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The Effect of Gadget Use on Gross and Fine Motor Development among Preschool Children: The Role of Primitive Reflexes

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Abstract

Excessive gadget use among preschool children may reduce physical activity and sensorimotor stimulation, thereby affecting primitive reflex integration and motor development. This study aimed to analyze the effect of gadget-use intensity and primitive reflex integration on gross and fine motor development among preschool children. A quantitative study with a cross-sectional design was conducted involving 100 preschool children in RT 01 RW 02 Sukasari Village, Bogor. Data were collected through measurements of gadget-use duration, primitive reflex examination, and assessment of gross and fine motor development using the Denver Developmental Screening Test (DDST). Data were analyzed using multiple linear regression with a significance level of 0.05. The results showed that gadget-use intensity significantly affected gross motor development ($p = 0.001$; $t = 3.365$) and fine motor development ($p = 0.003$; $t = 3.032$). Primitive reflex integration also had a significant effect on gross motor development ($p < 0.001$; $t = 7.654$) and fine motor development ($p < 0.001$; $t = 7.817$). Simultaneously, gadget-use intensity and primitive reflex integration significantly influenced children's motor development. Children who used gadgets for more than 2.7 hours per day were more likely to experience delayed motor development than those with approximately 2 hours of daily use. These findings indicate that excessive gadget use increases the risk of delayed motor development through reduced physical stimulation and emphasize the importance of parental supervision and active physical stimulation to support optimal motor development in preschool children.

INTRODUCTION

The rapid advancement of digital technology has significantly changed children's lifestyles, including preschool-aged children. Gadgets such as smartphones and tablets have become part of children's daily activities, serving not only as communication devices but also as media for entertainment and learning. According to the World Health Organization (WHO, 2019), excessive screen time during early childhood may negatively affect physical activity, sleep quality, and developmental outcomes. Similarly, the American Academy of Pediatrics recommends limiting screen exposure for preschool children to ensure optimal physical, cognitive, and psychosocial development (AAP, 2020).

Preschool age, ranging from four to six years, represents a critical period for child development. During this stage, children experience rapid growth in gross motor and fine motor abilities, which form the basis for future academic performance, social interaction, and independence (Chusna, 2017; Gieysztor et al., 2018). Gross motor development involves large

muscle activities such as running, jumping, balancing, and climbing, whereas fine motor development includes precise movements involving the coordination of the hands and fingers, such as writing, drawing, and manipulating small objects (Rohendi & Seba, 2017). Appropriate environmental stimulation and active physical play are essential for achieving optimal motor development.

The increasing accessibility of digital devices has substantially altered children's daily routines (Wulandari & Lestari, 2021). Many preschool children spend considerable time using gadgets for watching videos, playing games, or accessing educational applications. Although gadgets may provide educational benefits when used appropriately, prolonged screen exposure often reduces opportunities for physical activity and social interaction. Consequently, children become more sedentary, limiting experiences that stimulate motor skill development (Webster et al., 2019).

Several previous studies have demonstrated that excessive gadget use is associated with adverse developmental outcomes. Setiani (2020) reported that gadget use significantly influences children's social development. Agustin (2019) found a relationship between gadget use and emotional development among preschool children, while Husein (2022) reported that excessive gadget use was associated with decreased cognitive performance in children aged four to six years. Rahmawati and Latifah (2020) further demonstrated that increased gadget addiction negatively affected children's social-emotional development, whereas stronger mother-child interaction improved developmental outcomes. However, these studies primarily focused on cognitive, emotional, and social aspects rather than motor development.

Research specifically investigating the relationship between gadget use intensity and motor development remains limited. Andriani (2021) reported that the duration of gadget use did not significantly influence overall child growth and development. In contrast, Agustin et al. (2021) found that higher gadget-use intensity was significantly associated with poorer gross motor performance among preschool children. These inconsistent findings indicate that further investigation is required to clarify the relationship between gadget exposure and motor development.

