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REVIEW ARTICLE

The effects of an intervention, in the light of the Bobath concept, on motor function, in children with cerebral palsy

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Keywords:
Cerebral Palsy, Physical Therapy Specialty, Developmental Disabilities, child.

Abstract

The aim of this study was to assess the effects of an intervention in the light of the Bobath concept on motor function, in children with cerebral palsy. This is a systematic literature review that includes nine studies published between 2014 and 2019, and those were researched in three distinct databases: B-On; PubMed; ScienceDirect. The nine studies contemplated are indicative of the positive effects of the Bobath concept on the motor function of children with cerebral palsy, as well as on visual attention, contributing to the improvement and increase in the quality of life and independence in the daily living activities of these children. We concluded that the Bobath concept should integrate the physical therapy intervention which aims to improve the motor function of children with cerebral palsy. However, it is necessary to mention the need to carry out more studies that focus not only on the concept of Bobath, but also on the effects produced in motor function in this specific population.

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INTRODUCTION

Cerebral Palsy (CP), also known as Chronic Non-Progressive Childhood Encephalopathy, is a chronic disorder of posture and movement[1]. According to the Portuguese Society of Pediatric Neurology (SPNP), CP "is not a single entity in neuropathological or etiological terms, on the contrary, it encompasses very heterogeneous situations of developmental disability whose common denominator is to cause permanent changes in posture and/or movement, always translated due to motor functional limitation"[2].

It is a non-progressive neuromotor condition caused by damage to the fetal brain or immature central nervous system (CNS) that causes movement and posture disorders, which are reflected in performance and activities of daily living (ADL). Although persistent, the condition of CP is variable, due to a disorder without progression that occurs in the brain between the pre, peri or postnatal periods, up to two years[1].

CP has different etiologies, namely, brain malformations, placental problems, prematurity, hypoxemia, perinatal traumatic factors, low birth weight and severe anoxia[3]. In other words, "in its origin there must be non-progressive brain injury that occurred in a very early period of brain development, from the fetal period to the first 2 to 3 years of life. Despite severe motor and physical disabilities, situations such as neuromuscular diseases, spina bifida with neurological involvement or degenerative diseases of the nervous system are therefore excluded from the designation of CP"[2]. According to Victorio (2020)[4], many different types of brain malformations and brain damage can cause cerebral palsy, and sometimes more than one cause is involved. Problems that occur just before, during and shortly after birth cause 15 to 20% of cases. These problems include anoxia (lack of oxygen) during childbirth, infections and brain damage. Infections such as rubella, toxoplasmosis, Zika virus infection or cytomegalovirus infection during management occasionally result in cerebral palsy. Sometimes the brain malformations that cause cerebral palsy result from genetic abnormalities.

There are four types of Cerebral Palsy, spastic, athetoid (or dyskinetic), ataxic and mixed[4], however the Surveillance of Cerebral Palsy in Europe[5] only recognizes the first three.

Spastic CP is the most frequent type, affecting 70% of children with CP, characterized by stiff (spastic) and weak muscles. Muscle stiffness can affect different regions of the body, namely: both arms and both legs (quadriplegia), more legs than arms (diplegia), and it can also affect only the homolateral arm or leg (hemiplegia). More rarely, it may affect only the legs and lower body (paraplegia)[4]. Therefore, there is an increase in tone, pathological reflexes, hyperreflexia, pyramidal signs, resulting in an abnormal pattern of posture and movement[5]. It is also important to add that spastic CP can be unilateral, affecting only one of the hemibodies, or bilateral, affecting two or even four limbs[5].

Athetoid CP is characterized by involuntary contorted movements, being present in approximately 20% of children with this condition [(4)]. In this, the arms, legs and body move spontaneously, slowly and involuntarily, and there may also be contorted, spasmodic and abrupt movements[4]. Muscle tone is varied, with primitive reflex patterns, and this type can be subdivided into dystonic CP (characterized by involuntary movements and voluntary movements with abnormal postures caused by hypertonia) and choreoathetotic (characterized by the presence of hyperkinesia and hypotonia)[5].

