perspective of the child whose situation is being described (WHO, 2007). ICF classifies potential environmental factors influencing participation into five chapters: products and technology, natural environment and human-made changes to environment, support and relationships, attitudes, and services, systems and policies (Mihaylov et al. 2004; WHO, 2001).

In their review from 2004, Mihaylov et al. discuss environmental factors that influence participation of children with CP and concluded that there emerges a range of barrier and facilitator factors that may restrict participation in children with the diagnosis. Psychosocial pressures (family, peers, school), financial difficulties, inadequate public services, and social attitudes have been found to affect the participation attendance and activity competence among children with CP (Mihaylov et al. 2004; Van der Kemp et al. 2021). Although opportunities for children with CP to participate in activities of daily living, in home, school, and community activities are increasing (Palisano & Orlin, 2017, p. 454), it is also important to note that there remains a lack of research and reliable studies about environmental factors in relation to participation involvement and activity competence among children with CP (Van der Kemp et al. 2021).

2.3 Motor development and task-oriented approach

Understanding the motor development of a child and theories behind it may contribute to wider understanding of results from individual trials, and further on support clinical reasoning in evidence-based practice. In order to be able to evaluate and discuss the evidence gathered from meta-analysis in this review as well as its implications in pediatric clinical practice with children who suffer from cerebral palsy, the following sections briefly explain the connection between motor learning and task-oriented approach.

Neuroplasticity, the ability of the central nervous system to change its activity in response to stimuli by reorganizing its structure, functions, or connections, is believed to be the basis for learning in the intact or, in the case of neurodevelopmental diseases such as CP, damaged brain that occurs in the context of development of the age-appropriate skills (Kleim & Jones, 2008; Palisano & Orlin, 2017). Neuroplasticity in the brain is believed to be significantly enhanced during critical periods in early life. Experiences gained during this maturational time in the childhood have a peak effect on a child's development and learning (Hübener, 2014; Mundkur, 2005). Like many individuals with congenital disorders, children with the diagnosis CP are rarely trying to regain a certain function but to rather learn a skill for the first time without a motor image of how to perform the task, therefore being unable to assemble it from a pre-existing skill (Kleim & Jones, 2008; Krakauer et al. 2019; Palisano & Orlin, 2017).

Motor learning can be defined as experience-dependent improvement in performance, involving a number of interacting components; gathering of sensory information, learning key features of the given skill or task, and setting up appropriate control mechanisms in order to generate motor commands (Krakauer et al. 2019; Wolpert & Flanagan, 2010). After a period of skill acquisition, a motor behavior is retained and the newly acquired skill can be transferred to other similar tasks (Kleim & Jones, 2008). Therefore, in order to gain optimal efficacy, the practice of movements should be embedded in tasks that are meaningful, relevant, and challenging for the child, and that require progressively increased behavioral demands and involve active participation, rather than simply practice the patterns of movement (Kleim & Jones, 2008; Palisano & Orlin, 2017, p. 87-91).

Moreover, Dynamic Systems Theory (DST) explains motor development and achieving a functional task through self-organization and interaction of several subsystems. The theory emphasizes three sets of characteristics (subsystems) that have an impact on the capability and effectiveness of learning a motor skill: the person (the child), the task (i.e., skill or activity), and the environmental context. Within the child, the central nervous system, biomechanics, cognition, and personality should be considered. Within the task, factors such as the height of a chair the child is standing up from, or the height of the stair she/he is supposed to step on or from, can affect the child's motor behavior. Diverse factors in the environment, such the surface on which the child is moving as well as the child's interaction with the physical therapist, may contribute to their motor behavior and learning (Thelen et al. 1987; Thelen, 1989). That said, Palisano & Orlin (2017) argue that due to these subsystems being individual to each patient, no specific intervention can be argued as suitable for every child. Considering and assessing the effectiveness of task-oriented training in children with CP in the light of Dynamic Systems Theory is rather relevant in this review as the meta-analysis provide an overall effect score and does not take into account individual characteristics or variations within the intervention tasks. Therefore, the diverse factors represented in the Dynamic Systems Theory are discussed and considered when assessing the evidence for clinical practice and decision making.

Therapy interventions can be considered to be relevant and effective if they contribute to improvements that transfer to daily activities and help the child to meet their individual needs and goals (Reid et al. 2015). Modern concepts of motor learning have modified the framework of rehabilitation from a conventional neurodevelopmental therapy to a more dynamic, task-oriented approach in which the goal of practice is not normal movement quality, but rather achieving the given task through preferred, individual coordination strategies based on the child's movement capabilities (Barbeau et al. 2001; Valvano 2004). Intensity, relevancy, repetitions, therapist-client collaboration, and feedback are fundamental components of task-oriented training, which is a contemporary intervention based on behavioral neuroscience (Rowe et al. 2018; Valvano, 2004). The approach focuses mainly on activity limitations and skill acquisition rather than movement normalization and impairment-level disablements that are presented in body functions/structures in the ICF classification (Palisano & Orlin, 2017 p. 89). Activity focused interventions on pediatric neurological physical therapy aim to increase the child's independence and participation in daily routine. The therapist can contribute to successful and effective improvements by first developing individual activity-related goals with the child and the family, then identifying the child's strengths and limitations, and adapting the motor learning principles to the child's individual environment, needs and strengths, and finally integrating activity-focused intervention with impairment-focused intervention if required (Valvano, 2004).

2.4 Rationalism and empiricism in evidence-based practice

This section aims to describe the philosophical concepts of rationalism and empiricism, as well as to highlight their advantages and disadvantages on evidence-based practice and clinical reasoning in physical therapy. The philosophical approaches are discussed due to their relevance in systematic reviews and quantitative meta-analysis that ought to provide reliable evidence from clinical trials. Moreover, discussing rationalism and empiricism in the light of evidence-based practice is considered relevant as this study is largely based on assessing evidence of the effectiveness of a clinical intervention; it is a process that includes evaluating and discussing how different clinical and philosophical approaches and methods can affect single research, its results and data, and further on clinical reasoning in physical therapy practice for children with cerebral palsy.

2.4.1 Rationalism and empiricism

According to rationalism as an epistemological view, knowledge is based on and acquired through reason, without the aid of subjective senses or experiences which are considered second-class knowledge. A good example of rationalist knowledge is statistical and mathematical knowledge as through numbers and other mathematical concepts one can construct proof, and furthermore provide evidence for certain hypothesis. A causal understanding of the internal physical mechanisms of pathophysiology is thought to be a requirement in order to formulate rational principles to guide clinical practice, and therefore rationalism is often also referred to as mechanism-based reasoning (Fieser & Stumpf, 2014; Webb, 2018), causal mechanisms being defined as physical means by which something is accomplished (American Psychological Association 2022).

Rationalists believe that a human body is essentially an unconscious, complex machine that is separated from the spirit-mind. The variety of physiological actions and functions in the body are caused by mechanical motions of their parts, as naturally as the movements of a clock (Fieser & Stumpf, 2014), thereby emphasizing the theory of mechanistic biomedical model of a human body and health. Kirkengen et al. (2012) argue that such approach can significantly violate the individual's personal integrity, social relations, values, socio-cultural factors, and space as it values objective knowledge higher than the patient's subjectivity. Mechanistic biomedical theory has a number of disadvantages that should be considered in clinical practice and interventions for children with cerebral palsy. If the therapist sees the body and mind as two categorically different substances, they may significantly reduce their considerations and understanding of the connections between lived experiences and bodily dysfunctions (Kirkengen et al. 2012). For example, a physical therapist meets a child who is not be capable of walking in the stairs without support even though the therapist might evaluate the child's bodily functions sufficient for the task. The therapist is not aware of the child's previous experiences: the child has previously had an incident where they fell in the stairs and experienced pain in the right hip for several months. The child's bodily inscription of pain may trigger their fear of walking in the stairs without support, therefore preventing them to achieve the given task. Acknowledging the phenomenological concept of the lived body and seeing a human body as an interacting unity can contribute to improvements in understanding how dysfunctions can affect the child's perception both of the world and of their own body, and moreover, give the child new opportunities to participate (Kirkengen et al. 2012).

As a clinical practitioner, it is important for a physical therapist to reflect on several considerations within evidence-based research which base their results merely on "raw data". Lack of empirical observations and experimentations can result in significant limitations in treatment interventions, and moreover in ineffective outcomes. Statistically significant findings and mathematical data from systematic reviews and meta-analyses represent the results of several outcome measures, but do not necessarily consider or give information about the individual's subjective experiences, the assessor's perceptions under the situation, nor social or psychological aspects of the individual child, or testing situations. Thus, it can be suggested that rational numbers and statistical knowledge alone as evidence to decision making in practice may violate the clinical reasoning process. Øberg et al. (2015) refers to clinical reasoning as professional judgments made by a therapist before, during and after clinical training sessions. While a fundamental focus in clinical reasoning and physiotherapy interventions is on the body and movement, Øberg (2015) highlights the importance of understanding phenomenology of the body as this results in more interactive embodied-enactive clinical reasoning process between the patient and the therapist. Embodied-enactive theory emphasizes the importance of the patient as an active participant in clinical reasoning and decision making; a physical therapist as "a third person" cannot alone contribute to the process despite the knowledge within human anatomy, neuromuscular and brain function, as this leads to the therapist ignoring other important subjective aspects of the body (Øberg et al. 2015; Kirkengen et al. 2012).

In several studies on effectiveness of task-oriented training in children with CP (Ko et al. 2020; Kumar & Ostwal, 2016; Madhumati et al. 2020; Ogwumike et al. 2019; Rajalaxmi et al. 2021; Sah et al. 2019; Shaju, 2016) the standardized test procedures to evaluate outcome were conducted in similar, highly controlled conditions for each participant. Each child would perform one or several physical tasks, which provide a causal mechanism: for example, the child is able to accomplish an acceptable score in Timed Up & Go -test because they can stand up from a chair and walk independently as they have developed sufficient muscle strength, postural control, and stability, which are fundamentals of one's functional mobility and balance. Through this causal mechanism in an anatomical experiment a researcher can base their knowledge and results on reason and logic, rather than argue that functional mobility was achieved because the assessor perceived and observed it to happen. However, the group data from the chosen outcome measures does not consider different GMFCS levels of the participants, secondary conditions, environmental factors, or other individual characteristics of the children, nor does it describe the outcome of an individual child, therefore making it difficult to fully determine an evidence-based and recommended intervention for an individual child. In clinical practice, as mentioned in the previous section, the therapist should not base their decision-making regarding to an individual child merely on rational numbers and group data (Damiano, 2014; Palisano & Orlin, 2017), but instead in addition consider the characteristics of the child as this becomes significantly important when planning treatment protocol and setting individual goals.

Explaining a phenomenon, such as standing up from a chair or walking up the stairs, through a causal mechanism and reason alone does not widen one's understanding of it. Therefore empiricists, unlike rationalists, emphasize the need to not acquire a full understanding of all the complexities of the phenomenon but rather the need to obtain a wider view of the various aspects that might shape it and factors that possibly influence its impact. It is generally believed among empiricists that clinical causation can be multifactorial as it may differ in various settings and within individuals, and that the knowledge of a phenomenon is based on empirical evidence: sensory experiences which can be acquired upon perception and through observation (Newton, 2001; Webb, 2018). Empiricism as an approach assesses new interventions and treatments by not whether it follows "the body's true nature", but instead whether or not it helps the patient recover. Thus, the main interest lay in therapeutics rather than mechanisms of a disease, outcomes being the more important issue over prognosis. The effect of the treatment is thought to provide a clinician valuable evidence, whereas bodily functions during the intervention are given less attention (Cosans, 1997; Newton, 2001).

Empirical evidence for a treatment effect can, for example, be gathered from large, correlative studies that reveal statistically significant findings. However, despite the results, the evidence may remain clinically irrelevant due to lack of understanding individual and anatomical characteristics of the diagnosis, socio-cultural, and psychosocial factors (Webb, 2018). If one considers, for instance, a child with cerebral palsy with GMFM level IV. The child is recommended to do walking training in an adaptive mobility equipment for at least 30 minutes daily, according to the existing evidence from several clinical trials. Despite the significant findings on positive effect of the intervention, the training results in pain in the child's hip and eventually in a fracture in left femur due to low bone mineral density (BMD) and spasticity together with involuntary muscle contractions and instability around pelvis, contributing to scissor gait, positive Trendelenburg sign and fall danger towards left side. The pain, followed by a fracture, results in long inactive period which prevents the child to participate in meaningful daily activities. Over the time it may also contribute to decreased physical functions, such as muscle strength and postural stability, which further on prevents the child to participate in daily tasks and meaningful activities. Moreover, the pain and incapability to participate may lead to anxiety and fear to stand up and walk again. In this case, despite the recommendations and evidence from clinical trials, knowledge of certain characteristics of the diagnosis CP should have been considered as the empirical evidence from the trials has not considered anatomical and biomedical factors of different subtypes and classification levels of the disease.

Adopting a more epistemically balanced approach in clinical reasoning and practice may be accomplished by acquiring a synthesis of rationalism and empiricism, as they both contribute to the wider understanding of a human body and health, and clinical practice traditions (Van Gijn, 2005; Webb, 2018). Evidence-based practice and clinical reasoning in the light of characteristics from rationalism and empiricism is examined in the following section.

2.4.2 Evidence-based practice

Evidence-based practice (EBP) is based on three components (Fig. 2) that are used for decision-making and providing care and treatment for patients: best research evidence, clinical expertise, and patient values (Gilgun, 2006; Li et al. 2019). Evidence-based practice is considered the standard for pediatric physical therapy. In EBP, the therapist is ought to engage in lifelong acquiring and integrating knowledge, learning and professional development in order to apply the most current and best methods in their everyday practice (Palisano & Orlin, 2017).