From a neurophysiological perspective, prolonged gadget use may influence motor development through several mechanisms (Putra, 2017). Excessive screen exposure decreases children's participation in active movement, exploratory play, and sensory experiences that are essential for neuromuscular maturation. Novitandari et al. (2023) suggested that excessive gadget exposure may alter the balance of gamma-aminobutyric acid (GABA) and glutamate within the anterior cingulate cortex, potentially affecting motor function and overall brain development. Reduced physical activity also contributes to lower muscle strength, impaired coordination, and delayed acquisition of age-appropriate motor skills.

Motor development during preschool years is commonly assessed using standardized developmental screening instruments (Fadilah, 2015; Narullita, 2022; Purwanti et al., 2023). One of the most widely accepted developmental screening tools is the Denver Developmental Screening Test II (Denver II), which evaluates four developmental domains: personal-social, language, fine motor-adaptive, and gross motor development. Denver II has demonstrated excellent reliability and validity and is widely implemented in pediatric developmental screening programs (Sulistyawati, 2017).

The novelty of this study lies in three key aspects. First, this study simultaneously examines the effects of gadget-use intensity and primitive reflex integration on both gross and fine motor development, providing a more comprehensive understanding than previous studies that examined only one factor or one motor domain. Second, this study investigates this relationship in a community-based setting in Indonesia, reflecting children's actual daily lifestyles outside formal educational settings, which differs from clinical or institutional studies. Third, this study uses validated standardized instruments (Denver II and primitive reflex examination) with quantitative analysis, enabling the identification of specific threshold effects such as the finding that gadget use exceeding 2.7 hours per day increases the risk of motor delay.

In Indonesia, gadget ownership among young children continues to increase rapidly. Nevertheless, limited evidence is available regarding the relationship between gadget-use intensity and motor development among preschool children, particularly in community-based settings. Most Indonesian studies have focused on social, emotional, or cognitive development, while investigations addressing gross motor and fine motor development remain scarce. Furthermore, little evidence has been generated from local communities that reflect children's actual daily lifestyles outside formal educational settings.

RT 01 RW 02 Sukasari, Bogor, represents a community where gadget use among preschool children has become increasingly common. Parents frequently provide smartphones or tablets to occupy children during daily activities. Although this practice may provide temporary convenience, concerns have emerged regarding children's reduced physical activity and delayed motor skill acquisition. Scientific evidence from this community is therefore necessary to support parental education and guide healthcare professionals in developing appropriate intervention strategies.

Based on these considerations, this study aimed to analyze the relationship between the intensity of gadget use and gross motor as well as fine motor development among preschool children in RT 01 RW 02 Sukasari, Bogor. The findings of this study are expected to contribute to the existing literature regarding the developmental impact of gadget use in early childhood and provide evidence-based recommendations for parents, educators, and healthcare professionals in promoting healthy gadget use and optimal child development.

METHOD

This study employed a quantitative analytical research design using an observational approach with a cross-sectional design (Nursalam, 2019). The study was conducted to determine the relationship between the intensity of gadget use and gross motor and fine motor development among preschool children. Data on the independent and dependent variables were collected simultaneously during a single period of observation without any intervention from the researcher.

The research was conducted in RT 01 RW 02 Sukasari, Bogor, West Java, Indonesia. The study population consisted of preschool children aged 4–6 years residing in the study area. A total sampling technique was employed, resulting in 100 respondents who fulfilled the inclusion and exclusion criteria.

The inclusion criteria comprised children aged 4–6 years who resided permanently in RT 01 RW 02 Sukasari, regularly used gadgets, and whose parents or legal guardians agreed

to participate by signing informed consent. Children diagnosed with neurological disorders, congenital abnormalities, cerebral palsy, autism spectrum disorder, Down syndrome, or musculoskeletal disorders affecting motor development were excluded from the study.

The primary instruments used in this research were a structured questionnaire to assess the intensity of gadget use and the Denver Developmental Screening Test II (Denver II) to evaluate gross motor and fine motor development. The gadget-use questionnaire collected information regarding the duration of daily gadget use, frequency of use, age at first exposure to gadgets, type of gadget, type of digital activities performed, and parental supervision. Gross motor and fine motor performance were assessed using the standardized Denver II developmental screening instrument according to the official examination guidelines.

Data collection was conducted after obtaining ethical approval and permission from local authorities. Parents completed the gadget-use questionnaire, while children's motor development was evaluated directly by the researcher using Denver II. The examination procedures followed the standardized protocol described in the Denver II administration manual.