In ataxic CP, there is difficulty in controlling and coordinating body movements, namely when walking, being the rarest, affecting about 5% of children with this condition[4]. In these cases, coordination is very weak, as are the child's muscles, that is, there is a lack of muscle coordination, decreased tone, trunk and gait ataxia and tremor[4,5].

Finally, mixed CP depicts the combination of two of the aforementioned types of CP, with the most frequent combination being spastic CP with athetoid CP[4].

In terms of incidence and in the European scenario, it is important to mention that approximately two out of every thousand live births annually (2/1000) are diagnosed with CP[2]. In the Portuguese context, SPNP (2019)[2] points out that "in the national surveillance in Portugal carried out from notifications of cases of cerebral palsy at the age of 5 years of children born in 2001, showed an incidence (i.e., number of new cases) of 1.93 per thousand live births".

With the advances in science and medicine, the diagnosis of CP is possible, and a diagnostic examination by imaging of the brain can be performed (usually magnetic resonance imaging (MRI), blood tests and sometimes tests of nerve function and muscle[4]. According to Sebastião[6] (2016), tests such as electroneuromyography, muscle biopsy, computed tomography and magnetic resonance can be performed in order to clarify the differential diagnosis with other pathologies. when the child has a delay in motor development, persistence of primitive reflexes and atypical postural reactions and behaviors, which results in a delay in monitoring the child and family and, consequently, in the rehabilitation process, compromising their quality of life.

Given the greater knowledge provided by advances, namely in the field of neuroscience, today we are able to have a greater understanding of the nervous system and its various aspects. On this subject, Graham et al.[7] (2009), emphasizes that neuronal plasticity corresponds to the adaptive capacity of the CNS to modify its structural and functional organization, verifying that the greater knowledge of this capacity has enabled an early intervention with children with neurodevelopmental disorders, in particularly with PC[8].

The motor alterations caused by CP, as a rule, are accompanied by cognitive, behavioral, communicative, sensory and perceptive alterations, as well as epilepsy and secondary musculoskeletal problems[9]. However, these alterations mainly result in dysfunctions of the postural control system (PC) and, consequently, in alterations in the gait pattern[10].

Postural Control consists of the ability to maintain postural alignment and the relationship between the different body segments, given the exposure of gravity throughout the variation of the movement that the task requires, enabling the control and modulation of the body's position in space in relation to its orientation and stability, assuming itself as a stable reference for the distal segments[11-13].

In fact, PC is extremely important and depends on the interaction between several neural subsystems, namely: sensory (visual, somatosensory and vestibular); motor (prefrontal cortex and descending pathways to effectors), basal ganglia and cerebellum, among others[14].

Cerebral Palsy affects postural control, which is essential for the performance of functional tasks such as the beginning of gait, which represents a permanent challenge for children with this condition, since the beginning of gait depends on the constant harmony of neuromuscular mechanisms for the activation of multiple muscles in a correct and harmonious sequence[12,15,16]. In fact, the beginning of gait is achieved through the regulation of the postural tone and the proper alignment of the feet[17].

There is no cure for CP, but its treatment can improve the child's quality of life, mobility and independence. In this way, its treatment can be different, but it must always be suitable for each specific case. As an intervention we can highlight physical therapy, occupational therapy and speech therapy; the orthodontic appliance; botulinum toxin and other drugs to reduce spasticity; and sometimes, surgical intervention[4].

Therefore, treatment for children with CP is essential, at the same time it is crucial that the professionals who work with this population, and who must integrate a multidisciplinary team, have a vast knowledge of this condition, as well as the functionality, the abilities and the skills of each child. In this study we essentially focus on the neurodevelopmental intervention based on the Bobath Concept, in the motor function of children with CP. According to Geraldo[10] (2014), the intervention based on the Bobath Concept provides "a multidimensional approach based on the knowledge of neurophysiology and biomechanics, associated with the observation and analysis of the movement components of each child in different functional activities, establishing a relationship between their behavior and typical sensorimotor development". Developed in the 1950s by an English couple, Karel Bobath (physiatrist) and Berta Bobath (physical therapist), this method is assumed to be neuroevolutionary, since it follows the sequence of normal motor development, being the most used approach in clinical practice for the treatment of CNS lesions[6].

