

## Research Article

# Development of a Booklet and Exercise Protocol for Infant Trunk Control Using a Prototype Mobility Aid

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- Teaching Materials

**Abstract**

**Introduction:** Typical motor development represents a transition from initial reflex activities to voluntary motor skills. Children with disabilities face challenges in this process. Early intervention approaches, such as the use of mobility devices, can aid in the acquisition of developmental milestones. The creation of exercise protocols is valid to assist health professionals in promoting mobility, postural control, and achieving motor development milestones in children with disabilities.

**Objective:** To develop a booklet and exercise protocol for the acquisition of trunk control in infants using a prototype mobility device.

**Methods:** An investigative and analytical study aimed at developing an educational product with specific exercises for the acquisition of gross motor skills. It was designed to assist health professionals working in neuropsychiatric rehabilitation.

**Results:** A booklet was developed to be applied to infants aged 0-12 months with information on motor development, child development milestones, normal postural control and sitting posture, neuropsychiatric assessment and an exercise protocol for a prototype mobility aid.

**Discussion:** The lack of educational materials on childhood motor development for healthcare professionals has been identified. A product is presented to facilitate the use of a prototype in the process of being patented by health professionals.

**Conclusion:** Educational and scientific material has been developed with guidelines and exercises for neurodevelopmental disorders. It is intended to offer a product of easy applicability and reproducibility to facilitate the care of babies with trunk control dysfunctions, promoting full neuropsychomotor development in early childhood.

**ABBREVIATIONS**

CP: Cerebral Palsy; PI: Early Intervention

**INTRODUCTION**

Typical motor development is the set of several characteristics that, in constant evolution, allow the baby to progress from reflex motor activity to voluntary motor skills necessary for the performance of more complex and coordinated movements [1]. Children with disabilities may have sensorimotor alterations that

affect their full development, with alterations in the acquisition of gross and fine motor skills caused by varying degrees of deficiencies in body structures and functions, and limitations in activities such as sitting, crawling, standing without support, and walking [2].

The acquisition of postural control is a gradual process, and understanding its central and peripheral neural mechanisms is the basis for understanding postural stability and manipulative skills [4]. There is evidence that the development of the locomotor, manipulative, and postural systems occur simultaneously and

are fundamental to the emergence and refinement of gross motor skills. An immature postural system may limit the emergence of coordinated arm and hand movements and manipulative skills, as well as prevent the development of independent mobility [4]. It is a fact that postural control occurs sequentially and is associated with the acquisition of motor developmental milestones such as pulling, sitting, crawling, standing, independent standing, and walking, and that this precedes static balance control in infants [5-8].

Delayed child development can be attributed to a variety of factors and conditions, including the mother's behavioral influences during pregnancy and at the time of delivery. In addition, adverse elements such as genetic predisposition, malnutrition, and environmental factors can have remarkable effects on the child's overall development. It is crucial to emphasize that in many cases these delays are temporary and therefore do not inevitably determine the outcome of the child's evolutionary process. Therefore, it is important to carry out a continuous follow-up for a periodic and careful evaluation of neurodevelopment [9]. Atypical motor development, in turn, has a significant impact on the child's neuropsychomotor skills, which include areas such as gross and fine motor control, as well as personal-social and linguistic aspects [10].

Among the various therapeutic approaches, different approaches emerge depending on the specific need and the level of individual involvement, but some of them have a high cost for the patient and are not considered within the framework of the Unified Health System [11]. In this context, a prototype currently in the patent process stands out, offering a unique approach through a multifunctional mobility device. This device is designed as a low-cost alternative to reduce the investment required by offices, clinics and rehabilitation centers to purchase several different devices.

In the present study, it was proposed to develop an informative booklet and a proposal for an exercise protocol to stimulate gross motor skills in babies, with activities for the acquisition of neuropsychomotor development milestones such as sitting, crawling, kneeling, transition to semi-kneeling, bipedal postures and a facilitator for walking. In addition, it will be a device that will stimulate babies in postural transitions, in addition to assisting in stabilization, facilitation or resistance to movement, increase sensory input and facilitate the improvement of sensory integration. In addition, the proposed material will assist health professionals in early intervention programs (PI) and improve the quality of life of the patient and family, improving motor capacity in different tasks related to mobility.

