https://doi.org/10.7251/SSH26V072F
UDC: 159.922.7:[316.774:004.738.5
Original scientific paper
Originalni naučni rad

Improving Gross Motor Skills in Early Childhood: Through Aquatic Games and Coconut Shell Stilt Walking in Terms of Balance

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Abstract: *This research is based on the low level of aggressive motor skills in early childhood. This research aims to analyze: (1) the comparative effects of aquatic games and coconut shell stilts on the improvement of aggressive motor skills in early childhood. (2) The comparative effects of children with high and low balance on the improvement of aggressive motor skills in early childhood. (3) The interaction between aquatic games and coconut shell stilts in terms of balance on the increase in aggressive motor skills in early childhood. The research method used was an experiment with a 2 x 2 factorial design. The results showed that: (1) There was a significant difference in the effect of aquatic games and coconut shell stilts on the increase in aggressive motor skills, with a significance value of $p < 0.05$. The aquatic play model group performed better than the coconut shell stilts play model group in improving aggressive motor skills, with a posttest average difference of 1.2. (2) There is a difference in the effect between children with high and low balance on the improvement of aggressive motor skills in early childhood, with a significance value of $p < 0.05$. Children with large balance abilities were better than children with low balance abilities, with a posttest mean difference in aggressive motor skills of 1.8. (3) There is an interaction between aquatic game models and coconut shell stilts in terms of balance (high and low) on the increase in aggressive motor skills in children aged dni, with a significance value of p 0.000 < 0.05. Finally, it shows that the aquatic game model is a more efficient game model for children with high balance, and the coconut shell game model is more efficient for children with low balance.*

Keywords: *games; aquatic; coconut shell; balance; gross motor skills*

Introduction

Learning plays a significant role in children's lives because the development of character, mental behavior, and intellectual skills is built in early childhood. The quality of early childhood, including preschool, is a reflection of the quality of the nation to come. Early childhood education is intended as a foundation for children's future learning (Williams et al., 2019). Early childhood education is also a focus in Indonesia because early childhood is a period when children absorb a lot of information easily, so the stimuli provided must be appropriate and easily accepted by children. Through early childhood education, games need to be provided to stimulate children's development and motor skills.

Early childhood is a period of physical and motor development in children (Nieminen & Sajaniemi, 2016; Wijaya et al., 2024). Physical development is closely related to motor development in children, as physical development affects their daily movements. Motor development is coordinated through the nervous system, nerves, and muscles to develop physical movement abilities (Honrubia-Montesinos et al., 2021). Children's motor development is divided into two categories: gross motor skills and fine motor skills. Gross motor skills are a child's ability to perform movements that involve large muscles, such as the torso, arms, and legs (Ghassabian et al., 2016; Webster & Ulrich, 2017). In contrast, gross motor skills are a child's ability to perform movements that involve large muscles with hand-eye coordination (Cohen et al., 2018; Lelong et al., 2021). Of these two types of motor skills, gross motor development is very important for early childhood (Veldman et al., 2016). Gross motor development refers to the progression of movements that involve balance and coordination between body parts, such as crawling, walking, and running. Therefore, balance is very important for early childhood to maintain overall motor skills (Jain et al., 2022).

Balance is very important for young children in various activities they try, so that with good balance, all physical activities they do will also be good. In line with the above opinion, balance has various very important aspects, so that the aspect of balance here will play a very large role in children in carrying out various physical activities, both daily activities and branch activities according to their interests (Dobell et al., 2020; Edwards et al., 2017).

Therefore, it is very important to consider that a child's early development is primarily based on fundamental skills and abilities. The components of balance control include the sensory information system, synergistic postural muscle responses, muscle strength, adaptive systems, and joint range of motion (Hirata et al., 2018). The sensory information system is related to the visual, vestibular, and somatosensory senses. Visual input can influence human adaptation to changes in the immediate environment. Information received through the visual senses is processed in the brain, after which the musculoskeletal system works synergistically to maintain body balance (Faber et al., 2022). Having good gross motor skills at an early age is crucial for supporting children's movements in performing coordinated, controlled, and orderly reactions. Gross motor skills in children need to be trained and developed because, at an early age, these skills form the foundation for the development of other skills, such as sensory skills and cognitive skills.