In fact, Bobath's neuroevolutionary concept proves to be a problem-solving approach for patients who have suffered CNS injuries and who, consequently, acquire movement, function and postural control (PC)[11] disorders (IBITA, 2008). These are usually accompanied by cognitive, behavioral, communicative, sensory and perceptual changes, as well as epilepsy and secondary musculoskeletal problems[9]. However, these alterations mainly result in the aforementioned dysfunctions of the PC system and, as a result, in alterations in the gait pattern[10].

Based on this approach, the clinical reasoning developed will privilege the definition of intervention objectives oriented towards the main difficulty of each child, with the family having a crucial role in defining and achieving these same objectives[17-19]. In other words, this approach provides for a global treatment designed according to the difficulties and needs of each child, standing out for the fact that it allows observing, analyzing and interpreting the motor performance of a task, respecting the necessary sequence of skills acquisition, in terms of it concerns normal neuropsychomotor development[20,21]. It is then intended that children, perform active movements controlled by the physical therapist, with the aim of actively mobilizing the different joints, as well as adjusting the tone, increasing muscle strength and stimulating balance[22].

Using treatment techniques such as inhibition, facilitation and stimulation, the physical therapy approach based on the Bobath method aims to prepare the child for a function, maintain or improve the existing ones, where the intervention contemplates the adequacy of spasticity[6]. The basic techniques of the Bobath Concept are several, mainly: weight transfer, posture changes, tapping (enabling one to increase postural tone, activate weak muscle groups and stimulate balance reactions), placing and holding (these last two techniques imply the ability to control and maintain movements and positions voluntarily and automatically throughout the range of motion)[23].

In this sense, considering the Bobath Concept, the objective of this systematic literature review (SLR) is to identify the effects of a physical therapy intervention, based on this concept, on the motor function of children with CP.

Method

The present study takes the form of an SLR, which has become a type of study with increasing importance for healthcare professionals. Its main objective is to assess existing empirical results, that is, the results of other studies already carried out in the area of healthcare specifically under study[24].

The research question is, according to Fortin[25], the question to be answered through the research to be carried

out, defining key concepts and identifying the target population.

Therefore, to formulate the research question, we used the PICO strategy– Patient, Intervention, Comparison, Outcome – (table 1), as it is a strategy that allows and helps in the construction of "research questions of different natures, arising from the clinic, from the management of human and material resources, from the search for instruments for the evaluation of symptoms, among others"[26].

At present, based on the research question, we seek to assess the effects of a physical therapy intervention based on this concept, on the motor function of children with CP.

In addition, the PICO strategy was chosen, as its four components are also crucial, effectively helping the literature search for empirical evidence[27,28].

Bearing this in mind, the study question, which is expected to be answered, is: What are the effects of a physical therapy intervention based on the Bobath Concept on the motor function of children with CP?

Regarding the development of research, it is important to mention that its progression was guided by three stages, the first of which involved the definition of selection criteria (inclusion and exclusion); the second consisted of selecting the databases; and the third in the definition of the research.

The first phase - definition of the selection criteria for studies to be included in this SLR - reflected on Table 2, below, where the inclusion and exclusion criteria are specified.

In order to carry out the bibliographic research of empirical evidence, we used three databases: PubMed, a database of empirical evidence in the biomedical area; B-On, the Portuguese online knowledge library; ScienceDirect, one of the world's leading sources of scientific, technical and medical research.

In the three databases, the Boolean operator AND was used, formulating the following search expressions (in English) for each of these databases:

- In B-on cerebral palsy children AND physical therapy AND Bobath;
- In PubMed: (((cerebral palsy) AND (child)) AND (physical therapy)) AND (Bobath);
- In ScienceDirect: cerebral palsy children AND physical therapy AND Bobath.