## MATERIALS AND METHODS

This is a methodological, investigative, and organizational study aimed at developing of an educational and scientific product. The target population is health professionals, especially physiotherapists specialized in neuropediatrics, to assist them in the early intervention of neurodevelopmental disorders and the treatment of infants with delays in neuropsychomotor development.

The research was developed in 3 stages: i) bibliographical research to carry out an integrative literature review of articles found in scientific databases, followed by the selection of scientific articles on the proposed topic; ii) creation of the layout of the information material (booklet) on the graphic design platform CANVA,<sup>®</sup> iii) methodological review, structure and layout of the product proposed by the authors, spelling corrections and technical standards.

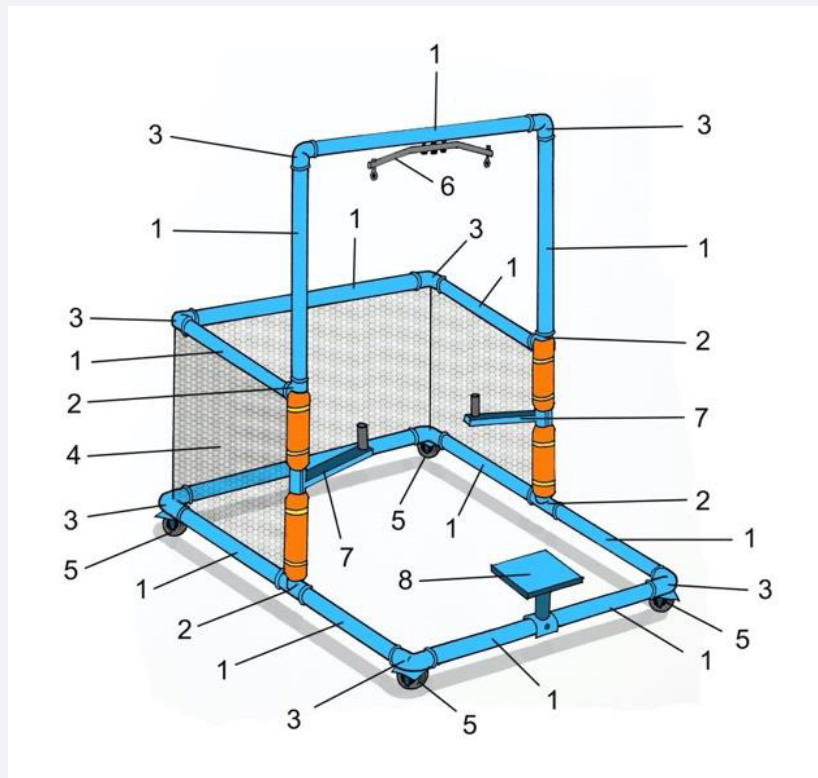
An integrative literature search was conducted using the scientific databases Medline, Virtual Health Library (VHL), Scielo and PubMed. Full-text articles published between 2007 and 2023 were selected. The Health Sciences Descriptors (DECS) were used: "Child Development", "Infant Development", "Global Disorders of Child Development", in English and Portuguese with the Boolean operator "AND".

The proposed design was developed using templates already developed on the online graphic design platform CANVA ([http://canva.com/pt\\_br](http://canva.com/pt_br)), with some adjustments. The images of the booklet were exported from the platform's image library to avoid copyright conflicts, and the images of the exercise protocol were developed by the authors.