Figure 2 – Components of evidence-based practice (EBP) (The University of Oklahoma).

Evidence-based practice is based on open and thoughtful clinical decision making that integrates the best available evidence (practice guidelines recommendations and research results) with clinical reasoning that takes place before, during, and after physical therapy intervention (Jewell, 2015; Palisano & Orlin, 2017; Øberg et al. 2015) Practice guidelines and recommendations can be used as a framework for individualized intervention, but non-conceptual and extra-neural factors of body and environment should also be taken into consideration. Individualized intervention may be supported and accomplished through the embodied-enactive clinical reasoning process in which the therapist simultaneously gathers information and evidence from active or inactive bodily exploration of movement possibilities, patient's bodily expressions (such as positioning, facial expressions, gestures), and ongoing verbal discussion through joint attention and action. In this type of dynamical interplay, the child has a chance to experience the therapist's touch and facilitation of different movements while the therapist can enhance their understanding of the child by observing and by hands-on interaction (Øberg et al. 2015). This process culminates in balance between rationalistic and empiristic approach as the therapist acknowledges the importance of the internal physical mechanisms of the body and movements, while sensory experiments of both parties is also taken carefully into consideration.

In order to be able to support and provide the framework for "best practice and treatment" in their everyday practice, the therapist must be able to ask a relevant and answerable clinical question, acquire the knowledge of the current best evidence, appraise the evidence, apply the evidence into practice, and assess the process (Mar et al. 2004; Sackett et al. 2000). Improved patient outcomes should result from the appropriate use of evidence regarding to the effectiveness of certain treatment strategies and physical therapy approaches. However, it is not always simple to gain knowledge of the current evidence and to select effective techniques in everyday clinical practice. There are several factors and barriers that are known to affect the application of evidence-based practice in physiotherapists' clinical work.

Firstly, despite the awareness of their responsibility and positive attitude towards working in an evidence-based manner, physiotherapists have pointed out that the extent of this can depend on support from their organization. In order to obtain latest information, evidence of clinical guidelines and evidence, one must obtain articles which can be inaccessible on certain databases without a special subscription. It should also be noted that lack of personal skills in searching relevant evidence affects the evidence-based process. These deficits together with time limitations during working hours can make it rather challenging to follow current research and therefore maintain evidence and provide "best treatment". Secondly, it is not always clear how, when, and why an action is performed despite the evidence from research.

For example, although an instrument or aid used in a treatment protocol is "evidence-based", it may be completely inappropriate in a certain situation. In these cases, the subjective experiences and preferences by the therapist and patient would be given a significant weight in the evaluation. Thirdly, working in an evidence-based manner can be a matter of access to facilities and resources. This culminates in time the therapist has for each patient, and in the availability of physiotherapists (Iles et al. 2006; Snöljung et al. 2018).

There is an increased number of studies on treatments of children with cerebral palsy, of which systematic reviews and meta-analysis of effectiveness of interventions are currently being considered as valuable resources of evidence for practitioners (Palisano & Orlin, 2017). However, these resources often face limitations in assessing the response of an individual. The effect size for most interventions in small to medium, and as evidence-based research supports several treatment approaches based on group data, the response of an individual child should not be blindly predicted from such kind of overall data (Damiano 2014; Palisano & Orlin, 2017). This is also supported by Croft et al. (2011), who argue that populations in clinical practice are heterogeneous, meaning that research evidence from homogenous trials cannot completely fit an individual child. Moreover, Croft et al. (2011) suggest that the randomized clinical trials as the only design paradigm to address a clinical question of evidence for an intervention is wrong, as they often do not assess or discuss questions regarding to adverse effects, prognosis, or diagnosis. Evidence from an RCT can be evaluated as "very low quality" due to possible deficiencies in validity or precision, inconsistencies in outcomes, indirectness of evidence, or publication bias.

Croft et al. (2011) further on argues that commitment only to evidence-based clinical decisions gives a limited view of what is actually needed in clinical practice, rather than develops strategies that consider the interactive relationship between the patient and the therapist before, during and after a clinical intervention. Reflective, embodied-enactive clinical reasoning supports the therapist's professional autonomy and development, and is especially vital for interaction and communication with patients with neurological impairments (such as children with cerebral palsy) because of their reduced sensory processes, perception, and motor abilities (Øberg et al. 2015). In pediatric physical therapy, dynamical interplay and continuous physical and verbal communication between the therapist and the child can provide the therapist with a wider understanding and information, thus eligible evidence about the individual child, the characteristics of the diagnosis, and the clinical situation. By strictly following and having only focus on the research evidence from homogeneous and highly controlled trials, the therapist may exclude significant components and individual characteristics from decision-making; patients' and clinicians' preferences, values and expectations, availability of treatments, or financial, ethical, and legal issues (Croft et al. 2011).

3 Method and material

This chapter explains and reasons the method and material used in this thesis. The review and meta-analyses explored the treatment effect for trials that used Pediatric Balance Scale (PBS), Timed Up & Go (TUG), and Gross Motor Function Measurement (GMFM) as their primary outcome measures. The numbers of studies for each measurement instrument were more than two. The post-test scores from each study were entered into the software (RevMan 5.3) for a summary estimate of the effect of task-oriented intervention. In addition, effect size for experimental and control groups in each individual trial was calculated.

In order to ensure the best possible quality of this literature review process, the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses statement) and the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al. 2020) were used.

3.1 Systematic review and meta-analysis

According to Davis et al. (2014), systematic literature reviews are mainly being produced within medical sciences, and the number of publications with 'meta-analysis' as a keyword has been highest in research related to medical sciences since late 1980's. Furthermore, Sackett et al. (2000) refer to systematic literature reviews including meta-analysis as a "gold standard" for evidence-based practice in medical sciences. A systematic literature review critically identifies, selects, appraises, and finally summarizes all the available, existing evidence on a specific topic in order to answer a clearly formulated research question (Higgings et al. 2020; White et al. 2005). A clearly defined protocol and strategy with a specific focus on the given topic must be followed as a systematic review is conducted (Higgings et al. 2020).

Meta-analysis is a study design that quantitatively and formally assesses published research studies and trials in order to contribute to profound conclusions about a treatment effect (Haidich, 2010). As part of a systematic review, meta-analysis is used as a statistical analysis that combines the results of multiple primary studies, and its statistical methods make it possible for the researcher to calculate an overall or 'absolute' effect (Bjørndal, 2008; Egger et al. 1997). There are several benefits and strengths in conducting meta-analysis: it can examine and assess sometimes complex and conflicting body of literature, evaluate heterogeneity and homogeneity of the studies, the ability to improve the power of small studies, as well as to reveal possible bias. Due to the number of benefits, meta-analysis can contribute to evidence-based practice and used as a tool to detect bias and thereby stimulate improvements in the quality of the data needed to optimize evidence regarding to interventions (Haidich, 2010; Ioannidis & Lau, 1999).

3.2 Search strategy and trial selection

The systematic literature search of this study was performed in October 2021. Relevant studies of randomized controlled trials were searched by using electronic databases. The following databases were used: MEDLINE (Ovid) <from 1946 to October 01, 2021>, PsycINFO <up to October Week 1 2021>, EMBASE <from 1947 to 2021 October 01>, the Cochrane Central Register of Controlled Trials (Cochrane) <up to October 10, 2021>, PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL) <from 1992 to October 2021>, and the Physiotherapy Evidence Database (PEDro) <database updated 15 October 2021>. Following key words with various combinations were used in the search: cerebral pals*, task-oriented or task-specific or goal-oriented or functional, training or activit* or exercis*. The search strategy was adapted to each database, and is provided in Supplementary material I. The following search strategy was used in Ovid MEDLINE:

1 Cerebral Palsy/
2 cerebral pals*.ti,ab,kw.
3 (task-oriented adj3 (training or activit* or exercis*)).mp.
4 (task-specific adj3 (training or activit* or exercis*)).mp.
5 (goal-directed adj3 (training or activit* or exercis*)).mp.
6 (functional adj3 (training or activit* or exercis*)).mp.
7 1 or 2
8 3 or 4 or 5 or 6
9 7 and 8

Literature search is seen as a flow chart in Figure 3. The search performed by using electronic databases yielded in total 1849 articles. In order to select retrieved articles for further assessment and to minimize the chance of including non-relevant articles, duplicates of the articles were first removed, resulting in 1026 records for further screening. Title and abstract screening was performed on 75 articles, of which 60 were excluded and the remaining 15 articles were assessed for eligibility by full-text reviewing. In addition, a hand search on relevant reviews and reference lists of retrieved articles was conducted, resulting in three additional trials that were included in the review and analysis. By the end of the search and study selection, altogether 9 trials were included in this systematic review and meta-analysis.

3.3 Inclusion and exclusion criteria

The following criteria were used to determine whether a study or publication would be included in the review and quantitative meta-analysis for purposes of estimating the effect of task-oriented training in children with cerebral palsy. The criteria were determined by the independent author.

3.3.1 Types of studies

The meta-analysis included random controlled clinical trials as they are considered primary study designs for statistical analysis. Unpublished studies, systematic reviews, study protocols, expert opinions, and conference abstracts were excluded. Relevant qualitative design and single-case studies were reviewed, analyzed, and discussed separately, when appropriate, from random controlled trials in an effort to provide explanations and further discussion for outcomes and findings regarded to the topic of this review.

3.3.2 Types of participants

The review included children between 2 to 18 years of age with the diagnosis of cerebral palsy. There were no exclusion criteria for certain subtypes of CP. Children with other neurological conditions and diagnosis, such as spinal diseases and traumatic brain injuries, were excluded. Only children with mild to moderate (GMFCS I-III) level of cerebral palsy were included in this review, ensuring that the participants were ambulant and could walk a short distance independently or with a walking aid/orthosis.

3.3.3 Types of intervention

Interventions included in the review engage the children in different types of task-oriented focused physical therapy. In the clinical trials, one group (experimental) would receive task-specific training with a physical therapist, and one group (control) another intervention method in physical therapy practice. Specific intensive gait training programs on a treadmill, robotic-assisted movement training, specific strength training programs tailored for the use of gym apparatus, and interventions including a limited single skill training (such as biking), were excluded. Specific task-oriented interventions for upper limb, as well as home-based training directed by caregivers were excluded.

3.3.4 Types of outcome measures

A variety of methods have been developed to assess clinical change in motor function in children with CP. In order to assess intervention effectiveness for CP children, as well as to provide further evidence for clinical recommendations, it is crucial to be able to reliably measure responsiveness to change in different gross motor functions (Alotaibi et al. 2013; Rosenbaum et al. 1990). Outcome measures in the meta-analysis included Timed Up & Go (TUG), Pediatric Balance Scale (PBS), and The Gross Motor Function Measure (GMFM). The instruments were assessed for their psychometric properties, and further used as part of the inclusion criteria in the review and meta-analysis. TUG and PBS were chosen as primary measurement instruments as they have been evaluated to possess excellent psychometric properties that can be used in the clinical setting when measuring various aspects of functional balance and mobility in children with cerebral palsy. Furthermore, the PBS total score strongly correlates with the GMFM-88 and walking speed (Gan et al. 2008). The extensively investigated and evaluated GMFM has been reported to conduct excellent levels of reliability when quantifying functional mobility in children with cerebral palsy and other neurological conditions (Adair et al. 2012), and was therefore included as the third primary measurement instrument in this review.

3.3.4.1 Psychometric properties – reliability and validity

Psychometric properties refer to the validity and reliability of a certain method or measurement tool. In order to be able to argue whether a method or an outcome measure has excellent psychometric properties and is therefore both reliable and valid, they must be evaluated extensively. Assessing the quality of different measurement tools, methods and instruments provide valuable evidence of psychometric properties, therefore helping researchers choose the best tool to use in their research (Asunta et al. 2019; Souza et al. 2017).

Reliability and validity refer to ways of demonstrating the quality of research process as well as the trustworthiness of findings of the research, evaluating how structured and well a certain method, a technique, or a test measures something. Reliability is one of the principal characteristics of an outcome measure in clinical trials, and it refers to how consistently or dependably a certain method or a measurement scale measures the characteristic(s) it is supposed to measure. It is concerned with a degree of errors in measurements, and it should be always considered by the researcher when choosing the primary outcome measure for a clinical trial. Validity, in the other hand, refers to the way of evaluating whether the actual observed measurement does or does not directly and accurately measure the desired characteristic. Validity of the outcome measure is often based on the knowledge of the underlying biological and physiological characteristics of the condition under study (Lachin, 2004; Roberts et al. 2006).

There are numerous assessment tools available for measuring, evaluating, and describing gross motor functions in children with cerebral palsy and other disabilities. In order to choose appropriate measurement instruments to be included in this meta-analysis, psychometric properties of different clinical measures were examined and assessed. Evaluation resulted in three different assessment tools that are of high validity and reliability, and that are used to specifically measure functional mobility and balance among children, therefore being appropriate for this review. The three assessment tools that were chosen as the primary outcome measures - The Gross Motor Function Measure (GMFM); Pediatric Balance Scale (PBS), and Timed Up & Go -test (TUG) - and their characteristics are presented individually in the following sections. In order to discuss the significance of the findings from the included trials as well as to evaluate the evidence obtained from the studies, it is necessary to understand the characteristics of the measurement instruments.