The empirical evidence search was carried out in January 2021, yielding a total of 836 papers (38 in PubMed, 426 in B-On and 372 in ScienceDirect), of which nine papers published between 2014 and 2019 were selected: 2 from PubMed (2014 and 2019); 6 of B-On (2015 to 2019); 1 from ScienceDirect (2015).

In this order of ideas, nine studies carried out by different authors were selected, which were published between 2014 and 2019, as shown in table 3 (Figure 1).

We then proceeded to specify the results obtained for each study included in this SLR.

RESULTS

As previously mentioned, this SLR includes nine studies, published between 2014 and 2019 and selected from the following databases: B-On; PubMed; ScienceDirect.

Table 4 presents, in a systematic way, the results obtained from the research of empirical evidence.

DISCUSSION AND CONCLUSION

Being the main objective of this SLR, to identify the effects of an intervention in the light of the Bobath's concept, in the motor function in children with CP.

In fact, it is imperative to understand how it is possible to improve the quality of life of patients in this age group and those with such a diverse, frequent condition and with different etiologies[37].

Table 1. PICO strategy for formulating the research question.

***P**atient*	Children (<10 years) with a CP diagnosis
***I**ntervention*	Bobath concept
***C**omparison*	Conventional therapy and intervention based on the Bobath concept
***O**utcomes*	Effects of the intervention on the motor function of children and adolescents with CP

Table 2. Selection criteria for SLR studies.

Inclusion criteria	Exclusion criteria
- Freely available papers, and in full	- Fully available papers, but not free
- Papers published from 2010	- Papers published before 2010
- Papers published in Portuguese, English and Spanish.	- Papers published in other languages
- Studies held with children and adolescents diagnosed with CP	- Studies held with adults with CP
- Papers that discuss intervention according to the Bobath's concept	- Papers that discuss other types of intervention

