



Puzzle Activities Enhances Fine Motor Skill Development in Preschool-Aged Children

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ABSTRACT

Background: rapid physical and psychological growth, especially fine motor development, characterizes the preschool period. Delays in fine motor skills can affect children's self-confidence and learning in the future.

Purpose: this study aimed to examine the effect of puzzle-based educational stimulation on fine motor outcomes among preschool children using the Denver Developmental Screening Test II (DDST II).

Methods: a quasi-experimental pretest–posttest control group design was employed, involving 46 children from TK Dharma Wanita 1 Keniten, Kediri, divided equally into intervention and control groups. Fine motor outcomes were assessed based on DDST II fine motor adaptive items, including tasks such as building towers, copying shapes, and drawing.

Results: the fine motor development status of preschool aged children in the intervention group increased from 60.9% at pretest to 100% at posttest, whereas the control group also showed a smaller improvement from 78.3% to 95.7%. The Wilcoxon test indicated a significant improvement within the intervention group ($p < 0.005$). However, the Mann Whitney U test showed no significant difference between the intervention and control groups in the posttest scores

Conclusion: puzzle-based stimulation effectively enhances children's fine motor development, highlighting its potential as an engaging educational strategy in early childhood programs

Keywords: DDST II; fine motor skills; preschool children; puzzle

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BACKGROUND

Preschool age is a critical stage of development, marked by rapid growth in both physical and mental abilities. During this period, the brain experiences significant acceleration in its development, commonly known as the rapid brain growth phase (NCDHHS, 2019). Fine motor development is a fundamental aspect of early childhood growth, encompassing the child's ability to perform small, precise movements such as grasping, cutting, drawing, and writing. During the preschool years, fine motor skills play a crucial role in preparing children for more advanced academic tasks (Maharani et al., 2024). Delays in fine motor development can result in learning challenges, reduced motivation to learn, and may even affect a child's personality, leading to low self-esteem and diminished confidence (Ludyanti et al., 2023). Fine motor development depends on the coordination between the eyes and small muscles to perform precise movements. Delays in this area can stem from various factors, including the child's personality, insufficient environmental stimulation, neuromuscular disorders, and problems with muscle tone (Utami, 2016).

Studies show that many countries, including Indonesia, have a high prevalence of fine motor developmental disorders. In 2019, 317 million children and young people were affected by health conditions contributing to a developmental disability (WHO, 2023). Additionally, according to UNICEF, around 3 million preschool-aged children in Indonesia (27.5%) experience fine motor developmental disorders (Unicef, 2019). Playing puzzle is one kind of stimulation which can enhance a child's development in a fun and engaging way. It has been demonstrated that puzzle-based activities can improve children's motor performance through enjoyable and structured stimulation (Anshori et al., 2024). Fine motor skill acquisition is enhanced by tasks that require repetition, active manipulation, feedback, and progressive challenge (Anshori et al., 2024). Puzzle play exemplifies these mechanisms where children repeatedly fit pieces, coordinate small finger movements and eyes, and gradually progress to more complex puzzles (Marhaeni et al., 2022). However, while prior research established short term benefits, few studies have examined sustained skill transfer or controlled for socioeconomic background, limiting the understanding of puzzle play's broader developmental impact.

Theoretically, puzzle play aligns with motor learning and cognitive development frameworks that emphasize active exploration, repetition, and feedback as key mechanisms for skill acquisition (Nadila et al., 2024). According to Piaget's constructivist theory, hands-on problem-solving activities such as puzzles help children integrate perceptual and motor experiences, thereby strengthening fine motor coordination (Mufidah et al., 2025). Similarly, motor learning theory highlights that task-oriented practice with increasing complexity such as fitting, turning, and manipulating puzzle

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pieces, enhances neural pathways responsible for precision movements and hand-eye coordination (Erawati & Adnyana, 2024).