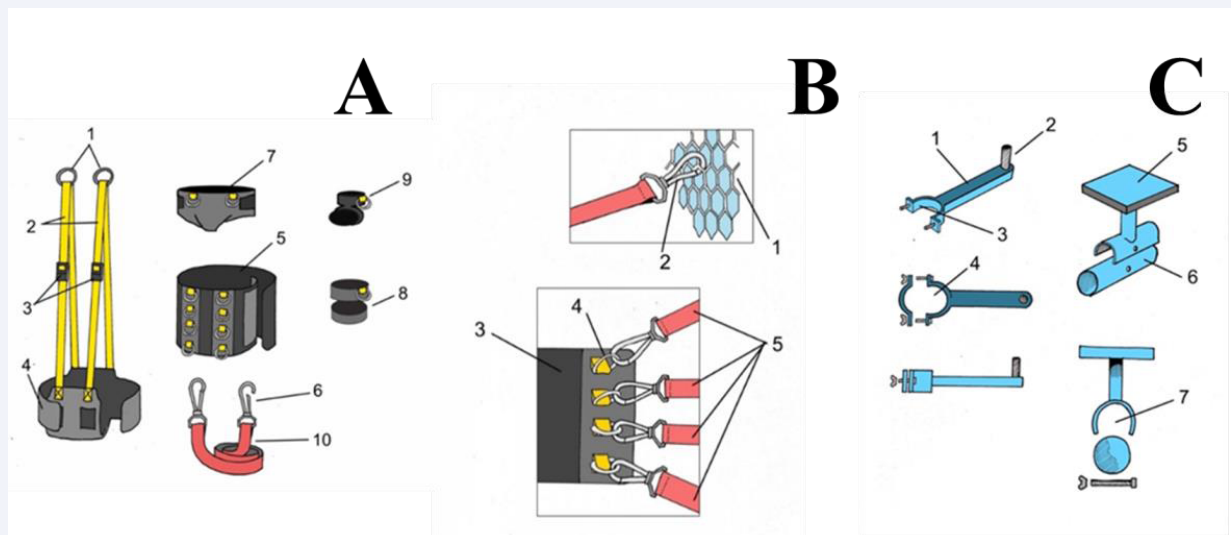
The educational material presents a prototype of a device that is in the process of being patented at the National Institute of Industrial Property (Registration No.: BR102021000550-5 (Figure 1)), registered by the Center for Innovation and Technology Transfer (NITT) of the State University of Pará. It was developed to support the mobility of babies; it is a device that supports and facilitates different postures during the child's development. In addition, it is intended to help babies with neuromotor sequelae that can lead to delay and/or loss of gait function. It is designed to be used by babies with both typical and atypical motor development. Among the conditions of neurodevelopmental disorders, Cerebral Palsy (CP), Congenital Spinal Cord Injury, Microcephaly, Myopathies and other pathological conditions that lead to functional loss and independence for postural control, transfers and gait stand out. The prototype of the mobility aid is called "LOCOMOBIL" and is intended for use in the area of health and physical functional rehabilitation of children with functional deficits in the lower limbs (Figure 1).

The object of the invention was to provide a low-cost multifunctional device that allows children with delayed motor development to adopt and acquire different functional postures, thereby promoting greater functional independence in performing tasks.

The prototype incorporates mobile elements, partial weight support and therapeutic garments (Figure 2), making it multifunctional and allowing for multiple uses due to its size. The prototype system consists of a tubular support system, a coin-shaped screen and a wheel system. With this system it is possible to keep the baby in certain postures against gravity, work tasks in static and dynamic posture, functional reach and allow training of the trunk stabilizing muscles.



**Figure 1** Overview of the mobility device, where you can see the tubular support system (1), T-connections (2), 90° knee connections (3), a stainless steel coin mesh (4), caster system with brakes (5), suspension support for the vest (6), articulated armrest (7), therapist's bench (8).



**Figure 2** System with elastic lifter accessories and therapeutic patient gown. (A) - Rings (1), nylon suspension strap (2), height adjustment (3), T-shirt (4), vest (5), metal carabiner (6), diaper (7), knee brace (8), ankle brace (9). (B) - Demonstrates the fit between the elastic tether hook and the coin mesh and between the elastic tether and the therapeutic garment. Stainless steel coin mesh (1), elastic tie rod hook (2), therapeutic vest (3), therapeutic vest rings (4), elastic tie rods (5). (C) - The system with the arm support attachments and the bench for the therapist. Armrest (1), Handle (2), Armrest Fitting (3), Connection between Tubular Support System and Armrest (4), Therapist Bench (5), Tubular System Metal Bar (7), Connection Between Tubular Support System and Bench (8).