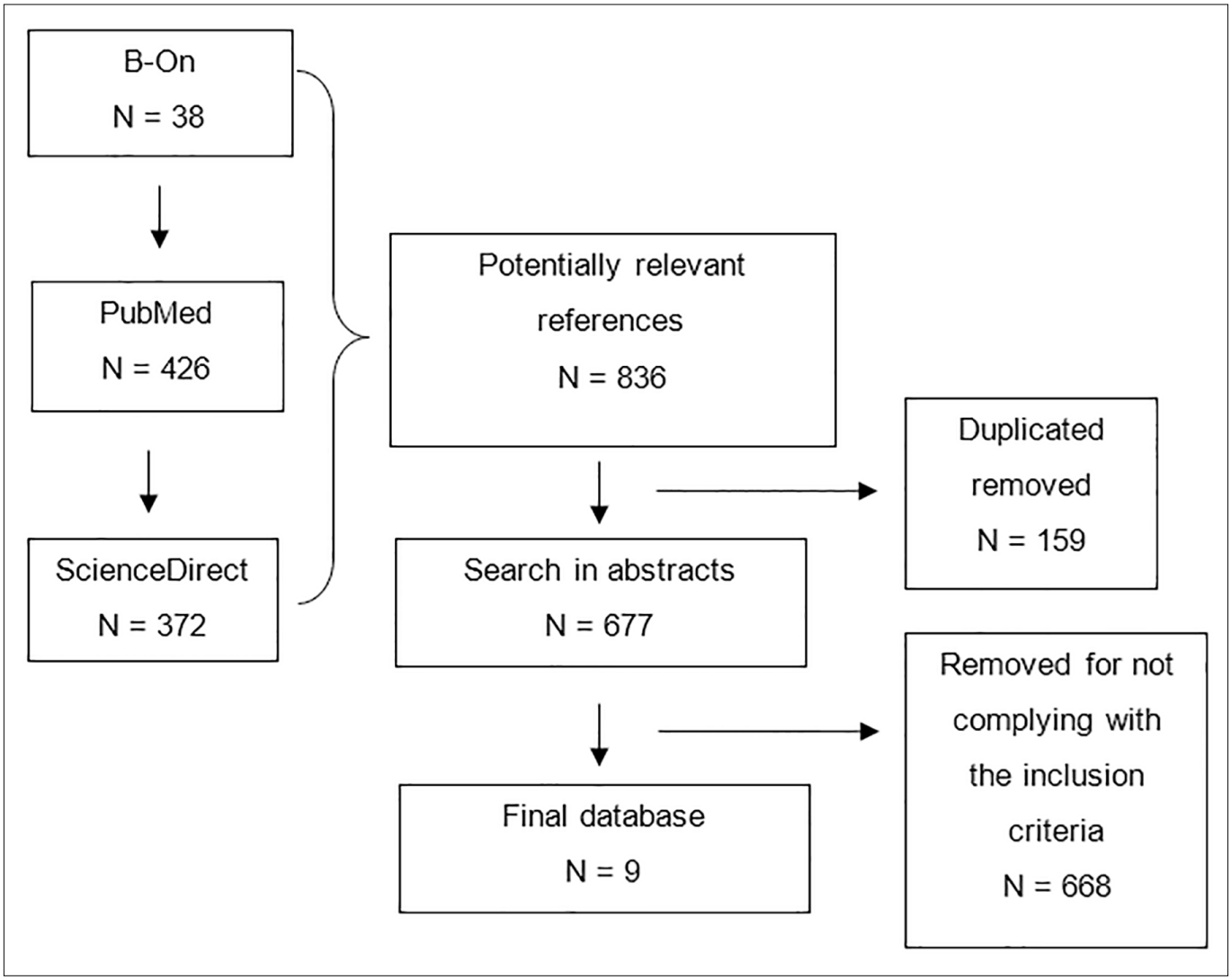


Figure 1. Search results systematization.

Table 3. Selected Studies.

Study (E)	Authors/Data	Data base
1	Yalcinkaya, Caglar, Tugcu & Tonbaklar[38] (2014)	PubMed
2	Mount & Delport[29] (2015)	B-On
3	Mackay[30] (2015)	B-On
4	Santos, Pagnussat, Simon, Py, Pinho, & Wagner[31] (2015)	ScienceDirect
5	Türker, Korkem, Özal, Günel, & Karahan[32] (2015)	B-On
6	Kashuba, & Bukhovets[33] (2017)	B-On
7	Tekin, Kavlak, Cavlak, & Altug[34] (2018)	B-On
8	Arshad, Imran, Munir, Akram, & Hameed[35] (2018)	B-On
9	Abuin-Porras, Pedersini, Berjano & Villafañe[36] (2019)	PubMed

CP, being a chronic disorder of posture and movement, is a persistent, variable condition and is due to a disorder without progression that occurs in the brain between the pre, peri or postnatal periods and up to two years[1].

Different authors[29,30,38] refer that the Bobath's concept has positive effects in the treatment of the neurodevelopment of children with CP, emphasizing, however, the need for further studies in this area. Yalcinkaya, et al.[38], in 2014, when evaluating the results of rehabilitation based on the Bobath concept, performed in an inpatient clinic for pediatric CP, indicated that this is promising.

One year later, Mount and Delport[29] also managed to achieve the defined objectives in their studies, with the achievement of objectives and targets being one of the pillars in the approach according to this concept, which privileges clinical reasoning and the definition of intervention oriented to the main difficulty of each child[17-19].

Table 4. Summary of studies.

