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The effect of outdoor physical activity-based learning on gross motor skills and concentration among kindergarten children

Masrun*, Ardo Okilanda, Khairuddin, Andra Rizky Putra
Universitas Negeri Padang, Indonesia
*Corresponding Author: masrun@fik.unp.ac.id

ABSTRACT

Fundamental motor skills are essential for children's physical, cognitive, social, and emotional development. Balanced motor development and concentration support optimal growth and learning. This study examined the effectiveness of outdoor physical activity-based learning in improving gross motor skills and concentration among kindergarten children at the Development School of Padang State University. This quasi-experimental study employed a two-group pretest-posttest design involving 40 kindergarten children selected through purposive sampling and divided into a control group (n = 20) and an experimental group (n = 20). The experimental group participated in 16 outdoor physical activity sessions over about five weeks, while the control group followed the standard school curriculum, including routine gymnastics and regular physical activity. Gross motor skills were assessed using the Test of Gross Motor Development-2 (TGMD-2), and concentration was measured using the Sequential Number Search Test (SNST). Data were analyzed using a two-way mixed analysis of variance (mixed ANOVA). The analysis showed a significant Time × Group interaction for gross motor skills, $F(1, 38) = 28.605$, $p < .001$, and concentration, $F(1, 38) = 5.490$, $p = .024$, indicating that improvements from pretest to posttest differed significantly between the control and experimental groups. These findings indicate that structured outdoor physical activity-based learning can effectively support the development of gross motor skills and concentration among kindergarten children.

Keywords: outdoor, physical, gross motor, concentration

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INTRODUCTION

Early childhood is a critical period for developing fundamental movement skills and cognitive abilities that support children's participation in learning and daily activities. Gross motor skills, particularly locomotor and object-control skills, provide an important foundation for physical activity participation, coordination, confidence, and subsequent motor competence (Benda et al., 2021; Dapp et al., 2021; Malambo et al., 2022). Motor competence is also associated with broader cognitive, emotional, and social development during childhood (Józsa et al., 2023; Shi & Feng, 2022). At the same time, concentration is an important component of children's readiness to participate in learning because it enables them to maintain attention and engage with tasks for an appropriate period. The learning environment, activity characteristics, motivation, and opportunities to participate in engaging activities can influence children's concentration (Skalski et al., 2021; Slattery et al., 2022). Therefore, early childhood learning approaches that simultaneously provide meaningful movement experiences and opportunities to sustain children's attention are important for supporting holistic development.

Physical activity and outdoor learning environments offer children varied movement experiences through running, jumping, balancing, throwing, catching, and interactive games. Such activities can support the development of locomotor, object-control, balance, and

coordination skills (Jeon & Jun, 2021; Kiviranta et al., 2024; Zheng et al., 2024). Previous intervention studies have also demonstrated that structured physical activity and fundamental movement skill programs can improve motor competence among preschool-aged children (Fu et al., 2022; Hui et al., 2024). Evidence also suggests that physical activity interventions may benefit more than motor development, including cognitive functioning (Srinivas et al., 2021). Nature- and outdoor-based early childhood environments may additionally provide varied sensory and social experiences that encourage physical activity, engagement, and interaction (Mann et al., 2022; Vella-Brodrick & Gilowska, 2022). Thus, outdoor physical activity has considerable potential as a context for developmentally appropriate learning.

However, growing evidence for the benefits of physical activity does not, by itself, show that all outdoor activity produces equivalent developmental outcomes. Recent evidence indicates that the characteristics and structure of physical activity interventions matter, with structured interventions showing meaningful effects on fundamental movement skills in preschool children. Similarly, recent evidence syntheses have identified several types of physical activity interventions, including general structured physical activity, fundamental movement skill programs, cognitively engaging physical activity, and multilevel interventions, indicating that the field has moved beyond the question of whether physical activity is beneficial toward understanding which forms of intervention are most effective and for which outcomes. Nevertheless, further research is needed to examine how structured outdoor movement experiences can be deliberately integrated into kindergarten learning to address motor and attentional outcomes simultaneously. This distinction is important because outdoor activity may function as free play, whereas activity-based learning deliberately connects movement, repetition, interaction, and specific learning objectives.

