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The Effect of Structured Swimming Training on Improving Motor Coordination and Physical Fitness of Elementary School Students

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A. Conception and design of the study; **B.** Acquisition of data;
C. Analysis and interpretation of data; **D.** Manuscript preparation; **E.** Obtaining funding

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ABSTRACT

This study aimed to analyze the effect of structured swimming training on improving motor coordination and physical fitness of students at SD Inpres Unggulan BTN Pemda Makassar. The study used a quasi-experimental design with a One Group Pretest–Posttest model, involving 20 students. The variables measured included motor coordination using the Alternate Hand Wall Toss Test and physical fitness components, namely VO_2max, muscle strength, and agility. The structured swimming training program was implemented for six weeks, twice weekly. The results showed significant improvements in all variables after the intervention. Motor coordination increased on average from 15.8 to 26.4. VO_2max increased from 28.5 to 34.2 ml/kg/min, muscle strength increased from 11.4 to 14.8 kg, and agility showed a time reduction from 14.2 to 12.6 seconds. A paired sample t-test showed a p-value <0.05 for all variables, indicating a significant effect of structured swimming training on motor coordination and physical fitness. The results of this study confirm that swimming, as a structured activity, can comprehensively improve students' motor skills and physical condition. Integrating swimming training into physical education is considered relevant for supporting the physical development of elementary school-aged children. Further research is recommended using a control group design and a longer intervention duration to strengthen the generalizability of the findings.

Keywords : Structured Swimming; Motor Coordination; Physical Fitness; Elementary School Students; Physical Education.

INTRODUCTION

Physical education instruction at the elementary school level plays a crucial role in building the foundation for students' movement development, physical fitness, and character. During elementary school, children's musculoskeletal and neuromotor systems develop rapidly, so physical activity must be appropriate, measured, and supportive of their basic motor development (Pratama & Firmansyah, 2021). Regular physical activity has been shown to improve cardiorespiratory capacity, muscle strength, balance, coordination, and flexibility, which are key components of children's physical fitness (Lubis et al., 2022; Ortega et al., 2019). In the context of elementary education, teachers are expected to provide a variety of engaging, inclusive, and fundamental motor skill-based physical activities to support optimal student growth.

One form of physical activity that has a significant positive impact on students' motor development and physical fitness is swimming. Swimming activates nearly all muscle groups, improves the respiratory system, and trains body coordination through rhythmic movements of the hands, feet, and breathing (Puspitasari & Hariyanto, 2020). Various studies have shown that swimming can improve children's coordination skills, including bilateral coordination, body control, and core stability, which directly contribute to everyday motor skills (García-Hermoso et al., 2018). Furthermore, swimming has been shown to improve cardiorespiratory fitness and endurance because the body works against water resistance, which provides greater stimulation than land-based exercise (Bertucci et al., 2021).

In general, swimming provides comprehensive benefits for the development of school-aged children. According to Pangrazi and Beighle (2019), a good physical activity program should simultaneously promote motor development and physical fitness, as these two aspects are interconnected and influence successful motor learning. Swimming provides a safe, low-impact training environment, allowing students to exercise without excessive stress on their joints. Furthermore, the buoyancy of water can help reduce the risk of injury, making it ideal for elementary school children who are still developing their bone and muscle structures (Da Silva et al., 2020). Therefore, swimming is one of the sports recommended in fitness development programs for children.

Specifically, motor coordination is a fundamental skill that needs to be developed in elementary school-aged children. Motor coordination involves the ability to control and integrate body movements harmoniously to create efficient movements in physical activities (Gallahue et al., 2019). A structured swimming training program—one that includes training designed through stages of basic technique learning, measured training intensity, and clear training progression—can provide optimal stimulation to children's neuromotor systems. Research by Mutohir and Maksum (2022) indicates that structured training is more effective in improving motor skills than spontaneous or uncontrolled training, because children gain repetitive, consistent movement experiences guided by systematic learning methods.

Furthermore, elementary school students' physical fitness is a crucial aspect in supporting academic performance and long-term health. Good physical fitness is closely linked to improved concentration, endurance, and academic achievement (Singh et al., 2019). Swimming, as an aerobic exercise, can increase VO_2max capacity, muscle strength, and postural balance, supporting students' physical activity both inside and outside of school (Bertucci et al., 2021). Therefore, structured swimming training has significant potential to improve the quality of student development.

