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# The Study on Brain Stimulation (Physical Activity) in Early Childhood Education: A Bibliometric Review Analysis

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**ABSTRACT**

***Objective:*** *This study aims to describe the research methods, developmental evolution, and evaluation of research on neurokinesthetic movement activities in children. The research contributes to quality early childhood education by incorporating physical activities designed to develop motor skills and stimulate brain development.* ***Method:*** *The research used a systematic literature review in the Scopus database with the query "TITLE-ABS-KEY (Brain Stimulation AND physical activity AND children)," which yielded 213 documents. Data collection was conducted using the Scopus database over 10 years; the data were then compiled into a CSV file and analyzed using Biblioshiny and qualitative thematic analysis.* ***Results:*** *The results indicate that the relevant research methodologies related to neurokinesthetics are experiments and systematic literature reviews. Furthermore, neurokinesthetic research has evolved into physical activities applied to humans to provide brain stimulation, thus necessitating further development within the context of physical activity. The evaluation of five relevant studies also indicates that neurokinesthetics serves as an alternative for early childhood through physical activity as a means of behavioral development. These findings suggest that neurokinesthetics is a form of physical activity that requires further development for early childhood education.* ***Novelty:*** *The study evaluates brain stimulation research as a form of physical activity in early childhood, focusing on its impact and relevant research methods.*

## INTRODUCTION

Globally, early childhood education has become an important foundation for improving the quality of human development. Early childhood experiences and stimulation during the early years can influence children's physical, cognitive, and socio-emotional development (Likhar et al., 2022; Mayra et al., 2022). One important aspect that requires attention is the development of motor skills, which are not limited to physical abilities but are also closely associated with children's cognitive development (Newell, 2020; Shi & Feng et al., 2022).

Appropriate motor skill stimulation from an early age can therefore contribute to the development of children's cognitive abilities while supporting the provision of quality early childhood education (Lee et al., 2025). However, providing meaningful and developmentally appropriate motor skill stimulation remains a challenge, highlighting the need for innovative approaches that can engage young children in activities that simultaneously promote motor and cognitive development. Therefore, innovation in early childhood education is needed to strengthen children's motor skills from an early

age while supporting their cognitive development and, ultimately, contributing to quality education.

One strategy for developing motor skills in young children is to provide them with physical activities. This is supported by research by Dapp et al. (2021) on the importance of physical activity in helping children develop motor skills. In this context, the goal is to develop new physical activities that build children's motor skills, thereby serving as a foundation for cognitive development. The desired physical activities involve an approach that integrates physical movement coordination (motor skills) with stimulation of cognitive processes (Coppola et al., 2024; Vazou & Mavilidi, 2021).

Neurokinesthetics is a form of physical activity designed to optimize brain cell development through direct movement experiences. This underscores the fact that neurokinesthetic activities simultaneously engage motor movements and cognitive processes to stimulate brain cells (Romero-Naranjo & Andreu-Cabrera, 2023). These activities should be implemented in early childhood education to foster strong motor skills. Furthermore, early childhood education does not require learning that relies on basic thinking skills, but rather education conducted through movement activities (Saracho, 2023).

In fact, research on neurokinesthetics remains limited, so its application in early childhood education is rare. This finding is supported by a study by Lazar & Ramakhrisnan (2025), which indicates that neurokinesthetics has few scientific publications to serve as references for movement activities. A literature review of the Scopus database reveals that, over the past five years, only four research documents on neurokinesthetics have been published. In this context, there is a need for education highlighting that neurokinesthetics plays a crucial role in early childhood education, serving as a means to stimulate motor skills and cognitive development.

Neurokinesthetics is synonymous with brain stimulation as a form of physical movement that promotes brain and motor stimulation. This assertion is supported by Khan et al. (2020), which indicates that neurokinesthetics is synonymous with brain stimulation, as both relate to neurons. Previous research has not yet explained how brain stimulation supports the development of motor skills in young children (Qi et al., 2022; Rathinam et al., 2024). According to Camacho-Conde et al. (2022), such activities can help young children develop cognitive skills through motor stimulation, so further evaluation of this is necessary.

This study evaluates research on brain stimulation as a physical activity for young children through a literature review. A systematic literature review can map research aligned with current needs and its impact (Anggraeni et al., 2023). The systematic literature review presented in this study differs from previous research by describing the impact and relevant research methods in line with contemporary developments. This study aims to describe the results of a literature review on neurokinesthetic movement activities in children; thus, the research questions in this study are as follows:

RQ1: What research methods are most commonly used in studies of neurokinesthetic motor activity in children?
RQ2: How has research on neurokinesthetic motor activity in children evolved and developed over the past 10 years?
RQ3: How has research on neurokinesthetic motor activity in children been evaluated over the past 10 years?

## RESEARCH METHOD

### *Information Source*

This study conducted a systematic literature review using the Scopus database to gather information and evaluate the literature. The Scopus database was used because it offers broad coverage of scientific literature across disciplines, including multidisciplinary and interdisciplinary fields, making it well-suited for a comprehensive literature review (Rusmila et al., 2026; Zhu et al., 2024). Additionally, the Scopus database provides information that can be used to evaluate research and its implications according to the desired scope of study (Asubiaro, 2023; Yeung, 2021). This serves as the basis for researchers to use the Scopus database, enabling them to identify gaps and opportunities for further research.

