Review

The effects of neurodevelopment (Bobath) therapy on children with cerebral palsy: a systematic review

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Abstract

Background/Aims The objective of this review was to explore whether there is scientific evidence about the validity of the Bobath concept as an effective therapy for children with cerebral palsy.

Methods A search was conducted between March and December 2020, of research databases (Cochrane, PEDro, PubMed, Web of Science), selecting randomised controlled trials published since 2015, which compared Bobath therapy with other therapies in terms of their effect on the gross motor functions of children with cerebral palsy.

Results Applying the eligibility criteria, four randomised controlled trials were selected, three of which found the Bobath to be more effective as a therapeutic method, while one found no difference between Bobath therapy and another therapy. No study that met the inclusion criteria found Bobath therapy to be less effective than another therapy.

Conclusions: The principal limitation of this review has been the restricted number of randomised controlled trials found. Nonetheless, studies showed that therapy based on the Bobath concept improves the gross motor function of children with cerebral palsy.

Key words

Bobath, Cerebral palsy, Children, Intervention, Neurodevelopment Therapy

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Introduction

Cerebral palsy is a group of disorders that affect movement and posture caused by brain damage before or at birth (Rosenbaum et al, 2007). Along with sensory and motor impairment, other dysfunctions are also common (Krigger, 2006; Patel et al, 2020; Stadskleiv, 2020), impacting general health and cognitive and sociobehavioural capacities, leading to a greater or lesser degree of permanent disability and to a diminished quality of life (Makris et al, 2019).

Cerebral palsy is considered the principal cause of physical disability in childhood and its prevalence is estimated at 2–3 cases per 1000 live births (Oskoui et al, 2013). The neurological damage, while not progressive, does vary in its clinical manifestations (Aisen et al, 2011; Sadowska et al, 2020). Specifically, these may include pain, contractures, postural abnormalities and

osteoporosis (Papavasiliou, 2009), which are secondary to the sensory and motor dysfunctions that commonly define cerebral palsy as a clinical condition (alterations in muscle tone and strength, abnormal reflex activity, sensory and motor incoordination, lack of balance, deficiencies in the control of posture and movement) and that tend to worsen with age (Opheim et al, 2011; Whitney et al, 2018). Physical therapy (physiotherapy and/or occupational therapy) is therefore essential to help with the effects of the primary issues and to develop or preserve the functional abilities of the person with cerebral palsy (Roquet et al, 2018; Kuliński and Żukowska, 2019).

However, therapy should not merely be focused on minimising the limitations on movement and its consequences, but should also aim to enhance the physical, mental and socioaffective wellbeing of the child with cerebral palsy (Anttila et al, 2008). Furthermore, as mentioned, the neuromotor symptoms of cerebral palsy are often accompanied by a wide variety of challenges that may even be more severe than motor dysfunction (Himmelmann and Uvebrant, 2011), thus, interventions for the person with cerebral palsy must take a comprehensive approach (Trabacca et al, 2016).

The Bobath concept, also called neurodevelopment therapy Zanon et al, 2018), has evolved towards therapeutic strategies carried out by interdisciplinary teams (Panteliadis et al, 2015) that focus on all the aspects that may hinder the development of children with cerebral palsy, with the main aim of achieving their maximum level of independence and preparing them for a future life that is as functional as possible (Bobath and Bobath, 1984). The Bobath concept is based on the following principles(Eckhardt et al, 2018; Levin and Panturin, 2011; Veličković and Perat, 2005; Zanon et al, 2018).:

- Holistic approach with a comprehensive vision of the person
- Neuroplasticity as a mechanism to instauration/improvement of functions
- Modification of anomalous muscle tone and patterns of postural dysfunction
- Sensory/motor integration to establish more organised movements
- Dynamic process of evaluation-intervention aimed at developing the potential competences of each person, according to their developmental moment
- Intervention in problems which hinder socioaffective adjustment, cognitive development and autonomy in daily life
- Learning and motor control, promoting functional activities in multiple contexts
- ‘24 hour’ dedication with the participation of the family
- A long term vision to enhance or maintain capacities and avoid deterioration

The Bobath theoretical framework continues to be renewed and enriched through ever-increasing knowledge about the neurophysiology of sensorial and musculoskeletal systems, orthotics and biomechanics, as well as the fundamentals of learning and motor control (Raine et al, 2013). In addition, the Bobath concept conforms to the classifications of the *International Classification of Functioning, Disability and Health* (World Health Organization, 2001) in the pursuit of the global wellbeing and improved quality of life of the affected person (Russell et al, 2018).