However, based on preliminary observations conducted by researchers in March 2025 at the Dharma Yoga Santi landfill site from two kindergarten classes, it was found that children's aggressive motor skills were still low. This is evidenced by the average scores obtained from 15 children, who scored 1 for motor skills, meaning they have not yet developed, and 10 children who scored an average of 2 for motor skills, meaning they are beginning to develop. In contrast, the standard score at this school is 3. When viewed in terms of the normative information on early childhood motor skills, this certainly falls into the category of deficient.

This is because the educational methods used to train children's aggressive motor skills are still inefficient. The learning methods used to train aggressive motor skills are: morning exercises once a week, ball catching, and throwing exercises. Cases observed during the learning process are: (1) during free drawing activities, children have difficulty holding writing instruments, (2) children have difficulty drawing and coloring, (3) children have difficulty using writing instruments and eating utensils correctly, (4) the child still has difficulty cutting according to patterns, (5) the child still needs guidance from the teacher when writing, drawing pictures, and tracing shapes, (6) the child still has difficulty catching and throwing balls.

If this situation continues to be allowed to affect the development of children's aggressive motor skills, learning in this area must be more careful in observing the increase in the aggressive motor skills of students and strive to find the right solution to the problems experienced. If teachers want children's aggressive motor skills to develop in line with their age and abilities, they must design appropriate and enjoyable learning activities and use media that are suitable for the development of children's skills so that educational goals can be achieved effectively.

One educational model that is considered capable of improving aggressive motor skills and balance in early childhood is game-based education. In physical education, games can be used to enhance educational goals (Gümüşdağ, 2019). Play activities that can improve aggressive motor skills must include activities such as running, walking, and jumping, which require large muscles (Roach & Keats, 2018). Games are one of the means of improving aggressive motor skills and balance in early childhood.

One game to maximize aggressive motor skills and balance in early childhood is aquatic play. The aquatic module contains activities that are tried in the swimming pool, such as water games, swimming styles, water safety, and the development of relevant knowledge aspects and values contained therein (Juan et al., 2022). Not only that, but providing education with innovative, interesting, and exciting methods also influences students' descriptions of the education module (Aljawarneh, 2020).

Stimulating development and growth in children aged 5-6 years is attempted through games that provide opportunities for children to move freely. The concept of movement-based educational development in water games is to use water as one of the tools in the game process (Arhesa & Badriah, 2021). Water is used as an effective medium to stimulate children's growth, including building self-confidence, motor skills, hand-eye coordination, and improving physical fitness.

The aquatic game model to improve the aggressive motor skills of early childhood is expected to be a teaching material for teachers in the education process. The aquatic game model for physical education has been adapted to the growth stages of children. This model was created to train the aggressive motor skills of early childhood. Another game activity that is considered capable of improving motor skills and balance is the coconut shell stilts game. The coconut shell stilts game model is a game that uses a coconut shell that has been split into two parts. A hole is made in the middle of the top part of the coconut shell to attach a rope, and the bottom part is reinforced with a board or plywood to prevent damage (Maryanti et al., 2021). Next, the child stands on the coconut shell while holding the rope, then walks forward by lifting the rope along with lifting their feet. While walking, the feet must not touch the ground. This egrang game can train balance and concentration.

Based on the explanation of the above issues, the researchers aimed to analyze the comparative effects of aquatic games and coconut shell stilts on the improvement of aggressive motor skills in early childhood from a balancing perspective. Thus, researchers can share the best solutions to improve the aggressive motor skills of early childhood, and this information can be used as further education for playgroup schools.

Materials and Methods

Research Design

This research is an experiment with a 2 x 2 factorial design. This experimental research uses two different treatment groups, namely aquatic games and coconut shell stilts, to test their effects on the aggressive motor skills of early childhood.

Research Procedure

The procedure for collecting information in this research was testing and measurement. Before the pretest and posttest measurements were taken, balance was measured first to identify high and low balance. To measure balance in this research, the Stork Stand Test was used with a measurement unit of seconds. The tests in this research used aggressive motor skills testing instruments. Aggressive motor skills tests included: (1) walking on a straight line for 5 meters, (2) running away from 5 obstacles for 15 meters, (3) standing on one foot for 10 seconds, (4) a test of jumping from a 15-centimeter-high block, (5) a test of jumping from a 15-centimeter-high block. The research process was conducted over 16 sessions, with 3 sessions per week. It ended with a final test and post-test to measure aggressive motor skills in early childhood to identify comparisons in children's aggressive motor skill scores after treatment.