3.3.4.2 Pediatric Balance Scale (PBS)

The Paediatric Balance Scale (PBS) was developed in 1994 as a modified version of the Berg Balance Scale, and is since then been used as a standardized assessment tool for identifying balance dysfunction and measuring functional balance abilities in children. Functional balance, as used within the PBS, can be described as the child's ability to attain and maintain upright control during activities of daily living in the child's known environment at home, school and society. PBS can be used to examine and identify age-appropriate functional balance as well as changes and regression in balance, thereby helping a physical therapist to plan, justify and modify individual intervention techniques (Darr et al. 2015; Franjoine et al. 2003).

The PBS consists of 14 items that are scored in a scale of 0 (lowest function) to 4 points (highest function), the maximum score being of 56 points. The scored items consist of tasks such as sitting to standing, standing with eyes closed, standing in "tandem" position, standing on one foot, turning, retrieving object from floor, and reaching forward with outstretched arm

(Darr et al. 2015; Franjoine et al. 2003). All of these tasks can be considered as daily activities that children with mild to moderate cerebral palsy need to perform in their everyday life, thereby making the PBS significantly relevant in order to identify functional mobility and balance. As demonstrated in their studies, Franjoine et al. (2003) and Darr et al. (2015) support the strong psychometric characteristics of the Paediatric Balance Scale.

3.3.4.3 Timed Up & Go (TUG)

Timed Up & Go -test (TUG) was developed in 1991, and is in today's clinical practice used as an assessment tool to measure functional mobility, anticipatory postural control, and dynamic balance. It was originally aimed to evaluate functional mobility and fall risk among elderly people, but has since then been applied to clinical practice with children and adolescents with motor limitation and disabilities, such as cerebral palsy (Carey et al. 2016; Dhote et al. 2012; Nicolini-Panisson et al. 2013). According to Carey et al. (2016), the TUG is most used to assess the functional mobility and balance in children with mild to moderate (level I-III) cerebral palsy including all the subtypes of the diagnosis.

The TUG is a quick and practical test that measures the time required for the child to stand up from a standard chair with armrest, walk 3m, turn around, walk back to the chair, and sit down again. The test score is measured in seconds (Nicolini-Panisson et al. 2013). As the test identifies the child's ability to perform transfers and maintain dynamical balance, it can be used to evaluate and describe one's functional independence in everyday tasks. Therefore, TUG can be considered as a useful tool for a physiotherapist to plan, adjust and modify intervention and treatment methods for an individual child. In their studies, Nicolini-Panisson et al. (2013) and Dhote et al. (2012) concluded that TUG can be used as a practical tool by pediatric physical therapists, and it has good reliability in children diagnosed with cerebral palsy.

3.3.4.4 The Gross Motor Function Measure (GMFM)

The Gross Motor Function Measure (GMFM) was developed in Canada in the late 1980's for assessing changes in gross motor functions, describing the child's motor abilities, and for evaluating intervention programs in children aged 5 months to 16 years with disabilities. The original version of the standardized GMFM is known as GMFM-88, and the most recent version as the GMFM-66. Both versions are validated to measure and assess gross motor functions in children with the diagnosis of cerebral palsy (Alotaibi et al. 2013; Rosenbaum et al. 2002).

There are, however, some differences between the 88 and the 66 version of the GMFM. While the GMFM-88 consists of 88 items and gives a more detailed description of the child's abilities and limitations, the GMFM-66 consists of 66 items. Furthermore, the GMFM-88 is administrated with shoes, ambulatory aids or orthoses, while the GMFM-66 must be administrated barefoot without any aids. A significant difference between the versions is also their validation for different populations; the GMFM-88 has been developed for children with cerebral palsy and other conditions, such as Downs syndrome or traumatic brain injury, while the GMFM-66 can only be used to assess motor functions in children with CP. Both versions consist of five dimensions that measure functional skills and capabilities in a) lying and rolling; b) sitting; c) crawling and kneeling; d) standing; e) walking, running, and jumping. (Alotaibi et al. 2013; Beckers et al. 2015; Ko et al. 2013; Rosenbaum et al. 2002). In this review, only categories D and E were included in the meta-analysis as they were evaluated the most relevant and appropriate for assessing functional mobility and balance in everyday activities and participation in ambulant children with CP.

The items are scored with four-point ordinal scales (0 = cannot initiate or is unwilling to attempt; 1 = initiates; 2 = partially completes the task; 3 = completes the task independently). A total score is then calculated after the percentage scores within each dimension is obtained. Higher score is (in a range of 0 to 100) indicates better functional capacity (Alotaibi et al. 2013; Beckers et al. 2015; Rosenbaum et al. 2002).

3.4 Data extraction

3.4.1 Extraction of descriptive information

Descriptive information of the included randomized clinical trials was independently extracted by the individual author of this review.

3.4.2 Requests for information and dealing with missing data

Attempts to obtain and clarify unpublished or numerical data from three trials was made by e-mailing the original authors of the studies in question. No response was received from two of the authors, while one author responded but could not provide further information by confirming or clarifying the ambiguity in the numerical data of the scored due to the trial being conducted over 12 years ago. Therefore, the author of this review used the data available in the published report in order to calculate and present the correct numbers in meta-analysis. In this case, reported change scores were used to obtain the true mean value of post-score results for one of the sample groups.

Requests for missing data resulted in one of the trials being excluded from the meta-analysis, as assumptions of particular data could not be made, nor missing values be calculated due to the missing information. However, the excluded trial was retained for further qualitative discussion of the intervention effect as well as strengths and limitations of the studies and this review.

Any other individuals or organizations outside the authors of the included studies were not contacted for further information or missing data.

3.5 Methodological quality assessment of selected trials

Bias is referred to as a systematic tendency of a statistic which can occur in data collection and analysis, interpretation phase, and publication. Regardless the intentionality or unintentionality of conducting biased research, they may cause false conclusion and therefore have a negative effect on conducting reliable evidence of effectiveness of an intervention method between two or more groups. Eventually, this may lead to false evidence gathered from several trials examining the same treatment effects (Bjørndal, 2008; Simundic, 2013).

In order to examine and assess all potential sources of bias, and reduce or minimize the deviation from the truth in the included controlled randomized trials, Revised Cochrane risk of bias tool for randomized trials (RoB 2.0) was used. The Rob 2.0, published in 2019, consists of five domains: bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, and bias in selection of the reported result. RoB was chosen as the risk of bias tool for this review as it is the most recommended tool for randomized controlled trials, and is suitable for individually randomized, parallel-group, and cluster- randomized trials (Higgings et al. 2016; Sterne et al. 2019).

3.5.1 Ethical considerations

Conducting biased research and publishing biased analysis is considered unethical due to the possibility of misleading information about clinical decisions and interventions. Moreover, this may lead into harm to the patients as well as into substantial financial losses (Simundic, 2013).

The Cochrane Handbook for Systematic Reviews of Interventions was used in order to avoid bias and misrepresentation in the process of determining the research question, inclusion and exclusion criteria, systematic search of records, collecting data, and in conducting assessment of quality on the included studies. Moreover, ethical attention was paid to each of the included trial. The original studies were narratively assessed for their procedure and ethical considerations. It was noted that all of the primary trials had received acceptance by their local ethical committee or a review board.

According to Cooper & Dent (2010), a meta-analysis as a research method does not face ethical issues regarding to treatment of humans or animals participating in their clinical work, unlike in primary research papers. In systematic literature reviews and meta-analysis published or unpublished reports are collected are statistically assessed and the findings concluded in the quantitative analysis. Due to extracting data from published or unpublished research papers, an author conducting a meta-analysis does not need to convince or seek an approval from an Institutional Review Boards (Cooper & Dent, 2010). In this review, no personal, sensitive or confidential information was collected from participants. Moreover, the included clinical studies used in this systematic review and quantitative meta-analysis are public documents that cannot be deceived or mistreated.

3.6 Measures of treatment effect

The Review Manager (RevMan) version 5.2 was used independently by the author in effort to analyse data and produce graphical forest plots for visual representations of the results.

In order to allow for variation of the different effect sizes in each study, the random effects model was selected as a priori. A random effects meta-analysis can be used to allow differences in the treatment effect from trial to trial, and to therefore provide an estimate of the average treatment effect (Riley et al. 2010). As factors such as age, classification of the diagnosis, gender, intervention lengths, outcome measures, and sample sizes varied between the included trials, the random effects model was considered to be most appropriate for this review (Borenstein et al. 2009). Continuous data was chosen due to a range of numeric values and measurable data (for example, the amount of time used to stand up and walk around an object; or the total numeric score from a measurement instrument), instead of dichotomous data that only results in certain, fixed values (for example, shoe size; “yes” or “no”; “dead” or “alive”; or a blood group of either “A”, “B”, “AB”, or “O”).

Forest plots for scores from each individual measurement instrument were conducted in the software. The forest plots present graphically the overall estimates from the meta-analysis, results from individual studies, heterogeneity, and almost all of the other essential information of meta-analysis that is used to examine, evaluate and discuss the effect of an intervention. Therefore, forest plots are considered to be very powerful tool in research papers (Verhagen et al. 2014) and were also assessed and chosen as the most appropriate graphical representation method for this review.

The overall p-value was examined from each section (PBS, TUG, GMFM D & E). The p-value, or probability value, in statistics is the level of marginal significance that describes the probability that the data obtained would have occurred by random chance. It is used in hypothesis testing to assess and decide whether to reject the null hypothesis (Bjørndal, 2008).

Effect size refers to the raw difference between group means, and is described as the main finding of a quantitative study. Effect size, unlike a p-value, is referred to as substantive significance and can reveal the size of the effect rather than only indicating whether an effect exists or not. The statistics of effect sizes are usually presented as a standard mean difference (SMD), described as either *Cohen’s d* or *Hedges’ (adjusted) g* (Brydges, 2019; Higgings et al. 2022; Sullivan et al. 2012). The main findings of effect sizes in this paper were described as standard mean difference (SMD) with 95% confidence intervals. The Mean Difference (Mean D) and Hedges’ g values were used to describe the effect sizes.

The Mean D measures the absolute difference of a treatment effect between the mean value in two groups (experimental and comparison) and therefore allows the examination of the amount by which the experimental treatment changes the outcome on average compared with the control intervention in clinical trial (Higgings et al. 2022). In addition, Hedges’ *g* was selected due to it allowing bias correction for small sample sizes in the trials (Brydges, 2019). In order to present these individual effect sizes, Hedges’ *g* values were calculated by using sample mean, sample standard deviation, and sample size. The values were calculated and collected for each measurement instrument based on the experimental and control group post-scores. This together with Mean D values, Hedges’ g values allowed examining and assessing the effect of task-oriented intervention between the two different sample groups across all included studies. In addition, Mean D and Hedges' g values were calculated from pre- and post-scores for individual groups in each trial in effort to compare these with the overall effect. When interpreting the results from Hedges' g values, Cohen's (2013) recommendations of the following rules were, with caution due to differences in context of particular studies, applied: 0.2 indicates small effect; 0.5 indicates medium effect, and ≥ 0.8 indicates large effect.

3.7 Assessment of heterogeneity

A forest plot allows the author to analyse heterogeneity and homogeneity of the included studies, which is important in order to obtain assurance of whether the intervention will have a similar effect when applied to new subjects (Von Hippel, 2015).

Statistical heterogeneity can be defined as variation across observed individual study effect sizes that can be caused by differences in study participants, study designs, interventions, or outcomes. The number of studies included in the analysis, between-studies variance, and within-study variance have on impact on heterogeneity. A level of heterogeneity is to be considered when conducting a meta-analysis as too much heterogeneity can indicate significant errors the effect size estimate, as for example differences in measurement methods and samples, thereby making the trials not similar enough to be quantitatively synthesized (Ruppar, 2020). In a forest plot, heterogeneity is described by using the I2 statistic or chi-squared (χ2, or Chi2) test.

Clinical heterogeneity of the included trials was first narratively explored and assessed by the author based on the following study-level factors; the similarity of the research questions and/or hypothesis, the population of participants, intervention of interest, and outcome measures. Further on, the level of statistical heterogeneity was identified from the findings of the meta-analysis. Factors contributing to statistical heterogeneity was inspected and narratively analysed. Results from statistic I2 and chi-squared (χ2, or Chi2) tests presented in the forest plots were reviewed and discussed. However, despite the clinical and statistical heterogeneity and the factors contributing to them was examined and assessed in this review, the statistics were not used to determine whether or not to perform the meta-analysis.

4 Results

This chapter presents main findings on total of 253 children who were participants in eight individual randomized controlled trials (RCT), with the intended outcome of establishing the effectiveness of task-oriented training on functional mobility and balance in children with cerebral palsy. The first section describes the studies included in the meta-analysis and the second section discusses the results of the meta-analysis.

4.1 Included studies

4.1.1 Identification of studies and study characteristics

The systematic search strategy conducted during October and November 2021 yielded in total of 1849 records. After removal of duplicates, of 1026 records were screened for titles. The screening resulted in 75 individual studies that were relevant for further screening on abstract. After the evaluation and screening for titles and abstracts, 60 records were excluded as they did not meet the inclusion criteria for further analysis. Relevant reviews and reference lists of retrieved articles were hand searched, which resulted in three additional studies that met the inclusion criteria and were thereby added into the review. The detailed selection and exclusion process of the records is described in Figure 3, and the characteristics of included studies are detailed in Table 1.

A total of nine studies met the inclusion criteria, but due to missing data in one of the trials, the data from eight randomized controlled trials with post-training measurements were included in the meta-analyses. A simple random allocation of the participants was applied in eight of the studies in order to divide the children into two different groups: an experimental group and a control group. One of the studies, Ketelaar et al. (2001), used a "prestratified randomization procedure" in order to ensure an equal distribution of subjects; the children were first separated into blocks based on their age and type of the diagnosis, and randomly allocated into groups afterwards. In addition, in this trial some of the participants were allocated into a certain group based on what group their "own therapist" would treat.