The collected data were processed through editing, coding, data entry, data cleaning, and tabulation. Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS). Descriptive (univariate) analysis was used to summarize participant characteristics, gadget-use intensity, and developmental outcomes by presenting frequencies, percentages, means, and standard deviations where appropriate.

Inferential (bivariate) analysis was conducted to determine the relationship between gadget-use intensity and gross motor development as well as fine motor development. Since the variables were measured on an ordinal scale and were not assumed to be normally distributed, Spearman's Rank Correlation test was employed. Statistical significance was established at a confidence level of 95% with a p-value of less than 0.05.

The study was conducted in accordance with research ethics principles, including respect for autonomy, beneficence, non-maleficence, justice, confidentiality, and anonymity. Participation was voluntary, and respondents were allowed to withdraw from the study at any stage without any consequences.

RESULTS AND DISCUSSION

Characteristics of Respondents

A total of 100 preschool children from RT 01 RW 02 Sukasari, Bogor, participated in this study. The respondents were assessed for gadget-use intensity, primitive reflex integration, and gross and fine motor development using the Denver Developmental Screening Test (DDST). The descriptive characteristics of the respondents are presented in Table 1.

Table 1. Characteristics of Respondents (n = 100)

Variable	Category	n	%
Primitive reflex integration	Normal	61	61.0
	Retained primitive reflex	39	39.0
Gross motor development	Normal	43	43.0
	Delayed	57	57.0
Fine motor development	Normal	49	49.0
	Delayed	51	51.0

Source: Primary data processed, 2025.

Table 1 shows that most preschool children had normal primitive reflex integration (61%), whereas 39% still demonstrated retained primitive reflexes. Although the majority had normal neurological maturation, more than one-third of the respondents continued to exhibit persistent primitive reflexes, indicating incomplete maturation of the central nervous system. Retained primitive reflexes beyond infancy may interfere with postural control, balance, bilateral coordination, and voluntary motor performance.

Regarding motor development, 57% of the children experienced delayed gross motor development, while only 43% achieved age-appropriate gross motor performance. Similarly, delayed fine motor development was identified in 51% of the respondents, whereas 49% demonstrated normal fine motor skills. These findings indicate that motor developmental delay remains common among preschool children in the study area.

The descriptive findings suggest that delayed motor development may be associated with both neurological and environmental factors. Therefore, further statistical analyses were conducted to determine whether gadget-use intensity and primitive reflex integration significantly influenced gross and fine motor development.

Effect of Gadget-Use Intensity on Gross Motor Development

The effect of gadget-use intensity on gross motor development was analyzed using multiple linear regression. The results of the partial regression analysis are presented in Table 2.

Table 2. Effect of Gadget-Use Intensity on Gross Motor Development

Variable	t-value	p-value	Decision
Gadget-use intensity	3.365	0.001	Significant

Source: Primary data processed, 2025.

The regression analysis demonstrated that gadget-use intensity significantly affected gross motor development among preschool children ($t = 3.365$; $p = 0.001$). Since the p-value was less than 0.05, the null hypothesis was rejected, indicating that higher gadget-use intensity was significantly associated with poorer gross motor development.

The mean analysis further demonstrated that children with normal gross motor development used gadgets for an average of **2.02 hours/day**, whereas children with delayed gross motor development had an average daily gadget use of **2.74 hours/day**. These findings indicate that an increase of approximately **0.72 hours per day** in gadget use was associated with poorer gross motor performance.

Gross motor development during the preschool period depends on continuous opportunities to perform movement-based activities such as running, jumping, climbing, balancing, and object manipulation. These activities stimulate vestibular, proprioceptive, and tactile systems that contribute to postural control, muscle coordination, and motor planning. Excessive gadget use may replace these essential movement experiences with prolonged sedentary behaviour, thereby reducing neuromuscular stimulation required for optimal motor maturation.

The present findings support neurodevelopmental theory, which emphasizes that active sensorimotor experiences are essential for cortical maturation and motor learning. Children who spend prolonged periods interacting with digital devices have fewer opportunities to

explore their physical environment, resulting in decreased motor practice and slower acquisition of age-appropriate gross motor skills. Reduced physical activity may also contribute to weaker postural stability, poorer balance, and decreased coordination, thereby increasing the risk of motor developmental delay.