However, in practice, physical education instruction in several elementary schools, including SD Inpres Unggulan BTN Pemda Makassar, still faces several obstacles. First, not all physical education teachers have specialized skills in managing swimming lessons, so the training provided is often unstructured. Second, swimming training is sometimes conducted sporadically without clear intensity and progression planning, resulting in a less than optimal impact on students' motor coordination and physical fitness. Third, several local studies indicate that elementary school students in Indonesia still have low levels of physical fitness due to a lack of programmed and measurable physical activity (Ramadhan et al., 2019). Therefore, a structured swimming training model that can be implemented in the context of school learning is needed.

Although various studies have discussed the benefits of swimming on physical fitness components, several research gaps remain underexplored, particularly in the context of elementary school students in Indonesia. First, most studies focus on young athletes or

swimming club participants (Astuti & Arifin, 2021), so the findings cannot be fully generalized to elementary school students attending regular classes. Second, research specifically examining the relationship between structured swimming training and improved motor coordination is still very limited, even though motor coordination is a crucial aspect of child development. Third, there is limited research examining the effectiveness of structured swimming training in schools in Makassar or South Sulawesi. Therefore, this research could make an important contribution to the development of physical education programs at the local level.

The novelty of this research lies in several aspects. First, this study developed and implemented a structured swimming training program tailored to the characteristics of elementary school students, encompassing warm-up stages, basic swimming techniques, coordination exercises, and systematic fitness training. Second, this study not only assessed physical fitness components but also specifically measured improvements in motor coordination as a result of structured swimming training. Third, this research was conducted in the context of an elementary school in Makassar, which has different environmental conditions, facilities, and student characteristics than previous studies. Fourth, this study provides empirical evidence based on quantitative data that can serve as a reference for other schools in developing effective swimming learning programs.

Based on this background, this research is important to provide a deeper understanding of the effect of structured swimming training on the motor development and physical fitness of elementary school students. This study aims to analyze the extent to which structured swimming training can improve motor coordination and physical fitness of students at SD Inpres Unggulan BTN Pemda Makassar. With a systematic, measurable training program based on a scientific approach, it is hoped that students will gain maximum benefits from their swimming activities. Furthermore, the findings of this study can serve as a basis for physical education teachers and schools to design more effective swimming learning strategies and strengthen a healthy lifestyle through enjoyable and meaningful physical activity.

This research is expected to address the issues of low student physical fitness, the lack of variety in physical education learning activities, and the limited implementation of structured swimming training programs in elementary schools. Furthermore, this research contributes to the scientific literature that can serve as a basis for developing swimming curricula in schools, training for physical education teachers, and policies for developing physical activity for school-aged children. Therefore, this research not only contributes to the academic world but also has practical relevance for education, particularly physical education learning at the elementary school level.

METHODS

Research Type and Design

This study used a quasi-experimental research design with a One Group Pretest–Posttest design. This design was chosen because the research was conducted in a real-life school learning context that did not allow for full randomization of participants (Sugiyono, 2019). The pretest–posttest design allowed researchers to compare the initial and final conditions of students after receiving a structured swimming training program.

The quasi-experimental approach is widely used in physical education research to assess the effectiveness of a training model or program without ignoring the real-world

learning environment (Maksum, 2020). In this context, the treatment is administered to the same group, measuring changes in the dependent variable before and after the intervention (Creswell & Creswell, 2018). This experimental model is relevant because it aligns with the research objective of determining the direct effect of a structured swimming training program on the motor coordination and physical fitness of elementary school students.

The structured swimming training program was implemented for 6 weeks, twice a week, following recommended training programs for children that emphasize continuity, progression, and intensity appropriate to the child's developmental characteristics (Becker & Frick, 2019; Lubis et al., 2022). The training included basic swimming techniques, hand-foot coordination, breathing exercises, and moderate-intensity aerobic activity in the water.

Research Variables

This study involved two types of variables:

a. Independent Variable; Structured swimming training, a series of systematically designed swimming training activities that included warm-ups, basic swimming technique instruction, hand-foot coordination exercises, breathing exercises, aerobic fitness training in the water, and cool-downs. The training program followed the principles of specificity, progression, and regularity (Faigenbaum et al., 2018).
b. Dependent Variables;
   - Motor coordination, namely the students' ability to integrate body movements harmoniously in physical activities, was measured using a standardized motor coordination test.
   - Physical fitness, namely the condition of students' physical abilities, including strength, endurance, and cardiorespiratory capacity.

