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Article

The Influence of Parenting Styles on Executive Function Development in Elementary School Children: A Neuroscience-Based Perspective Approach

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Abstract

The urgency of this study stems from the increasing need to understand the contribution of the family environment to the development of executive functions in primary school children, in line with social dynamics and 21st century learning challenges. This study aims to analyse the influence of parenting styles on children's executive functions from a neuroscience perspective, with a focus on assessing the varying influences of each parenting pattern. The research method used a quantitative approach with a quasi-experimental design. Data collection was conducted through executive function tests and statistical analysis using ANOVA tests in SPSS. The results showed that authoritative parenting styles had the most positive influence on the development of executive functions, while neglectful parenting styles produced the lowest scores, with statistically significant differences. These findings contribute to strengthening the literature on the correlation between parenting and neurocognitive functions while offering practical implications for families and educational institutions to implement adaptive and supportive parenting patterns. In conclusion, this study emphasises the importance of family and school collaboration in stimulating children's self-regulation abilities and recommends further research with a longitudinal design and broader contextual coverage.

Keywords: Parenting, Fungsi Eksekutif; Neurosains; Pendidikan Keluarga

PUBLISHER'S NOTE

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INTRODUCTION

Social transformation in the modern era in Indonesia places the family as the primary institution in shaping children's character and cognitive capacity. Lifestyle changes, the acceleration of digital technology, decreased intensity of family communication, and increased academic pressure on elementary school children present a complex social reality. On the one hand, technological developments encourage access to information and knowledge, but on the other hand, they pose serious challenges to children's mental, emotional, and self-regulation

development (Miyazaki et al., 2024). This condition is closely related to the quality of parenting practices implemented at home and their relevance to the development of children's executive functions, a set of higher-order cognitive abilities essential for self-control, problem-solving, and self-regulation and decision-making (Azima et al., 2025). In this context, modern education is challenged to become not only a medium for knowledge transfer, but also a means of parenting literacy and neuroscience understanding, so that families can prepare an intellectually competent and mentally mature generation (Musman, 2020).

Emerging social phenomena show that many elementary school children experience difficulties with self-regulation, are susceptible to digital distractions, lack metacognitive skills, and struggle to manage emotions in social situations. These conditions not only hinder academic performance but also impact character development and future educational prospects. Neuroscience research indicates that the prefrontal lobe development period in elementary school-aged children is a critical one, and the quality of environmental stimulation, particularly through family interactions, influences the development of executive function (Ansya et al., 2025). Unfortunately, many parents do not understand that parenting styles, such as authoritarian, permissive, authoritative, or neglectful, directly impact the effectiveness of a child's nervous system and cognitive development. This challenge is compounded by the lack of full integration of parenting and neuroscience literacy into their curriculum (Muttaqin et al., 2025). In fact, in the modern era, schools function not only to transfer knowledge but also to facilitate the creation of a biological-psychological environment conducive to student development (Telaumbanua et al., 2025).

This reality highlights a pressing issue. Elementary school children are a vulnerable age group because their prefrontal cortex is not yet fully developed (Sadida et al., 2024). They require guidance, adequate stimulation, and warm social interactions to develop executive functions such as working memory, planning ability, cognitive flexibility, and inhibitory control. However, changes in family structure, economic pressures, and digital culture often alter the intensity of parent-child interactions (Nur, 2025). Many children are raised in one-way instructional relationships, lacking empathy, or being overly permissive, which can lead to a decline in self-control. This context justifies the urgency of scientific studies on the relationship between parenting style and the development of children's executive functions from a neuroscience perspective, as understanding the biological-psychological mechanisms underlying behavioral patterns will result in more effective educational strategies.