Traditionally, and since its early beginnings in the 1940s, the Bobath concept has been considered innovative and revolutionary in the field of rehabilitation of motor dysfunctions caused by damage to the central nervous system (Raine et al, 2013). In more recent years, it has been recognised as the most used therapeutic method around the world and found to be a valid therapy for cerebral palsy (Mayston, 2008; Papavasiliou, 2009; Elbasan and Bezgin, 2018; Imas et al, 2018). Specifically, numerous studies have demonstrated its effectiveness in improving gross motor function in children with cerebral palsy (Bly, 1991; Knox and Evans, 2002; Tsorlakis et al, 2004;

Arndt et al, 2008; Ramya et al, 2013; Behzadi et al, 2014; Yalcinkaya et al, 2014; Labaf et al, 2015; Besios et al, 2018; Tekin et al, 2018).

Other studies have found benefits in a number of areas such as cerebral venous circulation (Bukhovets and Romanchuk, 2018), somatic development (Kashuba and Bukhovets, 2017), neuromuscular activation (de Souza Pagnussat et al, 2013), reduced spasticity with botulinum toxins (Desloovere et al, 2012), dental health (Santos and Manzano, 2007), gastric and respiratory functions (Redstone, 2007), manual dexterity (Acar et al, 2016), visual attention (Abuin-Porras et al, 2019), language development (Puyuelo and Rondal, 2005) or learning (Pina, 2016).

However, despite its broad application in paediatric care, the effectiveness of therapy based on the Bobath concept has not been systematically researched. There are few adequately designed, empirical studies which provide conclusive evidence of its benefits as a physical therapeutic method in cerebral palsy (Arndt et al, 2008). Several reviews and meta-analyses showed modest or limited results on the evidence for Bobath therapy (Ottenbacher et al, 1986; Anttila et al, 2008), positive but inconclusive trends (Dewar et al, 2015; Morgan et al, 2016; Zanon et al, 2018) or as ineffective (Novak, 2013; Novak and Honan, 2019; Das and Ganesh, 2019). The discrepancies and lack of consensus found in these reviews may be because of the use of different eligibility criteria, the variability of the samples used in the selected studies and the inclusion of studies with varying levels of methodological rigour.

Given that the Bobath concept is the most widely used therapy for children with cerebral palsy, it is essential to demonstrate its effectiveness. With this aim, the present study offers a systematic bibliographical review of empirical studies of the validity of the Bobath concept published since 2015.

Methods

This review was conducted independently by two researchers following the indications of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al, 2009). For any divergence in the selection and evaluation of the studies, the authors took decisions by consensus.

Search strategies

The bibliographical search was carried out between March and December 2020, consulting the databases PubMed, Web of Science, Cochrane and PEDro. The descriptors and Boolean terms used were: ‘Bobath AND cerebral palsy’, ‘neurodevelopmental therapy AND cerebral palsy.’ The number of terms used was expanded (NDT, treatment, approach) to ensure that additional studies could be located.

Selection of the studies

Because the effects of different therapies are analysed in aspects such as communication skills, epilepsy or manual abilities, in this review, the authors exclusively explored gross motor performance to avoid heterogeneous conclusions about the validity of the applied therapies, and also taking into account that the impairment of gross motor function is one of the essential characteristics of cerebral palsy. Gross motor function is considered as all responses or actions involving the basic capacities of neuromotor control (trunk control, balance, posture and/or movement) in relation to elemental actions (crawling, sitting, walking), which provide autonomy (Sah et al, 2019).