Research Participants

The population in this study consisted of all 38 children enrolled in the Dharma Yoga Santi preschool program. This study applied inclusion criteria to ensure the validity of the research, based on certain criteria desired by the researcher, including: specifically young children, children who are actively exploring school, children who are not sick, willing to explore the educational process, able to explore all educational programs that have been prepared, and children aged 5-6 years. Conversely, the exclusion criteria in this research were things that caused the sample to not meet the criteria to be used as a sample, such as sick children. The sample grouping was taken from children who had high independence (27%) and children who had low independence (27%) from the information that had been ranked. Based on this, 10 children with high independence and 10 children with low independence were selected as examples, for a total of 20 children. This study has obtained approval from all participants who have filled out a statement of willingness to be research examples and have met the research code of ethics requirements.

Data Analysis

The method of information analysis used in this study, using SPSS type 25, is by using two-way ANOVA at a significance level of 0.05. Furthermore, to compare the treatment mean pairs, the Tukey test was used (Santoso, 2018). Before using two-way ANOVA, prerequisite tests must be carried out, including: (1) a normality test and (2) a homogeneity of variance test, and hypothesis testing.

Results

The research results and discussion chapter will be presented sequentially, including: (1) research results data, (2) prerequisite analysis tests, and (3) hypothesis tests. The hypothesis tests in this study will be presented sequentially, including: (a) the difference in the effect of aquatic games and coconut shell stilts on improving gross motor skills in children; (b) differences in the effects of high and low balance on improving children's gross motor skills; and (c) interactions between aquatic play and coconut shell stilts models and balance on improving children's gross motor skills. The complete presentation is as follows:

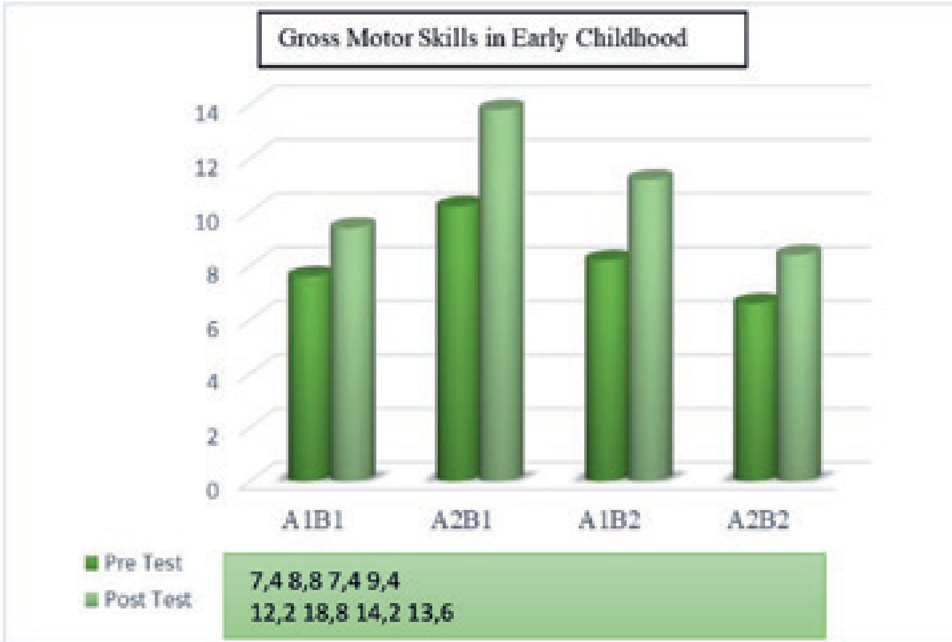

Figure 1. *Bar chart of children's gross motor skills pretest and posttest*

Description:

A1B1: A group of young children who were given aquatic games with a high level of balance.
A2B1: A group of early childhood children who were given a high-balance egrang batok game model.
A1B2: A group of early childhood children was given a low-balance aquatic game model.
A2B2: A group of early childhood children who were given a low-balance egrang batok game model.