	E1: Yalcinkaya et al. (2014)[38]
Published	*The Journal of Physical Therapy Science*.
Objective	To evaluate the results of rehabilitation based on the Bobath concept, performed in an inpatient clinic for pediatric CP.
Sample	28 children with CP admitted to a pediatric service.
Results	Post-admission gross motor function measurement scores at discharge, 1, and 3 months later showed a significant increase. The SF-36 social function and emotional role subscores increased substantially at discharge.
Conclusion	Bobath's treatment is promising, and additional controlled-randomized studies are needed for the rehabilitation approach.
	E2: Mount e Delport (2015)[29]
Published	*Developmental Medicine & Child Neurology*.
Objective	To explore the effects of the Bobath's intervention on bimanual hand function in children with hemiplegic CP.
Sample	9 children with ages between 5 and 12 years.
Results	The Assisting Hand Assessment (AHA) results were stable for the control group. Two of the participants demonstrated a positive clinical change after the intervention. Group interaction was found for time spent and all participants made a significant change in Goal Attainment Scaling (GAS).
Conclusion	We still need a study with greater methodological rigor and further exploration of the demographic nature of the participants who achieved a positive outcome after the intervention.
	E3: Mackay (2015)[30]
Published	*Developmental Medicine & Child Neurology*.
Objective	Conduct a retrospective review of cases where the AHA was used as an outcome measure over seven years.
Sample	33 children with ages between 1.6 year and 12.7 years.
Results	Therapy blocks typically range from 10 to 18 hours over 4 to 6 weeks, with the exception of a 5-hour block over five days. 18 cases showed significant changes in ordinal and logit-based data, with 14 showing significant changes (greater than or equal to 5 points of gross score).13 cases had increased scores of <4 points difference or <5 logit-based AHA units. One case showed no change in score and one showed a decrease in score.
Conclusion	Significant changes in bimanual skills were found in 54.5% of children after Bobath therapy blocks, as measured by the AHA. 14 cases had scores indicative of highly significant change. After the review, changes were made to the bimanual skills of children with unilateral CP after Bobath's therapy. However, more studies are needed to investigate whether the changes are sustained over time, which children respond best, and what important ingredients of therapy bring about such changes.
	E4: Santos et al. (2015)[31]
Published	*Research in Developmental Disabilities*.
Objective	To investigate the electromyographic (EMG) activity of the cervical and trunk extensor muscles in children with CP during two handlings according to the Bobath's concept.
Sample	40 spastic diplegic children.
Results	There was an increase in the EMG signal during the handling of external rotation at the levels evaluated, indicating an increase in muscle activation.
Conclusion	They concluded that the handling of humeral external rotation can be used for the rehabilitation of the cervical and trunk extensor muscles in a GMFCS (Gross Motor Function Classification) level dependent manner.
	E5: Türker et al. (2015)[32]
Published	*International Journal of Therapies and Rehabilitation Research*.
Objective	To investigate the effects of neurodevelopmental-based goal-directed therapy (GD-NDT) on motor functions and ADLs in children with CP.
Sample	26 children with CP, with mean ages of 9.5 years.
Results	Positive developments were found after the therapy in the children's gross motor functions. The defined goals were self-care, locomotion and transference, physical activity, social status and ADLs, which were achieved in 76.9%.
Conclusion	They concluded that targeted therapy improves children's gross motor functions, as well as their independence in terms of daily living and health-related quality of life in children with CP who underwent GD-NDT.

Continued **Table 4.**

	E6: Kashuba e Bukhovets (2017)[33]
Published	*Journal of Education, Health and Sport*.
Objective	To determine the effect of physical therapy using Bobath's therapy on physical development parameters in preschool children with CP.
Sample	69 children.
Results	The course of Bobath's therapy contemplated the provision of treatment using the specialized child's body position, the reduction of the influence of pathological reflexes, sucking, searching, cross-extensor reflex on the musculoskeletal system and the implementation of the exercise complex for the formation of elementary motor skills and the development of basic physical qualities.
Conclusion	Studies on the dynamics of physical development indicators in children with CP were carried out with Bobath's therapy for six months. They found that after six months of physical rehabilitation with Bobath's therapy, compared to standard approaches, there was an increase in children's physical development indices, namely in body length.
	E7: Tekin et al. (2018)[34]
Published	*Journal of Back and Musculoskeletal Rehabilitation*.
Objective	To reveal the effects of postural and balance training based on an eight-week neurodevelopmental treatment on postural control and balance in children with diparetic and hemiparetic CP.
Sample	15 children with CP, with ages between 5 and 15 years.
Results	After the training program, all children showed statistically significant improvements in terms of gross motor function. The results also showed improvements in balance and independence skills in terms of ADLs. The seated postural control measure scores increased after the program.
Conclusion	They concluded that eight-week neurodevelopmental-based posture and balance training is an effective approach to improving functional motor level and functional independence, improving postural control and balance in children with diparetic and hemiparetic CP.
	E8: Arshad et al. (2018)[35]
Published	*The Professional Medical Journal*.
Objective	Improve motor learning in children with spastic CP and reinforce weak movement patterns and discourage hyperactive ones.
Sample	13 children with ages between 2 and 10 years with spastic CP.
Results	The results were quite positive, revealing that Bobath's therapy has a positive effect on gross motor function.
Conclusion	They concluded that Bobath's techniques, in neurodevelopmental treatment, in gross motor learning are quite effective and play an important role in children with CP.
	E9: Abuin-Porras et al. (2019)[36]
Published	*Journal of Exercise Rehabilitation*.
Objective	To compare the effects of the Bobath's concept with the control session in improving visual attention in children with CP.
Sample	10 children with ages between 6 and 16 years.
Results	The results revealed a significant improvement in visual attention through improved motor control functions after the Bobath's session over the control session.
Conclusion	The effects of the Bobath's concept are quite positive on visual attention, improving motor control functions.

