

Motor Development in the Digital Era: Implications for Pediatric Rehabilitation and Preventive Kinetic Interventions

Andreea POPESCU¹

¹ Lecturer PhD., „Constantin Brâncuși” University of Târgu Jiu, România, andreeaungureanu91@yahoo.com

Received: 12 February 2026

Revised: 2 March 2026

Accepted: 12 March 2026

Available online: 13 March 2026

Suggested citation

A. Popescu. “Motor Development in the Digital Era: Implications for Pediatric Rehabilitation and Preventive Kinetic Interventions”, *Research and Science Today*, vol. 2026, no. 1, art. no. 13.2026, pp. 1–8, 2026, doi: 10.38173/RST.2026.1.13.

Abstract

The rapid digitalization of modern childhood has profoundly transformed the way children interact with their environment, influencing not only cognitive and social behaviors but also fundamental aspects of motor development. Increased screen exposure, reduced outdoor play, and prolonged sedentary postures have led to a decline in spontaneous movement experiences that are essential for neuromotor maturation. Unlike traditional developmental disorders, many children today present with functional motor delays not linked to neurological pathology but rather to environmental and lifestyle factors. This paper explores the neurodevelopmental foundations of motor acquisition and analyzes how digital-era behaviors may interfere with postural control, sensorimotor integration, and movement variability. The article proposes a conceptual framework in which pediatric rehabilitation professionals play a preventive and educational role, promoting movement-based experiences that support healthy motor development. Integrating kinetic stimulation into early childhood routines may represent a key strategy for counteracting sedentary developmental patterns and fostering long-term physical and functional well-being.

Keywords: *motor development; digital technology; pediatric rehabilitation; physical activity.*



INTRODUCTION

Over the last two decades, childhood has undergone a profound transformation shaped by rapid technological advancement, urbanization, and changes in lifestyle patterns. Digital devices—including tablets, smartphones, and computers—have become deeply embedded in children’s daily routines, often introduced during the earliest stages of development. While these technologies offer educational and communicative advantages, they have simultaneously altered the quantity and quality of children’s physical interactions with their environment. Traditional forms of active play, spontaneous movement exploration, and outdoor activities are increasingly replaced by sedentary, screen-based behaviors. [1]

This shift represents more than a sociocultural change; it has important developmental implications. Motor development in early childhood is fundamentally experience-dependent. The maturation of postural control, coordination, and body awareness relies on repeated sensorimotor interactions with gravity, surfaces, objects, and spatial challenges. Through crawling, climbing, running, and manipulating objects, children continuously refine neural pathways responsible for balance regulation, movement planning, and adaptive motor responses. These experiences serve as essential inputs for shaping the developing central nervous system and fostering neuroplasticity. [2]

When opportunities for varied movement are reduced, the developmental process may not be disrupted in a pathological sense but rather modulated by environmental constraints. Increasingly, clinicians and educators report observing children who do not meet criteria for neurological or musculoskeletal disorders yet display subtle deficits in motor competence [3]. These may include reduced postural endurance, poor coordination, limited movement variability, decreased spatial orientation, and difficulties in sustaining physical effort. Such features suggest the emergence of what may be described as environmentally influenced or lifestyle-related motor delays.

The concept of motor development influenced by environmental context aligns with ecological and dynamic systems theories, which emphasize that motor skills emerge from the interaction between the individual, the task, and the environment. In modern digital environments, children may encounter fewer opportunities to engage in the complex, multisensory experiences necessary for refining postural adjustments and sensorimotor integration. Prolonged sitting, repetitive fine-motor screen interactions, and reduced exposure to uneven terrains or dynamic play may contribute to a narrower repertoire of motor experiences.

From a public health perspective, this phenomenon intersects with broader concerns regarding physical inactivity in childhood. Sedentary behavior has been associated not only with metabolic and cardiovascular risks but also with delayed development of motor competence and reduced confidence in physical activity participation. Children who do not acquire adequate motor skills early may become less inclined to engage in movement later, creating a self-reinforcing cycle of inactivity and functional limitation.

