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THE EFFECT OF HIGH-INTENSITY FUNCTIONAL TRAINING (HIFT) TO IMPROVE THE SHOOTING ACCURACY OF STUDENTS IN ELEMENTARY SCHOOL FUTSAL EXTRACURRICULAR ACTIVITIES

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ABSTRACT

Research on improving shooting precision in elementary school futsal extracurricular activities is still dominated by technical training, while approaches that integrate biomotor capacity development and engineering skills through High-Intensity Functional Training (HIFT) are still limited.
This study aims to analyze the influence of HIFT on the shooting accuracy of students who participate in elementary school futsal extracurricular activities.
The study uses a quantitative approach with a pre-experimental method through a One-Group Pretest–Posttest design.
Participants consisted of 22 male students who were selected using the total sampling technique.
The HIFT program is carried out for eight weeks with a frequency of two exercises each week based on the principles of Frequency, Intensity, Time, and Type (FITT) and progressive loads.
Data were collected using a futsal precision shooting test that had been adapted and analyzed using descriptive statistics, Shapiro–Wilk normality test, paired sample t-test, and effect size analysis.
The results showed that the average score of shooting accuracy increased from 16.00 \pm 4.65 to 21.82 \pm 2.81, or an increase of 5.82 points (36.4%).
The peer-samples t-test showed a significant increase ($t(21) = 5.41$; $p < 0.001$), while Cohen's value $d = 1.15$ showed a large effect.
These findings show that HIFT is not only effective in improving statistically precise shooting accuracy, but also provides high practical benefits through the integrated development of various biomotor components.
This study provides empirical evidence that HIFT can be effectively applied to elementary school students as a training model that integrates the development of physical abilities and technical skills, so that it can be

an alternative for physical education teachers and futsal coaches in designing more effective and efficient extracurricular training programs.

Keywords: Elementary School, Futsal, High-Intensity Functional Training, HIFT, Shooting Accuracy.

INTRODUCTION

Modern futsal evolved into a high-intensity, intermittent sport that required players to perform repetitive acceleration and deceleration, explosive changes of direction, rapid transitions between the attacking and defensive phases, and decision-making in a very short period of time.
The characteristics of the game on a small court with limited movement space cause each player to be able to combine physical capacity, biomotor abilities, and technical skills simultaneously in order to maintain performance throughout the match (Borges et al., 2022; Spyrou et al., 2020; Wang et al., 2023; Xiao et al., 2025). Therefore, the demands of modern futsal games are no longer only oriented towards mastering basic techniques, but also on the ability to integrate strength, speed, coordination, balance, agility, and movement control in high-tempo game situations.

Among the various technical skills in futsal, shooting is the most decisive component of a team's success because it becomes Terminal Action, which directly converts opportunities into goals.
While the process of building an attack is influenced by both passing and dribbling skills, the

effectiveness of both skills ultimately depends on the player's ability to finish chances through accurate shooting. Thus, the quality of the final finish (Finishing) has a more direct contribution to the outcome of a match than any other technical skill.
Studies of sports biomechanics show that the success of shooting is not only determined by kicking techniques, but is the result of the integration of explosive force generating ability, neuromuscular coordination, postural stability, dynamic balance, efficiency Kinetic Chain, as well as the ability to transfer force from the lower extremities to the ball effectively during the propulsion phase until the foot comes into contact with the ball (Augustus et al., 2024; Boyne et al., 2024; Shan & Zhang, 2022; Zemková et al., 2022).
Therefore, the development of shooting skills in elementary school students requires a training approach that not only improves the quality of technique, but also develops biomotor capacity and neuromuscular control so that these skills can be applied effectively in the demands of the modern futsal game.

Although shooting is a very decisive skill in the game of futsal, the conditions on the field show that the shooting accuracy ability of elementary school students still needs to be improved.
Based on the results of initial observations on futsal extracurricular activities, most students have not been able to direct the ball consistently to the target, especially when shooting after running, changing direction, or being in a condition of unstable body balance.
This phenomenon is motorically shown by the direction of the kick that often deviates from the target, the quality of foot contact with the ball that is not consistent, the position of the footwork is not stable, and the coordination between the kicker's leg and the kicker's leg that has not taken place optimally.