The study characteristics are shown in Table 1. The 253 (273) participants in this review included children with a diagnosed mild to moderate cerebral palsy (GMFCS level I-III), meaning that the children were ambulant and could perform the given tasks independently with or without orthotics or walking aids, such as crutches. Shaju (2016) did not identify the GMFCS levels of the children who participated in the study. However, they excluded children who, due to medical or orthopaedic reason, could not perform the given tasks, thereby giving the assumption that the participants were ambulant and diagnosed with mild to moderate level of cerebral palsy. The range in the total number of participants, including both boys and girls, in the nine included studies was of 10 to 55 individuals, the Mean being of 30 participants. Two of the studies did not identify the age range of the children who participated in the trials. In the seven remaining studies, the range of age of the participants was of 2 to 15 years. Seven studies detailed the type of CP represented in the trials being spastic diplegic or quadriplegic, while two of the included trials did not specify of which subtypes were represented among the participants.

The interventions in all studies were performed by a physical therapist, and for example trials with home-programs were excluded. The experimental groups in each study received task-oriented training focusing on functional tasks, while the control groups received physical therapy with a focus on facilitation and normalization of movement patterns or passive stretching and range of motion exercises. The content of task-oriented training program used with the experimental groups varied briefly in the included trials that described details of the intervention. For example, in their trials Salem et al. (2009), Shaju (2016) as well as Kumar & Ostwal (2016) included activities such as walking forwards and backwards in different speeds, direction changes, sit-to-stand, stepping exercises, kicking a ball, and a variety of double-task balance exercises in their functional training intervention. The tasks remained the same for each child, but the progression of the given tasks was assessed and considered according to each child’s ability. Ko et al. (2019), in the other hand, delivered the intervention as group training in which the experimental group consisted of 2-4 participants. Despite the group training, individual functional goals for each child were established, thereby allowing the researchers allocate children with similar goals and objectives into one group according to their goals and activity levels. Sah et al. (2019) combined task-oriented training with NDT based facilitation principles, and compared the intervention with a treatment protocol of passive stretching, active/passive range of motion exercises, and an individual balance board exercise. In the contrast, Ketelaar et al. (2001) did not identify a standardized intervention program in their trial, but rather established individualized program for each child based on their personal goals and functional abilities.

The duration, intensity and overall dose of the interventions varied across the included trials. In their trial, Kumar & Ostwal (2016) used a more intensive program of 45 minutes sessions 6 times a week during a total of 4 weeks intervention. An intensive approach to the intervention in which the treatment was delivered more than twice a week within a 6-week period was also used by Sah et al. (2019), Shaju (2016), and Madhumati et al. (2020). In the contrast, Ketelaar et al. (2001) conducted a trial of 45 months for the control group and 41 months for the experimental group, the monthly frequency of sessions being detailed as 3.8 times for the control group and 3.4 times for the experimental group among the children whose therapy was uninterrupted during the study.

The outcomes of interest in the included trials were primarily functional mobility and balance. Some of the trials also measured the level of self-care, social functions, postural maintenance during positional changes, individual gait characteristics, and fine and gross motor proficiency of the upper limbs. In addition, Ko et al. (2019) did not use outcome measures but instead observed the social cooperation and participation of the children in the group training sessions. Paediatric Balance Scala (PBS) as well as Timed Up & Go -test (TUG) were used as outcome measures in four studies, while The Gross Motor Function Measure (GMFM) was used in three trials. In total of eight different measurement instruments were used in the included clinical trials, of which Paediatric Evaluation of Disability Inventory (PEDI), Postural Assessment Scale for Stroke (PAS), Bruininks-Oseretsky Test of Motor Proficiency (BOT-2), 10-meter walk test, and individual gait parameters were excluded from the meta-analysis due to them being irrelevant for the research question of this review, as well as for each of them being represented only in one of the included trials.

The included trials used mean (Mean D) and standard deviations (SD) to present the result values. The research group of the trial by Shaju et al. (2016) was contacted in order to obtain necessary data for calculating standard deviation for post-test values, but as the inquiry was not responded to, the trial was excluded from the meta-analysis and was instead used to qualitatively evaluate and discuss the effects of task-oriented training. In addition, the research group of Ogwumike et al. (2018) was contacted in order to obtain statistical data for further analysis of the results from GMFM. Due to no response from the authors, the trial was excluded from the meta-analysis for the given measurement instrument, and was therefore only used in the meta-analysis for TUG. The study results were further used to qualitatively evaluate and discuss the effects of the intervention.

In all of the trials the participants were tested at the baseline followed by the intervention period. Follow-up tests were conducted only immediately after the ending of the intervention period in five trials. In the contrast, a follow-up scores were gathered from the participant at 6 weeks post-intervention in two studies, at 16 weeks post-intervention in one study, and at 6-, 12-, and 18-months post-intervention in one trial.

The data for this systematic review and meta-analysis was obtained from well-designed randomized clinical trials that were capable of producing level II evidence (Burns et al. 2011). Six trials resulted in low risk of overall bias, while three trials indicated some concerns for overall bias. Concerns for bias in these trials were detected within randomization process.

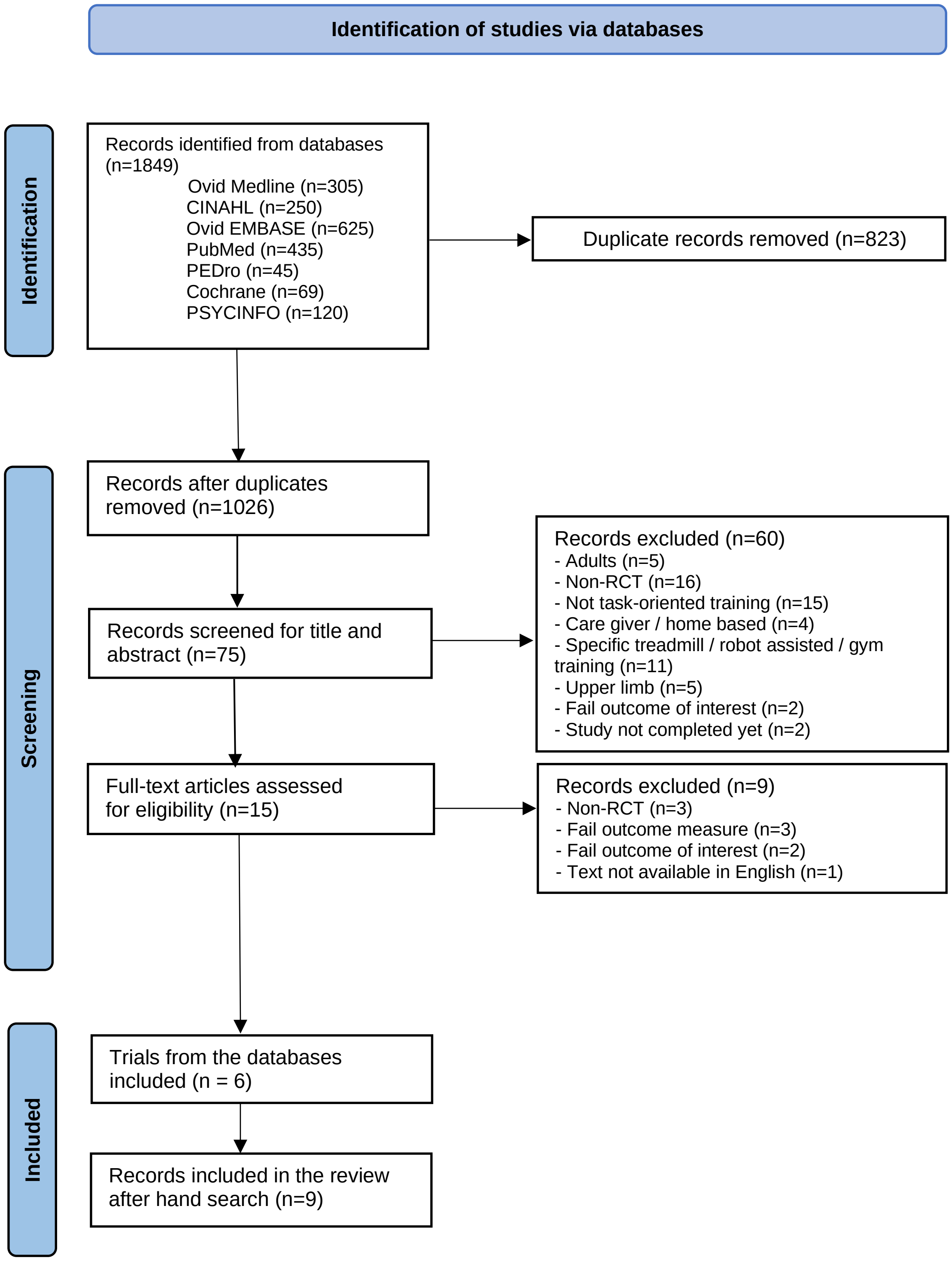

Figure 3 - The study flow diagram (Page et al. PRISMA 2020).

Study	*Follow-up*	*Participants: Age and level of diagnosis*	*N (groups)*	*Task-oriented intervention*	*Control group intervention*	*MI*
Ketelaar 2001	6-12-18 months	Age: 2-7y mild-moderate	55 (E=28, C=27)	41 months, 3.4 times/month Intervention for the group was not standardized. Task-specific therapy was for each child was established based on individual goals and motor abilities. The training would include, for example, kicking a ball and stepping over objects.	45 months, 3.8 times/month 19 children received intervention based on neurophysiological treatment method (NDT or the Vojta method), while the remaining children received treatment based on the principles of normalization of motor performance and quality of movement (without a specific method).	**GMFM D & E** (PEDI)
Ko 2020	IP 16 weeks	Age: 4-7.5y mild-moderate	18 (E=9, C=9)	8 weeks, 2x60min/week Group training with individualised training based on the child's goals and abilities. The training would include tasks sucah as standing up from a chair, walking forward, backward, and sideways, or turning around in circles.	8 weeks, 2x60min/week Individualized traditional rehabilitation therapy, of which 30 minutes was training with a physiotherapist and 30 minutes with an occupational therapist. Physical training was based on based on the principle of normalization of the quality of movement.	**GMFM D & E** (BOT-2, PEDI)
Kumar 2016	6 weeks	Age: 5-12y mild-moderate	30 (E=15, C=15)	4 weeks, 6x45min/week Standing and reaching in different directions, sit-to-stand from various chair heights, stepping sideways, forward and backward onto blocks of various heights, heel raise and lower while maintaining in a standing posture.	4 weeks, 6x45min/week Proprioceptive Neuromuscular Facilitation Exercises (PNF) based on manual contact, stretch, resistance, and verbal cuing elements.	**PBS** (10-m walk test, Gait parameters)
Madhumati 2020	IP only	Age: 5-15y mild-moderate	30 (E=15, C=15)	4 weeks, 5x45min/week Functional tasks such as sitting and reaching, standing and reaching, kicking a ball, stepping forward, backward and sideways, walking over various surfaces, picking up an object from a floor while standing, sit-to-stand from various chair heights.	4 weeks, 5x45min/week Activities on a mattress, stretching, lower limb strengthening exercise, weight bearing activity, kneeling and half-kneeling, range of motion exercises.	**PBS** (overall GMFM)
Ogwumike 2019	6 weeks	Age: n/a mild-moderate	46 (E=23, C=23)	12 weeks, 2x40min/week Sit-to-stand and forward step-up exercises, loaded sit-to-stand exercises, high stick-stepping and circular movement exercises, walking up and down the stairs.	12 weeks, 2x40min/week Passive and active range of motion exercises in prone and supine, assisted-resisted strengthening exercises in prone and supine, rolling exercises, sit-ups from supine.	**TUG**
Rajalaxmi 2021	IP only	Age: n/a mild-moderate	20 (E=10, C=10)	12 weeks, 6x45min/week Task-oriented training. Content of the intervention was not detailed.	12 weeks, 6x45min/week Proprioceptive Neuromuscular Facilitation Exercises (PNF)	**PBS** **TUG**
Sah 2019	IP only	Age: 7-15y mild-moderate	44 (E=22, C=22)	6 weeks, 6x60min/week Task-oriented activities based on NDT principles; sitting and reaching, standing and reaching.	6 weeks, 6x60min/week Passive stretching for the adductors, hamstrings, quadriceps, and calf muscles. Active/passive range of motion exercises. An individual balance exercise.	**PBS** (overall GMFM)

Salem 2009	IP only	Age: 4-12y mild-moderate	10 (E=5, C=5)	5 weeks, 2 times/week Walking forward, backward, sideways and through an obstacle course, walking up and down ramps and stairs, stepping forward, backward, and sideways, standing balance exercises with reaching tasks, standing up from a chair, single leg stance, kicking a ball.	5 weeks, 2 times/week Conventional physiotherapy based on principles of facilitation and normalization of movement patterns.	**GMFM D&E TUG**
Shaju 2016	IP only	Age: 4-8y n/a	20 (E=10, C=10)	6 weeks, 7x60min/week A number of different functional tasks: sitting and reaching, sit-to-stand from various chair heights, stepping forward, backward and sideways, heel lifts in standing, dual-task balance exercises in standing, walk and carry, walking over various surfaces and obstacles, speed walking, sudden stops and turns during walking, kicking ball.	6 weeks, 7x60min/week Conventional physiotherapy techniques; mat activities, lower limb strengthening exercises, specific stretching exercises for tightened muscles and full range free exercises.	**TUG PBS**

Table 1: Study characteristics.
(Abbreviations: IP = immediately post-intervention; n/a = not available; N = total number of participants; E = experimental group; C = control group; min = minutes; MI = measurement instrument; PBS = Pediatric Balance Scale, TUG = Timed Up & Go, PEDI = Paediatric Evaluation of Disability Inventory (PEDI), PAS = Postural Assessment Scale for Stroke, BOT-2 = Bruininks-Oseretsky Test of Motor Proficiency)

4.2 Meta-analysis and treatment effects

The treatment effects of physiotherapist delivered task-oriented training on children with cerebral palsy were analyzed using meta-analysis. The overall estimate of the intervention effect as well as results of the individual outcome measures from the included trials are presented in graphical forest plots (Fig. 4, 5, 6, 7) and explained in the upcoming sections.