In this context, the researchers did not use Google Scholar because they lacked information on the research implications and evaluation of relevant studies (Asl et al., 2023). This literature review focuses on articles related to brain stimulation as a form of physical activity in children. The database search used the keyword "TITLE-ABS-KEY (Brain Stimulation AND physical activity AND children)," which yielded 213 documents.

### *Eligibility Criteria*

Data collection and processing were conducted in May 2026 using the Scopus database. During data collection, the study applied specific criteria. The criteria for document selection are as follows:

1. Time Frame: The data meeting the criteria includes research data collected over the past 10 years; therefore, the data meeting these criteria covers the period from 2015 to 2025. The year 2026 is not included in the eligibility criteria because it involves new publications.
2. Document Type: The selected documents are those that play a key role in providing clear information (articles, conference proceedings, reviews, book chapters). These documents were chosen because they have a significant impact on the research community.
3. Language: The data that meet the criteria include studies conducted in English; therefore, studies conducted in languages other than English do not meet the data criteria. This is because English is generally the language of international communication.

Furthermore, data clustering is based on the type of document obtained from the Scopus database, as shown in Figure 1.

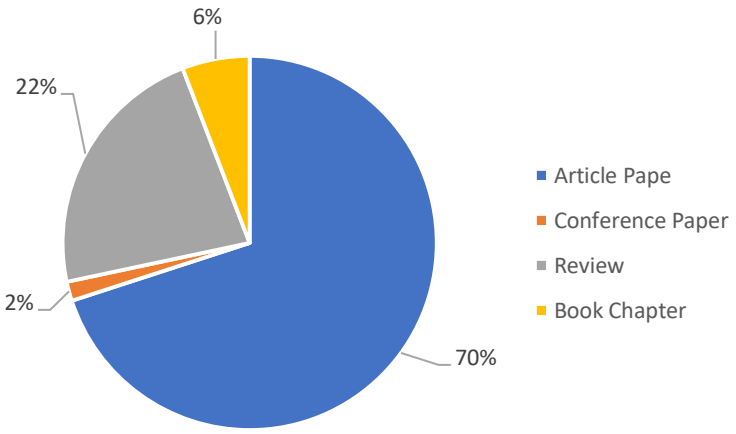


**Figure 1.** Eligibility document data

***Data Collection***

The database search used a broad search strategy and identified relevant issues in early childhood education, particularly regarding the development of motor skills and cognitive abilities. Subsequently, a data screening process was carried out, based on year (the last 10 years), document type, and language (English). This systematic approach ensures a comprehensive search and includes many relevant studies for evaluation (Lintangesukmanjaya et al., 2026). The screening process covered 10 years because the researchers wanted to identify trends in research over the past decade. English was used as the language filter because it is a widely used international language. The researchers selected these document types to identify opportunities for scientific publication in the form of articles, conference proceedings, reviews, and book chapters. Clustering by year, language, and document type helps identify opportunities in international publications (Cozzoline & Ferraro, 2022; Damarsha et al., 2026). According to Meirbekov et al. (2024), the language has been used over the past 10 years because it is well-suited to our needs, while English is used because it is an international language and therefore easier to use. For further details, see Figure 2 for the database collection process.