These emerging patterns challenge traditional distinctions between “typical development” and “rehabilitation.” Pediatric rehabilitation professionals are increasingly called upon not only to treat established disorders but also to support optimal developmental trajectories in children exposed to movement-restricted environments. In this context, physiotherapy and kinetic education may assume a preventive role, designing structured movement experiences that restore variability, promote postural activation, and facilitate sensorimotor integration. [4]

Understanding motor development in the digital era therefore requires a multidisciplinary perspective that integrates neuroscience, developmental physiology, behavioral science, and rehabilitation practice. By examining how contemporary



environmental factors shape neuromotor maturation, clinicians and researchers may better define strategies aimed at preserving the essential role of movement in healthy childhood development.

In this context, the present article aims to move beyond a purely descriptive overview of motor development challenges in the digital era and to propose a conceptual framework that redefines the role of pediatric rehabilitation from a predominantly corrective approach to a preventive, environment-oriented perspective. Specifically, the paper highlights how contemporary lifestyle factors—particularly increased screen exposure, reduced spontaneous movement, and limited sensorimotor exploration—may influence the development of postural control, coordination, and movement variability in early childhood. By integrating insights from developmental neuroscience, pediatric rehabilitation, and motor learning theories, the article proposes a model in which physiotherapists and pediatric rehabilitation specialists assume an expanded role as promoters of movement-rich environments and early preventive interventions. The originality of this approach lies in framing motor delays associated with modern sedentary behaviors not strictly as pathological conditions, but as modifiable functional adaptations influenced by environmental contexts.

NEURODEVELOPMENTAL FOUNDATIONS OF MOTOR DEVELOPMENT

Motor development is a complex and non-linear process emerging from the interaction between neural maturation, sensory experience, and environmental opportunities for movement. Rather than following a strictly predetermined biological program, motor skills evolve through continuous adaptation to internal and external stimuli. Contemporary developmental perspectives emphasize that movement is both a product and a driver of neurological organization, meaning that motor activity actively shapes the structure and function of the developing brain [1].

During early childhood, the central nervous system demonstrates high plasticity, allowing neural circuits to be refined through repeated sensorimotor experiences. The integration of vestibular, proprioceptive, visual, and tactile inputs supports the development of postural control and coordinated movement. This maturation process is strongly experience-dependent, as active exploration enables the calibration of balance responses and anticipatory motor strategies.

Postural control and movement variability represent key components of neuromotor maturation. Through repeated challenges to equilibrium and diverse movement experiences, children progressively refine coordination and develop efficient motor strategies [3,5]. Sensory feedback generated through movement contributes to synaptic strengthening and cortical organization, supporting the formation of internal models that guide motor planning and adaptation [4,6].

In contemporary environments characterized by increased sedentary behaviors and prolonged screen exposure, opportunities for spontaneous movement exploration may be reduced. Such environmental constraints may influence the diversity of sensorimotor experiences available during critical developmental periods and subtly affect the trajectory of neuromotor organization.

IMPACT OF DIGITAL LIFESTYLE ON MOTOR BEHAVIOR

The rapid integration of digital technology into children's daily lives has significantly altered patterns of movement, play, and environmental interaction. Activities that once required whole-body engagement—such as outdoor exploration, free play, and peer interaction—are increasingly replaced by screen-based behaviors characterized by prolonged sitting and limited motor variability. While digital tools can support learning and communication, excessive



exposure has been associated with reduced physical activity levels and altered developmental experiences in early childhood. [1]

One of the most notable changes associated with digital lifestyles is the decline in spontaneous physical activity. Unstructured play naturally stimulates balance reactions, coordination, and postural adaptability, all of which are fundamental to motor competence development [2]. When such activities are replaced by sedentary screen engagement, children may experience fewer opportunities to activate antigravity musculature and to develop dynamic postural responses, which are essential for neuromotor maturation [4].

Prolonged static postures during device use also influence musculoskeletal and neuromotor organization. Children frequently maintain flexed sitting positions with limited trunk mobility and reduced weight shifting. Over time, these repetitive patterns may contribute to decreased postural endurance and inefficient movement strategies [7]. Sedentary behavior during early developmental stages has also been linked to lower levels of motor skill proficiency and physical confidence. [6]

Another consequence of digitally mediated environments is the narrowing of movement variability. Traditional play exposes children to diverse sensory contexts—uneven terrains, dynamic obstacles, and tactile exploration—which promote adaptive motor problem-solving and sensorimotor integration [5]. In contrast, screen-based interaction often involves repetitive fine-motor gestures performed within a restricted spatial field, limiting opportunities to refine coordination and anticipatory control. [8]

