

# Therapeutic Effects of Horseback Riding Therapy on Gross Motor Function in Children with Cerebral Palsy: A Systematic Review

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**ABSTRACT.** *Purpose:* This systematic review examined the efficacy of hippotherapy or therapeutic horseback riding (THR) on motor outcomes in children with cerebral palsy (CP). *Methods:* Databases were searched for clinical trials of hippotherapy or THR for children with CP. *Results:* Nine articles were included in this review. Although the current level of evidence is weak, our synthesis found that children with spastic CP, Gross Motor Function Classification System (GMFCS) levels I–III, aged 4 years and above are likely to have significant improvements on gross motor function as a result of hippotherapy and THR. Evidence indicates that 45-min sessions, once weekly for 8–10 weeks, result in significant effects. *Conclusions:* The current literature on hippotherapy and THR is limited. Large randomized controlled trials using specified protocols are needed to more conclusively determine the effects on children with CP. From the current evidence, it appears that hippotherapy and THR have positive effects on gross motor function in children with CP.

**KEYWORDS.** Cerebral palsy, gross motor function, hippotherapy, therapeutic horseback riding

## INTRODUCTION

Cerebral palsy (CP) is a group of non-progressive and permanent disorders of the brain, which can result in impairments of movement, posture, sensation, perception, cognition, and motor control. These impairments are a result of brain damage that occurs during fetal development or surrounding birth that can lead to balance problems, mobility disturbances, and musculoskeletal problems (Rosenbaum, Paneth, Leviton, Goldstein, and Bax, 2007; United Cerebral Palsy, 2001). Horseback riding therapy is a modality for children with CP that is believed to improve gross motor function (Liptak, 2005; Snider, Korner-Bitensky, Kammann, Warner, and Saleh, 2007; Sterba, 2007). Two types of riding therapy are widely available and have been

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described in the literature: hippotherapy and therapeutic horseback riding (THR). In hippotherapy, a physical or occupational therapist guides a child's posture and movement while riding a horse (Latella and Langford, 2008; Snider et al., 2007; Sterba, 2007), and the therapist, rather than the child, controls the horse (Debuse, Gibb, and Chandler, 2009; Meregillano, 2004). In hippotherapy, the therapist uses the horse as a tool to influence the child's posture, balance, coordination, strength, and sensorimotor systems and the child interacts with and responds to the movement of the horse (Debuse et al., 2009; Meregillano, 2004). Therapeutic horseback riding, on the other hand, is provided by a non-therapist riding instructor who is accredited and follows the curriculum, standards, and procedures set by the North American Riding for the Handicapped Association (NARHA) for riding therapy (Snider et al., 2007; Sterba, 2007). In contrast to hippotherapy, the child participating in THR plays an active role in controlling the horse. The child engages in riding activities led by an accredited riding instructor as a form of exercise to improve coordination, balance, and posture and to encourage development of sensory and perceptual motor skills (Snider et al., 2007; Sterba, 2007).

Several features of horseback riding are believed to promote motor performance in children with CP. It is thought that the rhythmical pattern of the horse's gait mimics the movement of the pelvis during human gait (Latella and Langford, 2008). In addition to the rhythmical movements, the warmth and three-dimensional shape of the horse are believed to contribute to improvements in range of motion, tone, posture, balance, and coordination (Snider et al., 2007). The use of a horse as a dynamic therapy tool has the potential to benefit children with CP by reducing tone, promoting symmetrical alignment, mobilizing the pelvis, developing postural awareness and control, and improving gait and mobility (Debuse et al., 2009; Meregillano, 2004).

To date, four reviews of hippotherapy and/or THR for children with CP have been published. In 2004, Meregillano published a review that provided a detailed history and description of both hippotherapy and THR. Meregillano discussed the benefits of hippotherapy for children with CP and reported the results of five hippotherapy studies in this population. He concluded that these preliminary studies demonstrated positive benefits of hippotherapy in children with CP, but warranted further investigation due to small sample sizes. Liptak (2005) summarized the findings of seven hippotherapy studies in a review of complementary and alternative therapies for children with CP. These studies demonstrated positive gross motor benefits in children with CP.

