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IMPACT OF A SWIMMING PROGRAM ON PHYSICAL AND MOTOR DEVELOPMENT IN CHILDREN AGED 7–9 YEARS

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Abstract: Swimming is widely recognized as an effective physical activity for promoting healthy growth and motor development during childhood. The aim of this study was to investigate the effects of an eight-week beginner-level swimming program on the physical and motor development of children aged 7–9 years. The study included 14 children (7 girls and 7 boys) who participated in two 60-minute swimming sessions per week. The training program consisted of aquatic adaptation exercises, breathing techniques, gliding activities, basic freestyle and backstroke skills, as well as coordination and stability exercises. Physical and motor development was assessed before and after the intervention using anthropometric measurements (body weight, waist circumference, and chest circumference) and motor tests (20 m sprint, standing long jump, and sit-ups in 30 seconds). The results revealed improvements in all motor performance indicators. The most substantial increase was observed in abdominal muscular endurance, with the mean number of sit-ups increasing from 18.42 to 20 repetitions (+8%). Sprint performance improved by approximately 2%, while standing long jump performance increased by 1%. Anthropometric measurements showed slight increases in body weight and body circumferences, reflecting normal growth patterns rather than training-specific adaptations. Correlation analysis indicated generally weak relationships between anthropometric and motor variables, suggesting that motor performance at this age is influenced primarily by neuromuscular and coordinative factors. The findings suggest that participation in a structured swimming program can positively influence motor competence and physical fitness in children aged 7–9 years. Swimming appears to be an effective and safe activity for supporting healthy development, improving motor abilities, and promoting physical literacy during a critical stage of childhood growth.

Key words: swimming, motor development, children aged 7–9 years, motor competence, physical fitness, aquatic intervention, physical literacy, neuromuscular adaptation.

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INTRODUCTION

Physical education is the discipline in the school curriculum that can help in different ways to educate and train children, young people and adults, contributing to personal and professional development (Sandra et al., 2023).

Physical activity during childhood represents a key determinant of healthy growth and harmonious development, exerting a direct influence on somatic growth, motor abilities, and functional adaptations. The age interval of 7–9 years is considered a sensitive period for the consolidation of fundamental motor skills, as children demonstrate increased adaptability and responsiveness to motor learning stimuli.

Recent research has highlighted the importance of adapting teaching and training methods to children's developmental characteristics in order to optimize motor learning outcomes. Differentiated instructional approaches have been shown to contribute positively to motor skill acquisition and overall motor development in school-aged children (Cristea et al., 2025).

New activities during physical education and sports classes attract children to the desire to exercise (A. M. Bulz et al., 2024). An initiation-level swimming program conducted with children aged 6–8 years reported significant improvements in multiple basic motor capacities and increased group homogeneity at post-testing, indicating that early structured aquatic instruction may accelerate fundamental motor development (Pîrjol, Răsădean, & Baniaș, 2017). Similarly, a comparative study in a primary school showed that pupils who participated in additional swimming lessons within an integrated sports classroom demonstrated superior gains in conditional and intermediate motor skills compared with peers exposed only to compulsory physical education, reinforcing the role of swimming as a meaningful complementary stimulus for motor development (Bălan et al., 2023) .

The aquatic environment allows movement with reduced mechanical impact on the musculoskeletal system while providing uniform resistance, which supports neuromuscular control and coordination. Recent studies indicate that swimming may contribute to the development of fundamental movement skills and general physical fitness in children, although the magnitude of these effects depends on program structure and assessment methods (Sinclair et al., 2023).