These findings are consistent with previous studies reporting that excessive screen time is associated with lower physical activity levels and delayed gross motor development among preschool children. Nevertheless, the present study suggests that the developmental impact is not solely determined by gadget use itself but also by the duration of exposure. Therefore, limiting children's daily screen time while increasing opportunities for active physical play should be considered an important strategy for promoting healthy gross motor development.

Effect of Gadget-Use Intensity on Fine Motor Development

The effect of gadget-use intensity on fine motor development was analyzed using multiple linear regression. The results of the analysis are presented in Table 3.

Table 3. Effect of Gadget-Use Intensity on Fine Motor Development

Variable	t-value	p-value	Decision
Gadget-use intensity	3.032	0.003	Significant

Source: Primary data processed, 2025.

The results presented in Table 3 indicate that gadget-use intensity had a statistically significant effect on fine motor development among preschool children ($t = 3.032$; $p = 0.003$). Since the significance value was lower than 0.05, the null hypothesis was rejected, indicating that prolonged gadget use significantly increased the risk of delayed fine motor development.

The mean analysis showed that children with normal fine motor development used gadgets for an average of **2.10 hours per day**, whereas children with delayed fine motor development had an average gadget-use duration of **2.75 hours per day**. This finding indicates that children who experienced fine motor delay were exposed to gadgets for approximately **0.65 hours longer per day** than children with normal fine motor development.

Fine motor development requires repeated opportunities to manipulate objects using coordinated movements of the fingers, hands, and eyes. Activities such as drawing, colouring, cutting, assembling puzzles, building blocks, writing, and self-care tasks provide important sensorimotor experiences that strengthen intrinsic hand muscles and improve eye-hand coordination. Although gadget use involves finger movement, these movements are generally repetitive and limited to tapping or swiping the screen. Consequently, excessive gadget use cannot replace the variety of manipulative activities required for optimal fine motor development.

From a neurodevelopmental perspective, fine motor performance depends on the integration of visual perception, proprioception, tactile sensation, motor planning, and executive function. Continuous engagement in meaningful hands-on activities promotes cortical maturation and strengthens neural pathways responsible for manual dexterity and coordinated movement. Conversely, prolonged sedentary screen-based activities reduce children's opportunities to interact with three-dimensional objects and explore their environment through active manipulation. As a result, excessive gadget use may contribute to

poorer manual coordination, reduced finger dexterity, and delayed development of school-readiness skills such as drawing and writing.

The findings of this study are consistent with previous research demonstrating that prolonged screen exposure is associated with lower fine motor competence in preschool children. Children with excessive gadget use often spend less time participating in creative play and object manipulation, both of which are fundamental for the development of precise hand movements. However, several studies have suggested that the developmental effects of digital devices are influenced not only by screen-time duration but also by the quality of digital content, parental supervision, and the availability of complementary physical activities. Therefore, digital technology should be used appropriately as a complementary learning medium rather than replacing active play and direct interaction with the physical environment.

These findings have important implications for parents, educators, and pediatric rehabilitation professionals. Parents should establish appropriate limits on children's daily gadget use while encouraging participation in activities that stimulate fine motor development, including drawing, colouring, crafts, construction games, and other manipulative play. Pediatric physiotherapists should also assess children's screen-time habits during developmental screening and provide family-centred education regarding the importance of balancing digital media use with adequate sensorimotor stimulation. Such strategies are expected to promote optimal fine motor development and improve children's readiness for academic and daily functional activities.

Effect of Primitive Reflex Integration on Gross and Fine Motor Development

The differences in gross and fine motor development between children with normal primitive reflex integration and those with retained primitive reflexes were analyzed using the Mann–Whitney test. The results are presented in Table 4.

Table 4. Gross and Fine Motor Development Based on Primitive Reflex Integration

Primitive Reflex Integration	Gross Motor Normal n (%)	Gross Motor Delayed n (%)	Fine Motor Normal n (%)	Fine Motor Delayed n (%)
Normal (n = 61)	41 (67.2)	20 (32.8)	45 (73.8)	16 (26.2)
Retained (n = 39)	2 (5.1)	37 (94.9)	4 (10.3)	35 (89.7)
Mann–Whitney (p-value)	**<0.001**		**<0.001**	

Source: Primary data processed, 2025.