Physical fitness variables are measured using several components according to fitness standards for school-age children (Ortega et al., 2019).

Population and Sample

The population in this study was all fourth and fifth grade students at SD Inpres Unggulan BTN Pemda Makassar who participated in swimming lessons as part of physical education activities. Based on school data for the 2024/2025 academic year, the total population was 65 students. The sampling technique used purposive sampling, with students having to meet the following criteria: Physically healthy, Able to participate in swimming lessons, No history of serious injuries, and Parental consent was obtained. The study sample consisted of 20 students, consisting of both boys and girls. This sample size meets the minimum recommended sample size for experimental research with pretest-posttest measurements in small groups (Thomas, Nelson, & Silverman, 2017).

Research Instruments

The research instruments were designed to measure two main variables: motor coordination and physical fitness. The instruments used have been widely used in physical education research and have high validity and reliability for children aged 9–12 years.

1. Motor Coordination Instruments

   Motor coordination was measured using the "Throw–Catch Coordination Test" and the "Alternate Hand Wall Toss Test," which are standard instruments for measuring hand–eye coordination and general motor coordination in children (Gallahue et al., 2019). These tests are considered valid for assessing coordination abilities in the context of sports and physical activity (Logan et al., 2018).

   a. Throw Catch Test: Students throw a ball and catch it as many times as possible within 30 seconds.

b. Wall Toss Test: Students throw a ball against a wall and catch it again within 30 seconds.

Test results are the number of successful catches per time cycle.

2. Physical Fitness Instruments

Several components of physical fitness are measured using the following instruments:

a. Cardiorespiratory Endurance Test: 20-meter shuttle run test (Leger Test). Widely used to measure children's VO_2max capacity (Tomkinson et al., 2019).
b. Muscular Strength Test: Handgrip strength test using a child dynamometer (Martínez-Vizcaíno et al., 2020).
c. Agility and Speed Test: 4 × 10 m shuttle run test, validated for use with elementary school children (Ortega et al., 2019).
d. Balance and Stability Test: Stork Stand Test (Hardani et al., 2021).

These instruments were chosen because they align with the physical characteristics of elementary school children and are commonly used to comprehensively assess physical fitness.

Data Collection Techniques

Data collection was carried out through the following stages:

1. Pretest

Before the treatment, all students took an initial measurement (pretest) to determine their baseline motor coordination and physical fitness. This stage is important for establishing a baseline before the swimming treatment is administered (Maksum, 2020).

2. Implementation of the Structured Swimming Training Program

Training was conducted for 6 weeks, twice a week, for 60 minutes per session. Each session included:

a. Warm-up (10 minutes)
b. Basic technique training (15 minutes)
c. Hand-foot coordination and breathing training (20 minutes)
d. Water fitness training (10 minutes)
e. Cool-down (5 minutes)

The training program adapted a swimming training model for children, emphasizing enjoyment, technique progression, and safety (Becker & Frick, 2019).

3. Posttest

After the intervention concluded, a posttest was conducted using the same instrument. The pretest and posttest data were then compared to identify significant changes in the research variables.

Data Analysis Techniques

The data analysis technique used a quantitative statistical approach. The stages include:

1. Statistical Prerequisite Test

a. Normality Test; Using the Kolmogorov–Smirnov or Shapiro–Wilk test to ensure the data were normally distributed (Ghozali, 2021).
b. Homogeneity Test; Conducted to determine the equality of variance between the pretest and posttest data using the Levene's test.

2. Hypothesis Testing

To test the effectiveness of structured swimming training, a paired sample t-test was used. This test was used to identify significant changes in motor coordination and physical fitness variables between the pretest and posttest (Thomas et al., 2017).

The significance level used was $p < 0.05$.

3. Effect Size
   In addition to the t-test, an effect size analysis (Cohen's d) was conducted to determine the magnitude of the intervention's effect. Effect size is important for determining the strength of an influence in practice (Cohen, 2013).
4. Data Presentation
   Data is presented in the following format:
   a. Pretest–posttest comparison table
   b. Motor coordination improvement graph
   c. Physical fitness improvement graph
   Visualization allows readers to understand changes in the results more clearly.