The process of learning to swim in childhood is closely linked to principles of motor learning and progressive adaptation to the aquatic environment. A scoping review focusing on children aged 5–12 years emphasizes the importance of progressive task structuring, appropriate use of flotation aids, and age-adapted feedback to optimize learning outcomes (Minkels et al., 2025). These findings suggest that well-designed swimming programs may facilitate positive transfer effects to other motor capacities. From a psychomotor perspective, evidence from samples of 6–9-year-old children indicates that psychomotor behaviors (e.g., balance, coordination, body schema) are associated with the acquisition and quality of swimming technique, highlighting the close interaction between psychomotor maturation and swimming learning outcomes (Petrea et al., 2023). Moreover, a research focused on 9–10-year-old swimmers emphasizes the necessity of age-adapted programs targeting combined strength–speed capacities, underlining that well-structured training may optimize both general motor preparedness and sport-specific performance indicators at prepubertal ages (Țiucă, 2021).

Beyond motor benefits, swimming is associated with functional adaptations, particularly at the respiratory level. Previous research has reported that swimmers often exhibit higher lung volumes and superior ventilatory parameters compared to non-swimmers, adaptations attributed to both training effects and selection factors (Rochat et al., 2022). Swim training also involves specific breathing patterns that may stimulate respiratory muscle development and pulmonary function (Rodrigues et al., 2025). Furthermore, a recent systematic review and meta-analysis concluded that swimming interventions can improve lung function and cardiorespiratory fitness in children, while being well tolerated and safe even in pediatric populations with asthma (Ramachandran et al., 2021).

Experimental interventions conducted with children have shown that relatively short-term swimming programs can produce significant improvements in physical performance (Yu et al., 2024).

Within this context, the present study investigates the effects of a beginner-level swimming program on the physical and motor development of children aged 7–9 years. Based on the existing evidence regarding the benefits of aquatic activities during childhood, it is expected that regular participation in structured swimming sessions will lead to improvements in key motor abilities, particularly speed, muscular strength, and coordination. Previous research has demonstrated that the development of motor competence during childhood is strongly associated with participation in structured physical activity programs and may positively influence long-term engagement in physical activity (Barnett et al., 2016; Hulteen et al., 2018). Furthermore, the study examines whether the intervention contributes to a more homogeneous level of motor performance among participants, reflecting a positive influence on overall motor development. It is also assumed that the specific demands of the aquatic environment may generate neuromuscular adaptations that extend beyond swimming itself, facilitating positive transfer effects to land-based motor tasks, as suggested by recent research on aquatic-based motor learning and physical literacy development (Pratt et al., 2024; Sinclair et al., 2023). By exploring these aspects, the study aims to provide further evidence regarding the role of swimming as an effective tool for promoting healthy growth and motor competence during a critical stage of childhood development.

The novelty of this study lies in its integrated approach to assessing both motor performance and group homogeneity in response to a swimming-based intervention at early school age. Unlike previous research that predominantly focuses on isolated motor outcomes, this study combines performance indicators with variability measures to provide a more comprehensive understanding of developmental adaptations. This perspective is consistent with contemporary models of motor competence assessment, which emphasize the importance of evaluating both performance outcomes and developmental trajectories in children (Robinson et al., 2015; Hulteen et al., 2020). Additionally, the present study highlights the potential transfer of swimming-related adaptations to general motor abilities, contributing to the growing body of evidence supporting swimming as a multidimensional tool for child development and physical literacy promotion (Edwards et al., 2018; Sinclair et al., 2023).

MATERIALS AND METHODS

The study was conducted on a sample of 14 children (7 girls and 7 boys), aged between 7 and 9 years, who participated in a beginner swimming program over a period of eight weeks. The intervention consisted of two training sessions per week, each lasting 60 minutes. All sessions were supervised by qualified instructors and followed a progressive structure adapted to the developmental characteristics and swimming experience of the participants.

The training program included aquatic familiarization exercises, breathing control techniques, floating and gliding drills, basic propulsion exercises, introductory elements of freestyle and backstroke swimming, as well as coordination and stability activities designed to improve overall motor competence. The intensity and complexity of the exercises gradually increased throughout the intervention period.

To evaluate the effects of the program, participants underwent a battery of motor and anthropometric assessments before (pre-test) and after (post-test) the intervention. All measurements were performed under similar environmental conditions and by the same evaluators to ensure consistency and reliability.