In 2007, two systematic reviews on hippotherapy and THR were published. Snider et al. (2007) categorized outcomes from nine studies that evaluated the effects of hippotherapy ( $n = 5$ ) and THR ( $n = 4$ ) using the domains of the International Classification of Functioning, Disability and Health (ICF) model. Snider et al. concluded that level 2a evidence (fair quality randomized clinical trials (RCT)) supports short-term benefits from hippotherapy on muscle symmetry of the trunk and hip but that effects from THR on muscle tone have not been found. Levels 2 and 3 evidence (non-randomized trials/multiple baseline designs and one group pre-test-post-test designs, respectively), for both hippotherapy and THR, have shown positive benefits on activity outcomes but there is no evidence for participation outcomes (Snider et al., 2007). Sterba (2007) summarized the

results of five hippotherapy studies and six THR studies on gross motor function. This review concluded that hippotherapy and THR could be recommended by clinicians as an efficacious tool to improve gross motor function in children with CP.

Although these reviews reported positive effects, citing individual trials, they did not synthesize the findings from hippotherapy and THR trials to identify the types of children who benefit and the types of outcomes that can be expected. More synthesis needs to be conducted in order to understand the specific benefits of riding interventions. Furthermore, because the most recent review was conducted in 2007, an update on the current hippotherapy and THR evidence is warranted.

## **PURPOSE**

The previous reviews on hippotherapy and/or THR summarized clinical trials, but did not attempt to synthesize what is known from current evidence or describe what type of children with CP respond best to hippotherapy and THR and what types of outcomes result. Therefore, the purpose of this systematic review is to examine the efficacy of hippotherapy and THR in children with CP on motor outcomes through synthesis of research evidence.

## **METHODS**

### ***Study Identification***

The following databases were searched to identify appropriate studies to be included in this review: PubMed, Cochrane Reviews (1991-present), CINAHL Plus with Full Text (1982-present), Ovid Medline (1950-present), and EBSCOhost Medline with full text. Keywords utilized were “cerebral palsy,” “therapeutic riding,” “therapeutic horse riding,” “therapeutic horseback riding,” “horse riding,” “horseback riding,” “hippotherapy,” “equine-assisted therapy,” “equine-assisted movement therapy,” “equine therapy,” “equine movement therapy,” “developmental riding therapy,” and “riding for the disabled.” In addition, we selected “relevant article” links on the databases and research reports from our reference lists to assemble a comprehensive list of hippotherapy and THR studies. Furthermore, reference lists of relevant articles were searched to identify additional articles for potential inclusion.

### ***Study Selection***

In order to be considered for inclusion in this review, studies had to meet all of the following criteria: (a) Subjects in study have a diagnosis of CP (all types), (b) hippotherapy or THR was the primary intervention, (3) mobility or gross motor outcomes were investigated, and (4) a physical therapist, occupational therapist, or an accredited therapeutic riding instructor implemented the intervention. Studies were excluded from the review if they met any of the following criteria: (a) Barrel sitting or other types of horse simulation was used as primary intervention, (b) study was published prior to 1985, (c) subjects were adults aged 18 years and older, (d) study was not available in full text, (e) study was not available in English, (f) study

had not yet been published (grey literature), or (g) a qualitative research design was used.

### **Validity Assessment**

The authors reviewed studies that met the inclusion and exclusion criteria independently. A 10-point PEDro scale (Physiotherapy Evidence Database, 1999) was used to rate the validity of each study. A copy of this scale can be obtained at <http://www.pedro.org.au/english/downloads/pedro-scale>. It was determined by the authors that low-scoring studies lacked the level of rigor necessary to provide valid information. Therefore, any article that scored 2/10 or below on the PEDro scale was excluded from this review. After independently rating each article, the two authors met to discuss the ratings of each article. If a discrepancy in rating occurred, discussion about the rating was used to reach a consensus for a final rating. The Assessment of Multiple Systematic Reviews (AMSTAR) guidelines, which assess the methodological quality of a systematic review, were followed for this review (Shea et al., 2007). A copy of these guidelines can be obtained from Shea et al. (2007).