The empirical context at UNP Development Kindergarten also highlights the need for a more structured approach to outdoor physical activity. Before the intervention, the school provided physical activities as part of its routine learning program, including regular gymnastics and other physical activities. However, these activities were not specifically structured to simultaneously target gross motor skills and concentration through repeated, progressive, and attention-demanding movement tasks. This context provided a basis for introducing a structured outdoor physical activity-based learning approach that integrated movement practice, interaction, and concentration within the kindergarten learning process. The novelty of this study lies in integrating these components into a structured outdoor learning strategy rather than treating outdoor physical activity merely as routine physical activity or free play. The study also extends empirical evidence to an Indonesian kindergarten context. Accordingly, this study aimed to examine the effect of outdoor physical activity-based learning on gross motor skills and concentration among children at the UNP Development Kindergarten.

METHOD

This study examined the effectiveness of an outdoor physical activity-based learning model in improving the motor skills and concentration of kindergarten children at the UNP Development School. The study used a quasi-experimental, two-group pretest-posttest design (C. J. Miller et al., 2020). The population consisted of kindergarten children aged 4–6 years at the UNP Development School. The researchers used purposive sampling to select children who met the study criteria. Inclusion criteria were children aged 4–6 years enrolled at the UNP Development School with parental/guardian permission. We excluded children who were sick or not permitted to participate. A total of 40 children met the selection criteria and participated in the study, comprising 17 boys and 23 girls. The participants were divided into two equal groups: a control group (n = 20) and an experimental group (n = 20). The sample size was determined by the number of eligible children available at the study site and the feasibility of implementing the intervention within the kindergarten setting.

The experimental group received motor learning through an outdoor physical activity-based model. In contrast, the control group continued with the conventional school curriculum, which included routine gymnastics and regular physical activities provided by the school. The

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control group did not receive the structured outdoor physical activity-based learning program implemented in the experimental group. The outdoor learning model was implemented through 16 sessions, held three times a week, and involved activities designed to enhance motor skills and concentration. These activities included jumping rope, hopping on one leg, throwing and catching tennis balls, playing black-and-white running games, engaging in playground games, and walking on a balance beam. To measure motor skill development, the study used the Test of Gross Motor Development-2 (TGMD-2), a standardized and widely used instrument (Apriyani et al., 2018; Bisi et al., 2017; Rey et al., 2020; Ulrich, 2000). TGMD-2 consists of two subtests, Locomotor and Object Control, which assess different aspects of gross motor skills in children.

Table 1. Samples

	Group	n
A	Control (Conventional)	20
B	Outdoor physical activity	20

Concentration data were collected using the Sequential Number Search Test (SNST), which has a validity of 0.8 and a reliability of 0.7. Table 2 presents the assessment norms for the concentration test.

Table 2. Concentration test assessment norms

No	Criteria	Description
1.	< 5	Very Low
2.	6 - 10	Low
3.	11- 15	Medium
4.	16 - 20	Good
5.	>21	Very Good

The data were analyzed using descriptive statistics, tests of normality and homogeneity, and a two-way mixed analysis of variance (mixed ANOVA). Time (pretest and posttest) was treated as the within-subjects factor, while group (control and experimental) was treated as the between-subjects factor. We conducted the mixed ANOVA separately for gross motor skills and concentration. The primary analysis focused on the Time × Group interaction to determine whether changes in the outcome variables from pretest to posttest differed between the control and experimental groups. We set statistical significance at $\alpha = 0.05$.

FINDINGS AND DISCUSSION

Findings

Gross motor skills data description

Gross motor skills data can be seen in Table 3.