The device also has accessories that include a system of elastic bars, a therapeutic gown, an upper limb support, and a therapist's seat (Figure 2). Together, they facilitate the correct posture for body movement in four support or bipedal positions, which can be adjusted according to the patient's body measurements. The therapeutic postures that can be adopted with the use of the prototype are sitting, 4 supports, kneeling, semi-kneeling, biped and walking (Figure 2).

In addition to the presentation of the prototype and to facilitate its use, an exercise protocol has been developed by the authors. In this sense, the protocol suggests using the prototype to acquire postural control in the following postures: lying down, sitting, in 4 supports, kneeling, semi-kneeling, biped and walking. In this way, all stages of neurodevelopment are stimulated.

## RESULTS AND DISCUSSION

The educational booklet is entitled "Exercise protocol for children (0-12 months)" with the subtitle "The use of a prototype of equipment to support mobility". It was developed to serve as educational material on the topics of child development in early childhood, the maturation and sequential process of postural control in babies, topics of neuromotor development assessment, presentation of the LOCOMOBIL prototype and the protocol of exercises to be practiced in the mobility device. The proposed material is available for online viewing at the following link: [https://www.canva.com/design/DAFq\\_GFHiko/WBHSkw\\_azNkZffa3zJPwPw/edit?utm\\_content=DAFq\\_GFHiko&utm\\_campaign=designshare&utm\\_medium=link2&utm\\_source=sharebutton](https://www.canva.com/design/DAFq_GFHiko/WBHSkw_azNkZffa3zJPwPw/edit?utm_content=DAFq_GFHiko&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton).

The first page of the booklet presents the cover, with the title and subtitle of the product, place of development of the research, edition, and year. The back cover presents the university, center and undergraduate course where the product was developed, again presents the title and subtitle, the team organizing the product, their respective functions and academic background, as well as place and year. On the back of the second page there is institutional information and the catalogue file prepared by the Campus II Library of the Center for Biological and Health Sciences of the State University of Pará (UEPA).

The table of contents presents the list of all the topics to be covered in the booklet and their respective pagination. In the presentation, the authors give a brief description to the readers of the developed product, with its purpose and the target audience. In the introduction, the importance of Health Education in the teaching and learning process was addressed, highlighting its role in improving the quality of life, both for patients and health professionals. In addition, the complexity of child development is highlighted, emphasizing the early detection of neurodevelopmental abnormalities through the assessment of motor tasks. It also presents the existence of a low-cost prototype for the mobility of children with developmental atypia.

Within the theoretical approach, the first topic aims to inform and remind rehabilitation professionals, clear, objective,

and summarized topics for the following topics: Typical Motor Development, Milestones of Child Motor Development, from birth to their 4th trimester of life, Development of Postural Control, Trunk Control in Sitting Posture, the Importance of Early Childhood Assessment and Stages of Physical Therapy Assessment.

The prototype of the patented walking aid was presented in the topic "Prototype of the mobility aid", where the components of the prototype were shown along with illustrative pictures of it. In addition, its importance and feasibility were discussed. In the description of the prototype, the accessories that are included in the device are exposed, such as the elastic tie rod system, the therapeutic dress, support for the upper limbs and the therapist's seat. Together, they facilitate proper posture for performing therapeutic postures.

In order to facilitate and guide the physiotherapist in the use of the prototype, an exercise protocol has been developed to be used with it, to be performed in the following therapeutic positions: lying, sitting, 4 supports, kneeling, semi-kneeling, biped and walking (Figure 3). In the first posture, the goal is to stimulate rolling and gain cervical control. Accessories such as the Swiss Ball are used to promote movements that stimulate trunk and cervical control, as well as sideways movements that promote rolling. In the sitting position, the dynamic control of the anteroposterior and lateral-lateral trunk is stimulated, and the bean ball is used. In this exercise, the child is seated with the support of the therapist in the pelvic area and the ball is moved back and forth and from side to side (Figure 3).