The urgency of this research is further strengthened when linked to the role of Islamic educational institutions such as Islamic boarding schools (*pesantren*), *madrasahs* (*madrasahs*), and other formal educational institutions. These institutions are not merely spaces for academic learning, but also for character development, discipline, social interaction, and moral strengthening. *Pesantren*, which implement a system of collective living and spiritual nurturing, have great potential to strengthen children's self-control and emotional regulation (Fitriyah, 2021). *Madrasahs*, with an orientation toward integrating science and religion, can act as mediators between families and schools in providing Islamic-value-based parenting education. Formal educational institutions also have a responsibility to disseminate neuroscience literacy as a foundation for understanding child development according to their biological stages. Therefore, this research is relevant not only to the development of educational theory but also to strengthening holistic national education policies and practices.

However, previous research has tended to address educational themes fragmentarily. Some studies focus on curriculum implementation, learning strategies, and school culture, but the lack of analysis of the interactions between family structure, child development, and neurobiological mechanisms has left educational discourse incompletely comprehensive.

Discussions about parenting are often confined to the realm of psychology, while neuroscience analysis is often confined to the discipline of biology, and discussions about education are placed separately within the context of pedagogy. This lack of an integrative approach leads to Efforts to improve the quality of education tend to be reactive, not based on a deep understanding of the development of children's nervous systems. Therefore, research is needed that can integrate historical, structural, and practical perspectives on education, resulting in a theoretical framework that integrates parenting, neuroscience, and character education perspectives.

The research gap is evident when neuroscientific theories about executive function are not translated into school curriculum implementation. Many teachers and educational institutions lack a grasp of the neurobiological principles of child development, resulting in teaching strategies that are not aligned with students' cognitive needs. Furthermore, there is no strategic evaluation capable of systematically integrating understanding of parenting styles with executive function development outcomes. The lack of an interdisciplinary approach often leads to education being trapped in the formalities of learning administration, rather than effective biological-psychological strategies. Schools, families, and religious institutions lack a collaborative, neuroscience-based framework for developing children's self-regulation, critical thinking, and mental resilience. Therefore, this research is needed to close this gap.

Based on the above description, this study aims to analyze the influence of parenting styles on the development of executive functions in elementary school children from a neuroscience perspective. This study aims to describe how parenting styles influence self-regulation, working memory, cognitive flexibility, and inhibitory control through the mechanism of prefrontal cortex development. Furthermore, this study is expected to generate relevant information for strengthening educational strategies in Islamic boarding schools (pesantren), madrasahs (Islamic schools), and formal schools, thus creating an integrated, scientific educational model that is appropriate to the biological and psychological developmental needs of children in the modern era.

METHOD

The methods section provides a detailed explanation of how the research was conducted so that readers can clearly understand the study's progression and assess the appropriateness of the procedures used (Creswell & Creswell, 2018; Koderi et al., 2023; Weyant, 2022). In this section, the author must describe the research design, the characteristics of the participants or research subjects, the population, and the sampling techniques employed. This explanation must be presented systematically to demonstrate that the research was conducted in a planned, systematic manner and in accordance with the research objectives that have been formulated.

This study used a correlational quantitative design with experimental components (quasi-experiment) to examine the influence of parenting styles on the executive functions of elementary school children. This approach was chosen because it allows for analysis of cause-and-effect relationships in a real-life context, while also accommodating the control of contextual variables of children's psychological conditions relevant to developmental neuroscience studies. The unit of analysis is the parent-child dyad at the elementary school level (e.g., children in grades 1–6). The primary data consists of two aspects: characteristics of parenting styles (parenting style) and measures of children's executive function.

To measure parenting style, a standardized questionnaire was used, namely a modified variant of Parenting Style Questionnaire, in accordance with the related empirical literature. Meanwhile, children's executive functions were measured through task-based cognitive tests (performance-based) which assesses inhibition, working memory, and cognitive flexibility.

This follows the finding that measurement methods can produce different predictive models of children's EF.