Based on graph 1 above shows that the average pretest score for motor skills in the A1B1 group of early childhood children was 7.6, with an increase in the posttest score to 9.4. The average pretest score for the A2B1 group was 10.2, with an increase in the posttest score to 13.8. Group A1B2 had an average pretest score of 8.2 and an increase in the posttest score of 11.2. Group A2B2 had an average pretest score of 6.6 and an increase in the posttest score of 8.4.

1. Prerequisite Test Results

a. Normality Test

The Shapiro-Wilk method was used to test the normality of the data in this study. The normality test results for each analysis group were performed using SPSS version 24.0 for Windows software with a significance level of 5% or 0.05. The summary is presented in Table 1 as follows.

Table 1. *Summary of gross motor normality test results*

Group	*p*	Significant	Description
Pretest A1BI	0.814	0,05	Normal
Posttest A1B1	0.814		Normal
Pretest A2B1	0.421		Normal
Posttest A2B1	0.421		Normal
Pretest A1B2	0.421		Normal
Posttest A1B2	0.421		Normal
PretestA2B2	0.814		Normal
Posttest A2B2	0.201		Normal

Based on the statistical analysis of normality tests conducted using the Shapiro-Wilk test, all pretest and posttest data on gross motor skills in early childhood obtained from the normality test results had a significance value of $p > 0.05$, which means that the data were.

b. Homogeneity Test

The homogeneity test was conducted to test the similarity of several samples, namely, whether they were homogeneous or not. The homogeneity test was intended to test the similarity of the variance between the pretest and posttest. The homogeneity test in this study was the Levene Test. The results of the homogeneity test are presented in Table 2 as follows.

Table 2. *Summary of homogeneity test results*

Variable	F	df1	df2	*Sig.*
Motor skills	0.161	3	16	0.921

Based on the statistical analysis of homogeneity tests conducted using the Levene Test, the calculation results obtained a motor significance value of 0.921 ≥ 0.05, which means that the data groups have homogeneous variance. Thus, the population has similar variance or is homogeneous.

3. Hypothesis Test Results

The research hypothesis testing was conducted based on the results of data analysis and interpretation of the two-way ANOVA analysis. The sequence of hypothesis testing results was adjusted to the problem formulation, as follows.

a. Hypothesis: Differences in the Effects of Aquatic Games and Egrang Batok on the Improvement of Gross Motor Skills in Early Childhood

The first hypothesis states, “There is a difference in the effect between the aquatic game model and the coconut shell stilts on the improvement of gross motor skills in early childhood.” Based on the analysis results, the data in Table 3 is as follows.

Table 3. *ANOVA test results for the difference between the aquatic game model and coconut shell stilts on the improvement of gross motor skills in children*

Source	Variabel	Type III Sum of squares	Df	Mean Square	F	Sig.
Game Model	gross motor skills	3.200	1	3.200	1.969	0.002

From the results of the ANOVA test in Table 3 above, it can be seen that the significance value for gross motor skills is p = 0.002, and the F value is 1.969. Because the significance value p = 0.002 < 0.05, H0 is rejected. Thus, there is a significant difference in effect. Based on the analysis results, it appears that the aquatic game model group had a gross motor variable of 10.3, which was better than the egrang batok game model group, which had a gross motor variable of 11.1, with a posttest average difference of 1.2. This means that the research hypothesis stating that “There is a significant difference in the effect between the aquatic game model and the coconut shell stilts model on the improvement of gross motor skills in early childhood” has been proven.

b. Hypothesis of the difference in effect between the high and low balance groups on the improvement of gross motor skills in early childhood

The second hypothesis states that “There is a difference in the effect between the high and low balance groups on the improvement of gross motor skills in early childhood.” The calculation results are presented in Table 4 as follows.

Table 4. *Results of the ANOVA test of the high and low balance groups on the improvement of gross motor skills in early childhood*

Source	Variable	Type III Sum of squares	Df	Mean Square	*F*	*Sig.*
Balance	Gross motor skills	16.200	1	16.200	9.969	0.004

From the results of the ANOVA test in Table 4 above, it can be seen that the motor significance value p is 0.004 and the F value is 9.969. Because the significance value p is 0.004 < 0.05, H0 is rejected. Thus, there is a significant difference in influence. Based on the analysis results, it appears that the group of children with high balance in the gross motor variable of 11.6 is higher than the group of children with low balance in the gross motor variable of 9.8, with a posttest average difference of 1.8. This means that the research hypothesis stating that "There is a significant difference in influence between the high and low balance groups on the improvement of gross motor skills in early childhood" has been proven.

c. The interaction between the aquatic and egrang batok game models and balance (high and low) on the improvement of motor skills in early childhood

The third hypothesis states that "There is a significant interaction between the game model (Aquatic and Egrang Batok) and balance (high and low) on the improvement of gross motor skills in early childhood." The calculation results are presented in Table 5 as follows.