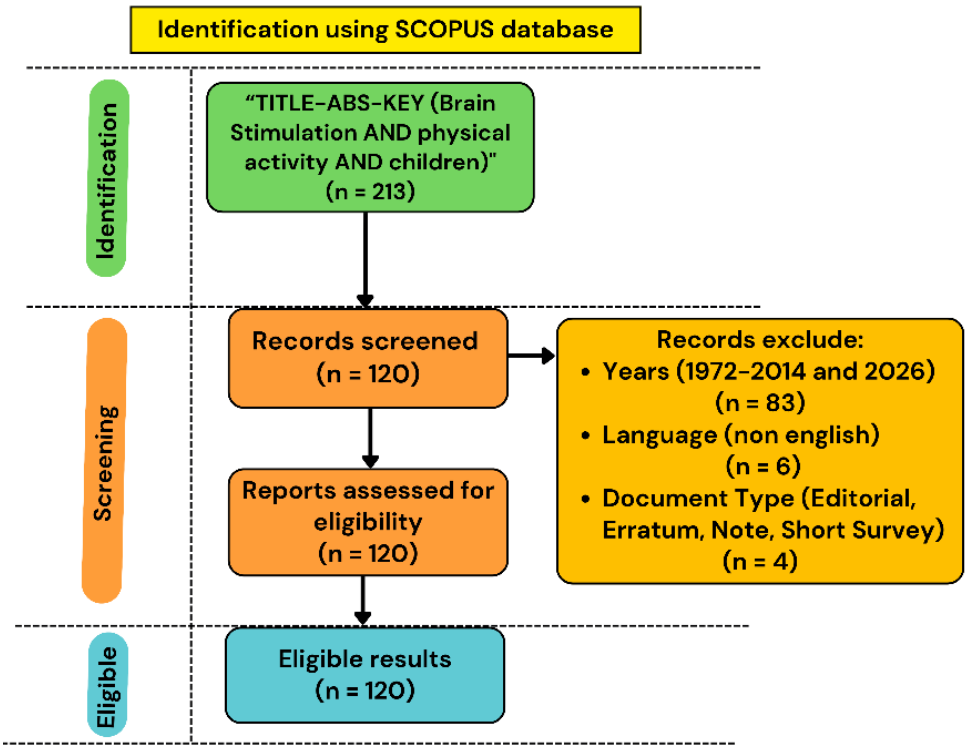


**Figure 2.** Screening processed

### *Data Analysis*

The screened data were then organized into categories and exported from Microsoft Excel as a CSV file, systematically listing the author's name, affiliation, position, country, journal title, and keywords. The next step involved a descriptive analysis designed to address the research questions, requiring a literature review and an assessment of the research's impact. For data visualization regarding the development and evolution of research, we used Bibliometrix in RStudio. These programs provide various analytical functions that allow us to study indicators such as the development and evolution of research (Srivastava & Srivastava, 2022; Wani & Ganaie, 2024). Furthermore, the researchers used a literature review based on top citations and FWCI analysis of the reviewed articles (Scelles & Teixeira da Silva, 2025). This served as an evaluation of research conducted over several years to determine the resulting impact.

## RESULTS AND DISCUSSION

### *Research Method Dominant*

In this subsection, the researcher will discuss the methods used to research neurokinesthetic movement activities in children. This discussion of the research methods used to study neurokinesthetic movement activities in children aims to ensure that the methodology is relevant (Harmon et al., 2025). Figure 3 illustrates the results of the research methods used in the study of neurokinesthetic movement activities in children.

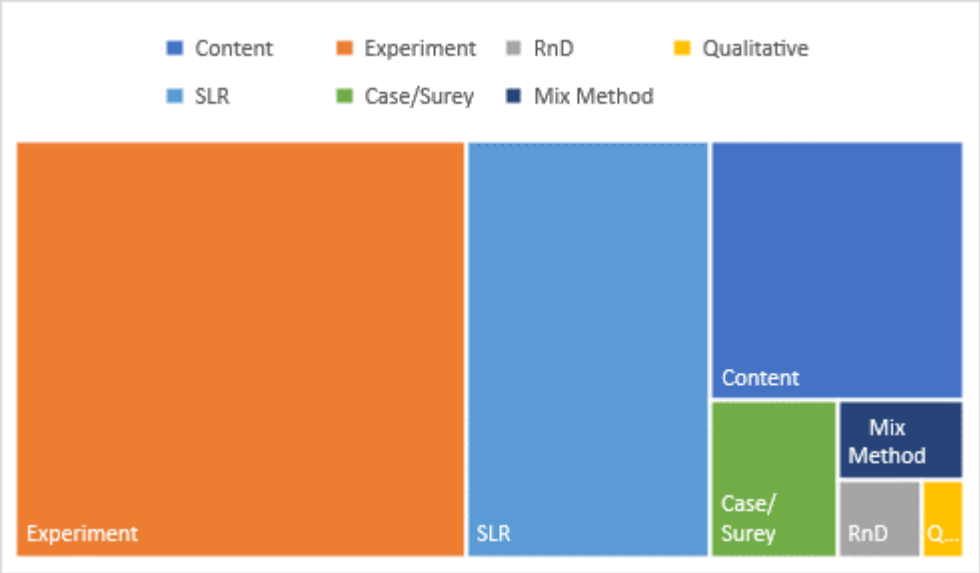


**Figure 3.** Research methodology dominant

Based on Figure 3, experimental methodology and systematic literature reviews are the most commonly used methodologies in research on neurokinesthetic movement activities in children. These results indicate that scientists have conducted numerous experiments to test neurokinesthetic activities as brain stimulants in children. Furthermore, these findings indicate that scientists conduct neurokinesthetic research by testing physical activities in children as brain or motor stimulants. According to Aithal & Aithal (2020), experimental methods yield more valid results, as each stage involves careful attention to precision. Moreover, in this context, neurokinesthetic research tends to employ experimental methodologies. This is because neurokinesthetics aims to understand the effects of activities that stimulate children, particularly on their motor skills (Yoanita et al., 2021; Cabrera et al., 2024). These findings provide insights for future researchers, indicating that developing neurokinesthetic activities requires experimental design. By conducting such experiments, researchers can then compare the results developed to inform future experiments in early childhood education.

Furthermore, the predominant research methodology moving forward is the systematic literature review. According to Sauer & Seuring (2023), systematic literature reviews are used to evaluate previous research to identify gaps in prior findings. In the context of neurokinesthetics, this means that this research requires extensive evaluation when implemented with children as a physical activity. Neurokinesthetic evaluation must continue to assess its effects on children, ensuring that the activities provide stimulation for both the brain and motor skills (Mesías et al., 2021). These findings indicate that research on neurokinesthetics is predominantly experimental in nature but requires further evaluation through a systematic literature review incorporating various scientific perspectives. This evaluation aims to prevent adverse outcomes that do not align with expectations, enabling future researchers to integrate data by combining experimental methods with systematic literature reviews.