In a forest plot, the vertical line in the center is the “line of null effect”, while the horizontal lines represent individual studies with the result plotted as a box. The width of the horizonal lines represents the 95% confidence interval for each trial. 95% CI of the mean can be defined as the range with an upper and lower number calculated from a sample, describing possible values that the mean could be, and is the preferred method for expressing statistical uncertainty. Should the horizonal line of the 95% CI cross the vertical line, the result from the trial is considered statistically non-significant. This is also evident graphically if the black diamond on the bottom of the plot crosses the vertical line. The diamond shows the result when all the individual studies are combined and averaged. The p-values for overall effect in the forest plots are evaluated for the significance of the null-hypothesis (H0) in this review: “the effect of task-oriented training on functional mobility and balance in the experimental group remains the same as among the participants who receive other type of treatment”.

The forest plots also allow analyzing heterogeneity and homogeneity of the included studies, which is important in order to obtain assurance of whether the intervention will have a similar effect when applied to new subjects (Von Hippel, 2015). The p-value of the Chi2 -test in GMFM D & E is 0.88 and 0.98, thereby confirming that the trial results were relatively heterogeneous. The overall I2 statistic of 42% indicate moderate heterogeneity within the trials that used PBS as a measurement instrument, while I2 value of 19% across the trials that used TUG corresponds to rather small amount of heterogeneity. Moreover, the p-value of the Chi2 -test suggests relatively high homogeneity across the results with the overall result of 0.16 (PBS) and 0.30 (TUG). However, due to the small number of included trials and small sample sizes, the point estimate I2 and Chi2 values may be considered rather imprecise (Von Hippel, 2015), and therefore confidence interval of individual studies as well as clinical heterogeneity has been assessed and discussed in this review instead.

The results and findings of meta-analysis for each measurement instrument are presented in the following sections.

4.2.1 Pediatric Balance Scale (PBS)

This section examines and analyzes the results and findings for Pediatric Balance Scale. The forest plot (Figure 4) shows the results of the meta-analysis, while the Tables 2, 3, and 4 show additional statistical information from the individual studies by Kumar, Sah, Madhumati, and Rajalaxmi.

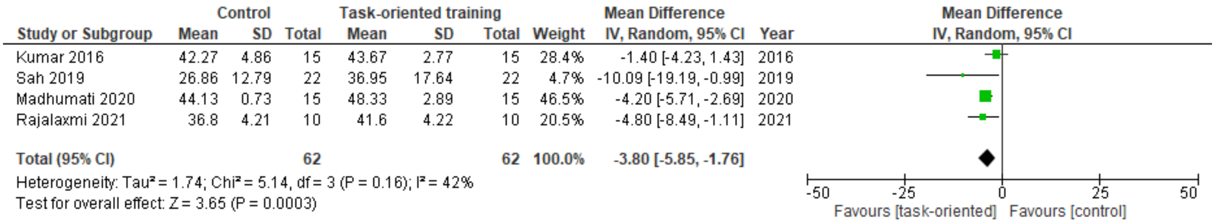

Figure 4 – The forest plot for Pediatric Balance Scale (RevMan 5.3).

Study	Pre Mean	Pre SD	Post Mean	Post SD	Mean D	Hedges' g	P-value
Kumar	37.27	3.48	43.67	2.77	6.40	2.035	< 0.0001
Sah	29.22	17.59	36.95	17.64	7.73	0.439	= 0.1530
Madhumati	43.20	3.28	48.33	2.89	5.13	1.660	= 0.0001
Rajalaxmi	33	2.36	41.6	4.22	8.60	2.515	< 0.0001

Table 2 – Pre and post intervention comparison of experimental groups for Pediatric Balance Scale (PBS).

Study	Pre Mean	Pre SD	Post Mean	Post SD	Mean D	Hedges' g	P-value
Kumar	38.27	4.27	42.27	4.86	4.00	0.874	= 0.0236
Sah	24.00	11.80	26.86	12.79	2.86	0.232	= 0.4451
Madhumati	41.93	0.80	44.13	0.73	2.20	2.872	< 0.0001
Rajalaxmi	32.86	1.28	36.8	4.21	3.94	1.266	= 0.0111

Table 3 – Pre and post intervention comparison of control groups for Pediatric Balance Scale (PBS).

Study	Mean D	Hedges' g
Kumar	2.40	0.356
Sah	4.87	0.655
Madhumati	2.93	1.993
Rajalaxmi	4.66	1.139

Table 4 – Pre-post intervention comparison (Mean D) and post intervention comparison (Hedges' g) of experimental and control groups for Pediatric Balance Scale (PBS).

A total of 124 children participated in the balance testing. As visually seen in the forest plot (Figure 4), the diamond does not cross the line of no effect, which indicates that there is a statistically significant difference between the experimental and comparison groups. The P-value of 0.0003 also indicates a statistically significant difference between the groups, as the smaller the p-value is, the stronger is the evidence for the null hypothesis being rejected. The 95% confidence interval indicates that the overall score of PBS with the experimental group compared with the control group varies between 1.7 (≈ 2) and 5.9 (≈ 6) points.

All of the four trials resulted in improvements in balance among the participants in both groups. The forest plot (Figure 3) for PBS scores indicates a total Mean Difference (Mean D) of 3.80 ≈ 4 points between the task-oriented group and control group. Furthermore, when examining the Mean D values from individual studies (seen in the Table 4), the largest effect size between the sample were observed in the trial by Sah (4.87 ≈ 5 points) and Rajalaxmi (4.66 ≈ 5 points), while the smallest effect size was observed from the trial by Kumar & Ostwal (2.40 ≈ 2 points). These findings are supported by the Hedges' g values from the post intervention scores (Table 4), in which Kumar & Ostwal resulted in medium effect size of <0.7 (≈0.4), while Sah and Rajalaxmi resulted in large effect size of ≥0.7 (Sah ≈0.7, Rajalaxmi ≈1.1). However, as seen in Tables 2 and 3, variations between baseline scores (Pre Mean D of 29.22 for experimental group and 24.00 for control group), as well as large standard deviation (SD) values, should be considered when examining the data from the trial by Sah, as they may have affected the results.

Moreover, it is interesting to examine the values from individual sample groups (Table 2, 3). The experimental group receiving task-oriented intervention resulted in largest Mean D values of 8.60 (≈ 9 points) in the trial by Rajalaxmi and 7.73 (≈ 8 points) in the trial by Sah (Table 2). The Hedges' g values for the experimental groups are examined cautiously. The Hedges' g value of 2.151 (≥0.7, therefore indicating a large effect) seems to correlate with the rather large Mean D value of 8.60 in the trial by Rajalaxmi. Meanwhile, despite the large Mean D value of 7.73 in the trial by Sah, the Hedges' g value for the experimental group in the study indicates significantly smaller effect of 0.439 (<0.7, therefore indicating a medium effect of treatment) when compared to the group in the trial by Rajalaxmi. This may be due to the variations between baseline scores and large SD values.

The highest improvements in balance across the comparison groups (Table 3) when assessing the skills in PBS were found in the trial by Kumar & Ostwal, and Rajalaxmi who resulted in Mean D values of 4.00 (4 points) and 3.93 (≈ 4 points).

4.2.2 Timed Up & Go (TUG)

The following section examines and analyzes the results and findings for Timed Up & Go -test. The forest plot (Figure 5) shows the results of the meta-analysis, while the Tables 6, 7, and 8 show additional statistical information from the individual studies by Ogwumike, Rajalaxmi, and Salem.

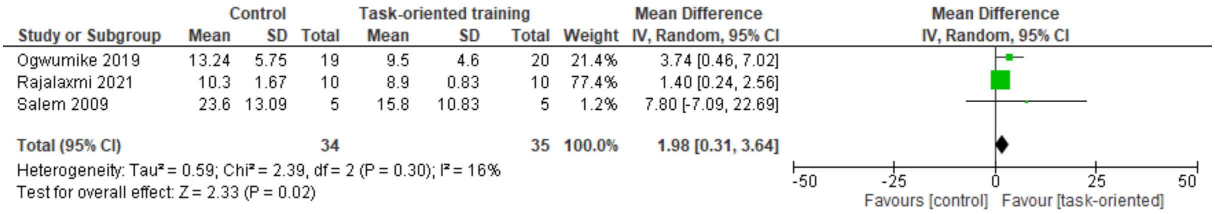

Figure 5 – The forest plot for Timed Up & Go (RevMan 5.3).

Study	Pre Mean	Pre SD	Post Mean	Post SD	Mean D	Hedges' g	P-value
Ogwumike	15.1	8.6	9.5	4.6	-5.60	0.812	= 0.0143
Rajalaxmi	12.8	1.16	8.9	0.83	-3.90	3.867	< 0.0001
Salem	19.8	11.32	15.67	10.83	-4.13	0.373	= 0.5718

Table 6 – Pre and post intervention comparison of experimental groups for Timed Up & Go (TUG).

Study	Pre Mean	Pre SD	Post Mean	Post SD	Mean D	Hedges' g	P-value
Ogwumike	14.7	10.4	13.2	5.8	-1.50	0.178	= 0.5863
Rajalaxmi	12.8	1.4	10.3	1.67	-2.50	1.622	= 0.0019
Salem	25.4	13.37	23.60	13.09	-1.80	0.136	= 0.8069

Table 7 – Pre and post intervention comparison of control groups for Timed Up & Go (TUG).

Study	Mean D	Hedges' g
Ogwumike	-4.10	0.709
Rajalaxmi	-1.40	1.062
Salem	-2.33	0.660

Table 8 – Pre-post intervention comparison (Mean D) and post intervention comparison (Hedges' g) of experimental and control groups for Timed Up & Go (TUG).

A total of 69 children participated in the testing for functional mobility and dynamic balance. The graphical forest plot (Figure 5) indicates that there is no statistically significant difference between the experimental and comparison group in the trial by Salem as the 95% confidence interval crosses the line of no effect. On the contrary, trials by Ogwumike and Rajalaxmi show a statistical significance. The P-value of = 0.02 for overall effect indicates that there is a 2% chance of observing a difference as large (or larger) than what was observed (1.98 seconds) in the sample. The total 95% confidence interval indicates that the overall score of TUG observed within the experimental group compared with the control group varies between 0.31 (≈ 0) and 3.64 (≈ 4) seconds, indicating a Mean D value of 1.98 (≈ 2) seconds.

The Mean D values from each trials (Table 8) indicate the largest effect of task-oriented treatment in the study by Ogwumike who resulted in -4.10 seconds between the groups. In contrast, the smallest effect was observed in the trial by Rajalaxmi (-1.40 seconds). When examining and assessing the results and effect size from the trial by Salem (Tables 6 and 7), the variations in baseline scores (Pre Mean D of 19.8 for experimental group and 25.4 for control group), as well as large standard deviation (SD) values, should be considered as they may have affected the results.

Moreover, the Mean D values from the pre- and post-test scores in the task-oriented groups (Table 6) indicate statistically significant improvements in functional mobility and dynamic balance. All of the three studies resulted in ≈4 seconds or higher (-3.9-5.60 seconds) improvements in the TUG test, while the control groups in each study resulted in ≤2.5 seconds improvements (Tables 6, 7), therefore indicating that larger effect was observed across the groups receiving task-oriented training.

4.2.3 The Gross Motor Function Measure (GMFM), section D

This section examines and analyzes the results and findings for the Gross Motor Function Measure, section D (standing). The forest plot (Figure 6) shows the overall results of the meta-analysis.

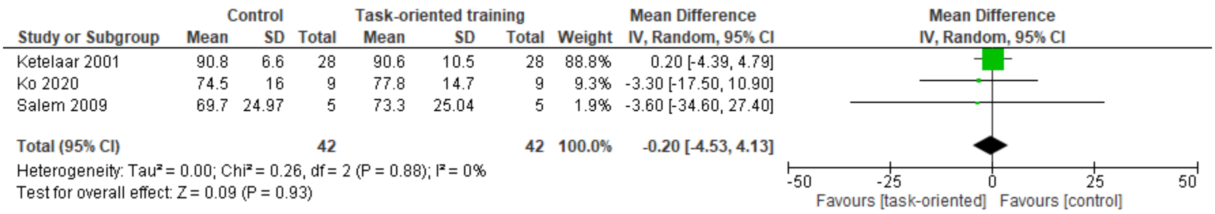

Figure 6 – The forest plot for GMFM section D (RevMan 5.3).

A total of 84 children in three trials participated in the testing. As seen in the forest plot, the diamond width as well as the 95% confidence interval results of all the three studies include the line of no effect, which indicates no statistical difference between the experimental and control groups. As cautiously considered due to the sample size of the study population, the insignificance of the results is also supported by the test for overall effect, P-value being of <0.93.