Table 1. Study Design and Experimental Procedure

Phase	Procedure	Variables / Content
Participants	Recruitment of children (n = 14; 7 girls, 7 boys; 7–9 years)	Age and sex distribution
Pre-test	Initial assessment	Body weight, waist circumference, chest circumference, 20 m sprint, standing long jump, sit-ups (30 s)
Intervention	Swimming program (8 weeks, 2 sessions/week, 60 min/session)	Aquatic adaptation, breathing exercises, gliding, freestyle and backstroke fundamentals, coordination and stability exercises
Post-test	Final assessment	Body weight, waist circumference, chest circumference, 20 m sprint, standing long jump, sit-ups (30 s)
Data analysis	Statistical processing	Mean, SD, CV, percentage differences, correlation analysis

20 m Sprint Test (Speed Assessment)

The 20 m sprint test was used to evaluate acceleration and running speed, which are important indicators of motor performance in children. The test was performed on a flat, non-slippery surface with a clearly marked 20-meter distance. Timing was recorded using a digital stopwatch with an accuracy of 0.01 seconds. Participants started from a standing position behind the starting line and were instructed to run maximally through the finish line without slowing down. Two trials were performed, with a recovery period of approximately two minutes between attempts, and the best result was retained for analysis.

Standing Long Jump Test (Explosive Strength Assessment)

Explosive lower-limb strength was assessed using the standing long jump test. Participants stood behind a marked line with feet shoulder-width apart and performed a maximal forward jump using a simultaneous two-leg take-off. Arm swing was allowed to facilitate maximal performance. The distance was measured from the take-off line to the closest point of contact upon landing, using a measuring tape with centimeter precision. Two attempts were performed, and the longest distance achieved was recorded.

Sit-Ups in 30 Seconds Test (Abdominal Muscular Endurance Assessment)

Abdominal muscular endurance was evaluated through the sit-ups test performed over a 30-second period. Participants lay on a gym mat in a supine position with knees flexed at approximately 90 degrees and feet stabilized. At the examiner's signal, children performed as many correctly executed sit-ups as possible within the allotted time. A repetition was considered valid when the participant raised the trunk sufficiently for the elbows to reach the knees and then returned to the starting position. The total number of correct repetitions was recorded.

Anthropometric Measurements

Body weight was measured using a calibrated digital scale and recorded in kilograms. Waist circumference was measured at the midpoint between the lower rib margin and the iliac crest using a flexible anthropometric tape. Chest circumference was measured horizontally at the level of the thorax during normal breathing. All measurements were performed according to standard anthropometric procedures and recorded to the nearest 0.1 cm or 0.1 kg.

Statistical Analysis

Descriptive statistics (mean, standard deviation, coefficient of variation, minimum and maximum values) were calculated for all variables. Percentage changes between pre-test and post-test measurements were determined to evaluate the effects of the swimming intervention. In addition, Pearson correlation coefficients were calculated to examine the relationships between anthropometric characteristics and motor performance variables. Statistical analyses were performed using Microsoft Excel.

RESULTS

The analysis of the pre- and post-intervention data revealed positive changes in both motor performance and anthropometric characteristics following the eight-week swimming program. Overall, the participants demonstrated improvements in all assessed motor variables, suggesting beneficial adaptations associated with regular participation in aquatic activities. At the same time, the anthropometric measurements showed slight increases, reflecting normal growth and development expected in children aged 7–9 years. The coefficients of variation remained relatively low for most variables, indicating a generally homogeneous sample and comparable responses to the training stimulus.

Presents the descriptive statistics (mean, standard deviation, and coefficient of variation) recorded before and after the intervention (table 2).