To be included in the review, studies had to meet the following inclusion criteria:

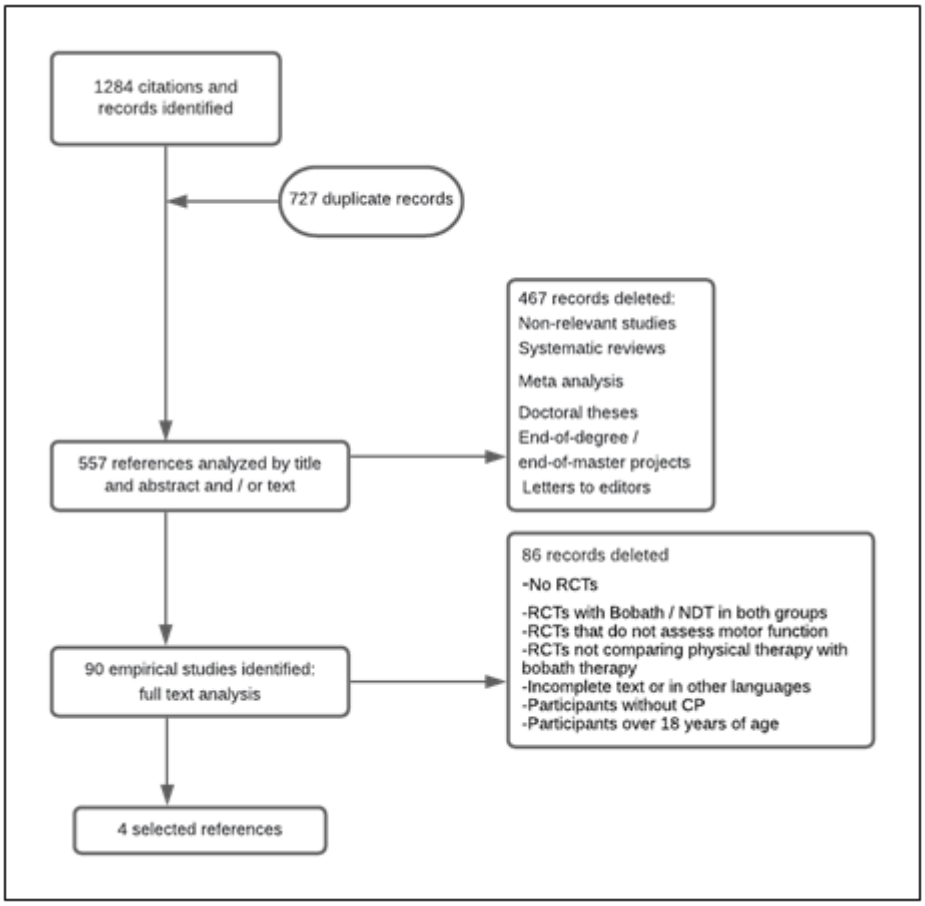
- Articles published since 2015
- In English
- Randomised controlled trials
- Studies conducted with children with cerebral palsy
- Studies that evaluated the effect of physical therapy (physiotherapy/occupational therapy) on gross motor functions
- Randomised controlled trials with an intergroup design comparing Bobath/NDT to another method
- The participants of the studies selected were under the age of 18
- Participants had to be diagnosed with cerebral palsy, regardless of the lesion topography, type and severity of cerebral palsy.

Studies were excluded if they were:

- Revisions, meta-analysis, theoretical studies, end-of-degree projects
- Empirical studies that are not randomised controlled trials (eg series or case reports, non-randomised trials)
- Randomised controlled trials in which Bobath/NDT was in both the intervention group and the control group
- Randomised controlled trials that compared Bobath/NDT with methods other than physical therapy (eg stem cells, music therapy)
- Randomised controlled trials that evaluated aspects other than gross motor functions (eg manual dexterity, respiratory function)
- Incomplete texts or those in languages other than English
- Studies in which the participants suffered from pathologies other than cerebral palsy.

Figure 1 shows the screening and selection process based on the proposed inclusion and exclusion criteria of the studies.

Figure 1. Flow chart of the selection method.



Data extraction and analysis

Full text analysis provided complete data on the characteristics, internal validity and risk of bias of the studies. A meta-analysis was not considered necessary given the limited number of studies selected.