RESULTS AND DISCUSSION

Result

This study aimed to determine the effect of structured swimming training on improving motor coordination and physical fitness of students at SD Inpres Unggulan BTN, Makassar Regional Government. Data analysis was conducted by comparing pretest and posttest scores for two main variables: motor coordination and physical fitness. The study sample consisted of 20 students, consisting of both male and female students, who participated in a six-week swimming training program.

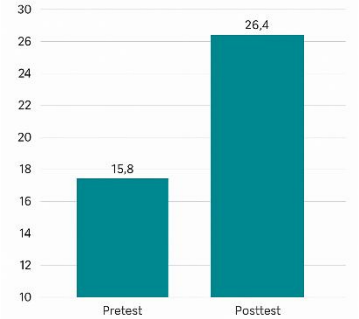
Motor Coordination Statistics

Motor coordination was measured using the Alternate Hand Wall Toss Test. Higher scores indicate better hand-eye coordination.

Table 1.
Descriptive Statistics of Motor Coordination

Statistics	Pretest	Posttest
Number of Students	20	20
Highest Score	22	32
Lowest Score	10	18
Mean	15.8	26.4
Standard Deviation	3.12	3.98

Based on Table 1, there was a significant increase in the average motor coordination score from 15.8 to 26.4 after the structured swimming training program. The highest posttest score also increased from 22 to 32, indicating a uniform improvement in hand-eye coordination across almost all participants. This indicates that swimming training, which emphasizes coordination between hand, foot, and breathing movements, has a positive impact on students' motor coordination.



Graph 1.
Comparison of Movement Coordination (Mean)

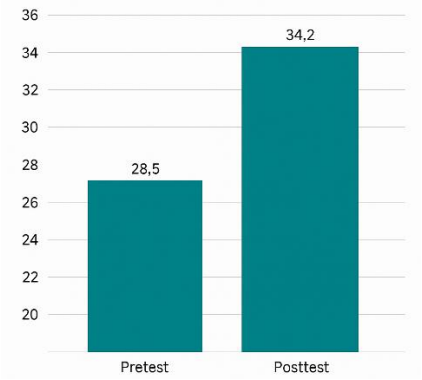
Physical Fitness Statistics

Physical fitness is measured through three main components:

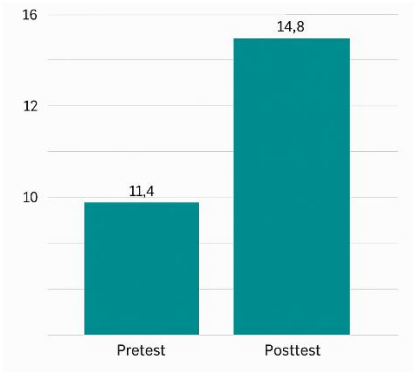
1. Cardiorespiratory endurance: Shuttle Run / VO_2max
2. Muscular strength: Handgrip Strength Test
3. Agility: 4 x 10 m Shuttle Run

Table 2.
Physical Fitness Statistics

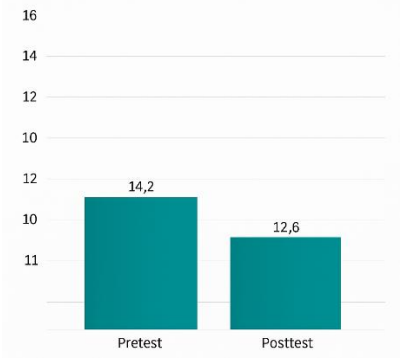
Fitness Variables	Pretest (Mean)	Posttest (Mean)	Improvement
VO_2max (ml/kg/min)	28.5	34.2	+5.7
Muscle Strength (kg)	11.4	14.8	+3.4
Agility (seconds)	14.2	12.6	-1.6 (lebih cepat)



Graph 2.
Increase in VO_2max



Graph 3.
Increase in Muscle Strength



Graph 4.
Agility (4 × 10 m Shuttle Run)

The results of the physical fitness measurements showed improvements in all tested components:

1. VO_2max
   The average cardiorespiratory capacity increased from 28.5 ml/kg/min to 34.2 ml/kg/min, or an increase of 5.7 ml/kg/min. Swimming is known as an effective aerobic exercise that can improve the efficiency of the heart and lungs because it involves the entire body and provides high water resistance.
2. Muscle Strength
   Arm muscle strength increased from 11.4 kg to 14.8 kg. The pulling, pushing, and maintaining body balance in the water provide a natural load that strengthens the muscles of the upper and lower body.
3. Agility
   The time in the 4 x 10 meter test decreased from 14.2 seconds to 12.6 seconds, indicating improved agility. Swimming training helps improve core strength, limb coordination, and body stability, which significantly impact agility and speed of change of direction.