For the four-legged position, priority is given to crawling and strengthening the upper limbs using a positioning roller. With the child in the prone position and the palms of the hands on the floor, the roller is placed on the child's abdomen, using back and forth movements to hold the child's legs. The goal of gait training is to strengthen the lower limbs [12]. The child is placed in the partial weight-bearing vest to reduce the gravitational force on his body, he moves through steps, stimulating the gait and gaining strength in the lower limbs.

The prototype has a rotation system that allows the equipment to be moved. For the control of the dynamic trunk in orthostatism, a trampoline can be adapted in the prototype, where displacements (jumps) are performed in the antero-posterior and laterolateral and supero-inferior directions. The booklet concludes with the final thoughts on the development of the product, as well as pages of bibliographic references used in its production, and an epilogue listing the authors and contributors with their respective backgrounds and specialties.

The first months of an infant's life are crucial for the development of motor milestones and the early detection of disorders of nervous system maturation [13]. Therefore, the main objective of the present study was to inform the reader, the healthcare professional, about the neurodevelopmental issues addressed in the booklet, in addition to providing a therapeutic

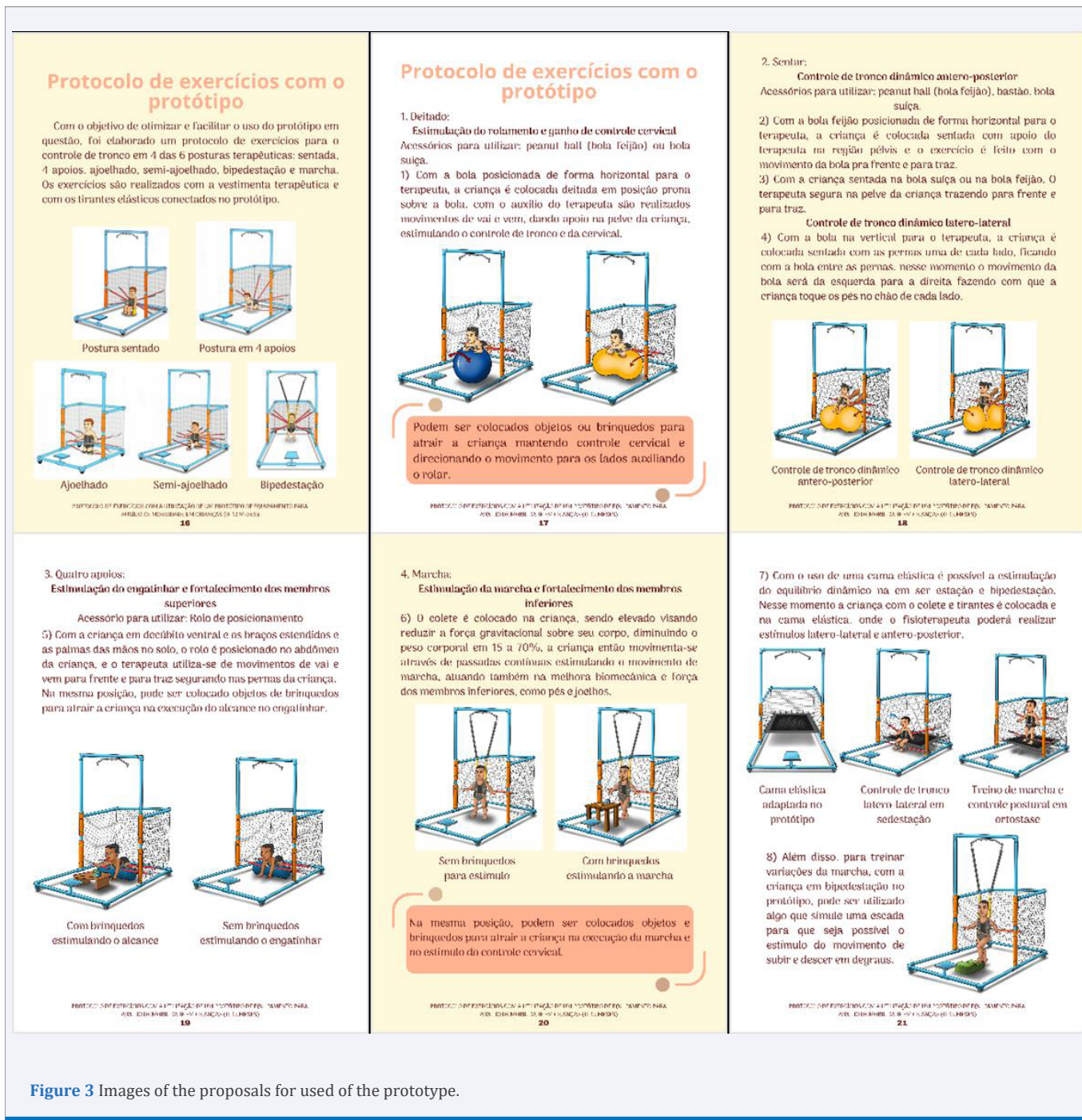


Figure 3 Images of the proposals for used of the prototype.

treatment approach, such as the use of a mobility prototype, and to assist these professionals in its use through an exercise protocol [14].

Early Intervention (PI) programs are recommended to minimize developmental deviations and/or anomalies, and currently there are several types of concepts, methods and treatment techniques in the field of physical therapy, as well as several types of equipment aimed at walking aids and postures for these children, but none is multifunctional [15]. The construction of an exercise book to stimulate trunk control using a prototype mobility aid may be valid for health professionals

to have access to an accessible, functional, and reproducible therapeutic resource.

In order to create conditions conducive to a child's good development, which help to eliminate or even reduce risks, IP is fundamental. One of its objectives is to facilitate the integration of children into the family, school and social environment, promoting their personal autonomy by reducing the impact of a disability or deficit [9]. Thus, IP or health monitoring programs have been designed specifically to support children with atypical motor development, with delays or at risk of developing them [15]. This booklet has been developed to meet the need for