Evaluation of the methodological quality

Only randomised controlled trials were included in the review since, according to the *American Academy of Cerebral Palsy and Developmental Medicine* (Darrah et al, 2008), the design of these studies is the most appropriate to control possible biases or other factors that may influence or contaminate the results in terms of the relationship between the intervention and its effects.

The PEDro scale was used to determine the internal validity of the selected studies (Maher et al, 2003; Blobaum, 2006); scores greater than 5 indicate high quality, scores of 4 to 5 indicate moderate quality and scores under 4 indicate low quality. Equally, to determine the risk and magnitude of bias, as well as the possibility of any other type of bias not included in the PEDro scale, the norms of the *Cochrane Handbook for Systematic Reviews of Interventions* were applied (Higgins et al, 2011).

Results

Of a total of 1284 registers and citations, 727 were discarded as duplicates. The remaining 557 works were analysed by their title and abstract, eliminating 467 works by applying the exclusion criteria. The complete text of 90 empirical studies was reviewed. After applying the exclusion criteria, only four studies were selected: three studies found the Bobath therapy to be more effective

as a physical therapeutic method and one found no difference between Bobath therapy and another rehabilitation programme.

The characteristics of the studies are presented in *Table 1*.

Table 1. Selected randomised controlled trials

Reference and objective	Characteristics of participants and comparison groups	Frequency	Tests*	Main findings
Arı and Günel (2017) To verify the effect of the Bobath method on the motor functions of children with cerebral palsy	*n*=40 Age: 3–10 years GMFCS I, II, III Type of cerebral palsy: spastic bilateral Comparison: Bobath vs conventional physiotherapy	45 minutes a session 2 days a week for 6 weeks	PBS TCMS 1MWT TUG	The Bobath group showed better results in gross motor activities, muscular strength, trunk control and balance than the control group
Numanoğlu Akbas and Günel (2019) To verify the effect of the Bobath method on the motor functions of children with cerebral palsy	*n* =36 Age: 4–18 years --- Type of cerebral palsy: spastic bilateral Comparison: Bobath vs conventional physiotherapy	45 minutes a session 2 days a week for 8 weeks (30 minutes a session more for Bobath/NDT group)	TCMS GMFM QUEST PBS GFAS	The Bobath group, considering the total scores in tests, showed better results in trunk control, movement of upper extremities, balance and gross motor activities, than the control group
Hielkema et al (2019) To verify the effect of a family and care-giver centred training programme for babies with or at risk of cerebral palsy	*n*=43 Age: 0–9 months GMFCS I -V Type of cerebral palsy: spastic unilateral and bilateral Comparison: family-centred programme vs Bobath	30–60 minutes a session 1 day a week for 1 year	AIMS GMFM	No significant differences were found between the two groups (family-centred programme and Bobath) in any measurement of motor activities
Sah et al (2019) To verify the effect of the Bobath method on	*n*=44 Age: 7–15 years	45 minutes a session 2 days a week	GMFM PAS	The Bobath group showed better results in trunk control, balance,

the motor functions of children with cerebral palsy.	GMFCS II, III Type of cerebral palsy: spastic diplegia Comparison: Bobath vs conventional physiotherapy	for 8 weeks	PBS TIS	postural control and gross motor activities than the control group

*Tests not evaluating gross motor functions were omitted. 1MWT: 1-Minute Walking Test; AIMS: Alberta Infant Motor Profile; GFAS: Gillette Functional Assessment Scale; GMFCS: Gross Moto Function Classification System; GMFM: Gross Motor Function Measurement; n: sample size; PAS: Posture Assessment Scale; PBS: Paediatric Balance Scale; QUEST: Quality of Upper Extremity Skills Test; TCMS: Trunk Control Measurement Scale; TIS: Trunk Impairment Scale; TUG: Timed Up and Go Test.

Table 2 provides the results of the assessment of internal validity of each study (PEDro scale), and risk of bias (Cochrane Handbook).

Table 2. Score on the PEDro scale and magnitude of risk of bias.