### *The Development and Evolution of Research*

This subsection analyzes research trends using thematic maps and the thematic evolution of the keywords identified.

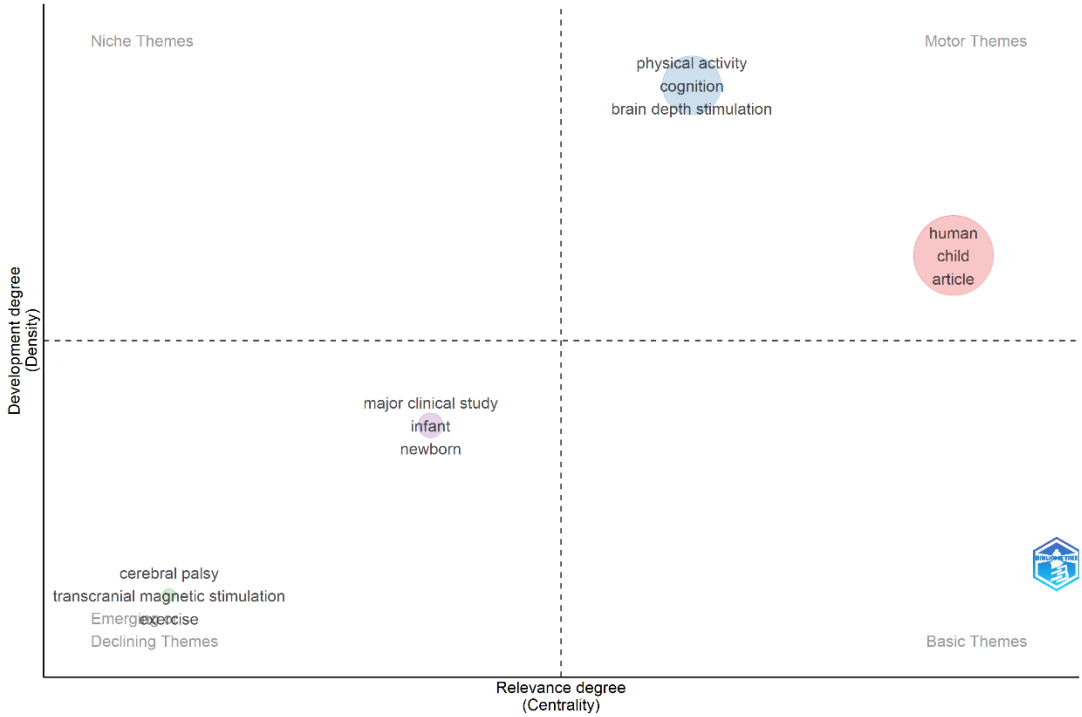


**Figure 4.** Thematic map

As shown in Figure 4, the graph has two axes: the x-axis (research relevance) and the y-axis (research development). The circles on the thematic map indicate keywords that demonstrate both relevance and development. Figure 4 shows that the keyword "child" has high relevance but minimal research development. Conversely, the keyword "brain depth stimulation" shows significant research development but lacks relevance. In this context, it indicates that "brain depth stimulation" has research development, but the relevance it provides remains minimal. In this regard, there is a gap: while neurokinesthetics has development in innovation, its relevance is small. This suggests that the implications derived from neurokinesthetic research are still insufficient, necessitating updates to enhance its relevance. The scarcity of neurokinesthetic research stems from a lack of research outputs, necessitating innovations to ensure the continuity of future research (Sanabria-Z et al., 2025).

Furthermore, the keyword "child" is highly relevant but shows limited development. These findings indicate a research gap on the sustainability of brain depth stimulation in children. This gap presents researchers with an opportunity to develop neurokinesthetic research in children further. It underscores the urgency of addressing the connection between physical activity, neurokinesthetics, and children. Early childhood education does not emphasize cognitive learning; instead, it focuses on developing motor skills in young children (Sutapa et al., 2021; Vazou & Mavilidi, 2021). Therefore, neurokinesthetic research is needed in education, particularly in developing students' motor skills.