Table 2. Descriptive statistics of motor and anthropometric variables before and after the swimming program

	Average			STDV			CV		
Indicator	Initial test mean	Final test mean	Difference (%)	Initial test mean	Final test mean	Difference (%)	Initial test mean	Final test mean	Difference (%)
20 m sprint (s)	4,7	4,59	2%	0,23	0,3	23%	0,1	0,01	9%
Standing long jump (cm)	138	138,71	1%	6,55	8,24	21%	9,04	11,43	21%
Sit-ups (repetitions)	18,42	20	8%	3,29	3,37	2%	0,6	0,67	10%
Waist circumference (cm)	128,92	130,21	1%	5,46	5,33	2%	7,05	6,95	1%
Chest circumference (cm)	60,14	61	1%	2,53	2,71	7%	2,53	2,71	7%
Weight	28,07	28,64	2%	1,19	1,28	7%	1,52	1,65	8%

The results indicate that the most notable improvement was observed in the sit-ups test, where the mean number of repetitions increased from 18.42 to 20.00 repetitions (+8%). This finding suggests a positive effect of swimming on abdominal muscular endurance and trunk stabilization, which are continuously involved during aquatic movement and breathing control.

A smaller but favorable improvement was recorded in the 20 m sprint test, where the average performance improved from 4.70 s to 4.59 s (+2%). Although the magnitude of change was moderate, the results suggest enhanced neuromuscular efficiency and acceleration capacity following the intervention. The increase in standard deviation indicates that the individual responses to training varied among participants.

The standing long jump results also showed a slight improvement, with the mean distance increasing from 138.00 cm to 138.71 cm (+1%). While the average gain was relatively small, it may indicate a positive influence of swimming on lower-limb explosive strength through enhanced neuromuscular coordination and force production. The increase in variability suggests that some participants benefited more from the intervention than others.

Regarding anthropometric measurements, all variables showed slight increases between the initial and final assessments. Body weight increased from 28.07 kg to 28.64 kg (+2%), while waist circumference increased from 128.92 cm to 130.21 cm (+1%). Similarly, chest circumference increased from 60.14 cm to 61.00 cm (+1%). These changes are consistent with normal somatic growth during childhood and should not be interpreted as direct effects of the training program alone.

An important observation is that the coefficient of variation remained relatively stable across most variables. In the case of waist circumference, a slight reduction in variability was observed, suggesting a tendency toward greater group homogeneity. Conversely, the increases in variability noted for sprint performance, standing long jump, chest circumference, and body weight likely reflect individual differences in biological maturation and responsiveness to training.

Overall, the results suggest that the swimming program contributed primarily to improvements in motor performance, particularly abdominal muscular endurance, while the anthropometric changes reflected the normal growth processes characteristic of this developmental stage.

Evolution of motor performance indicators (20 m sprint, standing long jump, and sit-ups) between the initial and final assessments (figure 1).

To facilitate the visualization of changes observed between the initial and final assessments, illustrates the evolution of the mean values, standard deviations, and coefficients of variation for the motor performance variables. This graphical representation provides an overview of both performance changes and group variability following the swimming intervention (figure 1).

Figure 1. Comparative analysis of average, standard deviation and coefficient of variation in the initial and final testing

The graphical analysis confirms the positive trend observed in the descriptive statistics. Among the assessed motor variables, the greatest improvement was recorded in the sit-ups test, where the average number of repetitions increased from 18.42 to 20.00 repetitions (+8%). This finding suggests an enhancement in abdominal muscular endurance and trunk stabilization, capacities that are continuously stimulated during swimming through body alignment and breathing control.

The 20 m sprint test also showed a favorable evolution, with mean performance improving from 4.70 s to 4.59 s. Although the percentage change was relatively modest (+2%), the reduction in sprint time indicates improved acceleration capacity and neuromuscular efficiency. The increase in standard deviation observed at the final assessment suggests that the magnitude of adaptation differed among participants, likely reflecting individual differences in motor learning and biological maturation.

Similarly, standing long jump performance improved from 138.00 cm to 138.71 cm. While the increase in mean value was limited (+1%), the result indicates a tendency toward enhanced explosive lower-limb strength. The higher standard deviation and coefficient of variation recorded at the final assessment suggest that some children experienced greater improvements than others, which is common in interventions involving young participants with different developmental rates.