Preliminary findings suggest that most students at TK Dharma Wanita 1 Keniten demonstrate underdeveloped fine motor skills. Teacher assessments using block building activities showed that many children struggled to arrange blocks correctly by size or numerical order. Limited learning media and inadequate stimulation appear to contribute to these delays. Therefore, integrating puzzle based educational play is expected to provide engaging, developmentally appropriate stimulation to support optimal fine motor development in preschoolers

OBJECTIVE

This study aimed to investigate the impact of puzzle activities on the fine motor development of preschool-aged children, assessed using the Denver Developmental Screening Test II (DDST II).

METHODS

This study employed a pretest-posttest control group design within a quasi-experimental framework. To evaluate improvements in children's fine motor skills, both the intervention and control groups underwent a pretest and posttest using the fine motor adaptive subset of the Denver Developmental Screening Test II (DDST II). Although DDST II is primarily a screening instrument, its fine motor adaptive domain (including tasks such as drawing, building towers, and copying shapes) has been previously used to evaluate intervention related changes in motor performance. The scoring followed the validated procedure outlined in the DDST II manual, focusing only on fine motor related items to ensure construct relevance.

The intervention consisted of structured puzzle-based activities conducted twice a week for four weeks, with each session lasting 30 minutes. Each session used age appropriate six to eight pieces wooden puzzles in week 1, progressing to twelve to sixteen pieces thematic puzzles (e.g., animals, daily activities) by week 4. The activities were conducted in small groups of 4-5 children under supervision to ensure standardization of instructions, time, and task difficulty. The control group participated in regular classroom play without puzzle involvement.

The study population consisted of 46 children who met the inclusion criteria: preschool-aged (3–6 years), physically and mentally healthy, and with parental consent. The sample was selected using a non-probability sampling technique based on inclusion criteria. No a priori power analysis was conducted, so the relatively small sample size may limit generalizability and the ability to detect small effects.

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Data were analyzed using descriptive statistics and the Wilcoxon signed rank test to compare pretest and posttest scores within groups, and the Mann Whitney U test to assess between group differences. Statistical significance was set at $p < 0.05$.

The study received ethical clearance from the Ethics Committee of the Faculty of Medicine, Universitas Brawijaya (Approval No. 357/EC/KEPK-S1-KB/10/2024).

RESULTS

Respondent Characteristics

Table 1. Frequency Distribution of Respondent Characteristics

Characteristics	Categorized	n	%
Age	3 Yo	0	0
	4 Yo	3	6.5
	5 Yo	18	39.1
	6 Yo	25	54.3
Sex	Male	25	54.3
	Female	21	45.7
Number of Family	Nuclear family	28	60.9
	Extended family	18	39.1
Mother's education	Primary school	8	17.4
	Secondary school	21	45.7
	Senior high school	14	30.4
	Collage/ University	3	6.5
Mother's occupation	No work	42	91.3
	Work	4	8.7
Father's education	Primary school	14	30.4
	Secondary school	21	45.7
	Senior high school	10	21.7
	Collage/ University	1	2.2
father's occupation	No work	0	0
	Work	46	100.0
Family income	Low	19	41.3
	Middle	16	34.8
	High	11	23.9

Table 1 presents the demographic characteristics of the study's respondents, consisting of 46 preschool-aged children and their families. The majority of the children were 6 years old (54.3%), followed by those aged 5 years (39.1%), and a small proportion aged 4 years (6.5%); no respondents were aged 3 years. In terms of gender, 54.3% were male and 45.7% were female. Regarding family structure, most children (60.9%) lived in nuclear families, while 39.1% lived in extended families. In terms of maternal education, the highest proportion of mothers had secondary education (45.7%), followed by senior

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high school (30.4%), primary school (17.4%), and only 6.5% had a college or university degree. Most mothers were not employed (91.3%), while 8.7% had a job. For paternal education, 45.7% of fathers had secondary education, followed by primary school (30.4%), senior high school (21.7%), and only 2.2% had completed higher education. All fathers (100%) were reported as employed. In terms of economic background, 41.3% of families were in the low-income group, 34.8% were classified as middle-income, and 23.9% belonged to the high-income category.