Table 5. *Results of the ANOVA test of the interaction between the game model (Aquatic and Egrang Batok) and balance (high and low) on the improvement of gross motor skills in early childhood*

Source	Variable	Type III Sum of squares	Df	Mean Square	*F*	*Sig.*
Game Model	Gross motor skills	64.800	1	64.800	39.877	0.000

From the ANOVA test results in Table 5 above, it can be seen that gross motor skills obtained a significance value of $p = 0.000$ and an F value of 39.877. Because the significance value of $p = 0.000 < 0.05$, Ho is rejected. Based on this, the hypothesis stating that "There is an interaction between the game model (Aquatic and Egrang Batok) and balance (high and low) on the improvement of gross motor skills in early childhood" has been proven.

After testing the interaction between the game model (Aquatic and Egrang Batok) and balance (high and low) on the improvement of gross motor skills in early childhood, it is necessary to conduct a further test using the Tukey test. The results of the further test can be seen in Table 6 below:

Table 6. *Summary of post hoc tests for gross motor skills*

Group	Interaction	Mean Difference	Std. Error	Sig.
A1B1	A1B2	-3.5000*	0.82023	0.002
	A2B1	-1.2000	0.82023	0.48
	A2B2	1.0000	0.82023	0.616
A1B2	A1B1	3.5000*	0.82023	0.002
	A2B1	2.3000*	0.82023	0.036
	A2B2	4.5000*	0.82023	0
A2B1	A1B1	1.2000	0.82023	0.48
	A1B2	-2.3000*	0.82023	0.038
	A1B2	2.2000	0.82023	0.052
A2B2	A1B1	-1.000	0.82023	0.618
	A1B2	-4.5000*	0.82023	0
	A2B1	-2.2000	0.82023	0.052

Based on Table 6, the results of the Tukey test show that the pairs that have interactions or pairs that are significantly different are: (1) A2B1-A2B2, (2) A2B1, (3) A2B1-A1B2, (4) A2B2-A1B2, while the other pairs are declared to have no difference in effect: (1) A2B1-A2B2 (2) A2B1 – A2B2. (3) A1B1-A2B1.

Discussion

This review of the research results provides further insight into the results of the information analysis that has been presented. Based on hypothesis testing, three groups of analytical conclusions were drawn: (1) There is a significant comparison of the influence of the main research factors; (2) there is a comparison of the influence between the high and low control groups on the increase in children's aggressive motor skills; (3) there is a significant interaction between the main factors in the form of a two-aspect interaction. The review of the analysis results can be further explained.

1. The effect of aquatic games and coconut shell games on improving gross motor skills in early childhood.

Based on hypothesis testing, it is known that there is a significant effect of aquatic games and coconut shell games on improving gross motor skills in early childhood. This is supported by previous research conducted by (Akinola et al., 2019), which states that aquatic activities can develop gross motor skills in children. Other research data conducted by (Battaglia et al., 2019) reveals that there is a significant effect of aquatic activity programs on the gross motor skills of children aged 4-6 years. Aquatic activities influence children's gross motor skills because the process of implementing aquatic activities includes factors underlying motor skill components. Research results (Cook et al., 2019) confirm that water exercise programs are effective in improving gross motor skills in preschool children. Additionally, improvements in gross motor skills were also observed through the implementation of the egrang batok game model. This finding aligns with previous studies by Mujtahidin & Rachman, (2022), who stated that they developed a method for playing egrang that can improve children's balance. These findings are consistent with previous findings (Sari et al., 2022), which explain that playing egrang for 4 weeks is an effective method for improving balance. This is because when playing egrang batok, children must walk on a shell with a diameter of about 10 cm, which requires a balanced body reaction to play it. Not only that, when playing coconut shell stilts, the muscles of the lower extremities and abdomen contract, resulting in muscle growth. Thus, the traditional game of coconut shell stilts can be used as a balance training program (Nugroho et al., 2023).