The highest possible overall score of the dimension D in GMFM being of 39 points (0 to 3 points for each task), the overall Mean D value of 0.20 (≈0) points can be argued to not indicate a significant difference in the clinical outcome between the experimental and control group. As Hedges' *g* values from each of the three included trials were calculated (Ketelaar 0.2; Ko 0.2; Salem 0.14), it can be argued that the effect between the groups is small. In conclusion, no statistically or clinically significant effect of the task-oriented intervention was observed when compared to other physical therapy treatment methods across these trials.

4.2.4 The Gross Motor Function Measure (GMFM), section E

The section examines and analyzes the results and findings for the Gross Motor Function Measure, section E (walking, running and jumping). The forest plot (Figure 7) shows the overall results of the meta-analysis.

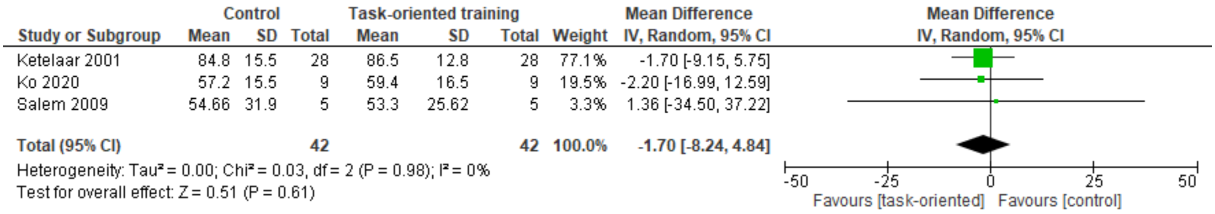

Figure 7 – The forest plot for GMFM section E (RevMan 5.3).

A total of 84 children in three trials participated in the testing. The forest plot indicates no statistical difference between the groups. This is supported by the line of no effect that is crossed by the diamond as well as by the horizontal lines (the 95% confidence interval results) of all the three studies. Moreover, the test for overall effect with the P-value being of <0.61, no significant difference between the groups shall be indicated. Furthermore, the overall Mean D of 1.7 (≈2) points in means does not indicate a significant difference in the clinical outcome between the sample groups, the highest possible overall score of the dimension E in GMFM being of 69 points (0 to 3 points for each task). The Hedges' *g* values for each trial also suggest small effect between the experimental and control groups (Ketelaar 0.11; Ko 0.13; Salem 0.04). Therefore, it can be concluded that no significant effect of the task-oriented training in functional mobility (walking, running and jumping) was achieved when compared to other physical therapy treatment methods in these trials.

In attempt to compare the effect size of the pre- and post-test scores for each group in the individual trials, Hedges' *g* values were calculated. Across the experimental groups, large effect of 1.0 was found in the study by Ketelaar. In the contrast, the trials by both Ko and Salem resulted in small effect of 0.3. The control group in the study by Ketelaar also showed rather significant improvements in functional mobility with moderate effect of 0.7. Meanwhile, control groups in the trials by Ko and Salem resulted both in small effect of 0.2.

5 Discussion

This chapter aims to summarize the study findings and discuss the results from the meta-analysis regarding the impact of task-oriented training. Moreover, the chapter examines the limitations of this review as well as the included studies, and provide possible implications for clinical practice in pediatric physical therapy as well as future studies.

This systematic review together with meta-analysis was conducted in an effort to examine and evaluate the overall effectiveness of task-oriented training in functional mobility and balance in children with CP. The present study aimed to assess the quality and consistency of the findings from the included trials and conducted meta-analysis, and discuss the topic in the light of evidence-based practice in pediatric physical therapy. The review included nine randomized clinical trials (of which eight were included in the quantitative meta-analysis) that compared the effect of task-oriented training with other physiotherapy interventions among ambulant children with CP. Other relevant trials that did not meet the inclusion criteria for the meta-analysis were qualitatively assessed and discussed, when appropriate.

Results of the meta-analysis were divided into four subgroups based on the measurement instruments; the effect of the intervention on functional mobility and balance was assessed and examined from the scores in Pediatric Balance Scale, Timed Up & Go -test, and Gross Motor Function Measure domains D and E. Improvements in functional abilities were observed in all of the trials and among both experimental and comparison groups. The results from the quantitative meta-analysis implicate a statistically significant effect of task-oriented training in children with cerebral palsy when compared to other treatment methods when assessed in Pediatric Balance Scale. Moreover, statistics from the TUG test also indicate a significant effect in the trials by Ogwumike and Rajalaxmi. No significant effect was observed in the outcome measures when assessing GMFM domains D and E. It is notable that relatively large effect sizes were calculated from the scores of Pediatric Balance Scale and Timed Up & Go-test when comparing the sample groups with each other, as well as when comparing the pre- and post-test results for each group individually (Tables 2, 3, 4).

5.1 PBS and TUG

Due to statistically significant results from Pediatric Balance Scale and Timed Up & Go -test, these two measurement instruments are discussed in this section in light of clinical significance of the treatment effect. The P-values of 0.0003 (PBS) and 0.02 (TUG) (Figures 4 and 5) indicate a statistically significant difference between the groups, as the smaller the p-value is, the stronger is the evidence for the null hypothesis being rejected (Bjørndal, 2008). When examining the p-value from these two studies, however, the sample sizes of 5 to 22 participants in the sample groups, as well as the limited number of included trials, must be considered and the overall p-value evaluated cautiously as a small study population can negatively impact the reliability of the p-value. With larger sample sizes of the study populations the results, including the p-value, are less likely to be affected by, for example, random error (Thiese et al. 2016).

Firstly, by reading the results from the forest plot (Figure 4) for PBS one can suggest that task-oriented intervention for balance in children with cerebral palsy seems to be statistically favoured by the overall effect. However, the significance of the overall difference between the two sample groups remains rather narrow and therefore cannot be firmly referred to as of high level in the light of clinical outcome. Nevertheless, as seen in the individual effect sizes calculated from the pre- and post-tests for each experimental group (Table 2) across the trials, the results indicate large effect in all of the four studies when examining the Mean D values. Furthermore, in all of the four studies, the individual effect size for the experimental group receiving task-oriented training resulted in higher scores compared to the control group (Tables 2 and 3), indicating a positive effect of the treatment.

When taking a more detailed look into the results, the meta-analysis indicates a significant effect of ≈4 points difference in means between the sample groups in task-oriented training when assessing functional mobility and balance in PBS. Due to the highest possible score in PBS being of 56 points, the clinical significance of the effect should be considered. The instrument consists of 14 tasks that are scored in a scale of 0 (lowest function) to 4 points (highest function), the highest possible score in PBS being of 56 points (Darr et al. 2015; Franjoine et al. 2003). In order to score 4 points in tasks such as transfers, or standing unsupported in different positions, the child would have to be able to maintain balance safely and perform the given task without or minimal use of hands. In the contrast, scoring 3 points in the given tasks would require supervision or use of compensation strategies (for example, using upper extremities in sit-to-stand, taking an extra step in order to maintain balance when reaching forward with outstretched arm) in order to be able to perform the functional tasks. Scoring lower in PBS also indicates a greater time used to successfully perform the tasks. All of the tasks in PBS are considered as daily activities that children with mild to moderate cerebral palsy need to perform in their everyday life (Darr et al. 2015; Franjoine et al. 2003), and the 4 points difference could thereby be considered as clinically significant, as a lower score in PBS indicates impaired functional mobility. Moreover, this contributes to limitations in participation and ability to engage in the ADL, at home, school and in the community (Bouca-Machado et al. 2017; Leonardi et al. 2009).

However, in their study, Chen et al. (2013) examined criterion-related validity and clinometric properties of PBS in children with CP, and suggested that the minimally clinically important difference (MCID) of the total score of PBS is of 5.85 change in points. Considering this, no clinically significant difference between the two sample groups was observed in any of the included trials (Table 4). However, as seen in Table 2, clinically important difference of ≥5.85 was observed across the experimental groups in all of the trials by Kumar & Ostwal (6.40), Sah (7.73) and Rajalaxmi (8.60). Higher scores in the trials by Sah and Rajalaxmi may be due to longer intervention period, as both Kumar and Madhumati (5.13) (Table 2) conducted a trial of 4 weeks. A shorter time to respond to the treatment may therefore have contributed to a smaller effect of each sample group and thereby the overall effect. In the contrast, control groups across all the included trials resulted in ≤4.0 points in change, which indicates smaller clinical effect of the intervention when compared to task-oriented training. As detailed in Table 1, the control groups received passive stretching exercises, active-passive range of motion exercises, and PNF techniques such as hold-relax, contract-relax, and hold-relax with agonist contraction. Rather few active tasks and exercises were included in the interventions for the control groups, which may have contributed to smaller improvements due to limitations in interactive components of the training. Through passive treatment the child faces limitations in gathering sensory information, learning key features of functional tasks, and setting up appropriate control mechanisms, which are fundamental components in motor learning and skill acquisition (Kleim & Jones, 2008; Krakauer et al. 2019). The intensity, relevancy, repetitions, therapist-child collaboration, and feedback in active task-oriented approach (Rowe et al. 2018; Valvano, 2004) may therefore contribute to better results and significant clinical improvements in the child's independency and ability to perform tasks and participate in daily functional tasks.

In the results from PBS across the included trials, a rather large variation in the standard deviations was observed. Sah et al. resulted in 17.64 SD and Madhumati et al. in 2.89 SD in the post-scores from the experimental groups (Table 2). The high standard deviation in the trial by Sah indicates that the result points are respectively spread above and below the mean, while the low 2.89 SD from the trial by Madhumati means that the data are clustered rather narrowly around the mean. In PBS, a high standard deviation of ≈18 (Salem, 2008) indicates a large variation in the results between the individuals in the sample group, which may be due to small study population and/or high level of heterogeneity in the experimental group: the sample group consisted of children of 7 to 15 years age, three different complex gait characteristics (crouch gait, scissoring gait, and walking with aid), as well as grade 1 to 3 spasticity (Modified Ashworth Scale for Spasticity) (Meseguer-Henarejos et al. 2018). Due to these individual characteristics, the participants possibly represented a variety of body function and structure impairments that may significantly affect the children's response to a certain treatment and, furthermore, their scoring in standardized tests (Graham et al. 2017; Palisano & Orlin, 2017; Wichers et al. 2009).

On the contrary, in the trial by Madhumati, the participants were ambulant children with mild to moderate cerebral palsy, and aged 5 to 15 years. However, due to lack of further demographic characteristics of the recruited subjects (such as level of spasticity or other secondary conditions, gait characteristics), profound and exclusive conclusions cannot be made regarding to the low standard deviation. Perhaps the sample groups were of high clinical homogeneity and consisted of only high functioning participants with mild secondary conditions, therefore resulting in low variance and relatively high overall mean score in control (≈44/56) and experimental (≈48/56) group.

The forest plot (Figure 5) for TUG indicates a statistically significant overall effect of task-oriented training in two of the included trials (Rajalaxmi and Ogwumike). Therefore, task-oriented intervention for mobility and dynamic balance in children with cerebral palsy is observed to be statistically favoured by the overall effect, but due to the limited number of trials with relatively small population, it is challenging to make profound and exclusive conclusions about the clinical significance. However, as seen in the individual effect sizes calculated from the pre- and post-tests for each experimental group (Table 6) across the trials, the results indicate rather large improvements in all of the four studies when examining the Mean D values. Furthermore, in all of the four studies, the individual effect size for the experimental group receiving task-oriented training resulted in higher scores compared to the control group (Tables 6 and 7), which can be assumed to indicate a positive effect of the task-oriented treatment.

In their study to examine TUG test in children with and without disabilities, Williams et al. (2005) resulted in mean scores of 4.9-7.0 seconds used to perform the test in healthy subjects. In the contrast, children with mild to moderate cerebral palsy resulted in mean scores of 8.3 (level I), 10.9 (level II), and 28.1 (level III) seconds. Evidence and guidance on interpretation of the TUG results in pediatric physical therapy practice is limited, making it therefore challenging to expand firm and exclusive conclusions about the clinical significance of the results. Guidelines for interpreting results in elderly people and adults with disabilities may be used as an indicative example for further discussion: a cut-off score of ≥15 seconds may be predictive of a fall risk. <10 seconds used in the task may indicate "completely independent gait function", < 20s. "independent for basic transfers", and < 30s. "dependent, requires assistance" (Podisadlo & Richardson, 1991).

Taking into consideration the study by Williams (2005) and the given interpreting examples, the overall difference of -1.98 seconds (Figure 5) in means between the sample groups may be considered as clinically significant as it may determine whether the task-oriented intervention can indeed result in improved and completely independent gait and balance function when compared with the comparison treatment approaches. In light of variation in GMFCS levels, subtypes of the diagnosis, as well as other demographic characteristics of the participants, it is interesting to consider the differences in means across the sample groups.

In their trial, Rajalaxmi resulted successfully in -3.90 seconds mean difference between the pre- and post-test results for the experimental group (Table 6). The difference is rather significant as the pre-test score of 12.8 seconds may be assumed to indicate mild to moderate difficulties in balance and gait, while the post-score of 8.9 seconds corresponds to independent and improved gait and balance function without a risk to fall. In their study, Williams et al. (2005) reported that only children with GMFCS level I performed the test in less than 10 seconds (Mean D of 8.3s.). In light of this, it is interesting to consider the results from the trial by Rajalaxmi in which the experimental group resulted in MD8.9±0.83SD (Table 6) after the intervention period. Although there is a lack of detailed information about the demographic characteristics of the participants, it is possible that the sample group consisted of children with moderate CP (GMFCS levels II-III), which indicates that task-oriented training may indeed significantly improve functional mobility among children with more severe CP and secondary conditions. Possibly, despite more severe functional limitations such as muscle tone abnormalities, reduced postural control, higher level of spasticity and contractures, the children with moderate CP were able to improve their ability to walk independently and perform the TUG test in less than 10 seconds. This assumingly indicates "completely independent gait function" (Podisadlo & Richardson, 1991) and thereby contributes to the child's participation and ability to independently perform functional daily tasks.