	Arı and Günel (2017)	Numanoğlu Akbas and Günel (2019)	Hielkema et al (2019)	Sah et al (2019)
PEDro scale	4/10	4/10	7/10	7/10
Biases	Magnitude			
Sequence generation	Low risk	Low risk	Low risk	Low risk
Allocation concealment	Unclear	Unclear	Low risk	Low risk
Blinding of participants and personnel	High risk	High risk	Unclear	Low risk
Blinding of evaluators	High risk	High risk	High risk	High risk
Incomplete outcome data	High risk	Low risk	Low risk	Low risk
Selective outcome reporting	Unclear	Low risk	Low risk	Low risk
Other biases	Unclear* (2)	High risk (1) †	High risk (3) ‡	Low risk

*Doubts if the intervention group received more therapy; †added to conventional therapy, the intervention group received therapy based on Bobath/NDT; ‡in both intervention groups, families were part of the therapy.

Arı and Günel (2017) and Numanoğlu Akbas and Günel (2019) applied a training program based on the Bobath concept to check its effectiveness in trunk control. They argued their choice of trunk control due to its influence on the acquisition of gross motor functions such as balance, sitting, walking... and on the consequent development of other functions related to activities of daily living. Both studies found that Bobath therapy had a significant positive effect on gross motor performance in children with cerebral palsy, compared to conventional therapy. [AQ: stabilising? improving?] .

However, as indicated in *Table 2*, their methodological accuracy is moderate and with risk of bias, particularly in the blinding method of participants and evaluators or in the application of more therapy time in the intervention group.

Hielkema et al (2019) compared a family-centred programme to Bobath therapy, and found no significant differences between these therapeutic approaches. Its internal validity was notable although the authors recognised that the control group (physiotherapy based on the Bobath concept) also included family members as did the intervention group, thus making it difficult to clarify the nature of each therapy. In addition, as previously stated, the involvement of families and caregivers in the therapeutic process of people with CP is one of the fundamental principles that underpin the Bobath concept (Veličković, & Perat, 2005). Therefore, the approach of this work, as well as its design, lacks precision when it comes to determining and defining the independent variable (type of therapy), since families are involved in both groups as part of the rehabilitation program. Another reason that could further undermine the validity of this study is the choice of participants with a "high risk of cerebral palsy"; however, according to their inclusion criteria, the participants had to show lesions in neuroimaging or clinical signs that are typical and frequent in children with cerebral palsy. Perhaps the fact that the diagnosis of cerebral palsy cannot be fully determined in babies was the reason the authors named the participants as being at high risk for cerebral palsy.The study that verified the effectiveness of Bobath/NDT with the greatest methodological rigour was that conducted by Sah et al (2019). The authors confirmed that the Bobath therapy had beneficial effects on the gross motor functions of children with cerebral palsy, with significantly better results in the intervention group (Bobath) than those receiving conventional physiotherapy. This is the study that provides a more detailed explanation of the two methods applied, and that make available information on the reliability and validity of the tests used to assess the results. The authors clearly described the statistical procedure and also provided data on the effect size in comparing the results for both groups: very high in gross motor activities (Gross Motor Function Measurement d=1.93), in posture control (Posture Assessment Scale d=1.13) and balance (Paediatric Balance Scale; d=1.13), and moderate for trunk control (TIS; d=0.77). As in the first two studies, this research focuses on trunk control along with other gross motor functions, and also compares the effect of Bobath therapy with conventional physical therapy.

Discussion

In this review, four randomised controlled trials were selected comparing Bobath/NDT with another therapy: three showed that intervention based on the Bobath/NDT concept had significantly more positive effect on the gross motor functions of children with cerebral palsy than conventional physiotherapy; one randomised controlled trial found no significant differences between a family-centred intervention programme and Bobath/NDT. No randomised controlled trials were found which met the inclusion criteria and showed that another type of physical therapy was more advantageous than Bobath/NDT therapy.