This condition indicates that the execution of shooting has not been fully supported by adequate neuromuscular control so that players have difficulty maintaining body stability and controlling the direction and power of the kick when in dynamic game situations.

The results of the initial test on 22 futsal extracurricular participants showed an average shooting accuracy score of 16.00 \pm 4.65 out of a maximum score of 35, with the lowest score of 9 and the highest score of 25.
This achievement only reached around 45.7% of the ideal score, thus showing that the initial shooting accuracy ability of students is still in the category that is not optimal and there is still a considerable gap in expected performance.
This condition shows that most students have not been able to maintain the consistency of the direction of the kick in various game situations, especially when the shooting is carried out after activities that require a change in direction, acceleration of movement, and adjustment of body position.
These preliminary findings reinforce the need for training programs that are not only oriented towards improving mastery of technique, but also able to develop the physical and neuromuscular components that support the quality of shooting execution.

Theoretically, the low accuracy of shooting is not only due to a lack of mastery of kicking techniques, but also related to the lack of optimal neuromuscular coordination, dynamic balance, postural stability, and the ability to integrate the work of various body segments while producing efficient movements.
When shooting, the nervous system must be able to coordinate the activation of the muscles of the stacking legs, kicking legs, Core Stability (Core Musculature), and a simultaneous balancing system so that the direction and speed of the ball can be controlled consistently.
If the coordination has not developed optimally, then the transfer of force through Kinetic Chain become less efficient so that the accuracy of the kick tends to decrease.
Studies have shown that shooting success in young athletes is significantly influenced by the quality of neuromuscular coordination, leg muscle strength, dynamic balance, postural stability, and biomechanical efficiency during movement performance (Augustus et al., 2024; Fauzi et al., 2023; Shan & Zhang, 2022; Williams et al., 2021; Zemková et al., 2022).
Therefore, improving shooting skills in elementary school students requires an exercise approach that is able to develop neuromuscular and biomotor capacities in an integrated manner so that the technical skills learned can be transferred more effectively into actual game situations.

The development of sports coaching science shows that shooting accuracy is the result of the integration of biomechanical skills, neuromuscular control, and movement coordination, not just the mastery of kicking techniques.
When shooting, the player must be able to generate force explosively, maintaining stability Core, efficiently transfer the force through Kinetic Chain, as well as coordinating the work of various body segments from the focus phase to the contact of the feet with the ball.
The integration of the process allows the transfer of force to take place optimally so that the direction,

speed and accuracy of the ball can be maintained consistently even when the player is in a dynamic game situation.

Thus, shooting accuracy is the result of a synergy between strength, balance, neuromuscular coordination, postural stability, and biomechanical efficiency that work in an integrated manner during the execution of movement (Augustus et al., 2024; Boyne et al., 2024; Shan & Zhang, 2022; Zemková et al., 2022).
Therefore, improving shooting skills in elementary school students requires a stimulus of training that not only improves mastery of techniques, but also develops biomotor capacity that supports overall movement efficiency.

At elementary school age, the neuromuscular system is in a developmental phase that is highly responsive to exercise stimuli so it is known as window of opportunity to develop Fundamental Movement Skills, coordination, balance, motion control, and biomotor abilities as the foundation of more complex sports skills.
The concept is in line with the principles of Long-Term Athletic Development (LTAD) which emphasizes that training in children should be prioritized to develop movement quality, neuromuscular capacity, and basic motor skills before entering the stage of sports specialization.
Exercise programs tailored to the child's stage of biological development have been proven to improve the efficiency of the neuromuscular system, movement quality, physical capacity, as well as readiness to learn more complex sports skills at the next stage of development (Granacher & Behm, 2023; Long et al., 2024; Williams et al., 2021).
Thus, an approach to training that integrates various biomotor components from elementary school age is seen as more appropriate than training that focuses only on improving one component of ability separately.