Table 2. Fine Motoric Skills in Pre Aged School Children Before Intervention

		Normal	Suspect	Untestable	Total	P-value
Intervention group	n	14	9	0	23	0.046
	%	60.9	39.1	0	100	
Control group	n	18	5	0	23	
	%	78.3	21.7	0	100	

Table 2 presents the baseline fine motor development status of preschool-aged children in the intervention and control groups before the intervention was implemented. The assessment results are categorized into three classifications: Normal, Suspect, and Untestable. From 23 participants in intervention group, 14 children (60.9%) were categorized as having normal fine motor development and 9 children (39.1%) were categorized as suspect, indicating possible developmental delays. In the other hands, 18 children (78.3%) showed normal fine motor development and 5 children (21.7%) were in the suspect category in control group. No children (0%) were classified as untestable in either the intervention group or the control group.

Table 3. Frequency Distribution of Puzzle Activities

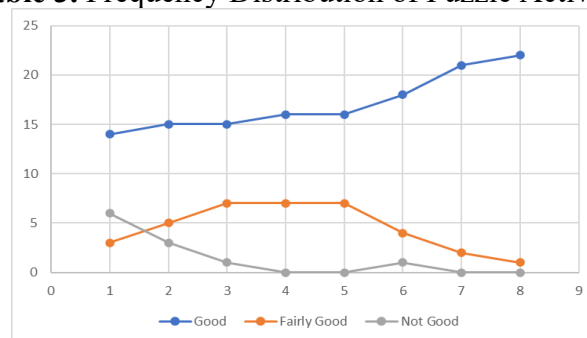


Figure 1. Children's Fine Motor Performance Throughout the Intervention

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Tabel 4. Analysis of the Effect of Puzzle Activities on Fine Motor Development in the Intervention Group

	Normal		Suspect		Untestable		Total	P-value
	n	%	n	%	n	%		
Pre test	14	60.9	9	39.1	0	0	23	0.003
Post test	23	100	0	0	0	0	100	

The table 4 shows the changes in fine motor development among children in the intervention group before and after participating in puzzle-based activities. The *p* value 0.003 indicates that puzzle-based activities had a positive and statistically significant effect on the fine motor development of children in the intervention group. After the intervention, all children reached the normal category, highlighting the effectiveness of the activity.

Tabel 5. Fine Motoric Skills in Pre Aged School Children After Intervention

		Normal	Suspect	Untestable	Total	P-value
		n	%	n	%	
Intervention group	n	23	0	0	23	0.317
	%	100	0	0	100	
Control group	n	22	1	0	23	
	%	95.7	4.3	0	100	

Table 5 presents the post-intervention fine motor skill outcomes in both the intervention group and the control group. All 23 children (100%) in the intervention group were classified as having normal fine motor development and no children fell into the suspect or untestable categories. There was a significant increase in the number of children with normal fine motor development in the intervention group, where 9 children were initially classified as suspect before the intervention. Meanwhile, in control group 22 children (95.7%) were classified as normal and 1 child (4.3%) was categorized as suspect, indicating a potential delay. However, Mann Whitney U Test indicates no significant difference between the two groups.

DISCUSSION

This study demonstrates that puzzle-based activities can effectively enhance fine motor development among preschool aged children. The improvement observed in the intervention group suggests that puzzles serve as an engaging form of task specific practice that strengthens the coordination of small muscles in the hands and fingers through repeated manipulation and problem solving.