Table 4 demonstrates a significant difference in both gross and fine motor development between preschool children with normal primitive reflex integration and those with retained primitive reflexes. The Mann–Whitney test showed a statistically significant difference for both gross motor and fine motor development ($p < 0.001$), indicating that primitive reflex integration status is strongly associated with children's motor performance.

Among children with normal primitive reflex integration, 67.2% demonstrated normal gross motor development, whereas only 32.8% experienced gross motor delay. In contrast, 94.9% of children with retained primitive reflexes exhibited delayed gross motor development, while only 5.1% achieved normal gross motor performance. These findings indicate that retained primitive reflexes substantially increase the likelihood of gross motor developmental delay.

A similar pattern was observed in fine motor development. Nearly three-quarters (73.8%) of children with normal primitive reflex integration achieved normal fine motor performance, whereas only 26.2% experienced developmental delay. Conversely, among children with retained primitive reflexes, 89.7% demonstrated delayed fine motor development, while only 10.3% showed age-appropriate fine motor skills. These findings suggest that incomplete primitive reflex integration is associated not only with impaired gross motor function but also with reduced fine motor competence.

Primitive reflexes are automatic movement patterns mediated by the brainstem that normally disappear during infancy as higher cortical centres mature. Their integration is a fundamental indicator of neurological maturation because it allows voluntary motor control, postural reactions, equilibrium responses, and coordinated movement to develop appropriately. When primitive reflexes persist beyond the expected age, they may interfere with efficient movement patterns by disrupting postural stability, bilateral coordination, body awareness, and motor planning. Consequently, children with retained primitive reflexes often experience difficulty performing age-appropriate motor tasks requiring coordinated movements.

The findings of this study support the neurodevelopmental model, which proposes that maturation of the central nervous system is a prerequisite for normal motor development. Persistent primitive reflexes indicate incomplete inhibition of lower brainstem activity by higher cortical structures, resulting in inefficient motor control and reduced movement quality. This neurological immaturity may explain why children with retained primitive reflexes in the present study consistently demonstrated poorer gross and fine motor performance than children with normal reflex integration.

An important observation in this study is that children with retained primitive reflexes frequently exhibited prolonged gadget use. Excessive screen exposure may reduce opportunities for crawling, climbing, balancing, and other sensorimotor experiences that naturally facilitate primitive reflex integration. Limited physical activity during early childhood may therefore delay neurological maturation and contribute to the persistence of primitive reflexes, which subsequently affects motor development. Although this study did not specifically test the causal pathway between gadget use and primitive reflex retention, the coexistence of these factors suggests a potential interaction that deserves further investigation through longitudinal research.

From a clinical perspective, these findings emphasize the importance of assessing primitive reflex integration during routine developmental screening. Pediatric physiotherapists should include primitive reflex examination as part of comprehensive motor assessment, particularly among preschool children presenting developmental delay or excessive gadget use. Early intervention focusing on postural control, balance, bilateral coordination, sensory integration, and movement-based activities may facilitate neurological maturation and improve children's functional motor performance.

Thus, the results demonstrate that primitive reflex integration is an important determinant of motor development among preschool children. Children with retained primitive reflexes were considerably more likely to experience delayed gross and fine motor development than children with normal neurological maturation. Therefore, early identification and appropriate intervention are essential to optimize children's motor development during the preschool years.

Simultaneous Effect of Gadget-Use Intensity and Primitive Reflex Integration on Gross and Fine Motor Development

To evaluate the combined effect of gadget-use intensity and primitive reflex integration on motor development, a simultaneous regression analysis (F-test) was performed. The results are presented in Table 5.

Table 5. Simultaneous Effect of Gadget-Use Intensity and Primitive Reflex Integration on Gross and Fine Motor Development

Independent Variable	F-value	p-value	Decision
Gadget-use intensity → Gross and fine motor development	6.926	0.002	Significant
Primitive reflex integration → Gross and fine motor development	48.120	<0.001	Significant

Source: Primary data processed, 2025.