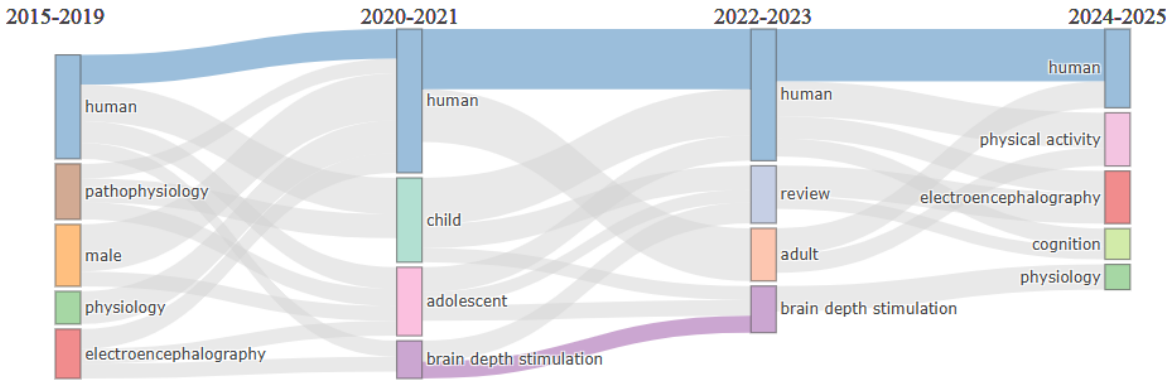


**Figure 5.** Thematic evolution

Based on Figure 5, from 2015–2019, research using the keyword "human" trended and then evolved through 2024–2025. In 2020–2021, the keyword "human" evolved into "brain depth stimulation," and the keyword "child" emerged. These results indicate that the keyword "human" evolved into several pathways: "human," "child," and "brain depth stimulation." Furthermore, these keywords evolved into "brain depth stimulation" and "adult," which stem from the evolution of "human" and "child." Additionally, by the final year, the keywords evolved into "physical activity," reflecting the evolution of "brain depth stimulation" and "adult" into "physical activity." This suggests that future researchers can develop studies related to physical activity. In this context, neurokinesthetics serves as a physical activity designed to provide brain and motor stimulation (Bakrisuk et al., 2025). These findings suggest that neurokinesthetics can be developed as a physical activity for young children to train motor skills and provide brain stimulation to foster cognitive development.

### *A Review of 10 Years of Research*

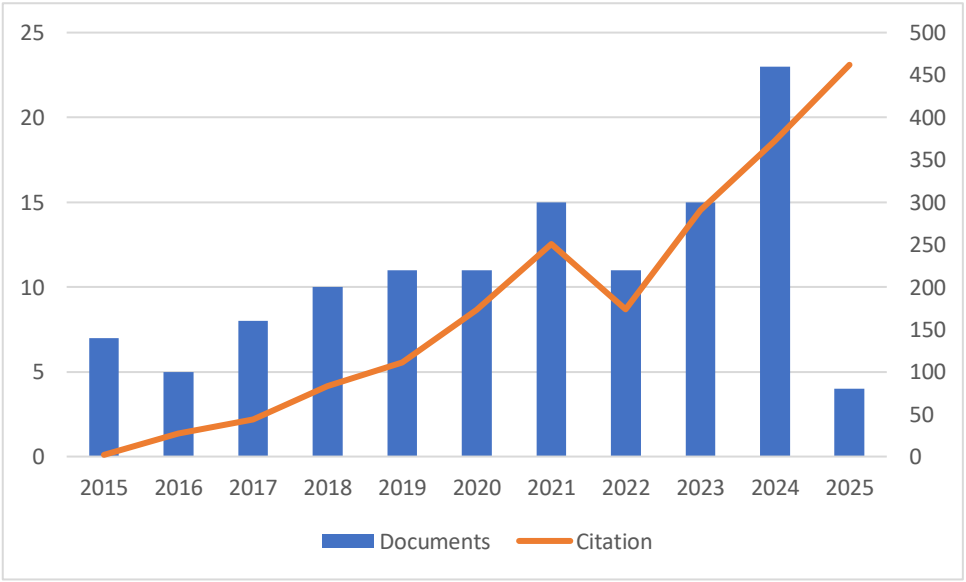


**Figure 6.** Research productivity

Figure 6 for the period from 2015 to 2025 shows an interesting fluctuation between the number of published documents and the number of citations received. In the early period (2015–2016), the number of documents was relatively low (7 and 5 documents). Still, the citation-to-document ratio was quite good, particularly in 2015 with an average of approximately 1.43 citations per document. Entering 2017–2018, there was an increase in the number of documents (8 and 10), accompanied by a significant surge in citations, from 50 citations in 2017 to 80 citations in 2018. This suggests improved publication quality or visibility. Document productivity peaked in 2024 with 23 documents, accompanied by the highest citations throughout the period, namely 380 citations. This suggests that the increase in publications is directly proportional to the scientific impact received. The year 2025 recorded a drastic surge in citations to 460, even though the number of documents dropped sharply to only 4 documents. This phenomenon is particularly intriguing as it indicates that the documents published in 2025 have an extraordinary impact, with an average of 115 citations per document—the highest figure throughout the period. These findings indicate that research on brain stimulation or neurokinesthetics as a physical activity for children will yield significant citations. This is due to the relevance of this novel approach and its alignment with thematic evolution (see Figure 4), which shows that physical activity is at the forefront of current research. According to Weismaye (2022), the high number of citations stems from the research's relevance and its implications for human life. This presents an opportunity for future researchers further to develop neurokinesthetics as a physical activity for young children.