## **RESULTS**

From our database search, 63 articles were identified to be relevant to this review. Of these 63 articles, 16 were determined to meet the inclusion and exclusion criteria. The primary reasons for the exclusion of the other 47 articles included that the studies were not available in English, mobility/gross motor outcomes were not studied, or barrel sitting was used instead of a live horse. The two authors on the PEDro scale rated the remaining 16 studies independently. Seven of these studies scored 2/10 and were excluded from this review. Therefore, nine studies were selected to be included in this review (Table 1). Two studies were RCT (Davis et al., 2009; MacKinnon et al., 1995), two were one-group pretest–post-test designs (McGee and Reese, 2009; Shurtleff, Standeven, and Engsborg, 2009), and the remaining five were repeated-measures within-subject designs (Bertoti, 1988; Casady and Nichols-Larsen, 2004; Hamill, Washington, and White, 2007; McGibbon, Andrade, Widener, and Cintas, 1998; Sterba, Rogers, France, and Vokes, 2002).

Six of the nine studies used hippotherapy as the primary intervention in which a physical therapist implemented the treatment (Bertoti, 1988; Casady and Nichols-Larsen, 2004; Hamill et al., 2007; McGee and Reese, 2009; McGibbon et al., 1998; Shurtleff et al., 2009). In Shurtleff et al.'s (2009) study, both a physical therapist and an occupational therapist administered treatment. Two studies used hippotherapy as the primary intervention with a physical therapist working in collaboration with an accredited therapeutic riding instructor to administer treatment (Davis et al., 2009; MacKinnon et al., 1995). The remaining study used THR as the primary intervention, in which an accredited therapeutic riding instructor implemented the intervention (Sterba et al., 2002).

All studies reported similar types of interventions and treatment sessions. The studies had the following in common: each child was matched to a horse based upon each child's individual physical characteristics and needs, the child wore a fitted helmet, the child rode on a sheepskin, blanket, or saddle selected on the basis of individual needs, the horses were led by experienced horse handlers on a lead

**TABLE 1. Summary of Studies of Hippotherapy/Therapeutic Horseback Riding for Children with Cerebral Palsy**

Study	Question	Level of Evidence	Participants	Intervention	Outcome Measures	Findings	PEDro Score
Bertoti, 1988	Effect of hippotherapy on postural changes.	Repeated-measures within-subject RCT	11 spastic quadriplegia & diplegia (2–9 yr)	Hippotherapy with PT only; 10 week; 2x/week; 1 hr.	Posture Assessment Scale (PAS)	Posture significantly improved ( $p < .05$ ).	3/10
Mackinnon et al., 1995	Effect of THR on posture, gross, and fine motor control, activities of daily living (ADL) improvements.	RCT	19 spastic: 10 intervention, 9 control (4–12 yr)	Hippotherapy with THR instructor and PT; mild group—saddles, moderate group—saddle pads; 26 week; 1x/week; 1 hr. *Stratified into mild and moderate groups. *Control: no riding, continued normal activities.	PAS, GMFM-88, Peabody Developmental Motor Scales (PDMS) (fine motor component), Bruininks-Oseretsky Test of Motor Proficiency (BOTMP)	Significant improvement in grasp on PDMS for moderately involved intervention group ( $p = .045$ ). No significant differences between intervention and control on PAS, GMFM, or BOTMP. However, gains were observed in posture for moderately involved intervention group.	6/10
McGibbon et al., 1998	Effect of hippotherapy on energy expenditure with gait, stride length, cadence, velocity, and performance on GMFM.	Repeated-measures within-subject RCT	5 spastic diplegia, & hemiplegia (9–11 yrs)	Hippotherapy with PT only; 8 weeks; 2x/week; 30 min.	Gait assessment, GMFM-88 dimension E (walking, running, jumping), Energy Expenditure Index (EEI).	No significant change in stride length; however, two 2 children demonstrated significant increases in stride length at post-test ( $p < .05$ ). Significant decrease in cadence at post-test ( $p < .05$ ). Significant change in GMFM dimension E and EEI ( $p < .05$ ).	4/10

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**TABLE 1. Summary of Studies of Hippotherapy/Therapeutic Horseback Riding for Children with Cerebral Palsy (Continued)**