Table 5 shows that both gadget-use intensity and primitive reflex integration had statistically significant simultaneous effects on children's motor development. Gadget-use intensity significantly influenced gross and fine motor development ($F = 6.926$, $p = 0.002$), while primitive reflex integration demonstrated an even stronger association ($F = 48.120$, $p < 0.001$). These findings indicate that both environmental exposure and neurological maturation contribute significantly to motor developmental outcomes among preschool children.

The descriptive analysis further demonstrated that children with normal gross motor development had an average gadget-use duration of **2.02 hours per day**, whereas children with delayed gross motor development used gadgets for an average of **2.74 hours per day**. Similarly, children with normal fine motor development used gadgets for approximately **2.10 hours per day**, while those with delayed fine motor development had an average screen-time duration of **2.75 hours per day**. These findings suggest that prolonged gadget exposure is consistently associated with poorer motor performance.

Although gadget-use intensity independently influenced motor development, the magnitude of the statistical effect observed for primitive reflex integration was substantially greater. This finding suggests that neurological maturation plays a central role in determining children's motor competence. Primitive reflexes represent early automatic movement patterns that should gradually disappear as cortical control develops. When these reflexes persist beyond infancy, they interfere with postural control, balance, bilateral coordination, and voluntary movement, thereby increasing children's vulnerability to motor developmental delay.

The interaction between excessive gadget use and retained primitive reflexes provides an important explanation for the findings of this study. Prolonged screen exposure often replaces physical activities such as crawling, climbing, jumping, balancing, and outdoor play, which are essential sources of vestibular, proprioceptive, tactile, and visual stimulation. Reduced movement experiences may slow neurological maturation and limit opportunities for integrating primitive reflexes. Consequently, children with both prolonged gadget exposure and retained primitive reflexes represent the group at greatest risk for delayed gross and fine motor development.

These findings support ecological and neurodevelopmental theories, which propose that children's development is shaped through continuous interactions between biological maturation and environmental experiences. Appropriate neurological maturation provides the

foundation for efficient motor control, whereas active physical experiences strengthen sensorimotor integration and motor learning. Disturbance in either process may compromise children's ability to acquire age-appropriate motor skills.

From a pediatric physiotherapy perspective, the present findings emphasize the importance of comprehensive developmental assessment. Screening should include evaluation of children's daily screen-time habits together with examination of primitive reflex integration. Children identified with excessive gadget use and retained primitive reflexes should receive early intervention programs focusing on postural control, sensory integration, balance training, bilateral coordination, and movement-based play. Parent education regarding healthy screen-time practices should also become an integral component of developmental intervention.

Overall, the findings indicate that optimizing preschool children's motor development requires a multidimensional approach. Limiting gadget-use duration alone may not be sufficient unless accompanied by adequate sensorimotor stimulation and early identification of retained primitive reflexes. Therefore, collaborative efforts involving parents, educators, pediatric physiotherapists, and other healthcare professionals are essential to promote healthy neurological maturation and improve children's gross and fine motor development.

General Discussion

The present study demonstrates that gadget-use intensity and primitive reflex integration are important determinants of gross and fine motor development among preschool children. The findings consistently indicate that children who were exposed to gadgets for longer durations were more likely to experience delayed motor development, while children with retained primitive reflexes exhibited substantially poorer motor performance than those with normal neurological maturation. These results suggest that motor development during the preschool period is influenced by both environmental factors and biological maturation.

One of the principal findings of this study is that gadget-use intensity significantly affected both gross motor ($p = 0.001$) and fine motor development ($p = 0.003$). Children with delayed gross motor development had a mean gadget-use duration of 2.74 hours per day, compared with 2.02 hours among children with normal gross motor development. Likewise, children with delayed fine motor development used gadgets for an average of 2.75 hours per day, whereas those with normal fine motor development used gadgets for approximately 2.10 hours per day. These findings indicate that increasing screen-time duration is associated with a greater risk of motor developmental delay.