Importantly, these influences do not necessarily produce identifiable pathology but may result in subtle functional changes affecting motor competence. Clinicians increasingly describe children who fatigue quickly during physical tasks, demonstrate immature balance strategies, or show reluctance to engage in active play despite the absence of diagnosed disorders. Such observations support the view that environmental and behavioral factors can modulate developmental trajectories by altering the quantity and quality of movement experiences. [3]

Recognizing this shift is essential for redefining the role of pediatric health professionals. Rather than addressing only established impairments, there is a growing need to understand how contemporary environments shape developmental processes and to design preventive strategies that reintroduce meaningful movement into children's daily lives. [9]

It is important to emphasize that the motor patterns observed in children exposed to predominantly sedentary digital environments should not necessarily be interpreted as manifestations of pathology. Rather, they may reflect subtle shifts in the developmental trajectory of motor organization. In this context, the issue is not the presence of a neurological deficit, but the gradual adaptation of the motor system to environments that provide fewer opportunities for diverse and spontaneous movement experiences. Consequently, these changes may influence the efficiency, variability, and adaptability of movement without constituting a clinically identifiable disorder. Understanding this distinction is essential, as it reframes the role of pediatric rehabilitation from primarily corrective interventions toward preventive strategies aimed at enriching the child's movement environment.

EMERGING FUNCTIONAL MOTOR DELAYS IN TYPICALLY DEVELOPING CHILDREN

In recent years, clinicians and educators have increasingly reported observing motor performance difficulties in children who do not present with diagnosed neurological or musculoskeletal disorders. These children are often classified as typically developing according to medical criteria, yet they demonstrate functional limitations that affect movement quality, postural endurance, and participation in physical activities.



Such manifestations may include poor balance reactions, reduced coordination, limited agility, early fatigue during play, and difficulty maintaining stable postures during seated or standing tasks. Unlike developmental coordination disorder or other defined clinical entities, these characteristics frequently fall within a gray zone that does not meet diagnostic thresholds but still reflects suboptimal motor competence. This phenomenon has been described as a decline in motor proficiency associated with lifestyle-related reductions in physical activity and exploratory play. [6]

Motor competence develops through repeated opportunities to interact dynamically with the environment. When these opportunities are constrained, children may not acquire the same level of adaptive variability that supports efficient movement. As a result, motor behaviors may appear less automatic, less economical, and more fatiguing, even in the absence of structural impairment. [2]

Educational environments have also noted changes in children's readiness for physical engagement. Teachers increasingly report reduced endurance for sustained activity, difficulty performing fundamental movement skills, and lower confidence in physical participation. These observations suggest that motor development is being shaped not only by biological maturation but also by contemporary behavioral contexts that limit active exploration.

Importantly, these emerging functional delays are often modifiable. Because they are environmentally mediated rather than pathology-driven, they may respond positively to targeted movement enrichment, structured physical experiences, and guided sensorimotor challenges. This reinforces the need to view pediatric rehabilitation not solely as a corrective discipline, but also as a preventive and developmental support strategy.

It is important to distinguish these emerging functional delays from clinically defined developmental disorders such as Developmental Coordination Disorder (DCD). While DCD involves persistent motor coordination difficulties associated with neurodevelopmental alterations that significantly interfere with daily functioning, lifestyle-related functional delays appear to arise primarily from environmental constraints, particularly reduced opportunities for diverse and spontaneous movement experiences. In this context, motor performance differences may reflect adaptive responses to sedentary behavioral patterns rather than the presence of an underlying neurological disorder. This distinction is essential for framing pediatric rehabilitation not only as a corrective discipline, but also as a preventive field focused on optimizing the child's movement environment.

ROLE OF PEDIATRIC REHABILITATION IN PREVENTION

The changing landscape of childhood development calls for an expanded understanding of pediatric rehabilitation, one that extends beyond the treatment of diagnosed disorders to include the promotion of healthy developmental trajectories. In environments where natural opportunities for movement are increasingly limited, rehabilitation professionals may assume a preventive role by facilitating structured motor experiences that support neuromotor maturation.

Preventive pediatric rehabilitation focuses on enriching the child's movement repertoire rather than correcting pathology. Through guided activities that challenge balance, coordination, strength, and spatial awareness, therapists can provide the sensorimotor input necessary for refining postural control and movement adaptability. Such interventions aim to restore variability and complexity to motor experiences, compensating for the relative uniformity of sedentary digital behaviors.