However, based on the results of information analysis, it was found that the aquatic game model group performed better than the coconut shell stilts game model group in terms of improving aggressive motor skills in young children. This is supported by research findings (Tyas & Phytanza, 2019), which prove that aquatic programs can increase muscle strength in children. According to (Siega et al., 2021) Aquatic activities are activities carried out in water that aim to train children to improve their gross motor, cognitive, affective, and social skills. Aquatic activities are activities carried out in water that aim to train children to achieve progress in gross motor skills, cognition, affective, and social development. Aquatic activities or water media can provide a unique and exciting atmosphere for all children with disabilities, including the deaf. The purpose of water games is to build their courage in performing activities in water, provide movement enrichment for them, especially their gross motor skills, and reduce psychological, physical, and social disorders or deviations.

Water games designed to improve the gross motor skills of deaf children are expected to be used as teaching materials for teachers in the educational process. Water games for physical education have been adapted to the growth stages of deaf children in special elementary schools.

2. Differences in the effects of high and low balance groups on the improvement of gross motor skills in early childhood

The results of the analysis show that there is a significant difference in the influence of children with high and low balance on the improvement of gross motor skills in early childhood. The group of children with high balance is better than the group of children with low balance in terms of the improvement of gross motor skills in early childhood. One aspect that influences children's gross motor skills is balance (Giolanda, 2025). This is in line with the results of previous research conducted by (Faizah et al., 2024), which reported that children with high balance performed better than children with low balance in terms of the improvement of children's gross motor skills.

This balance is very important to try when children are young because it greatly affects the activities that children try every day. However, this exercise must be tried repeatedly because when children learn new movements, they cannot immediately perform them. It takes time and guidance so that children can hold their bodies to prevent falling and can move the large muscles in their bodies. (Fitri & Imansari, 2020) Argue that children with balance disorders tend to have poor nerve function and structure, such as in cases of vision, hearing, bone disorders, and so on. The appropriate method for training children's balance is through games.

3. Interaction between aquatic models and coconut shell stilts and their balance on improving gross motor skills in early childhood

Based on the results presented in this study, there is a significant interaction between aquatic models and coconut shell stilts and their balance on improving gross motor skills in early childhood. The research results show that aquatic game models are more efficient for children with high levels of balance, while coconut shell models are more efficient for children with low levels of balance. Water activities have a buoyancy style that can work as a boost to reduce body weight or as resistance (Barbosa et al., 2019). The floating style can act as resistance if the movements that occur in the water are movements that push against the bottom or into the water; this resistance can be used as muscle strengthening. Activities that are attempted against gravity can strengthen and support muscles and connective tissue because muscles can generate force to move or hold weight. From the results of the interaction, it can be seen that the main factors of the research in the form of two aspects show a significant interaction. In the results of this study, the interaction has meaning in that each cell or group has a comparison of the influence of each group that is paired.

CONCLUSION

Based on the results and reviews that have been found, the following conclusions can be drawn: 1) There is a significant difference in the effect of aquatic games and coconut shell stilts on the increase in aggressive motor skills in early childhood. The aquatic game model group performed better than the coconut shell stilts group in terms of improving the aggressive motor skills of early childhood. 2) There is a significant difference between children with high and low balance in terms of improving the aggressive motor skills of early childhood. Children with high balance performed better than children with low balance in terms of improving the aggressive motor skills of early childhood. 3) There is a significant interaction between the game model (Aquatic) and (Egrang Batok) on the increase in aggressive motor skills in early childhood. The research results show that the game model (Aquatic) is a more efficient model for children with high balance, and the game model (Egrang Batok) is more efficient for children with low balance.

Acknowledgment
This research article was made possible thanks to the assistance of various parties. Therefore, the researcher would like to express his deepest gratitude to the principal of PRA TK Dharma Yoga Santi, Yogyakarta Province, who supported this research, as well as the entire team of research partners from the elementary school physical education department at Yogyakarta State University.
Conflict of Interest
We acknowledge that there are no conflicts of interest related to this publication, and there has been no significant financial support for this work that could influence the results. As the corresponding author, I confirm that the manuscript has been read and approved for submission by all authors mentioned.

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Primljen: 30. oktobar 2025. / Received: October 02, 2025
Prihvaćen: 07. decembar 2025. / Accepted: December 07, 2025