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A puzzle is a simple yet stimulating game composed of interlocking image or shape pieces that must be arranged to form a complete picture (Diana, 2019). This activity requires children to demonstrate patience, perseverance, and concentration while assembling the pieces. Playing with puzzles enhances hand eye coordination and trains children to differentiate visual details and spatial relationships, thereby stimulating the right hemisphere of the brain and improving visual spatial intelligence which refers to an individual's ability to understand, imagine, recall, and reason using visual representations (Harmila et al., 2023). Puzzle play also enhances executive functions such as attention, cognitive flexibility, and planning, which indirectly contribute to better motor control. Studies in early childhood education have emphasized that puzzle-based activities foster persistence, self-regulation, and problem solving skills that align with the holistic development of preschoolers (Nadhira et al., 2024).

Puzzles based activity stimulates the five senses, trains patience, and enriches children's knowledge of colors, shapes, and sizes. However, the effectiveness of puzzle therapy is also influenced by other factors such as parental education, the child's gender, and the quality of guidance provided by therapists or teachers during play (Arisanti et al., 2022). Various stimulation strategies, such as using puzzles, recycled materials, and mosaic activities have been shown to effectively improve fine motor skills in young children (Paninsari et al., 2024). Additionally, factors like parental knowledge, nutritional status, and learning environments play a vital role in shaping motor outcomes. Studies highlighted in this review support the idea that fine motor development is closely linked to children's cognitive, emotional, and social growth (Maharani et al., 2024).

The consistent improvement observed in the children's performance throughout the eight puzzle activity sessions (table 3 and figure 1) reinforces the idea that repetitive and engaging tasks promote developmental gains. Puzzle therapy not only encourages cognitive control and sustained focus but also provides a motivating and developmentally appropriate strategy for children with attention difficulties (Mulyaningsih & Palangngan, 2020). Children who received puzzle therapy demonstrated greater improvements in attention focus and self-regulatory behavior compared to those in the control group (Putri & Ririn, 2025). The findings suggest that attention enhancement plays a critical role in developing self-regulation, and puzzle-based play is an effective, engaging medium for achieving these outcomes (Winarsunu et al., 2022).

Interestingly, although the post-intervention differences between the intervention and control groups were not statistically significant, the within-group improvement in the intervention group was strong (Wigati et al., 2023). This may be due to the small sample size or other external factors. Moreover, as suggested by Unicef (2019), a lack of early stimulation is a common cause of developmental delays in Indonesian children. Therefore, integrating puzzle-based learning into early childhood education programs, particularly in settings with limited access to learning materials, could be a cost-effective

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and practical strategy to promote early developmental milestones (Yusuf et al., 2020).

This study acknowledges several limitations. First, the research involved a relatively small and non-random sample ($n = 46$), which restricts its statistical power and limits the generalizability of the findings. Future investigations should consider using larger sample sizes and randomized selection methods to improve external validity. Second, the intervention was conducted over a short duration of four weeks, which may not adequately reflect the sustained or long-term effects of puzzle-based stimulation on fine motor development. Therefore, longitudinal studies with extended observation and follow-up assessments are recommended to examine the persistence and transfer of acquired skills

CONCLUSION

This study demonstrated a significant improvement in the fine motor development of children who participated in puzzle-based activities, with all participants in the intervention group achieving normal developmental status after four weeks. However, the between-group comparison did not show a statistically significant difference, suggesting that while puzzle play has a positive developmental effect, the short intervention duration and small sample size may have limited the ability to detect broader group level differences.

Despite this, the findings emphasize the practical potential of puzzles as a low cost, engaging, and developmentally appropriate tool for stimulating fine motor growth in preschool settings. Teachers can integrate puzzle-based learning into daily classroom activities. At the policy level, early childhood education programs could incorporate affordable, locally produced puzzles into curricula to promote equitable access to motor skill development resources, especially in low resource environments.

For future research, longitudinal studies are recommended to assess the long-term retention and transfer of fine motor skills developed through puzzle play. Incorporating neurocognitive assessments (e.g., visuospatial reasoning, attention, and executive function) could help clarify the underlying mechanisms of improvement. Additionally, future studies should consider integrating puzzle activities with other motor skill interventions, such as drawing or threading tasks, to evaluate combined effects on overall motor proficiency.

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