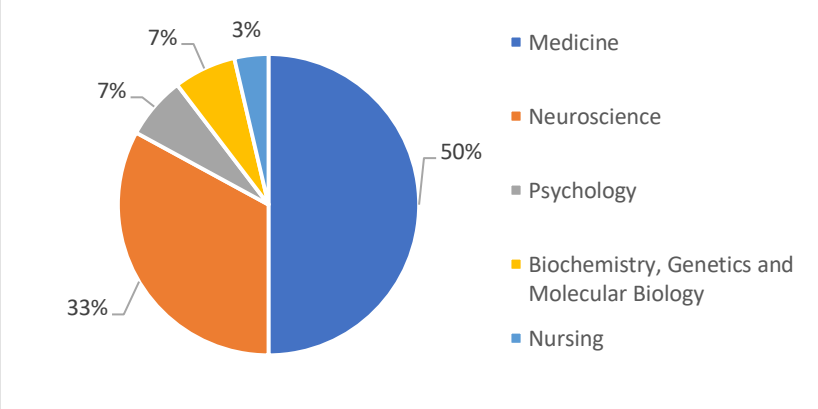


**Figure 7.** Subject area research

Figure 7 shows that Medicine accounts for 50% of the total. This indicates that the primary focus of the publications or research analyzed lies in the medical field, which may reflect institutional priorities, global research trends, or the characteristics of the journals or data sources used. Ranking second is Neuroscience with a 33% contribution; this figure is quite significant and indicates that neuroscience is the second most important field, likely closely related to Medicine, given that many neuroscience studies have clinical applications. Next, Psychology and Biochemistry, Genetics, and Molecular Biology each have an equal share of 7%. Although these percentages are small compared with the top two categories, the presence of psychology indicates a focus on behavioral

and mental aspects. At the same time, biochemistry, molecular biology, and genetics suggest basic research that supports understanding biological mechanisms. Among the top 5 research topics, neurokinesthetics tends to focus on psychology when related to education.

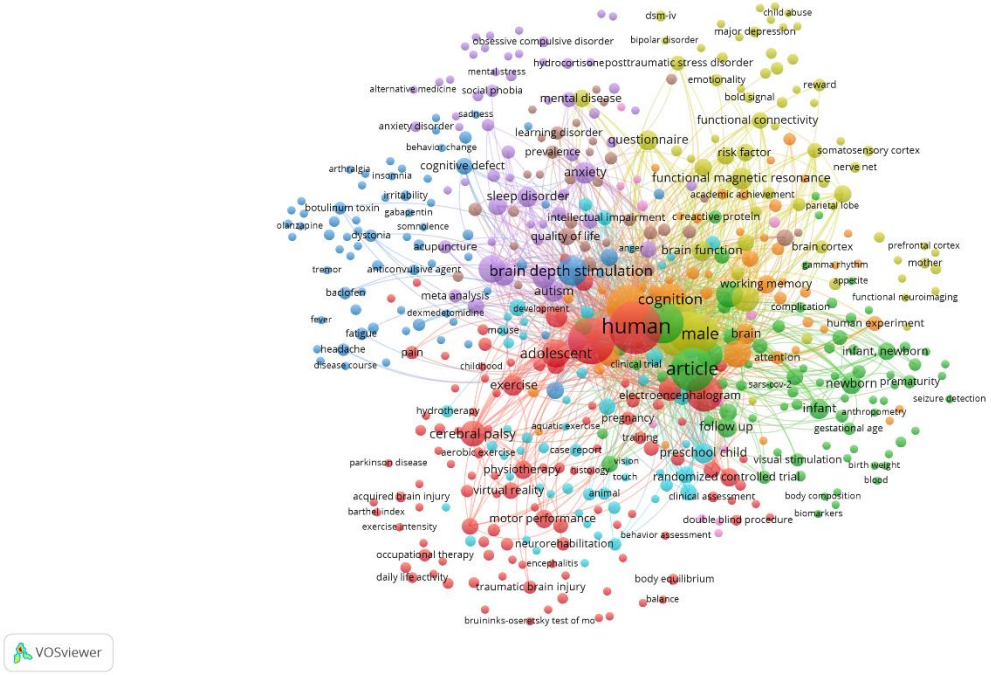


**Figure 8.** Network visualization by keywords

The VOSviewer co-occurrence network shows that research on motor skills and child development is strongly interconnected with cognitive, physical, neurological, and psychological aspects. The network centers on prominent keywords such as "human," "cognition," "brain," "brain development," "motor performance," and "article," indicating that human development and cognitive–motor relationships are major research themes in this field. The red cluster predominantly represents motor development and physical activity, with keywords such as motor performance, exercise, cerebral palsy, physical activity, and body equilibrium, highlighting research on the relationship between motor abilities, physical activity, and functional development.

The green cluster is closely associated with early childhood and developmental processes, including infant, newborn, preschool child, visual stimulation, attention, and human experiment, suggesting growing attention to motor and cognitive development in the early stages of life. Meanwhile, the yellow cluster emphasizes cognitive and neurological development, represented by terms such as cognition, working memory, brain function, attention, academic achievement, and prefrontal cortex. The purple cluster reflects psychological and behavioral dimensions, including mental health, anxiety, depression, sleep disorder, and quality of life, indicating that developmental outcomes are also connected to children's psychological well-being.

Overall, the density and interconnection among these clusters demonstrate that motor skill development is increasingly viewed as a multidimensional process that extends beyond physical development and is closely related to cognitive function, brain development, attention, and children's overall well-being. This pattern provides a strong basis for developing innovative early childhood education interventions that integrate motor activities with cognitive stimulation to support holistic child development (Apriyansyah et al., 2024; Lestari et al., 2026).