In addition to the principle Long-Term Athlete Development (LTAD), the effectiveness of exercise in children can also be explained through the concept of neuroplasticity, which is the nervous system's ability to form, strengthen, and reorganize connections between neurons in response to learning experiences and repetitive stimuli of exercise.
In childhood, the capacity of neuroplasticity is still at its optimal developmental phase so that structured, progressive, and appropriate exercises in accordance with the stages of biological development can accelerate the process Motor Learning, improve neuromuscular coordination, as well as improve the efficiency of motion control.
Various studies show that regular physical activity supports the process of nervous system adaptation and motor learning, including through neurobiological mechanisms such as an increase in neurotrophic factors that play a role in nerve plasticity, thus contributing to the development of movement skills in children (Rico-González et al., 2025; Stricker et al., 2020).
Therefore, the eight-week HIFT program in this study theoretically has the potential to improve accuracy Shooting Because exercise not only develops physical capacity, but also optimizes the movement learning process through the adaptation of the nervous system that supports coordination, balance, and movement control.

These characteristics are in line with the concept of High-Intensity Functional Training (HIFT), which is a training approach that integrates a variety of multi-joint functional movements through a combination of strength, explosiveness, coordination, balance, agility, endurance, and motion control exercises in a series of exercises.
Unlike conventional training which generally only develops one component of ability separately, HIFT provides simultaneous neuromuscular stimulus so that it is more in line with the demands of modern futsal games that require the integration of biomotor capacity and technical skills in high-intensity game situations.
Various studies show that HIFT is able to improve physical fitness, movement quality, neuromuscular capacity, and Sport-specific performance through comprehensive physiological and neuromuscular adaptation (McDougle et al., 2023; Wang et al., 2023; Xiao et al., 2025).
Therefore, theoretically, HIFT is expected to be a suitable exercise approach for elementary school students because it not only increases physical capacity, but also optimizes motion control, postural stability,

biomechanical efficiency, and neuromuscular coordination which are the basis for more effective shooting execution.

Various studies have reported that shooting ability can be improved through various training approaches, such as the drill, the use of audiovisual media, as well as exercises using Resistance Band (Mahyuddin & Siregar, 2024; Pratama et al., 2024).
Although such approaches have been shown to improve certain aspects of engineering, they are still largely oriented towards the repetition of movements (repetitive practice) or the development of one component of a separate physical condition so that it is less able to produce comprehensive neuromuscular adaptation.
The training approach has not optimally integrated strength, coordination, balance, agility, movement control, and postural stability in a series of activities that resemble the demands of the game.
In addition, in

elementary school students, monotonous and repetitive exercises have the potential to reduce motivation, engagement, and the quality of motor learning because they are not in accordance with the characteristics of children's development that require varied, fun, and challenging learning activities.
The findings are in line with international studies that show that exercises that develop physical abilities and engineering skills separately are not yet fully capable of producing optimal performance transfer to specific sports skills, so a more integrated training approach is needed to improve movement quality as well as technical performance (Bashir et al., 2022; Chaabene et al., 2020; Deuker et al., 2024; Mao et al., 2024; Ribeiro et al., 2021)

Based on these conditions, High-Intensity Functional Training (HIFT) is seen as a training approach that has the potential to bridge the development of biomotor capacity with technical skills through functional movements that resemble the demands of the game of futsal.
The characteristics of HIFT that combine strength, explosiveness, coordination, balance, agility, endurance, and motion control training in one training session allow for more comprehensive neuromuscular adaptation than exercises that only develop one component of ability.
This approach is expected to not only increase physical capacity, but also improve the quality of movement so that technical skills can be transferred more effectively into actual game situations (Wang et al., 2023; Xiao et al., 2025).
Thus, HIFT has a strong theoretical foundation to be applied to elementary school students who are still in the development phase of motor and neuromuscular abilities.

However, research on HIFT to date is still dominated by the adolescent and adult athlete population and evaluates more physical fitness improvements, biomotor components, or Sport-specific performance in general.
Systematic review and Meta-analysis What is done Wang et al.
(2023) concludes that HIFT effectively improves various components of physical fitness, but has not explained how such biomotor capacity enhancement is transformed into specific engineering skill improvements.
Similarly, research Kozlenia et al.
(2024) focuses more on changes in muscle strength and body composition in the context of physical education without evaluating specific sports skills.
Recent studies that examine the improvement of football technique skills also generally focus on proprioceptive training or Skill-based training without integrating the HIFT approach as an engineering capability development strategy (Carlsson et al., 2025; Eraslan et al., 2025).