Larger improvements within the experimental group receiving task-oriented training were also observed in the trial by Ogwumike (Tables 6 and 7). The Mean D score of -5.60 seconds was reported from a sample group that consisted of 20 children with GMFCS level I (7), II (6), and III (7). In addition, several subtypes of the diagnosis (diplegic, hemiplegic, dyskinetic, ataxic) were represented in the group. 13 of the children did not use walking aids, while the remaining participants used either a rolling walker, quadripod, or walking frame. Due to these given characteristics, the clinical heterogeneity of the experimental group can be argued to be rather large, which may explain the larger SD value of 4.6 when compared to the data from the trial by Rajalaxmi (SD 0.83). Due to the individual demographic characteristics, a number of the participants are ought to have suffered from variety of body function and structure impairments that may have significantly affected their response to the treatment and, furthermore, their scoring in TUG. However, as data from the individual scores is not available, profound conclusions on whether the children with milder condition scored better than children with more severe CP cannot be reliably made despite the trial by Williams et al. (2005) supporting this assumption. Moreover, Williams et al. (2005) concluded that children with spastic quadriplegia scored significantly lower than children with spastic hemiplegia or diplegia. As Ogwumike included subjects with different subtypes of CP and secondary conditions in their trial, this may explain the higher SD value of the experimental group in which the children with milder CP possibly showed larger improvements compared to the children with more severe condition.

5.2 Factors contributing to treatment response and results

Based on the results from the individual trials in this review, improvements in functional mobility and balance among children with cerebral palsy were reported. Improvements were observed regardless the intensity or length of the intervention, or the characteristics and individual limitations of the participants. Generally, the groups receiving task-oriented training showed a larger treatment effect (Tables 2-7) than control groups.

There may be several factors that have an impact on the individual child's response to the treatment. The study by Ko et al. resulted in the smallest effect sizes (Hedges' g value of 0.2 / 0.1 in the GMFM domain D & E) for both the experimental and comparison group. In this case, it may be relevant to consider the effectiveness of group-based intervention when comparing it to individual treatment delivery. The trial by Ko reported that only one pediatric physical therapist was delivering the intervention in the group training sessions, which may result in significant limitations in comprehensive clinical reasoning in which an individual child and the therapist are ought to be active participants as suggested by Øberg et al. (2015). Lack of simultaneous participation from both parties may limit gathering evidence from bodily exploration of individual movement possibilities as well as from bodily expressions and verbal discussion, therefore affecting optimal goal setting and individualizing the tasks for each child. Moreover, joint attention and thereby quality of the treatment may suffer due to several individuals receiving the same treatment at the same time when the intervention is delivered by one physical therapist. This is also supported by Størvold et al. (2010) who, in their multiple single-subject study to evaluate the effect of goal-directed motor skill training on children with CP, reported challenges in creating meaningful and motivational joint activities in the group training. This was due to the individual goals the participating children had and ensuring that each of them were addressed specifically and frequently during the treatment sessions. However, in their trial, Størvold et al. (2010) had several professional and parents included in the group training, thereby ensuring that there was at least one adult per child during the activities.

On the contrary, the trial by Ketelaar et al. resulted in rather large effect sizes (Hedges' g value of 1.0 and 0.6 in the GMFM domains), indicating rather significant improvements in functional mobility and balance. In the trial by Ketelaar, the functional tasks were not standardized but were in fact based on individual characteristics, abilities and priorities of each child. Each child received verbal feedback and instructions during the treatment sessions with the aim of improving their performance. In other trials reporting significant treatment effect (Mean D values) (Tables 2-7), such as Sah, Madhumati, and Ogwumike, the given tasks were similar to each participant. Progression of increasing the repetitions and complexity of the tasks was considered according to each child's ability. Large effect size (Mean D) was also observed in the Rajalaxmi (Tables 2-4) who, however, did not define the detailed procedure of the treatment. As these several trials resulted in rather large and positive treatment effects, it can be suggested that one-to-one training sessions may have a more positive effect in the outcome when compared to a relatively similar intervention delivered in group sessions. The differences between the trials by Ketelaar and Ko when assessing functional balance may be due to wider possibilities in individual and comprehensive clinical reasoning for each child in one-to-one treatment, in which the child and therapist are active participants in simultaneous interaction.

Continuous clinical reasoning before, during and after intervention is ought to be based on several factors, one of them being individual movement possibilities and physical characteristics (Øberg et al. 2015). Therefore, the clinical heterogeneity of the sample groups must be considered when examining the results and children's response to the treatment. All of the trials included children with cerebral palsy and GMFCS level I-III, as well as different types of CP, meaning that the functional levels of the participants varied fairly significantly as a child with GMFCS level I is considered to have rather few physical limitations compared to children with GMFCS level III that indicates a need for assistive mobility and gait devices and varying use of a wheelchair in longer transportations (Palisano et al. 2008). Children with higher level classification in GMFCS suffer from wider body function and structure impairments (Graham et al. 2017, Palisano & Orlin, 2017; Wichers et al. 2009) that may significantly affect their response to a certain treatment as well as their scoring in standardized tests when comparing to children with milder impairments. Task-oriented training is considered a strongly dynamic and intensive intervention (Barbeau et al. 2001; Valvano, 2004) in which children with poor postural control, spasticity, contractures and lower energy levels may show slower and smaller improvements than children with higher functional ability. In this review, these factors must be carefully considered as the intervention tasks as well as the tasks in the measurement instruments require sufficient and rather advanced functional abilities. For example, a child with level I CP may not face difficulties in performing sit-to-stand and walking tasks, while a child with GMFCS level III may perform and score significantly lower due to functional limitations such as abnormalities in muscle tone, reduced postural control, and contractures that contribute to, for example, gait pattern and balance. This is supported by Saether et al. (2013) who studied gait characteristics in children and adolescents with CP, and observed that children with increasing GMFCS levels showed increasing difficulties in walking due to greater impairments in gross motor functions.

Moreover, in addition to variety of GMFCS levels represented in the clinical trials, different subtypes of the diagnosis were included in the sample groups. It must therefore be noted that several physical characteristics of the diagnosis among the participants may have contributed to different response to the treatment as well as results among children with hemiplegic, spastic diplegic, and spastic quadriplegic CP. In the following paragraphs, the upper limb function and anticipatory postural adjustments (APAs) related to functional mobility and balance are discussed.

Bonnefoy-Mazure et al. (2014) characterized the arm and thorax patterns in children with CP during gait. Significant correlations between elbow angles, shoulder angle ROM, and gait speed were observed. The subjects who suffered from limited arm function and ROM adopted different movements between their affected and non-affected upper limbs in order to optimize their gait. These conclusions support the need for interventions to improve upper limb function and inter-limb coordination in patients with cerebral palsy. Additionally, several studies (Johansson et al. 2014; Rafsten et al. 2019) have concluded that reduced upper limb function due to a neurological disorder can have a significant impact on individual's mobility, balance strategies and coordination. Manual Ability Classification System (MACS) is used to classify the manual ability among children with CP, and a high correlation between MACS and GMFCS has been observed especially in quadriparetic children. Studies support that the higher GMFCS level is, the more upper limb functional difficulties a child with cerebral palsy may show (Gunel et al. 2008; Eliasson et al. 2006; Morris et al. 2006). Moreover, as Graham (2016) and Hallman-Cooper & Rocha Cabrero (2021) explain, spasticity in quadriplegic cerebral palsy is often more severe in upper extremities than in the legs, contributing to limitations in range of motion, contractures, and pain. Moreover, children with quadriplegic cerebral palsy have often greater limitations in upper limb functions when compared to children with spastic diplegic cerebral palsy, which should be taken into consideration when assessing the group data and treatment response.

Girolami et al. (2011) support the need for upper extremity practice to improve speed and fluidity of movement in different tasks. Despite the differences in individual physical characteristics due to GMFCS levels and subtypes of the diagnosis, the children in the included trials received similar treatment and performed the same tasks. Four studies detailed that the tasks included reaching exercises in sitting and standing, however, apart from that, the tasks delivered by a physical therapist focused mainly on exercises for lower extremities, such as stepping, turning, walking, and kicking a ball. Limitations in functional level of either one or both upper extremities have a negative impact on the individual's mobility, balance and coordination (Johansson et al. 2014; Rafsten et al. 2019), which is due to reduced sensory information from the hand and limited mobility of the upper limb(s) that may result in malalignments of the arm(s). These factors contribute to reduced body orientation and, thereby, characteristics such as balance, coordination, and gait (Syre & Gjelsvik, 2016). That being said, the lack of focus on tasks involving and improving arm function in the included trials may have resulted in lower response to the treatment in quadriparetic children with higher GMFCS level.

This may have further on contributed to lower individual and overall results in the measurement instruments as all of them assess the child's ability to perform tasks that require body orientation. To support this, Milosevic et al. (2011) concluded in their study that that the contribution of upper limb movements in the performance of clinical balance and functional mobility tests is sufficiently large and that, for example, in TUG test the time used to perform the task decreased with active upper arm use. Furthermore, in their study to examine the relation between impaired upper limb motor function and postural balance in stroke patients, Rafsten (2019) reported that reduced function in the arm significantly associates with impaired postural balance. This was observed when assessed with BBS (Berg's Balance Scale) and TUG.

Girolami et al. (2011) observed in their study that children with spastic diplegic cerebral palsy were unable to generate anticipatory postural adjustments of the same magnitude as children with hemiplegic CP. Moreover, children with diplegic CP have been reported to exhibit weaker postural balance control ability as well as less standing ability when compared to children with hemiplegic children (Rojas et al. 2013). In the trials included in this review, reduced APAs, truncal control and ability to maintain vertical posture may have contributed to large differences in treatment responses and results between hemiplegic, diplegic and quadriplegic children with variety of GMFCS levels. For example, a diplegic child with GMFCS level III who, compared to a child with hemiplegia and GMFCS level I, assumingly has reduced APAs and balance control may have to use more energy in order to maintain sufficient vertical posture in dynamic tasks such as walking, stepping, circular movements, and kicking a ball. In view of this, one must take into consideration that some of the significant fundamental components of task-oriented training are indeed intensity and repetitions (Rowe et al. 2018; Valvano, 2004). It may be possible that children with greater impairments in postural and selective control may have not reached a similar intensity and/or repetition levels in the included trials when compared to children with higher functional abilities in the same sample group, thereby possibly making their improvements in functional mobility and balance slower within given intervention period. Furthermore, this may have contributed to lower individual and overall results in the measurement instruments that assess the child's ability to perform dynamic tasks that require efficient activation of APAs, sufficient balance control, and ability to maintain vertical posture.

The study by Hong et al. (2017) supports the importance of considering the GMFCS and response levels when examining score results of children with CP. In their study to examine effect of intensive therapy in motor functions among children with CP, Hong observed that children with GMFCS levels I and II were more likely to respond well compared to the children with level IV and V. There was no significant difference between those with levels III and V, which indicates that the children with levels I-II resulted in faster and better outcomes in responding to the treatment than children with level III. The intervention of intensive therapy in the study consisted of functional goal-directed training combined with NDT concepts. Better response rate to physical therapy among children with levels I-II is also supported by Chen et al. (2013), who suggest that perhaps due to more substantial baseline difficulties, such as limitations in functional abilities and body structures, the participants with level III-V did not respond as effectively to the intervention. It could, therefore, be assumed that in the trials that were included in this review, the children with milder cerebral palsy possibly responded better to the dynamic goal-directed functional training than the children with moderate CP. The trials allocated the participants into experimental and control groups in which GMFCS levels I-III together with different subtypes of the diagnosis (spastic diplegic, spastic quadriplegic, hemiplegic, ataxic) were represented. Due to heterogeneous groups of participants in several included studies, the overall results from the trials and of the meta-analysis may not represent generalized response level to the treatment of all children with the given GMFCS levels and subtypes. However, as individual statistics from the trials are not available, profound and exclusive conclusions in this matter cannot be reliably made.

5.3 Evidence for clinical practice

Meta-analysis is ought to contribute to evidence-based decisions and guidelines in clinical practice as it assesses published research studies and trials in order to contribute to profound conclusions about a treatment effect by producing quantitative statistical data (Haidich, 2010). The statistical and mathematical knowledge gained through numbers and other mathematical are ought to construct proof and provide evidence for certain clinical hypothesis (Fieser & Stumpf, 2020; Webb, 2018). In the conducted meta-analysis of this review, the overall statistical data from PBS and TUG tests (Figures 4 and 5) provide evidence that supports the null hypothesis, while the individual effect sizes among experimental groups (Tables 2 and 6) show rather significant improvements in the outcomes. However, the data is collected from standardized tests that measure numeric values and assess children's functional abilities through causal mechanisms. Kirkengen et al. (2012) argue that emphasizing the physiological actions and functions in the body rather than showing consideration and understanding to the relation between lived experiences and bodily dysfunctions, the therapist remains with objective knowledge of the patient. This further on is ought to violate the subjectivity of an individual.