In this context, this indicates that future researchers will have opportunities if their studies are linked to psychology. Logically, neurokinesthetics is a physical activity that develops motor skills in young children and relates to the psychological context of early childhood (Buzescu et al., 2020). Thus, further research is needed on the psychological state of young children when applying neurokinesthetics as a physical activity. Furthermore, this study presents the literature review in Table 1, based on five relevant studies.

**Table 1.** Top 5 relevant research

| Identity | Results | Citation | FWCI |
|---|---|---|---|
| Gorodetsky et al. (2025) | testing deep brain stimulation (DBS) in the nucleus accumbens to address severe self-injurious behavior (SIB) in children, as a pilot study focusing on safety. Although DBS will never be implemented in early childhood education settings, this study has important implications for early childhood education, namely: reinforcing the understanding that extreme SIB has a neurobiological basis; emphasizing the importance of early detection and referral to medical professionals before the behavior becomes chronic; and raising awareness among educators that interventions for children with special needs must be conducted in a multidisciplinary, ethical, and humane manner. | 13 | 6.40 |
| Mufti et al. (2024) | offers a safe (non-surgical) and precise new approach to improving the motor and cognitive functions of children with cerebral palsy (CP). In the context of early childhood education (PAUD), these findings are highly relevant because: (1) they underscore the importance of early detection and referral of children with CP during the critical window of 0–6 years of | 4 | 0.40 |

| Identity | Results | Citation | FWCI |
|---|---|---|---|
| | age, when neuroplasticity is still high; (2) it promotes the creation of an inclusive ECE environment by reducing the stigma that CP is unchangeable; and (3) it requires close collaboration between teachers, parents, and medical teams so that therapies such as NIBS can be integrated with functional exercises at school | | |
| Cadenas-Sánchez et al. (2016) | A randomized controlled trial designed to demonstrate that structured physical exercise not only improves the physical condition of overweight children but also enhances their brain function, cognitive abilities (such as attention and working memory), and mental health. In the context of early childhood education (PAUD), these findings are crucial because the 0–6-year-old period is the golden age for habit formation and brain development; high-quality PAUD programs must incorporate daily guided physical activities—not just free play—because movement has been proven to enhance school readiness, reduce the risk of early-onset obesity, and build children's self-esteem and mental health, especially for those who are already overweight | 94 | 4.78 |
| Cangussu et al. (2024) | A combination of non-invasive brain stimulation (tDCS) and physical therapy can improve motor function in children with cerebral palsy (CP) more effectively than physical therapy alone. In the context of early childhood education (PAUD), this research is highly relevant because CP is typically detected between the ages of 0 and 3, and early intervention is crucial for maximizing the child's brain neuroplasticity. For ECE teachers, understanding this therapy encourages early detection of motor delays and prompt referral to medical professionals, creates an inclusive environment that | 1 | 0.25 |

| Identity | Results | Citation | FWCI |
|---|---|---|---|
| | reduces the stigma that children with CP "cannot change," and fosters active collaboration with therapists and parents so that motor exercises can be continued in the daily classroom setting (e.g., grasping or balance exercises). | | |
| Chen et al. (2021) | the synergistic effects of hydrotherapy (warm water therapy that relaxes muscles and facilitates movement) and non-invasive brain stimulation (tDCS) to improve motor function in children with cerebral palsy (CP). In the context of early childhood education (PAUD), this research is highly relevant because CP is typically detected between the ages of 0–4 years, and this combination of therapies is enjoyable and aligns with the principles of early childhood learning, which are based on play and sensory experiences. For ECE teachers, understanding hydrotherapy + tDCS facilitates early detection of motor delays and prompt referral to medical professionals, creates an inclusive environment where children with CP can participate more actively once their motor function improves, and incorporates hydrotherapy principles (slow, relaxed movements, in a supportive medium) into daily classroom activities (e.g., playing with water in a basin, imitating the movements of aquatic animals, or balance exercises accompanied by music) | 4 | 0.12 |