Table 3. Gross motor skills data

	N	Range	Min	Max	Mean	Std. Deviation	Variance
Pretest A	20	16	18	34	25.05	4.947	24.471
Posttest A	20	15	21	36	30.50	4.123	17.000
Pretest B	20	16	18	34	25.15	5.153	26.555
Posttest B	20	13	34	47	39.30	3.975	15.800
Valid N (listwise)	20						

Based on Table 3, the mean gross motor skills score in the control group (Group A) increased from 25.05 in the pretest to 30.50 in the posttest. The standard deviation decreased from 4.947 to 4.123, indicating that the scores were less dispersed at the posttest than at the pretest. Similarly, the variance decreased from 24.471 to 17.000, indicating reduced variability in gross motor skills scores after the intervention period.

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In the experimental group (Group B), the mean gross motor skills score increased from 25.15 at pretest to 39.30 at posttest. The standard deviation decreased from 5.153 to 3.975, while the variance decreased from 26.555 to 15.800. These results indicate an increase in the mean gross motor skills score accompanied by reduced score variability from pretest to posttest. The increase in the experimental group was greater than that observed in the control group (Figure 1).

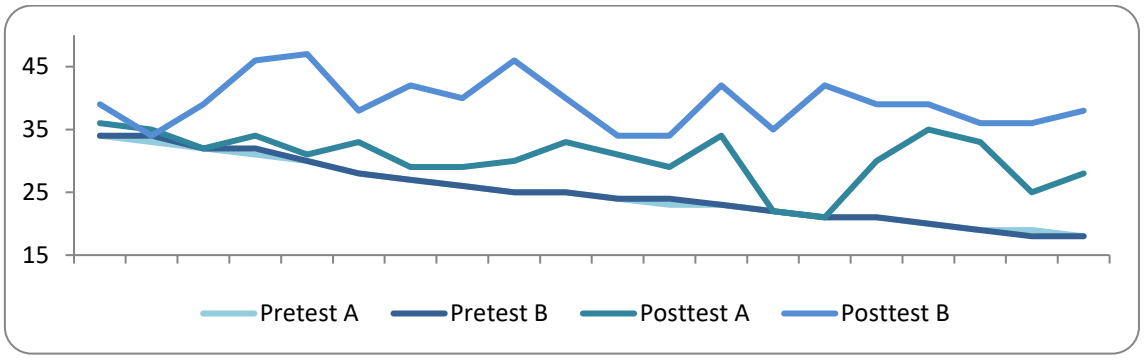


Figure 1. Motor Skills Data Graph

Concentration data description

Concentration data can be seen in Table 4.

Table 4. Concentration data

	N	Range	Min	Max	Mean	Std. Deviation	Variance
Pretest A	20	14	4	18	11.30	4.281	18.326
Posttest A	20	10	11	21	15.70	2.867	8.221
Pretest B	20	15	4	19	11.90	4.217	17.779
Posttest B	20	10	13	23	19.00	2.753	7.579
Valid N (listwise)	20						

Based on Table 4, the mean concentration score in the control group (Group A) increased from 11.30 in the pretest to 15.70 in the posttest. The standard deviation decreased from 4.281 to 2.867, while the variance decreased from 18.326 to 8.221. This indicates that, in addition to the increase in mean concentration scores, the score distribution became less variable at the posttest.

In the experimental group (Group B), the mean concentration score increased from 11.90 at pretest to 19.00 at posttest. The standard deviation decreased from 4.217 to 2.753, while the variance decreased from 17.779 to 7.579. These results indicate higher concentration scores and reduced variability among participants at posttest. The mean concentration score increased more in the experimental group than in the control group (Figure 2).