IP programs and the production of informative, educational and scientific material, in this case with the presentation of an exercise protocol.

The differential of the invention for mobility aid presented in the proposed material is due to the numerous forms of applicability in the context of rehabilitation, the number of existing mobile and fixed components and the reduced cost. The device has greater functionality due to its dimensions. It can be positioned in small environments, allows stationary use on a flat track or treadmill and is also dynamic, as it is equipped with casters with brakes, reducing the force required to move in the vertical plane, over gravitational action [16-19].

Postural trunk control and seated trunk control have been added to the booklet because they are important milestones in children's motor development. The theory of motor control, also known as neuromaturation, proposes that the development of motor skills is based on a cephalocaudal development and acquisition of control that moves from more proximal to more distal regions [20]. The acquisition of postural trunk control prepares the infant for the acquisition of later, more complex motor skills, making it one of the most important motor milestones in infant neurodevelopment [1-3]. With this in mind, it is important to emphasize that the booklet is a support material for the neuropsychiatric rehabilitation professional, who in turn should seek more in-depth knowledge of the topics briefly addressed, only the use of the material will not train the professional, but rather promote their training and assist in their care.

## CONCLUSION

The proposal to develop educational material for specialized physiotherapists went beyond the simple presentation of the patented prototype. It was designed to inform and support physiotherapists in their daily care and monitoring of babies' health. The booklet plays a central role in consolidating information and promoting an effective dissemination of knowledge among professionals in the field.

Early intervention plays an extremely important role in the prevention and treatment of neurodevelopmental disorders, with the primary objective of improving the clinical and functional status of affected babies. The primary objective of the present study was to contribute to the scientific and professional field, seeking to simplify the process of prognosis and treatment of such pathologies.

This work not only provides practical guidance and instruction for health professionals, but also fits into a broader context of interdisciplinary research and collaboration. The development and dissemination of such educational materials has the potential not only to improve the quality of care provided to infants with trunk control disorders, but also to strengthen the commitment to child health promotion.

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