Even though there was a small number of selected studies, the results obtained match the abundant available literature that points out to the Bobath concept as an effective physical therapy for children with cerebral palsy (Mayston, 1992; Redstone, 2007; Shamsoddini and Hollisaz, 2009; Desloovere et al, 2012; Imas et al, 2018; Salatenko et al, 2020). However, this does not coincide with certain studies that found limited evidence of these benefits (Zanon et al, 2019); and a systematic review has recommended not using this method (Novak et al, 2013), provoking a response from Ganley (2014), who criticised the study of Novak et al. (2013) for being based on three other reviews (Brown and Burns, 2001; Butler and Darrah, 2001; Martin et al, 2010) that indicated there was insufficient evidence to conclusively establish its effectiveness. Another systematic review (Franki et al, 2012) noted by Ganley (2014) established that Bobath was the only therapy that had significant effects across all levels of the International Classification of Functioning, Disability and

Health (i.e. body structure/function, posture, movement efficiency, activities and participation, etc) compared to other therapies (i.e. Vojta, functional task-oriented approach or sensory integration).

Butler and Darrah (2001), following the caveat expressed in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins et al, 2011), which suggests 'the lack of evidence does not demonstrate the lack of effect', concluded that the absence of evidence does not prove the therapy was ineffective but may indicate that further research is needed. Other authors have insisted that as the Bobath concept is a promising and most widely used therapeutic method for cerebral palsy, more randomised controlled trials are required to certify its efficacy (Arndt et al, 2008; de Saldanha Simon et al, 2009; Yalcinkaya et al, 2014).

It has been argued that the greatest difficulty in conducting experimental studies that demonstrate the validity of the Bobath concept lies in the diversity of the procedures and exercises applied or in the difficulties of systematizing and quantifying the results of clinical practice because of the complexity of its theoretical framework (Butler and Darrah, 2001; Eckhardt et al, 2018); however, Farjoun et al (2020) found that therapists trained in the Bobath approach coincide in their use of common terminology, theoretical principles and procedures in the therapeutic approach to cerebral palsy. Additionally, Raine (2006) found that the clinical practice of the Bobath method does not consist in merely inhibiting reflexes or facilitating motor activity, nor is it a passive therapy (Zanon et al, 2018), as some reviews have attempted to show, but rather a dynamic and constantly evolving 'concept of life' within the context of contemporary neuroscience (Graham et al, 2009).

Although there is no robust evidence regarding the Bobath concept, there is also no clear consensus that other therapies, such as Vojta method, conductive education, movement constriction, etc. are effective (Patel, 2005). Nevertheless, there is abundant research demonstrating the efficacy of Bobath therapy on gross motor function in children with cerebral palsy (Arndt et al, 2008; Ramya et al, 2013; Behzadi et al, 2014; Yalcinkaya et al, 2014; Labaf et al, 2015; Besios et al, 2018; Tekin et al, 2018). Addicionaly, the most widely used therapy in clinical trials for cerebral palsy is Bobath, either in the experimental group or in the control group (Morgan et al, 2016), and many authors have also employed Bobath in research into the impact of therapy according its frequency (Trahan and Malouin, 2002; Tsorlakis et al, 2004; Evans-Rogers et al, 2015; Park, 2016; Lee et al, 2017; Besios et al, 2018).

Following on from the idea expressed by Ottenbacher et al (1986) that, in order to verify the validity of the Bobath concept, experimental studies should establish realistic objectives, the present review questions the reiterated tendency of trials to consider the improvement of functions in cerebral palsy as an indicator of its effectiveness. This is despite the demonstrated fact that, from adolescence onwards, there is a significantly increased risk of deterioration and loss of capacities (Bartlett et al, 2010). Thus, and coinciding with Bain (2011) who noted that the absence of deterioration and regression are themselves a positive and sufficient achievement in the physical rehabilitation of cerebral palsy, it is suggested that studies should assess the maintenance rather than 'enhancement' of functions, especially at the end of childhood.

Limitations

The limitations of this study were the small number of selected randomised controlled trials, the dubious methodological standards of some of them and the small sample sizes.

Conclusions

Studies showed that therapies based on the Bobath concept are beneficial and improve the gross motor functions of children with cerebral palsy. These results should be confirmed by further

research in order to establish a reliable body of evidence that the Bobath concept is an effective therapeutic therapy for cerebral palsy. Additional and future studies are needed to determine the contribution of the Bobath physical therapy on enriching or maintaining other abilities such as feeding, communication skills, intellectual development, as well as to deepen the knowledge about the consequences derived from improving or preserving gross motor performance in other functions commonly affected in cerebral palsy.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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