Analysis of the variability indicators reveals that the coefficients of variation remained relatively low in both assessments, indicating acceptable group homogeneity. Despite slight increases in variability for the standing long jump and sit-ups tests, the overall results suggest that the participants responded positively to the swimming program and demonstrated improvements in key motor abilities.

These findings support the view that even a relatively short-term swimming intervention can contribute to the development of fundamental motor capacities during childhood, particularly those related to core endurance, speed, and explosive strength.

DESCRIPTIVE AND COMPARATIVE ANALYSIS

The findings indicate an overall improvement in motor performance, reflected by reduced sprint times and increased values in the standing long jump and sit-up tests. The largest percentage increase was observed in the sit-up test, suggesting a significant enhancement in abdominal muscular endurance.

Anthropometric indicators showed moderate increases, remaining within age-appropriate reference ranges, which suggests balanced physical development during the study period.

Speed – 20 m Sprint

The mean sprint time improved from 4.70 s (initial) to 4.59 s (final), representing a 2% decrease in time, which indicates improved running speed.

However, the standard deviation increased from 0.23 s to 0.30 s (+23%), suggesting greater dispersion of individual results in the final test. This is further reflected in the variability indicators, showing reduced homogeneity in sprint performance at post-test.

The swimming program appears to have produced a small but positive effect on speed performance, although the increased variability suggests that improvements were not uniform across participants. At this developmental stage (7–9 years), neuromuscular coordination develops rapidly, which may explain inter-individual differences in adaptation.

Explosive Strength – Standing Long Jump (cm)

The mean increased slightly from 138.00 cm to 138.71 cm (+1%), indicating a minimal improvement in lower-limb explosive strength.

The SD increased from 6.55 cm to 8.24 cm (+21%), and the CV increased from 9.04% to 11.43% (+21%), demonstrating increased inter-individual variability.

The improvement in explosive strength was marginal. The increased SD and CV suggest that while some children improved, others showed little or no progress. Swimming training may not provide sufficient land-based plyometric stimulus to significantly enhance horizontal jump performance.

Muscular Endurance – Sit-Ups (repetitions)

The mean number of sit-ups increased from 18.42 to 20 repetitions (+8%), representing the largest relative improvement among performance variables.

The SD changed minimally (3.29 to 3.37; +2%), while the CV increased from 0.60 to 0.67 (+10%), indicating slightly greater variability but overall stable dispersion.

Core muscular endurance showed a clear positive adaptation, likely due to the continuous trunk stabilization demands in swimming. The relatively stable SD indicates that improvement occurred across most participants, making this the most consistent training effect observed.

Anthropometric Results

Waist Circumference (cm)

The mean waist circumference showed a slight increase from 128.92 cm to 130.21 cm (+1%), which can be considered a normal outcome for children within this age range, reflecting ongoing somatic growth rather than an increase in adiposity. At the same time, both the standard deviation (from 5.46 to 5.33; −2%) and the coefficient of variation (from 7.05% to 6.95%; −1%) decreased slightly, indicating a marginal improvement in group homogeneity. This suggests that, despite individual growth differences, the participants followed relatively similar developmental trajectories during the intervention period.

Chest Circumference (cm)

Chest circumference increased from an average of 60.14 cm to 61.00 cm (+1%), highlighting a normal progression in thoracic development. This growth may be partially associated with the specific demands of swimming, which involves continuous respiratory effort and may stimulate the development of respiratory muscles. However, the increase in standard deviation (from 2.53 to 2.71; +7%) and coefficient of variation (+7%) indicates a slight rise in inter-individual variability. This finding reflects differences in biological maturation and individual responsiveness to both growth and training stimuli.

Body Weight (kg)

The average body weight increased from 28.07 kg to 28.64 kg (+2%), a change consistent with expected growth patterns in children aged 7–9 years. The observed increases in standard deviation (from 1.19 to 1.28; +7%) and coefficient of variation (from 1.52% to 1.65%; +8%) suggest a moderate increase in variability within the group. This can be explained by natural differences in growth rates, body composition, and maturation timing among children, rather than by any negative effect of the training program. Overall, these results support the interpretation that the swimming intervention occurred alongside normal and healthy physical development.