Still regarding the positive effects of neurodevelopmental treatment, Mackay[30], in 2015, found that significant changes in bimanual skills occurred in more than half of children after Bobath's therapy blocks, as measured by the AHA. This study further demonstrated that 14 children had scores indicative of highly significant change, resulting in changes in the bimanual skills of children with unilateral CP after the intervention.

Tekin et al.[34], who focused on the effects of postural and balance training based on an eight-week neurodevelopmental treatment on postural control and balance in children with diparetic and hemiparetic CP, concluded that posture and balance training based on neurodevelopment week is an effective approach to improving functional motor level and functional independence, while also improving postural control and balance in children with diparetic and hemiparetic CP. In fact, Bobath's approach provides a global treatment that is designed according to the difficulties and needs of each child, standing out for the fact that it enables observing, analyzing and interpreting the motor performance of a task, respecting the necessary sequence of acquisition of skills and abilities with regards to normal neuropsychomotor development[20,21].

As Graham et al.[7] explains, neuronal plasticity corresponds to the adaptive capacity of the CNS to modify its structural and functional organization, verifying that the greater knowledge of this capacity has allowed an early intervention with children with neurodevelopmental disorders,

and in particular, with CP[8,39]. In fact, the studies contemplated reveal how the concept of Bobath can contribute to a significant improvement in the quality of life and independence of children with CP.

Another study that highlights its positive effects, among children with CP, is that of Santos et al.[31], when demonstrating that the handling of humeral external rotation can be used for the rehabilitation of the cervical and trunk extensor muscles, depending on the GMFCS (Gross Motor Function Classification) level. In the same sense, also Türker et al.[32] found that targeted therapy improves children's gross motor functions, as well as their independence in activities of daily living and health-related quality of life in children with CP who underwent GD-NDT.

Still on the positive impact on motor function, Arshad et al.[35], in 2018, reveals that Bobath's techniques in gross motor learning are quite effective and play a major role in children with CP.

According to Kashuba, & Bukhovets[33], we can also add that after six months of physical rehabilitation with Bobath's therapy, compared to standard approaches, there was an increase in children's physical development indices, namely, in body length.

It is then possible to confirm that the effects of the Bobath's concept are quite positive in various physical aspects such as motor function, visual attention and motor control[(36,40)]. In fact, as IBITA, in 2008[11], points out, the neuroevolutionary concept of Bobath proves to be a very useful approach in solving problems in patients who have suffered a CNS injury and who, as a consequence, have movement, function and movement disorders and postural control.

In this way, the physical therapy approach includes the Bobath's method, and will prepare the child for a certain function, to maintain or to improve the existing ones, and it will be a contemplative intervention and with due adequacy of the spasticity presented[6].

As observed both in the studies included in this SLR and in the excluded ones, it is worth noting the need for more studies, with a high degree of evidence, that enables deepening knowledge about the effects of the Bobath's concept, in general, and in particular on the motor function of children with Cerebral Palsy.

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