Study	Question	Level of Evidence	Participants	Intervention	Outcome Measures	Findings	PEDro Score
Sterba et al., 2002	Effect of THR on gross motor function.	Repeated-measures within-subject	17 spastic & mixed diplegia, quadriplegia, & hemiplegia (12 GMFCS level I–III; 5 GMFCS level IV–V) (5–16 yr).	THR with THR instructor only; 18 weeks; 1x/week; 1 hr.	Functional Independence Measure for Children (WeeFIM), GMFM-88	No significant difference on WeeFIM. No significant difference on GMFM-88 after 6 weeks. Significant increase on GMFM-88 total score after 18 weeks ( $p < .04$ ). Significant increase on GMFM dimension E (walking, running, & jumping) after 12 weeks ( $p < .02$ ), after 18 weeks ( $p < .03$ ), and at 6-week post-test ( $p < .03$ ). Subjects who were classified as GMFCS levels IV–V had no change on GMFM total score or GMFM dimension E. No significant differences on GMFM dimensions A–D (lying & rolling, sitting, crawling & kneeling, and standing).	5/10
Casady & Nichols-Larsen, 2004	Effect of hippotherapy on performance on PEDI and GMFM.	Repeated-measures within-subject	10 spastic quadriplegia, hemiplegia, & athetoid (2.3–6.8 yr).	Hippotherapy with PT only; 10 weeks; 1x/week; 45 min (20–30 min on horse).	PEDI, GMFM-88	Significant change in all PEDI subscales ( $p < .05$ ). Significant change on all GMFM dimensions except dimension A (lying/rolling).	4/10

Hamill et al., 2007	Effect of hippotherapy on performance on GMFM and postural control.	Repeated-measures within-subject	3 GMFCS level V: mixed, hypotonic, & dystonic quadriplegia (2–4 yr).	Hippotherapy with PT only; 10 weeks; 1x/week; 50 min.	GMFM-88, Sitting Assessment Scale (SAS)	No significant differences on GMFM-88 or SAS after 10 weeks of hippotherapy.	3/10
Davis et al., 2009	Effect of hippotherapy on physical function	RCT	72 GMFCS levels I–III: 35 intervention 36 control (4–12 yr).	Hippotherapy with THR instructor and PT; 10 weeks; 1x/week; 30–40 min. *Stratified by age and GMFCS. *Control: no riding, continued normal activities.	GMFM-66	No significant difference on GMFM-66.	5/10
McGee & Reese, 2009	Immediate effect of hippotherapy on spatiotemporal parameters of gait.	One group, pretest–post-test.	9 GMFCS level I–IV: spastic quadriplegia, & hemiplegia (7–18 yr).	Hippotherapy with PT only (one session); 30–45 min.	GAITrite	No significant differences were found immediately after therapy on spatiotemporal parameters of gait.	3/10
Shurtleff et al., 2009	Effect of hippotherapy on head/trunk stability and reaching speed/efficiency	One group, pretest–post-test	11 spastic diplegia (5–13 yr).	Hippotherapy with PT & OT; 12 weeks; 1x/week; 45 min.	Video motion capture of control of head and trunk movements on a barrel, upper-extremity functional reach test.	Significant improvement in head and trunk stability and upper extremity functional reach test (improvements in reaching/targeting, elapsed time, & efficiency).	3/10

line, and each child had one or two side walkers (trained volunteers) to help reposition or stabilize the child. Typical sessions begin with warm-up walking around the arena, then may include a variety of interventions such as altering the speed and direction of the horse, the child participating in active range of motion and stretching activities, the child engaging in therapeutic games and activities (e.g., reaching for objects, catching/throwing balls), and also the child riding in various positions in the saddle (e.g., forward, backward, prone) (Bertoti, 1988; Casady and Nichols-Larsen, 2004; Davis et al., 2009; Hamill et al., 2007; MacKinnon et al., 1995; McGee and Reese, 2009; McGibbon et al., 1998; Shurtleff et al., 2009; Sterba et al., 2002). In hippotherapy, compared to THR, the therapist specifically works on each child's impairments and functional limitations. For example, in hippotherapy, the physical therapist may mobilize the child's pelvis while on the horse (Bertoti, 1988). In THR, by comparison, the child works on riding skills such as leading the horse through cones and obstacles (Sterba et al., 2002).

We further synthesized the findings of nine studies by examining the participant characteristics of children who benefit from hippotherapy and THR, the treatment frequency and duration associated with gross motor function improvement, and the gross motor outcomes associated with effective intervention. In addition, in order to analyze the strength of the interventions, the authors calculated effect sizes for all studies based on data from the research reports.