This condition shows that the relationship between biomotor adaptation of HIFT results and increased shooting accuracy in elementary school futsal extracurricular participants has not been widely researched, so there is still a scientific gap that requires empirical proof.

Based on these gaps, the novelty of this research lies in testing how the increase in biomotor capacity produced through High-Intensity Functional Training can be transformed into an improvement in specific technical skills in the form of shooting accuracy in elementary school futsal extracurricular participants through neuromuscular adaptation mechanisms and movement learning.
In contrast to previous studies that evaluated the influence of HIFT on physical fitness or sports performance in general, this study places shooting as an output of engineering skills that are the result of the integration of biomotor capacity, neuromuscular control, and biomechanical efficiency in the context of elementary school-age futsal learning.
Therefore, this research is expected to be able to make a conceptual and empirical contribution to the development of a HIFT-based futsal training model that is more in line with the characteristics of children's development.

Based on this description, this study aims to analyze the effect of High-Intensity Functional Training (HIFT) on improving the shooting accuracy of elementary school futsal extracurricular participants through the integration of biomotor capacity development, neuromuscular adaptation, and specific engineering skills.
The results of this study are expected to enrich the empirical evidence regarding the effectiveness of HIFT as an exercise approach that is able to transform physical capacity building into technical skills improvement in the context of futsal learning in elementary school age students.

METHODS

This study uses a quantitative approach with a pre-experimental method through a One-Group Pretest-Posttest Design design to analyze the effect of High-Intensity Functional Training (HIFT) on the shooting accuracy of elementary school futsal extracurricular participants.
This design

was chosen to compare the changes in participants' abilities before and after the intervention.
The absence of a control group was recognized as a limitation of the study.
However, SD IT Mutiara Cendekia only has one active futsal extracurricular group, so the formation of control groups and randomization is not possible without interfering with the school training program.
In addition, the limited number of populations (n = 22) has the potential to lower statistical power if divided into two groups.
Therefore, each participant participates as a control for himself through a comparison of pretest and posttest scores.

To minimize the threat to internal validity, the intervention was implemented for eight weeks to limit the effects of maturation.
Participants are asked not to take part in futsal training programs held outside of school as long as research and compliance are confirmed weekly to the coaching teacher.

The measurement procedures, instruments, testers, field, balls, goals, scoring system, number of attempts, and the time of implementation of the pretest and posttest are made the same.
All measurements were taken when participants were in good health and had adequate rest time so that the change in score reflected more of the effects of the intervention than of external factors.

The research was carried out at SD IT Mutiara Cendekia, Bandung Regency, in April-May 2025.
The school was chosen purposively because it has a futsal extracurricular program that is carried out regularly with a structured training schedule, uses the same futsal field facilities in each session, and has relatively homogeneous participant characteristics so that the variety of the training environment can be minimized.
Participants consisted of 22 male students aged 10–12 years old who actively participated in futsal extracurriculars.
The sampling technique uses total sampling.
Inclusion criteria include active participants in futsal extracurriculars, healthy, not suffering from musculoskeletal injuries, and obtaining written consent from parents or guardians.
Exclusion criteria include participating in an intensive futsal training program at an academy or club outside of school, experiencing an injury or health impairment during research, or not obtaining parental consent.
All participants completed the entire series of research so that there were no dropouts or lost data.
The adequacy of the sample count was calculated using G*Power 3.1 with the peer-samples t-test, $\alpha = 0.05$, power = 0.80, and effect size (Cohen's d) = 0.80.
The results of the analysis showed that a minimum of 15 participants were needed so that the sample number of 22 participants was considered capable.
Before the research was carried out, the researcher obtained permission from the Head of SD IT Mutiara Cendekia and the futsal extracurricular coaching teacher.
All parents or guardians sign informed consent after obtaining an explanation of the purpose, procedures, benefits, risks, and rights of the participant.
All participant data is kept confidential and only used for research purposes.