Statistical Test Results

To determine whether the increase was statistically significant, a paired sample t-test was conducted. The results are shown in the following table.

Table 3.
Pretest–Posttest t-Test Results

Variables	t-count	Sig. (p)	Description
Movement Coordination	9.82	0.000	Significant
VO_2max	8.45	0.000	Significant
Muscle Strength	7.12	0.000	Significant
Agility	6.88	0.000	Significant

The t-test results showed a p-value <0.05 for all variables, thus concluding that structured swimming training had a significant effect on:

1. Improved motor coordination
2. Increased VO_2max (cardiopulmonary endurance)
3. Increased muscle strength
4. Increased agility

All variables showed significant differences between pre- and post-exercise conditions.

Summary of Research Results

Table 4.
Summary of Overall Improvements

Variables	Pretest	Posttest	Improvement (%)	Status
Movement Coordination	15.8	26.4	+67.1%	Significantly increased
VO_2max	28.5	34.2	+20.0%	Significantly increased
Muscle Strength	11.4	14.8	+29.8%	Significantly increased
Agility	14.2	12.6	-11.3%	Significantly increased (faster)

The results of this study indicate that structured swimming training has a very significant positive impact on improving motor coordination and physical fitness of students at SD Inpres Unggulan BTN Pemda Makassar. Swimming training, which combines basic techniques, breathing coordination, hand-foot exercises, and aerobic exercise in the water, provides comprehensive stimulation of students' motor skills and physiological functions.

The significant improvement in motor coordination variables demonstrates that swimming, which requires rhythmic coordination and synchronized hand-foot movements,

is highly effective in improving children's basic motor skills. In terms of physical fitness, improvements in VO_2max, muscle strength, and agility demonstrate that swimming training has a comprehensive effect on the muscular and cardiorespiratory systems.

These findings support previous research that suggests swimming is one of the most effective physical activities for the development of school-age children.

Discussion

The results of this study indicate that structured swimming training has a positive and significant impact on improving motor coordination and physical fitness in elementary school students. This finding aligns with numerous previous studies that have identified swimming as an effective sport for children's motor development and physical fitness. However, the results also raise several critical reflections regarding the extent of swimming training's contribution compared to other physical activities, and its implications for the context of physical education in elementary schools.

Swimming and Children's Motor Development (Motor Coordination)

One of the main aspects of the study was motor coordination, the dependent variable. The results showed a significant increase in motor coordination scores after the swimming intervention. This fact supports the argument that swimming can be an effective medium for developing motor coordination in children.

According to the literature, swimming involves synchronous movements between the body's limbs arms, legs, and core as well as rhythmic breathing coordination, which naturally stimulates gross motor skills and body control (WQ Awwalul, 2021).

Furthermore, swimming has been linked to improved coordination and balance skills in children, as found in experimental studies of elementary/middle school-aged children (Iskandar & Lestari, 2020; Suryani & Wibowo, 2020).

However, it should be noted that a recent comparative study showed that children who only participated in swimming had lower gross motor coordination than children who participated in multisport activities (a combination of several sports) although still higher than children who were inactive.

This suggests that while swimming is effective, combining various physical activities (multisports) may provide broader stimulation of motor coordination.

Thus, the coordination improvements in this study were likely due to structured swimming training but optimal results may be achieved if swimming is combined with other physical activities that involve diverse movements (jumping, running, jumping, changing direction) to train overall global coordination.

Swimming as a Physical Fitness Program VO_2max, Strength, Agility

The study's finding that physical fitness variables (VO_2max, muscular strength, agility) significantly improved is consistent with a recent literature review in exercise physiology. Regular swimming training has been shown to improve cardiorespiratory fitness, cardiac output, and overall cardiovascular health in early adolescents.