### ***Participant Characteristics***

#### *Type of CP*

Seven of the nine studies investigated children who had spastic CP (Bertoti, 1988; Casady and Nichols-Larsen, 2004; MacKinnon et al., 1995; McGee and Reese, 2009; McGibbon et al., 1998; Shurtleff et al., 2009; Sterba et al., 2002). Hamill et al. (2007) used participants with mixed, hypotonic, and dystonic quadriplegia and Davis et al. (2009) did not specify the type of the investigated CP. In the studies that did specify that spastic CP was the primary diagnosis, all types of spastic CP were represented (diplegia, hemiplegia, and quadriplegia). Six of the seven studies reported significant positive outcomes of hippotherapy and THR on gross motor function and mobility with moderate to large treatment effects (Bertoti, 1988; Casady and Nichols-Larsen, 2004; MacKinnon et al., 1995; McGibbon et al., 1998; Shurtleff et al., 2009; Sterba et al., 2002). In the study of children with spastic CP that did not find positive effects, McGee and Reese (2009) measured the immediate effects of hippotherapy on spatiotemporal parameters of gait. These authors concluded that longer intervention duration might be necessary to observe significant changes on gait parameters in children with spastic CP. In support of the hypothesized goals of hippotherapy, i.e., to reduce muscle tone, increase postural symmetry, and promote postural stability, current evidence, including one RCT, suggests that children with spastic CP demonstrate moderate to large treatment effects as a result of hippotherapy and THR (Bertoti, 1988; Casady and Nichols-Larsen, 2004; MacKinnon et al., 1995; McGibbon et al., 1998; Shurtleff et al., 2009; Sterba et al., 2002).

#### *GMFCS Level*

Only four studies reported the Gross Motor Function Classification System (GMFCS) levels of their subjects. In an RCT, Davis et al. (2009) studied children who

were at GMFCS levels I–III. A majority of the participants ( $n = 12$ ) in the Sterba et al. (2002) study were at GMFCS levels I–III with five participants at levels IV–V. McGee and Reese (2009) investigated children at levels I–IV. Hamill et al. (2007) included only children at level V. Of these studies, only Sterba et al. (2002) reported significant improvements in gross motor function, and only the children who were at levels I–III showed improvement. Children who were at levels IV–V did not make gains. Since only a portion of the studies reported the participants' GMFCS levels, it is difficult to draw conclusions about the effectiveness of hippotherapy and THR for children at different levels of gross motor functioning.

### *Age of Subjects*

These nine studies included participants of varied age ranges. The studies that demonstrated positive effects contained samples of children aged 4 years and older (Bertoti, 1988; Casady and Nichols-Larsen, 2004; MacKinnon et al., 1995; McGibbon et al., 1998; Shurtleff et al., 2009; Sterba et al., 2002). Based on the studies' findings, it appears that age 4 years and above can benefit from riding therapy; however, it is unknown from these studies which age range of children benefit most from hippotherapy and THR.

### *Treatment Protocols*

#### *Frequency and Duration of Riding Sessions*

As McGee and Reese (2009) investigated the effects of one hippotherapy session, their study was not considered in this section. The frequency of riding in the eight remaining studies ranged from once per week to twice per week. In six of the studies, the children rode once per week (Casady and Nichols-Larsen, 2004; Davis et al., 2009; Hamill et al., 2007; MacKinnon et al., 1995; Shurtleff et al., 2009; Sterba et al., 2002). Of these studies, only Davis et al. (2009) and Hamill et al. (2007) did not achieve significant results. In two repeated-measures within-subjects studies (Bertoti, 1988; McGibbon et al., 1998), the children rode twice per week and made significant gains in gross motor function with large and moderate treatment effects, respectively. It cannot be determined as to whether or not riding twice per week produced a larger effect because these studies measured different outcomes. However, the evidence suggests that riding once per week is sufficient to achieve significant improvements in gross motor function and mobility.

The duration of each session in the studies ranged from 30 min to 1 hr. Six studies in which children rode for at least 45 min a week found significant improvements in gross motor function (Bertoti, 1988; Casady and Nichols-Larsen, 2004; MacKinnon et al., 1995; McGibbon et al., 1998; Shurtleff et al., 2009; Sterba et al., 2002), suggesting that riding for 45 min per week is associated with significant improvements in gross motor function.