CORRELATION ANALYSIS

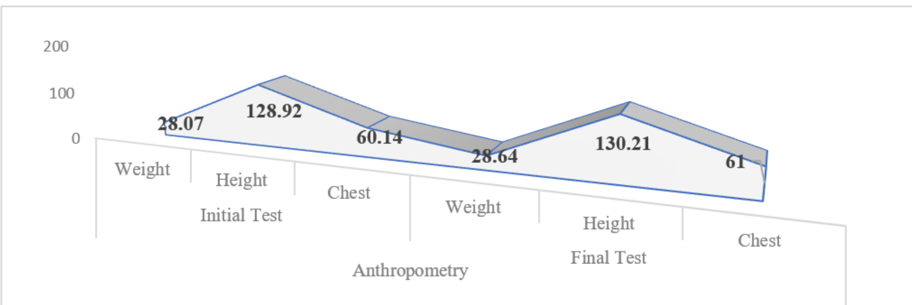

Figure 2. Comparative analysis of anthropometric indicators in the initial and final testing

Correlation analysis highlights weak associations between anthropometric and motor variables, suggesting that physical performance in children aged 7–9 years is influenced more by neuromuscular and coordinative factors than by body dimensions alone.

A weak positive correlation between waist circumference and standing long jump ($r \approx 0.30$) indicates that somatic development may slightly support explosive strength, but it is not a determining factor. The relationship between 20 m sprint and sit-ups was negligible (r ≈ −0.06), confirming that speed and abdominal endurance develop largely independently.

Similarly, the weak to moderate negative correlation between chest circumference and sit-ups (r ≈ −0.27) suggests that abdominal endurance relies more on trunk control and muscular efficiency than on thoracic size.

Overall, these findings reinforce the idea that motor performance at this age is multifactorial, with limited direct influence from anthropometric characteristics.

DISCUSSION

The findings of the present study indicate that participation in a structured swimming program over an eight-week period contributed to positive changes in both motor performance and physical development among children aged 7–9 years. Although the intervention was relatively short, improvements were observed in all motor variables assessed, supporting the premise that swimming can serve as an effective means of stimulating motor development during a critical stage of childhood growth. This observation is consistent with the conceptual framework proposed by Stodden et al. (2008), who described motor competence as a central factor influencing children's physical activity participation and long-term health trajectories. Similarly, Barnett et al. (2016) emphasized that improvements in motor competence during childhood are associated with positive developmental outcomes and enhanced physical fitness

The most pronounced improvement was recorded in abdominal muscular endurance, as evidenced by the increase in the number of sit-ups performed within 30 seconds. This result is not surprising given the specific characteristics of swimming, which require continuous activation of the trunk musculature to maintain body alignment, stability, and efficient propulsion in the water. The ability to control body position while coordinating upper- and lower-limb movements places considerable demands on the core musculature. Similar observations have been reported by Minkels et al. (2025) and Petrea et al. (2023), who highlighted the importance of swimming in developing postural control, coordination, and neuromuscular efficiency in children. The present findings further support the idea that swimming can be an effective tool for enhancing core endurance even when it is practiced at an introductory level.

Positive changes were also observed in sprint performance and standing long jump results. Although the magnitude of improvement was smaller compared with that recorded for abdominal endurance, the observed gains suggest that the aquatic environment can facilitate adaptations extending beyond swimming-specific skills. Water provides continuous resistance during movement, requiring coordinated muscular activation and greater control of body segments. These demands may contribute to improvements in neuromuscular recruitment patterns, which can subsequently influence land-based motor tasks. Similar findings have been reported by Logan et al. (2012), whose meta-analysis demonstrated that structured movement-based interventions can significantly improve children's motor skills and overall movement competence. The findings are consistent with those reported by Bălan et al. (2023), who found superior motor development among children participating in supplementary swimming lessons, as well as Sinclair et al. (2023), who emphasized the role of swimming in enhancing fundamental movement skills and general physical fitness.