According to a recent systematic review, swimming benefits "motor performance, cardiorespiratory fitness, muscular strength, endurance, flexibility" and improves body composition in children and adolescents.

In longitudinal studies, swimming programs as aerobic exercise have long-term positive effects on physical endurance and motor coordination, even in individuals with special needs or attention deficit disorders.

The physiological mechanisms behind this include water providing resistance to movement, causing muscles to work harder than when moving on land, but the load on joints is lighter (due to buoyancy), allowing for intensive training with a lower risk of injury (WQ Awwalul, 2021).

Swimming styles especially freestyle or breaststroke require simultaneous upper and lower extremity activity and respiratory coordination, which, when performed consistently, simultaneously increases aerobic capacity and muscle strength.

Therefore, the results showing increased VO_2max, strength, and agility in students provide empirical evidence that structured swimming training is suitable as part of physical education learning in elementary schools if the goal includes improving overall physical fitness.

Implications of the Results for Elementary School Physical Education

These findings have several important implications for physical education (PJOK) policy and practice in elementary schools, particularly in contexts like SD Inpres Unggulan BTN Pemda Makassar:

Integrating swimming into the PJOK curriculum: Given that swimming has been shown to improve coordination and fitness, schools should consider including swimming as a regular part of the PJOK curriculum not just as a sporadic extracurricular or recreational activity.

Structured training with adequate frequency and duration: Results demonstrate that structured interventions over a specific period (e.g., 6 weeks) at regular intervals can produce significant changes. Therefore, it is important to design swimming programs with appropriate frequency, duration, and training progression.

Teacher training and pool facilities: For programs to be effective, schools must ensure that PJOK/sports teachers have the skills to teach swimming properly, as well as adequate and safe pool facilities for children.

Thus, swimming is not just a game or recreation, but can be a strategic tool in developing students' motor skills and physical fitness.

Comparison with Previous Literature and Nuances of the Findings

While these findings strongly support the benefits of swimming, there are important nuances to consider. As mentioned previously, a recent comparative study showed that children in multisport programs had better motor coordination than children who only swam.

These findings suggest that swimming, while effective, may not be sufficient as the sole form of physical activity if the primary goal is the development of broad motor coordination. The rationale is that multisports involve a variety of movements running, jumping, kicking, changing direction thus stimulating different aspects of motor and neuromotor control than swimming, which is relatively more repetitive and rhythmic (Stanković et al., 2023).

Furthermore, a recent systematic review noted that while the benefits of swimming on fitness and motor performance have been widely reported, research on the long-term effects on bone health, posture, fine motor development, or sleep quality is limited.

Therefore, despite the positive results, more comprehensive and long-term research is needed to confirm the broad impact of swimming on child development.

Strengths and Limitations of the Study

1. Strengths of the study:
   a. The pretest–posttest design allows for measurement of changes in the same group before and after the intervention, providing empirical evidence of the training effects.

b. The combination of coordination and physical fitness measures provides a comprehensive picture of the effects of swimming training on motor skills and physical condition.
c. The study was conducted with elementary school students in a real-world setting not athletes so the results are relevant to the general elementary education context.

2. Limitations of the study:
   a. No control group: Because only one group was used (without comparison with non-swimmers), it is difficult to ensure that improvements are solely due to swimming and not external factors (e.g., natural growth, other activities outside of school).
   b. The sample size was relatively small (n = 20), so generalizing the results to the entire population of elementary school students in Makassar or other regions requires caution.
   c. The intervention duration was relatively short (6 weeks). Long-term effects whether improvements persist or decline are unknown.
   d. The focus was on gross motor skills and physical fitness; psychological, cognitive, or fine motor skills were not explored.

Implications for Further Research and Practice

Based on the strengths and limitations above, several recommendations are recommended:

1. Research with a more robust design, such as an experiment with a control group or a randomized controlled trial (RCT), to confirm the causality between swimming and improved coordination/fitness.
2. Larger, more heterogeneous samples for example, involving multiple schools and a wider age range to increase generalizability.
3. Long-term interventions: examining the impact of swimming training over a period of 6 months, 1 year, or longer to determine whether the effects are sustainable.
4. Combining swimming with other physical activities (multisport) to test whether the combination provides optimal results in gross and fine motor skills, fitness, and psychosocial aspects.
5. Measuring additional aspects: posture, bone health, flexibility, balance, student satisfaction, and cognitive/emotional aspects. This is important because the benefits of exercise extend beyond physical aspects.