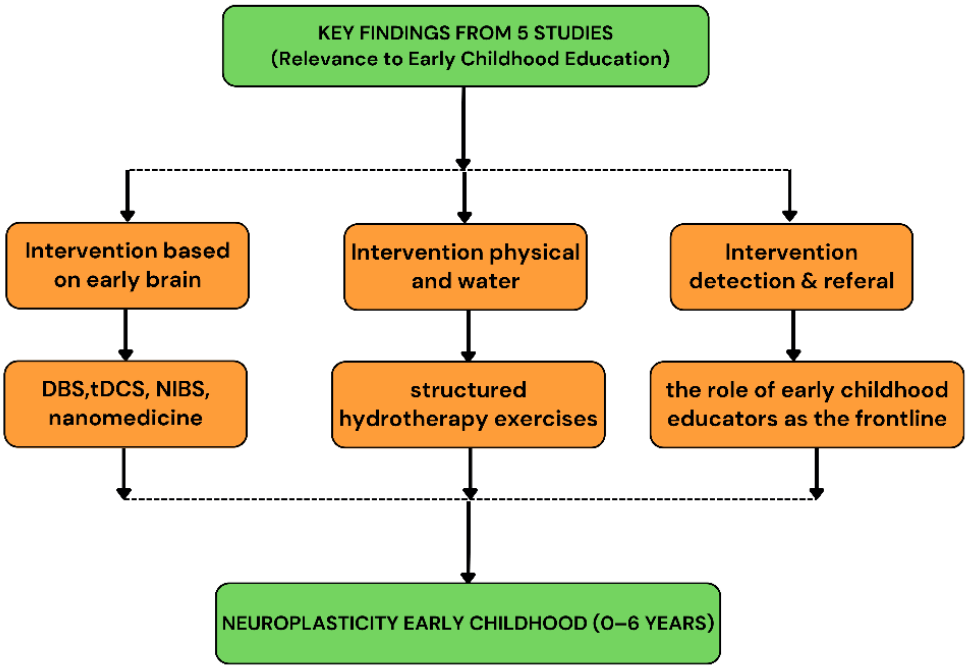


**Figure 9.** Thematic literature

Based on Table 1 and Figure 9, which summarize the results of five relevant studies, the literature findings relate to neurokinetics. The findings indicate that the five relevant studies can be divided into three intervention categories: early brain intervention, physical and water intervention, and detection and referral. The results of the early brain intervention demonstrate a connection to brain simulation, as shown in the research by Gorodetsky et al. (2025). Their study explains that testing the brain through movement activities shapes behavior via motor skills. In this context, neurokinesthetics serves as an alternative for young children through physical activities aimed at shaping behavior.

Psychologically, physical activities performed by young children stimulate motor skills, which then send signals to the brain (Smits-Engelsman & Verbecque, 2022). These findings underscore the importance of educating young children about physical activities, thereby fostering motor skill development and brain stimulation. Furthermore, this study found that detection and physical interventions are linked to brain stimulation. According to Mufti et al. (2024), intervention detection is related to physical activity, whereby young children experience the activity and send signals to the brain. In this context, teachers are needed to guide the physical activities young children perform. Teachers' role in neurokinesthetic physical activities is to supervise young children as they perform them and prevent errors and injuries (Invernizzi et al., 2022). This study provides information for evaluating research on neurokinesthetics as an alternative form of physical activity for developing motor skills in young children. This study aims to contribute to quality education for young children who learn through physical activities designed to develop motor skills and stimulate the brain.

This study has several important implications for early childhood education. Neurokinesthetics can be considered an alternative approach to designing physical activities that simultaneously stimulate children's motor and cognitive development, rather than treating motor development solely as a physical outcome (Fitria et al., 2026; Wardoyo & Utanto, 2025). These research trends can guide early childhood educators and curriculum developers in designing developmentally appropriate learning activities that integrate movement, coordination, balance, attention, and cognitive stimulation. The findings highlight the importance of integrating neuroscience-informed physical activities into early childhood education to promote holistic child development and improve the quality of early learning. Finally, the study provides a foundation for future empirical research to examine the effectiveness of neurokinesthetics-based interventions in improving specific motor and cognitive outcomes among young children across different educational contexts.

## CONCLUSION

**Fundamental Findings:** The research conducted concludes that the relevant research methodologies for neurokinesthetics are experiments and systematic literature reviews. These research methods are relevant because experiments provide research implications and allow for comparisons. Meanwhile, systematic literature reviews are relevant because neurokinesthetics still requires long-term evaluation. **Implication:** This neurokinesthetic research has evolved into physical activities applied to humans to stimulate the brain. This presents an opportunity for future researchers to apply neurokinesthetics as a form of physical movement. Additionally, the research findings indicate that a significant percentage of the study subjects were involved in psychology-related themes. This aligns with the theme of early childhood education, which is closely tied to child psychology. The evaluation results also indicate that neurokinesthetics serves as an alternative for early childhood education through physical activities aimed at shaping behavior. In this context, teachers can implement this approach through neurokinesthetic physical activities. **Limitation:** This study employs a bibliometric approach to examine the impact of brain stimulation (via physical activity) in early childhood education, though it is limited by the number of documents and the scope of the Scopus database. **Future Research:** Specific objectives are recommended to contribute to quality education for young children by utilizing physical activities to develop motor skills and stimulate the brain.

## AUTHOR CONTRIBUTIONS

**Sulis Setyarini** was coordinator research and manuscript writing. **Rachma Hasibuan & Ruqoyyah Fitri** processed and analysed bibliometric data. **Nurul Istiq'faroh & Sayhidul Haq** performed data validation and discussion. **Andi Kristanto** supported the literature search, reference compilation, and final editing. All authors approved the final manuscript.

## CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest, either financial or personal, that could influence the content or results of this study.

## ETHICAL COMPLIANCE STATEMENT

This article has met the standards of research and publication ethics. The author affirms that this research is original, conducted with academic integrity, and free from unethical practices, including plagiarism.

## STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The final responsibility for the content of the manuscript rests entirely with the authors. The author declares that this manuscript was prepared entirely without the assistance of artificial intelligence (AI) or other digital tools. The entire process, from planning, data processing, analysis, to writing and editing the manuscript, was carried out manually by the author. Thus, full responsibility for the content and authenticity of this article rests solely with the author.

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