Prolonged gadget use may reduce children's opportunities to participate in physical activities that stimulate motor learning and neuromuscular development. During the preschool years, repeated experiences such as running, climbing, jumping, balancing, drawing, manipulating objects, and participating in outdoor play provide essential vestibular, proprioceptive, tactile, and visual stimulation required for motor maturation. When these activities are replaced by prolonged sedentary screen exposure, children receive fewer opportunities to develop postural control, coordination, balance, bilateral integration, and manual dexterity. Consequently, excessive screen time may contribute to delayed gross and fine motor development.

Another important finding of this study is the significant association between primitive reflex integration and motor development. Children with retained primitive reflexes

demonstrated markedly poorer motor performance than children with normal primitive reflex integration. Specifically, 94.9% of children with retained primitive reflexes experienced delayed gross motor development, while 89.7% experienced delayed fine motor development. In comparison, children with normal primitive reflex integration showed substantially better developmental outcomes. These findings indicate that neurological maturation is a fundamental prerequisite for the development of efficient voluntary movement. Primitive reflex integration reflects the maturation of higher cortical centres responsible for inhibiting automatic brainstem-mediated movement patterns. Failure of primitive reflex integration may interfere with postural stability, equilibrium reactions, motor planning, bilateral coordination, and body awareness. Consequently, children with retained primitive reflexes frequently demonstrate difficulties performing age-appropriate motor activities requiring coordinated movement, precision, and balance.

The findings also indicate that neurological maturation and environmental stimulation should not be considered independent processes. Although primitive reflex integration represents an intrinsic developmental process, adequate environmental stimulation through active physical play is necessary to support normal neurological development. Children who spend excessive time using gadgets may receive insufficient sensorimotor stimulation, thereby limiting opportunities to reinforce postural control, balance, and coordinated movement. This interaction may explain why children presenting both prolonged gadget exposure and retained primitive reflexes demonstrated the poorest motor performance.

The present findings provide important implications for pediatric physiotherapy practice. Developmental assessment should include evaluation of children's daily screen-time habits together with examination of primitive reflex integration. Early identification of excessive gadget uses and retained primitive reflexes enables pediatric physiotherapists to implement interventions focusing on sensory integration, postural control, balance training, bilateral coordination, and age-appropriate motor activities. Parent education regarding appropriate screen-time management should also be incorporated into preventive child health programs to minimize the risk of developmental delay.

This study also has important implications for parents, educators, and public health professionals. Parents should establish consistent limits on children's daily gadget use while encouraging participation in outdoor play and movement-based activities. Early childhood education programs should provide sufficient opportunities for active learning experiences rather than relying predominantly on digital media. Collaboration among families, schools, healthcare providers, and community health services is essential to create environments that support optimal child development during the critical preschool period.

The present study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships between gadget-use intensity, primitive reflex integration, and motor development. Second, the study was conducted in a single community with a relatively limited sample size, which may affect the generalizability of the findings. Future studies employing longitudinal designs with larger and more diverse populations are recommended to investigate the long-term effects of gadget exposure on neurological maturation and motor development.

Overall, this study demonstrates that prolonged gadget use and retained primitive reflexes are significant risk factors for delayed gross and fine motor development among

preschool children. Early developmental screening, appropriate regulation of children's screen time, and provision of adequate sensorimotor stimulation should therefore become integral components of child health promotion strategies to optimize neurological maturation and support children's motor development.

CONCLUSION

This study concluded that gadget-use intensity and primitive reflex integration are significant factors influencing gross and fine motor development among preschool children. Most children in RT 01 RW 02 Sukasari exhibited high gadget-use intensity, with an average daily duration exceeding 2.7 hours, which was associated with an increased risk of delayed motor development. Gadget-use intensity showed a significant partial effect on both gross motor and fine motor development, while children with retained primitive reflexes demonstrated significantly poorer motor performance than those with normal reflex integration. The highest prevalence of motor developmental delay was observed among children who experienced both prolonged gadget exposure and retained primitive reflexes. Furthermore, gadget-use intensity and primitive reflex integration simultaneously had a significant influence on children's motor development. These findings highlight the importance of limiting daily screen time and promoting active physical stimulation to facilitate primitive reflex integration and optimize motor development in preschool children. The results may serve as evidence for parents, healthcare professionals, and policymakers in developing strategies to support healthy child development.

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