Our results are also in agreement with the systematic review conducted by Ferreira et al. (2024), which reported positive effects of swimming on motor performance, physical conditioning, and body composition in young populations, suggesting that aquatic exercise may support multiple dimensions of physical development.

An important aspect of the present study is that the improvements were observed despite the relatively low training frequency of only two sessions per week. This suggests that even moderate exposure to structured aquatic activities may provide sufficient stimulus to induce measurable adaptations in children. Considering the developmental characteristics of the 7–9-year age group, when neural plasticity and motor learning capacity are particularly high, swimming appears to represent an appropriate activity for supporting the acquisition and refinement of fundamental motor abilities. This interpretation is supported by Hulteen et al. (2018), who highlighted that appropriately designed movement programs can enhance both movement competence and confidence in children, even when the volume of training is relatively moderate.

The anthropometric results require a different interpretation. While slight increases were observed in body weight, waist circumference, and chest circumference, these changes are most likely attributable to normal growth processes rather than to the direct effects of the swimming program. Children within this age range experience continuous somatic development, and modest increases in body dimensions are expected over a two-month period. Similar conclusions were reported by Yu et al. (2024), who emphasized that anthropometric changes in pediatric populations should be interpreted within the broader context of biological maturation and growth. Therefore, the anthropometric findings of the present study should be viewed primarily as indicators of healthy development rather than specific training adaptations.

Another noteworthy observation concerns the variability of the measured parameters. The coefficients of variation remained relatively low throughout the study, indicating a homogeneous sample and comparable developmental characteristics among participants. Furthermore, the slight reduction in variability observed for some indicators may suggest that the swimming program contributed to a more uniform level of motor competence within the group. This tendency is consistent with the findings of Pîrjol et al. (2017), who reported increased group homogeneity following structured swimming instruction in young children. Such results are particularly relevant from an educational perspective, as they suggest that swimming may not only improve average performance but also reduce differences in motor proficiency between children.

The correlation analysis performed in the present study provides additional insight into the mechanisms underlying motor development. The generally weak relationships observed between anthropometric and motor variables indicate that performance at this age is influenced more strongly by neuromuscular and coordinative factors than by body dimensions alone. A similar perspective was proposed by Robinson et al. (2015), who suggested that motor competence development is determined by a complex interaction of biological, behavioral, and environmental factors, with anthropometric characteristics representing only one component of this process. The weak positive association between waist circumference and standing long jump performance suggests that somatic development may contribute to explosive strength to a limited extent; however, the low correlation coefficient indicates that other factors play a more important role. Similarly, the absence of a meaningful relationship between sprint performance and abdominal endurance supports the view that different motor capacities develop through distinct physiological and neuromuscular pathways.

These findings reinforce the contemporary understanding that motor development during childhood is a multifactorial process involving the interaction of growth, maturation, motor learning, and environmental stimuli. Swimming appears to provide a favorable context for this process by combining technical skill acquisition, coordinative demands, postural control, and whole-body muscular engagement within a safe and low-impact environment. From a broader developmental perspective, such experiences may contribute not only to improvements in motor competence but also to the development of physical literacy, including confidence, motivation, and long-term engagement in physical activity (Edwards et al., 2018).

Despite the positive findings, several limitations should be acknowledged. The relatively small sample size limits the generalizability of the results, and the absence of a control group makes it difficult to isolate the effects of the swimming program from those associated with natural growth and maturation. Additionally, the intervention period was relatively short, and longer-term studies may reveal larger adaptations in both motor and anthropometric variables. Future research should include larger samples, control groups, and additional functional assessments to provide a more comprehensive understanding of the long-term effects of swimming participation during childhood.

Overall, the findings of this study support the growing body of evidence suggesting that swimming represents an effective and accessible form of physical activity for children. From a broader developmental perspective, participation in swimming may contribute not only to the improvement of motor performance but also to the development of physical literacy, which encompasses movement competence, confidence, motivation, and lifelong engagement in physical activity (Edwards et al., 2018).