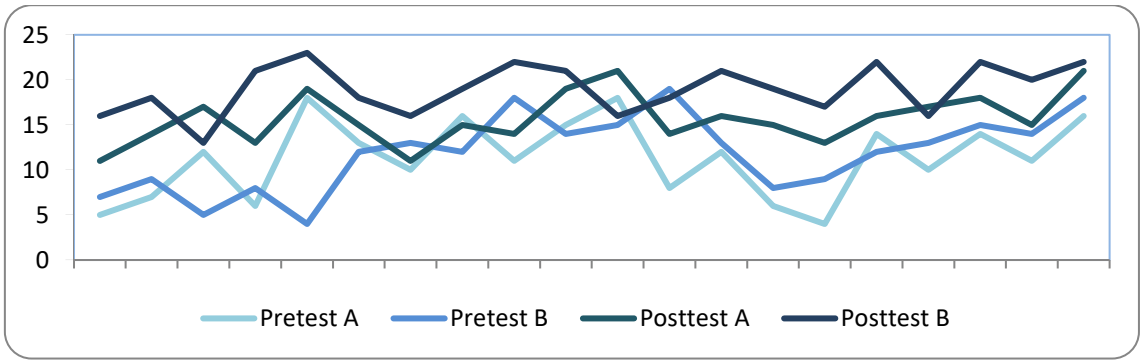


Figure 2. Concentration Data Graph

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Normality test

The normality test is a statistical procedure to determine whether the data in a sample comes from a normal distribution. The results of the normality test can be seen in Table 5.

Data is normally distributed if Sig > α 0,05
Data is not normally distributed if Sig < α 0,05

Table 5. Normality test results

		Tests of Normality Kolmogorov-Smirnov[a]				
		Motor Sig.	Description	α	Concentration Sig.	Description
Control Group	Pretest	.200*	Normal	0,05	.200*	Normal
	Posttest	.200*	Normal		.200*	Normal
Experimental	Pretest	.200*	Normal		.197*	Normal
Group	Posttest	.200*	Normal		.149*	Normal

Based on Table 5, all variables showed significance values greater than 0.05. For gross motor skills, the pretest and posttest data in both the control and experimental groups had significance values of .200. For concentration, the control group had significance values of .200 for both pretest and posttest. In contrast, the experimental group had significance values of .197 and .149 for the pretest and posttest, respectively. Therefore, all data were considered normally distributed and met the normality assumption for subsequent analysis.

Homogeneity Test

The homogeneity test was conducted to determine the variance similarity between the control and experimental groups. The results of the homogeneity test can be seen in Table 6.

Data is distributed homogeneously if Based on Mean Sig > α 0,05
Data is not homogeneously distributed if Based on Mean Sig < α 0,05

Table 6. Homogeneity test results

	Tests of Homogenity				
	Motor Sig.	Description	α	Concentration Sig.	Description
Based on Mean	.910	Homogeneous	0,05	.952	Homogeneous

Based on Table 6, the homogeneity test showed significance values of .910 for gross motor skills and .952 for concentration. Both values exceeded 0.05, indicating that the variances between the control and experimental groups were homogeneous. Therefore, the homogeneity assumption was met for both outcome variables before the mixed ANOVA.

Hypothesis test

The results of the hypothesis test can be seen in Table 7.

Table 7. Hypothesis test results

Variable	Effect	F	df	Sig.
Gross motor skills	Time	145.182	1, 38	< .001
Gross motor skills	Time × Group	28.605	1, 38	< .001
Concentration	Time	99.594	1, 38	< .001
Concentration	Time × Group	5.490	1, 38	.024

Table 7 presents the mixed ANOVA results. For gross motor skills, time showed a significant main effect, $F(1, 38) = 145.182$, $p < .001$, indicating a significant change from pretest to posttest across the two groups. More importantly, a significant Time × Group interaction was

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observed, F (1, 38) = 28.605, p < .001, indicating that the change in gross motor skills differed significantly between the control and experimental groups.

For concentration, the mixed ANOVA also revealed a significant main effect of time, F (1, 38) = 99.594, p < .001, indicating a significant change in concentration from pretest to posttest across the two groups. Furthermore, a significant Time × Group interaction was found, F (1, 38) = 5.490, p = .024, indicating that the change in concentration differed significantly between the control and experimental groups.