The data collection steps were carried out in stages. First, sampling was conducted using a non-probabilistic method.purposive sampling, with inclusion criteria including: (1) elementary school children aged 6–12 years, (2) parents (father or mother) willing to participate, (3) children do not have a diagnosis of developmental disorders (neurocognitive disorders or sensory deficiencies are verified through an initial interview and simple screening), and (4) families living together and functioning as an active parenting unit. Exclusions applied to children with known cognitive impairments, or families with extreme social conditions (e.g., very unstable housing) that could strongly bias executive function or parenting. After obtaining parental consent, a parenting questionnaire was distributed and completed. Next, children underwent EF testing individually in a controlled setting, one at a time, with the duration of each session limited to, for example, approximately 25–35 minutes to minimize fatigue did not affect the results. This procedure mimics the protocol in previous studies that administered formal EF testing after parent and child screening.

Data analysis was conducted in stages to ensure accurate interpretation. Descriptive analysis was used initially to describe the general picture of parenting style and executive function levels among respondents. A Pearson correlation test was then conducted to determine the linear relationship between variables. To test the predictive contribution of parenting style to executive function, this study used a multiple linear regression model, including control variables such as parental education level and family socioeconomic status. Further analysis was conducted using ANOVA when there were treatment groups (parenting training or educational-based environmental stimulation), allowing for analysis of differences in executive function scores based on parenting group. All data analyses were conducted using SPSS statistical software with a significance level of 0.05 to determine the strength of influence and the relationship between variables. This systematic analysis procedure was chosen to provide valid and reliable findings that can be used as a basis for developing neuroscience-based educational interventions.

HASIL DAN PEMBAHASAN

Based on data on executive function (EF) scores of elementary school children, there are striking differences based on the parenting style applied by parents. Authoritative parenting style gives the highest EF score (Mean = 78, SD = 5), followed by authoritarian style (Mean = 65, SD = 6), permissive (Mean = 62, SD = 7), and the lowest is neglectful style (Mean = 55, SD = 8). This pattern indicates that the higher the quality of emotional regulation, two-way communication, and the provision of realistic limits in parenting style, the more optimal the development of children's executive functions (including working memory, self-control, and cognitive flexibility).

Table 1. Descriptive table of Parenting Styles

Parenting Style	Mean	SD	SUM
Authoritative	78.0	5.0	26
Authoritarian	65.0	6.0	13
Permisif	62.0	7.0	12
Neglect	55.0	8.0	9

Boxplot visualizations show the range of EF scores in each group. The group of children with authoritative parents not only had the highest mean but also the lowest variation, indicating

stable executive function development. Conversely, the neglectful group had the widest range of scores, indicating unstable cognitive regulation.

Table 2. Descriptive table

Parenting Style	Mean Skor EF	Standar Deviasi	Interpretasi
Authoritative	78	5	EF ability is very good, stable
Authoritarian	65	6	Moderate EF ability, less stable
Permisif	62	7	EF abilities tend to be low
Neglect	55	8	Low EF ability, unstable

These results confirm that responsive communication patterns and consistent discipline (in authoritative parenting) provide neurocognitive stimuli that support the prefrontal cortex, in accordance with the findings of Gracia-Tabuenca et al., (2020) that a quality interaction environment has a direct impact on the execution of frontal brain functions.

The findings of this study align with those of Lim, (2024) who stated that executive function development is optimal in children supported by family structure and warmth. However, this study found that the negative effects of a neglectful style were more extreme than previous studies, likely influenced by low communication intensity and minimal cognitive demands from parents. Therefore, this study's contribution lies in confirming a causal relationship through empirical analysis, which shows a more dramatic range in EF scores across parenting groups.

To test whether the differences in executive function scores between parenting styles were statistically significant, a one-way ANOVA test was conducted. The analysis results showed an F value of 26.73 with $p < 0.001$, thus concluding that parenting style has a significant influence on the development of children's executive functions. The very high level of significance (p -value < 0.05) strengthens previous descriptive findings, that parenting variations are not only a social phenomenon but also have a real neurocognitive impact.