#### *Duration of Intervention*

As McGee and Reese (2009) investigated a single hippotherapy session, only eight studies are considered in this section. The duration of the intervention in the studies ranged from 8 to 26 weeks. Sterba et al. (2002) reported no significant changes in gross motor function after 6 weeks, but found significant gains after 12 weeks ( $p < .02$ ) and 18 weeks ( $p < .03$ ) of THR. Shurtleff et al. (2009) implemented a

12-week hippotherapy intervention and also found significant results. Among the four studies that had 10-week interventions (Bertoti, 1988; Casady and Nichols-Larsen, 2004; Davis et al., 2009; Hamill et al., 2007), Bertoti (1988) and Casady and Nichols-Larsen (2004), both a repeated-measures within-subjects design, achieved significance and the children demonstrated large treatment effects. McGibbon et al. (1998) found significant improvements in gait and gross motor function after 8 weeks of twice weekly hippotherapy. It appears that positive outcomes can be achieved with different durations of intervention; findings are influenced by the selected measures and their sensitivity to progress. Based on findings from our review, however, it appears that a minimum of 8–10 weeks may be necessary to achieve positive effects and that longer interventions are more likely to yield improvements in gross motor function.

### **Gross Motor Outcomes**

#### *Gross Motor Function Measure*

The most common outcome measure used in these studies was the Gross Motor Function Measure (GMFM) (Casady and Nichols-Larsen, 2004; Davis et al., 2009; Hamill et al., 2007; MacKinnon et al., 1995; McGibbon et al., 1998; Sterba et al., 2002). These studies used all or sections of the GMFM-88 except for Davis et al. (2009), who used the GMFM-66. The two RCT studies conducted by Davis et al. (2009) and MacKinnon et al. (1995) did not yield significant results on the GMFM-66 or GMFM-88, respectively, in comparison to the control groups. However, three repeated-measures within-subject designs conducted by Casady and Nichols-Larsen (2004), McGibbon et al. (1998), and Sterba et al. (2002) found that the children who received hippotherapy and THR, respectively, improved significantly on the GMFM-88. Casady and Nichols-Larsen (2004) observed significant changes with a large treatment effect ( $r = 0.84$ ) on all GMFM dimensions (which included sitting, crawling/kneeling, standing, and walking, running, and jumping) except for dimension A (lying/rolling) after 10 weeks of hippotherapy. McGibbon et al. (1998) also observed significant changes with a moderate treatment effect ( $d = 0.51$ ) on dimension E of the GMFM after 8 weeks of hippotherapy. Finally, after 18 weeks of THR, Sterba et al. (2002) found a large treatment effect ( $d = 0.96$ ) on the total score of the GMFM-88. Furthermore, after 12 weeks of THR, there was a significant difference with a large treatment effect ( $d = 0.84$ ) on the dimension E of the GMFM (walking, running, and jumping) that was maintained at 18 weeks ( $d = 0.87$ ). Hamill et al. (2007) did not find significant improvements in their subjects on the GMFM-88 after 10 weeks of hippotherapy. As mentioned previously, this could relate to their sample selection, i.e., the participants were aged between 2 and 4 years and did not have spastic CP. The evidence suggests that hippotherapy and THR are likely to result in gross motor improvements on walking, running, and jumping (dimension E). In addition, improvements in sitting, crawling and kneeling, and standing may be observed after hippotherapy and THR.

#### *Other Motor Benefits*

A variety of other benefits were reported in these studies. Casady and Nichols-Larsen (2004) found significant improvements with a large treatment effects on the

Pediatric Evaluation of Disability Inventory (PEDI) in self-care, mobility, and the amount of caregiver assistance needed for self-care and mobility. Other reported benefits of hippotherapy and THR include posture, head and trunk stability, and functional reaching (Bertoti, 1988; Mackinnon et al., 1995; Shurtleff et al., 2009). Using gait analysis, McGibbon et al. (1998) demonstrated significant improvements with small-moderate treatment effects on increased stride length ( $d = 0.44$ ), decreased cadence ( $d = 0.24$ ), and decreased energy expenditure during gait ( $d = 0.61$ ). It is clear from these studies that both hippotherapy and THR can result in positive motor benefits in children with cerebral palsy.

### **Limitations of Studies**

Research design remains a primary limitation of horseback riding studies in children with CP. A majority of the studies were repeated-measures within-subject or one group pretest–post-test designs. Every study (except Davis et al., 2009) had small sample sizes. Furthermore, the lack of comparison groups and randomization in a majority of the studies makes it difficult to draw conclusions from these results. The two randomized studies in this review also have limitations. For example, Mackinnon et al. (1995) used a small sample size (10 children in the intervention and nine in the control) and did not report the participants' type of CP.