Early intervention is particularly relevant because of the heightened neuroplasticity observed during childhood. Providing developmentally appropriate movement challenges during these sensitive periods may enhance neural organization and improve the efficiency of



motor strategies. Activities emphasizing transitions between positions, dynamic balance, bilateral coordination, and interaction with varied surfaces can stimulate the integration of sensory and motor systems essential for functional competence.

Equally important is the educational role of pediatric rehabilitation. Parents, caregivers, and educators often underestimate the developmental significance of movement, viewing physical activity primarily as recreation rather than as a neurodevelopmental necessity. Rehabilitation professionals can contribute by offering guidance on creating movement-rich environments, encouraging active play, limiting prolonged sedentary behaviors, and integrating physical experiences into daily routines.

Interdisciplinary collaboration also plays a central role in preventive strategies. Partnerships between therapists, schools, and community programs may help reintroduce structured physical engagement into children's lives, ensuring that opportunities for motor exploration are accessible beyond clinical settings. Such approaches shift rehabilitation from an individualized corrective model toward a broader public health perspective.

By positioning movement as a foundational component of development rather than merely a therapeutic tool, pediatric rehabilitation can contribute to addressing the emerging challenges associated with sedentary childhood environments. This preventive orientation aligns with contemporary models of health promotion that emphasize early, proactive support for functional well-being.

From a preventive perspective, pediatric rehabilitation professionals may contribute to the enrichment of children's movement environments through various practical strategies. Examples include school-based activities designed to stimulate postural control and dynamic balance, such as guided balance tasks, coordination games, and structured movement breaks integrated into classroom routines. Sensorimotor variability can also be promoted through motor circuits that combine locomotor challenges, object manipulation, and changes in body orientation. In addition, parental guidance plays a key role in organizing home environments that encourage active play, exploration, and reduced sedentary screen time. These types of interventions illustrate how pediatric rehabilitation can extend beyond clinical treatment and contribute to the promotion of healthy motor development within everyday environments.

INTEGRATING MOVEMENT BACK INTO CHILDHOOD: PRACTICAL AND CONCEPTUAL PERSPECTIVES

Addressing the reduction of movement opportunities in contemporary childhood requires coordinated strategies that extend beyond clinical intervention. Reintegrating movement into children's daily lives involves reshaping environments, routines, and expectations to support active engagement as a fundamental component of development rather than an optional activity. [3,5]

One key approach is the intentional design of movement-rich environments. Homes, schools, and community settings can be structured to encourage natural physical exploration through accessible play spaces, varied surfaces, and opportunities for climbing, balancing, and dynamic interaction. Such environments stimulate continuous sensory feedback and promote the adaptive motor responses necessary for postural and coordinative development.

Educational systems also play a crucial role [4]. Incorporating short bouts of physical activity throughout the school day—rather than confining movement to limited physical education sessions—can enhance attention, postural activation, and motor competence. Movement-integrated learning models demonstrate that physical engagement supports not only physical development but also cognitive and behavioral outcomes.

Families represent another essential component in restoring active developmental experiences. Encouraging unstructured outdoor play, limiting prolonged screen exposure, and



promoting shared physical activities can reintroduce variability and spontaneity into children's movement patterns [1]. These experiences are particularly valuable because they combine emotional engagement with sensorimotor stimulation, reinforcing learning through meaningful interaction.

From a rehabilitation perspective, practitioners may adopt consultative and community-oriented roles, guiding caregivers and educators in implementing development-supportive movement strategies. Rather than functioning solely within therapeutic settings, pediatric rehabilitation professionals can contribute to preventive frameworks that extend into everyday life.

Conceptually, this shift reflects a transition from a deficit-based model of intervention to a developmental enrichment model. The focus moves from correcting impairments to optimizing environmental conditions that allow motor systems to mature through active use. Such an approach aligns with contemporary views of health promotion, where prevention, participation, and functional capacity are central outcomes.

Reintegrating movement into childhood is therefore not merely a matter of increasing physical activity but of restoring the diverse, adaptive, and exploratory experiences that underpin neuromotor development.