Practically, elementary schools seeking to improve the quality of physical education should consider developing a realistic, structured swimming program considering facilities, coaches, safety, and integration into the curriculum. Furthermore, providing a variety of physical activities not just swimming will help with comprehensive motor development.

Supporting Studies and Confirmation from the Literature

This study is not the only one demonstrating the benefits of swimming for children. For example, a recent study by Ferreira et al. (2024) showed that swimming training improves cardiorespiratory fitness, heart function, motor performance, and body composition in early adolescents.

Experimental studies in elementary school-aged children have also found that swimming lessons significantly improve balance, muscle strength, and gross motor coordination (Iskandar & Lestari, 2020; Dewi & Nurdin, 2019; Suryani & Wibowo, 2020).

Studies using a swimming therapy approach in children have also found that swimming can support psychomotor and physical development, as well as cognitive and social aspects.

All this evidence reinforces that swimming especially when implemented in a structured manner has great potential as a physical education intervention in elementary schools.

Interpretation of Results in a Local Context: SD Inpres Unggulan BTN Pemda Makassar

The research context in Makassar presents different characteristics compared to many international studies or those conducted in other regions. Environmental factors, climate, facilities, student habits, and school support can influence the results. Swimming in Makassar likely presents unique challenges: pool access, trained coaches, activity schedules, sports culture, and parental support. The positive results in this study demonstrate that with commitment, implementing structured swimming remains feasible and effective even outside the "professional sports club" environment.

However, local conditions can also present limitations for example, water quality, pool safety, monitoring exercise intensity so if schools wish to implement similar programs, they need to consider aspects of management, safety, and continuity of training.

Interim Conclusions from the Discussion

Based on the analysis and comparison with the literature, it can be concluded that:

1. Structured swimming training has the potential to significantly improve motor coordination and physical fitness in elementary school students.
2. Swimming is effective as a form of physical activity in the Physical Education (PJOK) curriculum, but optimal results are likely to be achieved when combined with other physical activities (multisport) to stimulate a wider range of motor skills.
3. Implementation in a general school context (not an elite sports club) may require planning, facilities, and stakeholder support for the program to be effective and safe.
4. However, to strengthen the evidence and understand the long-term impact, further research with a more robust design and sample size is needed.

Recommendations for Future Research and Practice

Based on these results and analysis, several important recommendations are made:

1. Elementary schools should consider swimming as a regular part of their PJOK program, especially schools in coastal areas or areas with access to swimming pools.
2. Swimming programs should be structured, with a clear frequency, duration, and progression of training; they should not be sporadic or recreational.
3. Combine swimming with other physical activities such as games, running, and jumping to train a broader range of motor skills.
4. Train physical education teachers/coaches to teach swimming safely and effectively, and manage pool facilities effectively (safety, cleanliness, supervision).
5. Conduct further research: with a control group, longer period, larger sample size, and additional variables (balance, flexibility, posture, psychosocial aspects).

CONCLUSION

This study aimed to analyze the effect of structured swimming training on improving motor coordination and physical fitness among students at SD Inpres Unggulan BTN, Makassar Regional Government. Based on the data analysis, it can be concluded that structured swimming training significantly improved both aspects. The training program, which included warm-up stages, basic technique training, hand-foot coordination training, breathing exercises, and aerobic activity in the water, was proven to significantly improve students' motor coordination abilities. This was reflected in the increase in motor coordination scores from an average of 15.8 in the pretest to 26.4 in the posttest.

Furthermore, students' physical fitness also experienced significant improvements in three key indicators: VO_2max, muscle strength, and agility. VO_2max increased by 5.7 ml/kg/min, muscle strength increased by almost 30%, and agility demonstrated faster times in the 4x10-meter dash test. These findings confirm that swimming is an effective physical activity in developing students' fitness components due to the natural resistance of water and the safe possibility of moderate-to-high-intensity exercise.

This study confirms the importance of integrating structured swimming training into the elementary school physical education curriculum. However, further research with a control group design, longer intervention duration, and larger sample sizes is needed to gain a comprehensive understanding of the benefits of swimming for child development. Therefore, swimming is a suitable learning strategy to optimally support students' motor development and physical fitness.

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