Discussion

The data analysis results support the hypothesis that outdoor physical activity-based learning significantly affects gross motor skills and concentration in kindergarten children. The mixed ANOVA results showed a significant Time × Group interaction for gross motor skills, F (1,38) = 28.605, p < .001, indicating that the improvement in gross motor skills from pretest to posttest differed significantly between the control and experimental groups. A significant Time × Group interaction was also found for concentration, F (1,38) = 5.490, p = .024. These findings indicate that participation in structured outdoor physical activities led to greater improvements in both outcomes than the control condition. Physical activity during early childhood supports children's physical development and may also contribute to broader cognitive and psychosocial development (Eyler et al., 2021; Szpunar et al., 2021; Tulchin-Francis et al., 2021).

The stronger effect observed for gross motor skills than for concentration may reflect the direct alignment between the intervention activities and the motor outcomes assessed in this study. The outdoor program provided repeated, structured opportunities to practice fundamental movement patterns, whereas concentration was assessed as a cognitive outcome that factors beyond physical activity may influence. The activities therefore matched more directly to gross motor skill development than to concentration, which may explain the larger improvement observed in the motor outcome.

The specific activities included in the intervention also provided different opportunities to engage the components assessed by the TGMD-2 and the concentration measure. Jumping rope and one-leg hopping required repeated control of body position, balance, coordination, and locomotor movement, which may have directly supported locomotor skill development. Throwing and catching tennis balls provided repeated practice of object-control movements while also requiring children to visually track the ball, respond to its movement, and maintain attention to the task. Similarly, black-and-white running games and playground activities required children to respond to instructions and game rules while performing locomotor movements, thereby combining movement practice with attentional demands. Balance beam walking placed particular demands on postural control, balance, and body coordination. Thus, although all activities contributed to an active learning environment, their most direct and repeated demands related to motor execution, consistent with the stronger improvement observed in gross motor skills.

Nevertheless, consider alternative explanations when interpreting these findings. The observed improvements may have been influenced not only by the outdoor physical activity-based learning model but also by teacher involvement, children's motivation and engagement, repeated exposure to the assessment procedures, and differences in the learning atmosphere between outdoor and indoor activities. Teacher encouragement and feedback may have increased children's participation, while the novelty and enjoyable nature of outdoor activities may have enhanced motivation. In addition, repeated testing may have contributed to familiarity with the assessment procedures. Differences in learning atmosphere, including greater space and opportunities for movement, may also have affected children's engagement and concentration. Because these factors were not independently controlled or measured in this quasi-experimental design, their potential contribution cannot be ruled out. Future studies should control for or measure these factors to clarify the specific contribution of structured outdoor physical activity-based learning to gross motor skills and concentration.

The improvement in gross motor skills observed in the experimental group is consistent with previous research showing that structured physical activity interventions can support children's motor development. Regular opportunities to practice fundamental movements provide

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children with repeated experiences in performing, controlling, and coordinating body movements (Khudolii et al., 2025; Marinšek & Denac, 2020). In the present study, the outdoor activities included jumping rope, one-leg hopping, throwing and catching a tennis ball, running games, playground activities, and walking on a balance beam. These activities provided opportunities for children to practice locomotors, object-control, and balance-related movements in an active and enjoyable setting. In addition, group-based physical activities give children opportunities to interact with peers, cooperate, and participate in shared activities (Liu et al., 2025).

Gross motor skill development is particularly important during the kindergarten period because children experience rapid growth in movement coordination and physical competence. Outdoor environments give children more opportunities to move, explore, and practice different movement patterns than restricted indoor settings. Previous research has indicated that outdoor play environments can support children's motor development by providing varied spaces and movement opportunities (Nanda et al., 2025; Taylor et al., 2024). The repeated practice provided during the 16 intervention sessions may also have contributed to improvements in movement performance. Furthermore, outdoor activities may expose children to varied movement challenges, requiring them to adjust their balance, coordination, speed, and body control during physical activity (Johnstone et al., 2022).