CONCLUSIONS

The present study investigated the effects of an eight-week beginner swimming program on the physical and motor development of children aged 7–9 years. The findings demonstrate that regular participation in structured aquatic activities can generate positive adaptations in several key components of motor performance during a critical stage of childhood development.

The most important improvements were observed in abdominal muscular endurance, sprint speed, and lower-limb explosive strength, indicating that swimming provides a comprehensive stimulus capable of enhancing both neuromuscular function and motor coordination. These results support the hypothesis that the aquatic environment promotes adaptations that extend beyond swimming-specific skills and may positively influence general motor competence. The improvements recorded in land-based motor tests suggest the existence of transfer effects from aquatic training to fundamental movement abilities, reinforcing the educational and developmental value of swimming practice in children.

From an anthropometric perspective, the slight increases in body weight, waist circumference, and chest circumference observed during the intervention period were consistent with normal growth patterns expected in children of this age. No disproportionate changes or adverse adaptations were identified, confirming that participation in the swimming program occurred within a framework of healthy physical development. Furthermore, the relatively stable variability observed across most indicators suggests that the intervention contributed to balanced progress among participants and may have supported a more homogeneous level of motor competence within the group.

The correlation analysis highlighted that motor performance was only weakly associated with anthropometric characteristics, suggesting that neuromuscular and coordinative factors play a more important role than body dimensions in determining performance at this age. This finding emphasizes the importance of providing children with varied and stimulating movement experiences that facilitate motor learning and functional development rather than focusing exclusively on physical growth indicators.

The practical implications of this study are particularly relevant for physical education teachers, swimming instructors, coaches, and health professionals working with children. The results suggest that even a relatively short-term swimming program, performed only twice per week, can contribute to measurable improvements in motor abilities that are essential for long-term participation in physical activity and sport. Consequently, swimming may represent an effective complementary activity within school-based physical education programs and extracurricular sports initiatives aimed at promoting lifelong physical literacy.

Although the present study was conducted on a relatively small sample and over a limited intervention period, the findings provide additional evidence supporting the role of swimming as a safe, accessible, and developmentally appropriate activity for children. Future research involving larger samples, longer intervention periods, and control groups is recommended to further clarify the magnitude of swimming-induced adaptations and their long-term impact on motor development.

In conclusion, the results of this study confirm that structured swimming programs can positively influence motor performance while supporting normal physical growth in children aged 7–9 years. Swimming should therefore be considered not only a means of acquiring aquatic skills and water safety competence but also an effective educational and developmental tool capable of fostering physical fitness, motor proficiency, and healthy growth during childhood.

LIMITATIONS AND FUTURE DIRECTIONS

Although the results of the present study indicate positive effects of a structured swimming program on the motor and physical development of children aged 7–9 years, several limitations should be acknowledged. First, the study was conducted on a relatively small sample of only 14 participants, which limits the extent to which the findings can be generalized to larger populations. Individual differences in growth, maturation, and responsiveness to training may have influenced the results and should be considered when interpreting the outcomes.

A second limitation is the absence of a control group. Without a comparison group that did not participate in the swimming program, it is difficult to determine the exact contribution of the intervention relative to the natural growth and developmental processes characteristic of this age. Furthermore, the intervention period lasted only eight weeks, which may have restricted the magnitude of the adaptations observed, particularly in anthropometric variables that typically require longer periods to show substantial changes.

Another limitation concerns the range of variables assessed. While the selected motor and anthropometric tests provided valuable information regarding speed, explosive strength, muscular endurance, and physical growth, other important aspects of motor development, such as balance, agility, coordination, flexibility, and swimming-specific skills, were not evaluated.

Future research should involve larger and more diverse samples, include control groups, and extend the duration of the intervention. Additionally, incorporating a broader range of functional and swimming-specific assessments would provide a more comprehensive understanding of the effects of aquatic training on childhood development. Such studies could further clarify the long-term contribution of swimming to physical literacy, motor competence, and healthy growth during childhood.

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