Data collected using tests Shooting customized precision from Nurhasan (in Das et al., 2024).
The instrument was chosen because it was suitable for igniting changes in abilities Shooting before and after the intervention.
In order to match the characteristics of futsal, the instrument was adapted using a size 4 futsal ball, a standard futsal goal (3×2 m), a futsal field, and a kick distance according to the futsal penalty point (6 m), while the scoring system, number of attempts, and testing procedures still refer to the original instrument construct so that the validity of the construct remains (Augustus et al., 2024; Shan & Zhang, 2022; Wang et al., 2023)

The adaptation instruments were tested first through a pilot study on 22 students who had similar characteristics but were excluded from the study sample.
The test results showed a validity coefficient of 0.73 and reliability of 0.78, so that the instrument was declared valid and reliable.
All pretest and posttest measurements use the same field, ball, goal, goal, tester, procedure, and scoring system to minimize measurement bias.

The overall research flow starts from the research preparation stage, participant selection, pretest implementation, provision of High-Intensity Functional Training (HIFT) intervention for eight weeks, posttest implementation, data analysis, interpretation of research results, to drawing conclusions.
The groove is presented in Figure 1.

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Figure 1.
Research Flow

The High-Intensity Functional Training (HIFT) program is structured based on the principles of Frequency, Intensity, Time, and Type (FITT) as well as the principles of specificity, progressive load, and individualization. The program is carried out for 8 weeks with a frequency of 2 sessions per week (16 sessions).
Each session lasts 45–60 minutes, consisting of warm-ups, core exercises, technique exercises Shooting, and cooling.
Exercise movements in the form of Functional multi-joint movement which aims to improve strength, explosiveness, coordination, dynamic balance, core stability, and neuromuscular control that supports precision Shooting (Kozlenia et al., 2024; Wang et al., 2023).
Details of the program are presented in Table 1.

Table 1.
Eight-Week High-Intensity Functional Training (HIFT) Protocol Developed Based on the FITT Principle and Adapted from Previous Literature for Elementary School Students

| Week | Frequency (F) | Intensity | Time (Total Session Duration) | Type of Exercises | Training Volume (Set x Repetition) | Rest Between Sets | Progressive Overload | Targeted Physical Component |

| 1 | 2 session/week | 60-65% HRmax | 45 minutes | Bodyweight Squat, High Knees, Front Plank, Short Shuttle Run | 2 sets x 8 reps | 90 s | Familiarization with movement patterns and exercise technique | Coordination, core stability, fundamental movement skills |

| 2 | 2 session/week | 65-70% HRmax | 45 minutes | Walking Lunge, Basic Agility Ladder, Side Plank, Shuttle Run | 2 sets x 10 reps | 90 s | Increase reps | Balance, lower-body strength, coordination |

| 3 | 2 session/week | 65-70% HRmax | 50 minutes | Modified Burpee, Squat Jump, Mountain Climber, Agility Ladder | 2 sets x 10 reps | 75 s | Increase exercise complexity | Explosive power, agility, coordination |

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| Week | Frequency (F) | Intensity | Time (Total Session Duration) | Type of Exercises | Training Volume (Set x Repetition) | Rest Between Sets | Progressive Overload | Targeted Physical Component |

| 4 | 2 session/week | 70-75% HRmax | 50 minutes | Shuttle Run, Walking Lunge, Front Plank, High Knees | 2 sets x 10-12 reps | 75 s | Increase repetitions and movement control | Agility, body stability, muscular endurance |

| 5 | 2 session/week | 70-75% HRmax | 50 minutes | Modified Burpee, Squat Jump, Shuttle Run, Side Plank | 3 sets x 8 reps | 60 s | Increase number of sets | Power, balance, coordination |

| 6 | 2 session/week | 75-80% HRmax | 55 minutes | Mountain Climber, Advanced Agility Ladder, High Knees, Front Plank | 3 sets x 10 reps | 60 s | Increase the total volume of training | Muscular endurance, agility, core stability |

| 7 | 2 session/week | 75-80% HRmax | 55-60 minutes | Functional Circuit, Cone Drill with Change of Direction, Shuttle Run to Shooting | 3 sets x 10 reps | 60 s | Increase movement complexity and execution speed | Power, agility, coordination, shooting preparation |

| 8 | 2 session/week | 80-85% HRmax | 55-60 minutes | Functional Circuit, Cone Drill, Shuttle Run + Shooting, Small-Sided Games (3v3/4v4) | 3 sets x 10 reps | 60 s | Maintain training intensity while integrating futsal-specific skills.
| Shooting accuracy, game performance, movement efficiency.