The findings also indicate that outdoor physical activity-based learning was associated with improved concentration among kindergarten children. Concentration is an important component of children's readiness to participate in learning activities because children need to maintain attention and respond appropriately to instructions and environmental stimuli. Previous research has demonstrated a relationship between physical exercise and cognitive functioning in children, suggesting that physical activity can provide benefits beyond physical development (Singh et al., 2025). In addition, researchers have examined interventions involving physical activity and other structured activities to improve sustained attention among children and adolescents (Ruhland & Lange, 2021). In the present study, outdoor activities involved varied movements, rules, objects, and game situations that required children to observe instructions, respond to stimuli, and maintain attention throughout the activity.

The outdoor learning environment may also provide children with a more varied and stimulating learning context. Exposure to natural and outdoor environments allows children to interact with different objects, spaces, and activities, increasing opportunities for exploration and active engagement. Research on nature-based learning has emphasized the potential of outdoor environments to support children's learning and development through direct experiences and interaction with the environment (Mann et al., 2021). In addition, nature-based experiences may support children's cognitive and psychological development by offering opportunities for active engagement outside conventional indoor learning environments (N. C. Miller et al., 2021). Therefore, outdoor physical activity-based learning may help develop physical abilities and create learning experiences that encourage children's attention and active participation.

Outdoor activities can also help children develop awareness of and positive relationships with their surrounding environment. Activities conducted in natural or outdoor settings allow children to experience their environment directly rather than learning about it only through verbal or classroom-based instruction. These experiences can shape children's awareness of, and attitudes toward, the natural environment (DeVille et al., 2021). Thus, incorporating outdoor activities into kindergarten learning may provide additional educational value by combining physical activity, exploration, and direct environmental experience.

Another important aspect of outdoor physical activity-based learning is the opportunity for social interaction. Many intervention activities were conducted individually within a group setting or involved interaction with peers. Through running games, ball activities, and playground activities, children had opportunities to communicate, follow rules, cooperate, and respond to peers' actions. Participation in play and physical activities can provide important contexts for children's peer interaction and social participation (Köngäs et al., 2022). Similarly, physical education interventions have been shown to support children's social and moral competence through structured interaction and participation (Bronikowska et al., 2024).

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Overall, the findings show that outdoor physical activity-based learning can provide meaningful opportunities to develop both gross motor skills and concentration among kindergarten children. The significant Time × Group interactions obtained from the mixed ANOVA indicate that the changes observed in the experimental group were significantly greater than those in the control group. These findings suggest that outdoor physical activity can be integrated into kindergarten learning as an approach that simultaneously provides opportunities for physical development, attention, exploration, and social interaction. However, because the study used a quasi-experimental design with a relatively small sample of 40 children, the findings should be interpreted in the context of the study population and intervention conditions. Future studies with larger samples, randomized designs, and longer follow-up periods are needed to examine further the effectiveness and sustainability of outdoor physical activity-based learning.

CONCLUSION

This study indicates that outdoor physical activity-based learning significantly improved gross motor skills and concentration among kindergarten children at the UNP Development Kindergarten. The mixed ANOVA showed significant Time × Group interactions for gross motor skills, $F(1,38) = 28.605$, $p < .001$, and concentration, $F(1,38) = 5.490$, $p = .024$. The experimental group demonstrated greater improvements from pretest to posttest than the control group. These findings suggest that structured outdoor physical activities can be effectively integrated into kindergarten learning to support children's gross motor development and concentration. However, these findings should be interpreted within the context of the 40 children from the UNP Development Kindergarten and the quasi-experimental design used in this study. They therefore should not be generalized beyond similar populations and settings without further evidence. Outdoor physical activity-based learning therefore offers a practical approach that combines physical movement with active, engaging learning experiences.

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