Other limitations of these studies include lack of specificity and detail in descriptions of the intervention; for example, in a majority of these studies, it was not clear how long each subject was actually on the horse during the session. We do not know if the studies reported the time of the entire session or time spent on the horse. Due to these limitations, results of these studies must be interpreted with caution.

## **DISCUSSION**

This systematic review synthesized the research evidence for hippotherapy and THR efficacy when used with children with CP. This review attempted to determine the characteristics of children who benefited, the treatment frequency and duration associated with gross motor function improvement, and gross motor outcomes associated with hippotherapy and THR. Although the current level of evidence remains limited, our synthesis identified that children with spastic CP, aged 4 years and above, are likely to have significant improvements with moderate to large treatment effects on gross motor function and mobility as a result of hippotherapy and THR (Bertoti, 1988; Casady and Nichols-Larsen, 2004; Hamill et al., 2007; Mackinnon et al., 1995; McGee and Reese, 2009; McGibbon et al., 1998; Shurtleff et al., 2009; Sterba et al., 2002). Evidence also indicates that 45-min sessions (Bertoti, 1988; Casady and Nichols-Larsen, 2004; McGibbon et al., 1998; Sterba et al., 2002) of hippotherapy and THR once per week for at least 8–10 weeks result in significant effects. Children with CP who participated have shown improvements primarily in walking, running, and jumping (Casady and Nichols-Larsen, 2004; McGibbon et al., 1998; Sterba et al., 2002). Other benefits may include posture, head and trunk stability, functional reaching, and spatiotemporal parameters of gait, such as stride length and cadence (Bertoti, 1988; Mackinnon et al., 1995; McGibbon et al., 1988; Shurtleff et al., 2009). As the majority of these results are based on one-group

pretest–post-test and repeated-measures within-subject designs, more rigorous research is needed to validate these conclusions.

This review found that hippotherapy and THR trials lack consistency in intervention protocols. Not a single study used the same treatment duration and frequency. A manualized approach for hippotherapy and THR is needed. Future randomized studies need to investigate the treatment protocols in this review that achieved significance to confirm these results. It is not clear who benefits from hippotherapy and THR or how outcomes may vary for children with different types or severity levels of CP. For example, children with spastic diplegia may achieve better outcomes than children with spastic quadriplegia. Further study is needed to develop clinical guidelines specifying the age ranges and types of cerebral palsy that benefit from hippotherapy and THR.

### ***Limitations of Present Study***

While this review attempted to systematically synthesize the literature on hippotherapy and THR, we acknowledge several limitations. Our review was limited to only studies available in English. Several studies were excluded from the review because they were published in German, Russian, or Polish. Therefore, this review does not report a complete representation on the current evidence regarding the effects of hippotherapy and THR on gross motor function in children with CP. In addition, this review did not consider psychosocial benefits of hippotherapy and THR for children with CP, which is an important aspect of children's function and may influence mobility and gross motor performance.

### ***Implications for Practice***

Our review suggests that children with cerebral palsy improve in gross motor performance as a result of hippotherapy or THR. Specifically, the research suggests that children with spastic diplegia (aged 4 years and above) who have limitations in postural stability, walking, running, and jumping are likely to achieve positive effects in gross motor performance. Although the trials varied in intensity and duration, the dosage of hippotherapy and THR sufficient to achieve positive effects appears to be 45 min per week for 8–10 weeks. Practitioners can use these findings in developing hippotherapy and THR guidelines, recognizing that intervention must be individualized to the child's strengths and limitations and the family's priorities.

## **CONCLUSION**

Most of the current literature on hippotherapy and THR is limited to repeated-measures within-subject designs with small sample sizes. More randomized trials, with larger sample sizes, and consistent protocols are needed to determine the effects of hippotherapy and THR on children with CP. Manualized approaches are to be investigated with samples that systematically vary by age and level and type of disability. The dosage of hippotherapy and THR associated with positive effects should be further investigated to confirm or refute the results of this review. Important outcomes using the GMFM-88 found in multiple studies include walking, running, and jumping in young children with CP. From the current evidence, it

appears that hippotherapy and THR have positive effects on gross motor function in children with CP.

**Declaration of Interest:** The author reports no conflicts of interest.

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