In this context, reintegrating movement into childhood should be viewed not only as a therapeutic objective but also as part of a broader public health strategy. This perspective reflects a shift in paradigm from interventions focused primarily on the individual child toward approaches that address the environments and daily routines in which development occurs. Rather than relying exclusively on corrective interventions after motor difficulties emerge, preventive strategies aim to reshape the contexts that influence children's movement opportunities, including educational settings, family routines, and community spaces. By promoting movement-rich environments, pediatric rehabilitation can contribute to fostering healthier developmental trajectories at a population level.

CONCLUSIONS

The present article highlights the need to reinterpret motor development in the digital era through the lens of the dynamic interaction between neuroplasticity and contemporary behavioral constraints. Rather than representing solely a matter of individual neurological maturation, children's motor trajectories are increasingly shaped by environmental conditions characterized by prolonged sedentary behaviors and reduced opportunities for spontaneous movement exploration. Within this framework, pediatric rehabilitation should not be viewed exclusively as a field dedicated to the treatment of motor pathology. Instead, it emerges as an important contributor to preventive strategies aimed at supporting optimal motor development by promoting movement-rich environments and healthier behavioral routines during childhood.

Recognizing these emerging patterns requires a shift from a purely rehabilitative model toward a preventive and development - oriented perspective. Pediatric rehabilitation professionals are uniquely positioned to address this need by promoting structured, varied, and meaningful movement experiences that support neuromotor maturation. Through collaboration with families, educators, and communities, rehabilitation can extend beyond clinical settings to foster environments that encourage active exploration and participation.

Reintegrating movement into everyday childhood routines represents an essential strategy for supporting healthy development in the digital era. Rather than opposing technological advancement, health professionals must seek balanced approaches that preserve the fundamental role of physical interaction with the environment in shaping functional capacity and lifelong well-being.



Author Contributions: The author confirms being the sole contributor to this work and has approved it for publication.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were not required for this study.

Informed Consent Statement: The manuscript does not contain identifiable personal data.

Data Availability Statement: All relevant data are included in the manuscript.

Conflicts of Interest: The author declare no conflict of interest.

REFERENCES

- [1]. Stiglic, N., & Viner, R. M. (2019). Effects of screentime on the health and well-being of children and adolescents. *BMJ Open*, 9(1), e023191;
- [2]. Adolph, K. E., & Hoch, J. E. (2019). Motor development: Embodied, embedded, enculturated, and enabling. *Annual Review of Psychology*, 70, 141–164. <https://doi.org/10.1146/annurev-psych-010418-102836>;
- [3]. Rudd, J. R., Barnett, L. M., Butson, M. L., Farrow, D., Berry, J., & Polman, R. C. J. (2020). Fundamental movement skills are more than run, throw and catch: The role of stability skills. *BMC Public Health*, 20, 181. <https://doi.org/10.1186/s12889-020-8188-7>;
- [4]. Carson, V., Lee, E. Y., Hewitt, L., Jennings, C., Hunter, S., Kuzik, N., Stearns, J. A., Unrau, S. P., Poitras, V. J., Gray, C., & Tremblay, M. S. (2021). Systematic review of the relationships between physical activity and health indicators in early years. *BMC Public Health*, 17(5), 854;
- [5]. Newell, K. M. (2020). What are fundamental motor skills and what is fundamental about them? *Journal of Motor Learning and Development*, 8(2), 280–314. <https://doi.org/10.1123/jmld.2020-0013>;
- [6]. Barnett, L. M., Webster, E. K., Hulteen, R. M., De Meester, A., & Valentini, N. C. (2020). Through the looking glass: A systematic review of longitudinal evidence, providing new insight for motor competence and health. *Sports Medicine*, 50(4), 875–920. <https://doi.org/10.1007/s40279-019-01230-0>;
- [7]. Gao, Z., Zeng, N., Pope, Z., Wang, R., & Yu, F. (2022). Effects of sedentary behaviors on physical development and motor competence in children: A review. *International Journal of Environmental Research and Public Health*, 19(3), 1465. <https://doi.org/10.3390/ijerph19031465>;
- [8]. Lopes, L., Santos, R., Pereira, B., & Lopes, V. P. (2021). Associations between sedentary behavior and motor coordination in children. *American Journal of Human Biology*, 33(1), e23416. <https://doi.org/10.1002/ajhb.23416>;
- [9]. World Health Organization. (2020). Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. WHO Press.