In pediatric physical therapy practice, one of the fundamental components of task-oriented training is setting individual goals that are based on subjective values and preferences, and planning tasks that are meaningful for each child (Palisano & Orlin, 2017; Valvano, 2004,). In the included studies, only Ketelaar provided each child with an intervention period that included tailored tasks based on the child's and family's values and priorities. In the other studies, the tasks remained same for every participant. Despite the relatively large effect sizes within experimental groups (Tables 2 and 6) which indicate a positive effect of the intervention, considerations should be taken when assessing this statistical knowledge due to its lack of providing evidence about individual characteristics.

The Dynamic Systems Theory emphasizes the importance of different subsystems in motor development and achieving a functional task, suggesting that a child's performance in a testing situation or an intervention session is based on characteristics such as the individual's cognition and personality, task-related factors, as well as environmental characteristics (Thelen et al 1987; Thelen, 1989). This being said, the statistical data from meta-analysis may not provide enough information and evidence for pediatric physical therapists in clinical practice, as in this review the included clinical trials conducted highly controlled testing situations and similar intervention tasks for each child despite their individual characteristics such as motor abilities related to the level of the diagnosis, or previous subjective experiences. Despite the rather large effect sizes among experimental groups (Tables 2 and 6), evidence-based clinical reasoning and decision making should consider the embodied-enactive theory in which the therapist and child contribute actively to the process that is continuous before, during, and after physical therapy sessions. The evidence and information for efficient and appropriate treatment on an individual level is ought to be gathered not only through physical mechanisms of the body and movements, but also through sensory experiments of both parties, simultaneous communication, and feedback (Øberg et al. 2015). Therefore, while the statistical effect sizes from individual trials (Tables 2-8) suggest that the task-oriented intervention can be considered rather effective, attention should be given to comprehensive evaluating of an individual child in pediatric clinical practice with children with cerebral palsy.

5.4 Limitations and strengths of the included trials

This section discusses the limitations and strengths across the studies that were included in the meta-analysis. Generally, the eight well-designed randomized controlled trials in this review provided level II evidence for examining and assessing the effectiveness of task-oriented approach in functional mobility and balance among children with cerebral palsy. The assessment in all of the trials was conducted by performing standardized tests with measurements instruments that are considered to have high psychometric properties. The intervention was delivered, and testing of the participants performed by an authorised physical therapist in all of the included trials.

Firstly, strengths and limitations regarding to the intervention procedures must be considered. Seven of the studies described in detail the content of task-oriented training, thereby allowing explorative examination and assessment of treatment response on individual level which is considered relevant in this review due to the meta-analysis including a rather few number of trials. The duration and frequency of the intervention period was also detailed in every trial, which contributes to the narrative examination and evaluation of the clinical evidence for everyday physical therapy practice. However, some limitations in the intervention procedures should be considered.

Firstly, the trial by Ko delivered group-based task-oriented training, which may have resulted in potential limitations in the given tasks being appropriate, sufficiently challenging, and meeting the individual and specific needs of each participant. Secondly, another limitation in the trial by Ko, Kumar, Madhumati, Sah, and Salem is the intervention duration of only 4 to 8 weeks, which may have significantly reduced possibilities for the children to response to the treatment. Moreover, trials by Salem, Ogwumike, and Ko delivered the intervention two days a week, which can be considered rather low frequency for physical therapy with children for CP when the priority of the intervention is to achieve improvements in gross motor functions (Størvold et al. 2020). It should also be noted that the control groups in the included trials received a variation of different physical therapy treatments, including interventions based on neurophysiological methods (NDT or Vojta), passive stretching and range of movement exercises, and Neuromuscular Facilitation Exercises. Moreover, the trials by Madhumati and Sah included weight bearing, mobility and balance tasks in their intervention for the comparison groups. These given tasks were considered as task-oriented exercises in the other trials, and were therefore included in the intervention for the experimental groups. In addition, activities and participation outside the physical therapy sessions should be considered when further assessing and examining the results. For example, the trial by Ko reported that the children also participated in school and community activities, which may have contributed to improvements and better outcome results. In the contrast, the children participating in the study by Ketelaar generally received only physical therapy, which may have limited the possibilities for a larger combination of activities and interventions that involve several professionals.

In summary, variations and contradictions across the interventions in the trials and sample groups contribute to limitations in providing profound and generalized evidence for clinical practice.

Secondly, considerations should be taken on the study population and recruiting process. Generally, all the trials had a rather small number of children who participated, thereby resulting in small sample sizes. Children were generally recruited from similar geographic locations in the individual studies, as well as from similar socioeconomic backgrounds. The clinical heterogeneity of the sample groups varied across the studies, mainly due to different GMFCS levels (mild to moderate) and subtypes (hemiplegic, diplegic, quadriplegic) of the diagnosis among the participants who were allocated randomly into sample groups. Due to the clinical heterogeneity of the groups across the studies, profound and reliable comparison between two interventions can be considered rather limited. Moreover, as the trials generally had rather narrow inclusion criteria and only recruited children with mild to moderate CP without severe secondary conditions, the results from the individual trials cannot be generalized to all children with the diagnosis. This further on creates limitations in applying the intervention in pediatric clinical practice with CP children. Conducting a study and testing the intervention with larger, homogeneous cohort groups might contribute to more profound and generalized evidence of the treatment effect.

In order to follow up the treatment effect after the intervention period, only four of the included trials in this review performed a follow-up assessment and reported the data. The trials by Ketelaar, Ko, Kumar & Ostwal, and Ogwumike conducted a follow-up assessment varying from 4 weeks to 18 months post-intervention. However, the trial by Ko did not evaluate or report the follow-up outcome measurements of the comparison group. In the contrast, the studies by Madhumati, Rajalaxmi, Sah, and Salem conducted an immediate post-intervention assessment only. The lack of follow-up data sets limitations in assessing the effectiveness of the intervention in long-term basis, which should be considered due to CP being a permanent, non-progressive disorder.

5.5 Limitations and strengths of this systematic review

A systematic literature review and meta-analysis is referred to as a "gold standard" for evidence-based practice in medical and health sciences as they critically identify and assess existing evidence on a specific hypothesis in order to answer a research question. The method is used to statistically analyze data from multiple studies in attempt to calculate and discuss the findings: an overall or "absolute" effect of an intervention (Bjørndal, 2008; Egger et al. 1997; Sackett et al. 2000). However, despite a meta-analysis being considered as the "gold standard" for providing evidence for clinical reasoning and practice, several limitations and bias can arise in the process of conducting a systematic review followed by the statistical analysis.

The first considered limitation of this study is the rather small number of individual studies included in the meta-analysis as in total eight randomized controlled trials were included in the quantitative analysis after conducting a systematic literature search and defining selection criteria for the studies. The inclusion criteria of the three specific measurement instruments may have excluded trials with potential evidence of the effectiveness of task-oriented training. Moreover, only the independent author of the review assessed the eligibility of the studies, which may have resulted in study selection bias. Three to four studies were analyzed for overall effects for each measurement instruments, making the meta-analysis for each subgroup small. A small number of studies resulted in general limitations and lack of statistical information from which to assess conclusions and discuss evidence about potential effects of the intervention and its application to clinical practice. Moreover, relatively small sample sizes of the individual studies set limitations in providing profound and more generalized conclusion of the treatment effects. Meta-analysis performed with very few studies of rather small sample sizes led the author to focus on summarizing and discussing the study results by means of qualitative characteristics and evidence of the included trials, rather than providing meaningful overall evidence syntheses.

Due to the limited number of trials, estimating statistical heterogeneity reliably across the studies could not be performed. Evaluating heterogeneity of the trials is considered as one of the most crucial tasks when conducting meta-analysis (Bender et al. 2018; Haidich, 2010), and therefore the limitations in performing the assessment in this review should be taken into account. Larger studies can provide more precise and reliable values in the statistical heterogeneity than small trials. Moreover, estimating overall heterogeneity across few studies can result in biased statistical values of I2 and Chi2 test (Borm et al. 2015; Von Hippel, 2015), thereby affecting the reliability of the evidence from a small meta-analysis.

This review and meta-analysis consist of level II evidence obtained from randomized clinical trials (Burns et al. 2011). The quality assessment of each individual trial was generally conducted by the individual author of this review. In case of uncertainties and incomprehension about the given questions in the quality assessment sheet, a small group of co-students and Associate Professor of Physiotherapy discussed the matters together with the author. However, as the decisions regarding the level of quality for each study were made independently by the author, some bias in the quality of conduct are possible. Additionally, the data from the included trials was extracted by the individual author. Possible bias in entering and assessing the information may have occurred despite the systematic and meticulous handling of the data. Authors of three studies were contacted in order to obtain missing data or discussing ambiguities within the statistical information of the given studies, however, no response or further discussion of the results was brought about. This resulted in excluding one of the studies.

6 Conclusion

This study attempted to examine and assess the effectiveness of task-oriented training in functional mobility and balance in ambulant children with cerebral palsy. Eight randomized clinical trials were included in the meta-analysis that assessed and concluded results from three measurement instruments: Pediatric Balance Scale (PBS), Timed Up & Go (TUG), and Gross Motor Function Measure (GMFM) domains D & E.

Based on the results from the meta-analysis, a significant effect of task-oriented training in children with cerebral palsy was observed when assessing functional mobility and balance in PBS and TUG. Improvements in the outcomes were observed in the individual studies regardless the intensity or length of the intervention. On the contrary, no statistical or clinical significance of the treatment effect was observed in the scores of Gross Motor Function Measure D & E. The evidence for positive effects of task-oriented training supports the use of goal-directed functional training for children with cerebral palsy as the results for experimental groups show clinically significant improvements in functional skills. Improvements were also observed in comparison groups, but larger effects were achieved within participants in the experimental groups.

Task-oriented approach that consists of the principles of motor learning theories emphasizes intensity, relevancy, therapist-child collaboration, and feedback in the process of skill acquisition can improve the child's independency and ability to perform daily tasks and participate in school and community. Large effect and significant improvements were reported from trials that contributed to individual goal-setting and tailored training sessions. Additionally, this review observed that larger improvements were achieved in one-to-one training sessions rather than in group-based training, which may be due to wider possibilities in individual and comprehensive and simultaneous embodied-enactive clinical reasoning with each child.

However, several this review together with the included trials faced several limitations. Limited number of trials, relatively small study population, and heterogeneity of the sample groups make it challenging to conclude profound and exclusive guidelines and evidence of the treatment effects. In order to make decisions about appropriate intervention for each individual child, clinical reasoning in pediatric physical therapy with children who have cerebral palsy should be based on the clinical evidence from research as well as on information gathered through active communication and participation of the therapist(s), child, and the family. This is in the line with the principles of evidence-based practice that consists of best research evidence, clinical expertise of the physical therapist(s), and individual values and preferences of the patient.

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Supplementary material

Search strategy for each database

Ovid Medline

1 Cerebral Palsy/
2 cerebral pals*.ti,ab,kw.
3 (task-oriented adj3 (training or activit* or exercis*)).mp.
4 (task-specific adj3 (training or activit* or exercis*)).mp.
5 (goal-directed adj3 (training or activit* or exercis*)).mp.
6 (functional adj3 (training or activit* or exercis*)).mp.
7 1 or 2
8 3 or 4 or 5 or 6
9 7 and 8

CINAHL

1 (MH "Cerebral Palsy")
2 cerebral pals*
3 TI (task-oriented N3 (training OR activit* OR exercis*)) OR AB (task-oriented N3 (training OR activit* OR exercis*))
4 TI (task-specific N3 (training OR activit* OR exercis*)) OR AB (task-specific N3 (training OR activit* OR exercis*))
5 TI (goal-oriented N3 (training OR activit* OR exercis*)) OR AB (goal-oriented N3 (training OR activit* OR exercis*))
6 TI (functional N3 (training OR activit* OR exercis*)) OR AB (functional N3 (training OR activit* OR exercis*))
7 S1 OR S2
8 S3 OR S4 OR S5 OR S6
9 S7 AND S8

Ovid EMBASE

1 cerebral palsy/
2 cerebral pals*.ti,ab,kw.
3 (task-oriented adj3 (training or activit* or exercis*)).mp.
4 (task-specific adj3 (training or activit* or exercis*)).mp.
5 (goal-directed adj3 (training or activit* or exercis*)).mp.
6 (functional adj3 (training or activit* or exercis*)).mp.
7 1 or 2
8 3 or 4 or 5 or 6
9 7 and 8

PubMed

1 Cerebral Palsy[mesh:noexp]
2 cerebral pals*[tiab]
3 (task-oriented AND (training OR activit* OR exercis*[tiab]))
4 (task-specific AND (training OR activit* OR exercis*[tiab]))
5 (goal-directed AND (training OR activit* OR exercis*[tiab]))
6 (functional AND (training or activit* OR exercis*[tiab]))
7 #1 OR #2
8 #3 OR #4 OR #5 OR #6
9 #7 AND #8

Cochrane

#1 [mh "Cerebral Palsy"]
#2 cerebral pals*
#3 (task-oriented NEAR/3 (training or activit* or exercis*)):ti
#4 (task-specific NEAR/3 (training or activit* or exercis*)):ti
#5 (goal-oriented NEAR/3 (training or activit* or exercis*)):ti
#6 (functional NEAR/3 (training or activit* or exercis*)):ti
#7 #1 OR #2
#8 #3 OR #4 OR #5 OR #6
#9 #7 AND #8

PSYCINFO

1 exp Cerebral Palsy/
2 cerebral pals*.mp.
3 (task-oriented adj3 (training or activit* or exercis*)).mp.
4 (task-specific adj3 (training or activit* or exercis*)).mp.
5 (goal-directed adj3 (training or activit* or exercis*)).mp.
6 (functional adj3 (training or activit* or exercis*)).mp.
7 1 or 2
8 3 or 4 or 5 or 6
9 7 and 8