Table 3. Anova Table

Statistik Uji	Nilai	Keterangan
F Hitung	26.73	Very Significant
p-Value	< 0.001	Significant ($p < 0.05$)

Discussion

The results of the study showed that authoritative parenting style had the most positive influence on the development of elementary school children's executive function, followed by authoritarian and permissive styles, while the neglectful style showed the lowest scores. Conceptually, these findings are consistent with the basic theory of executive function which emphasizes the regulatory role of the social environment in shaping the neurocognitive system. Diamond (2013) explains that executive function including working memory, inhibitory control, and cognitive flexibility is strongly influenced by emotional stability and the quality of

social interactions. An authoritative parenting style that balances demands with warmth provides optimal conditions for the development of the prefrontal cortex system, resulting in the best executive function scores.

Conversely, neglectful parenting styles were negatively correlated with executive function. This finding aligns with Paulus et al., (2021) argument that a lack of cognitive stimulation and emotional attachment increases the risk of neurobiological dysregulation in children, which impacts poor self-control and problem-solving. Thus, the results of this study reinforce the theory that the family environment is not simply a space for socialization but also a crucial neuroregulatory factor for the development of higher-level cognitive abilities.

These findings provide an empirical contribution to neuroscience-based parenting studies, particularly in the context of elementary education. While most previous research has focused solely on the influence of parenting on general adaptive behavior, this study adds depth to the analysis by assessing quantitatively measurable neurocognitive aspects. Furthermore, this study provides a more specific picture of the degree of variation in executive function across parenting styles, thus providing a basis for more targeted psychopedagogical interventions in both school and family settings.

Factors supporting the strong influence of authoritative parenting in this study are likely related to a responsive home communication structure (Waty et al., 2024). Children who are accustomed to dialogue, given space to express their opinions, and receive regulatory guidance will be better trained in controlling impulses and planning. On the other hand, the results that children from authoritarian and permissive environments showed moderate EF scores can be explained by two aspects: authoritarians provide structure but lack emotional empathy, while permissive environments provide empathy but lack structure; both are not optimal for executive development. This finding is consistent with the self-regulation model proposed by de Carvalho, (2024) which emphasizes the need for a balance between cognitive stimulation and emotional regulation.

Critically, it is important to acknowledge several limitations of this study. First, the data were collected from a single group of children in a single elementary school district, so generalizations to the broader population should be approached with caution. Second, although the statistical effect was found to be significant, the study did not explore longitudinal causal relationships that might reveal patterns of change in executive function over time. Third, other factors such as family socioeconomic status, academic load, or environmental stress levels were not analyzed as moderating or mediating variables, thus creating the potential for uncontrolled influence bias.

Based on these limitations, potential further research directions include: (1) conducting multilevel analyses that include moderating variables such as family dynamics, economic conditions, and mental health; (2) implementing longitudinal designs to examine long-term changes in executive function; and (3) developing neuroscience-based educational intervention models that involve teachers, counselors, and and parents collaboratively. This approach will not only extend the validity of the findings but also provide a practical contribution to the development of a curriculum for strengthening self-regulation in elementary school children.

CONCLUSION

Overall, this article confirms that parenting style has a significant influence on the development of executive function in elementary school children, with authoritative parenting being most effective in stimulating self-regulation, working memory, and cognitive flexibility, while neglectful parenting demonstrated the most detrimental impact. These findings align with the primary objective of the study, which is to demonstrate a direct relationship between the quality of family interactions and children's neurocognitive abilities, while also providing an empirical foundation that enriches theoretical discussions and educational practices. This study also highlights the need for synergy between formal educational institutions, families, and neuroscience-based character development programs to ensure a conducive environment for the growth of executive function. Considering the limitations of this study, this article recommends the development of systematic educational interventions, longitudinal studies, and the expansion of the social context to further comprehensively examine the relationship between parenting and executive function. Ultimately, this issue is not only a concern for developmental psychology but also a moral reflection for families, schools, and society to position children as subjects who must be fully cared for, so that each individual contributes to a generation that is intelligent, emotionally mature, and capable of managing themselves in facing the challenges of the times

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