As presented in Table 1, the intensity of exercise is set gradually in the range of 60–85% maximum heart rate (HRmax) and monitored through manual pulse measurement using radial artery palpation for 10 seconds, then converted to beats per minute.
In weeks 1 to 3, the exercises are focused on mastering movement techniques (Movement Competency) and early adaptation with an intensity of 60–70% HRmax.
From the 4th to 8th week, the intensity of the exercise is gradually increased to 70–85% HRmax through the addition of reps, the volume of the exercise, the complexity of the movement, and the reduction of the rest time between ets.
Increased load is only given if participants are able to complete the exercise in the previous session with correct movement techniques and without showing signs of excessive fatigue.
Application Progressive overload This gradually aims to optimize neuromuscular adaptation while minimizing physiological stress and risk of injury, so that the exercise program remains safe and in accordance with the developmental characteristics of elementary school children (Granacher & Behm, 2023; Kozlenia et al., 2024; Li et al., 2025).

All training sessions were led by researchers with the assistance of futsal extracurricular coaching teachers to ensure movement techniques, participant safety, and compliance with training protocols.
A summary of the program is presented in Table 2.

Table 2.
Program Summary

| Component | Description |

| Program Duration | 8 weeks |

| Training Frequency | 2 sessions per week |

| Total Sessions | 16 sessions |

| Session Structure | Warm-up (10 min) → HIFT Main Training (25–35 min) → Futsal Technical Training/Shooting Drill (10–15 min) → Cool-down (10 min) |

| Training Supervision | All sessions were supervised by the researcher and a physical education teacher to ensure proper technique, participant safety, and adherence to the training protocol.

Data were analyzed using IBM SPSS Statistics version 26.
Descriptive analysis is used to obtain mean values, standard deviations, minimum values, and maximums.
Before testing the hypothesis, the presence of outliers was checked using a standardized z-score on the difference score.
All values are at a distance of ±3, so no out-of-the-box data is found.

The normality of the data was tested using Shapiro–Wilk because the sample count was less than 50 participants.
The test results showed that the data was normally distributed so that it met the parametric assumptions of the analysis.
Because the study used a One-Group Pretest–Posttest design, testing the homogeneity of variance between groups (Levene's Test) is not required.
Furthermore, the effect of HIFT on accuracy Shooting Analyzed using paired T-sample test at significance level α =

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0 05 Pallant 2020.
In addition, Cohen's d was calculated to determine the magnitude of the effect of the intervention with interpretations of 0.20 (small), 0.50 (moderate), and \(\geq0.80 \) (large).

RESULTS

This study involved 22 students in grades IV–VI who actively participated in elementary school futsal extracurricular activities.
The characteristics of the participants are summarized in Table 3.

Table 3.
Demographic and Anthropometric Characteristics of Participants

| Characteristics | Average ± School | Elementary | Minimum | Maximum |

Age years 10 95 0 65 10 12

Height cm 14 6 6 8 132 154

Weight kg 36 4 5 7 28 48

BMI kg m2 17 8 1 9 14 9 21 2

Based on table 3, the participants showed relatively homogeneous basic anthropometric characteristics, with comparable age, height, and weight.

All participants completed the intervention and were included in the final analysis.
Before statistical analysis is carried out, the data is first checked for the existence of outliers using a standardized z-score on the difference score.
The results of the examination showed that all z-score values were in the range of \(\pm3 \) , so no outlying data was found that required deletion or special handling.
Therefore, all data from 22 participants were used in the next analysis.
Descriptive statistics for shooting accuracy are presented in Table 4, while changes in mean shooting accuracy before and after the intervention are illustrated in Figure 2.

Figure 2.
Comparison of mean shooting accuracy scores between pretest and posttest.

Note.
Error bars represent the 95% confidence intervals.

Table 4.
Descriptive Statistics of Shooting Accuracy Scores Before and After the Eight-Week High-Intensity Functional Training (HIFT) Program

| Variable | n | Minimum | Maximum | Red | Std.
Deviation | 95% CI (Lower-Upper) |

Pretest 22 9 25 16 00 4 650 13 94 18 06

Posttest 22 17 27 21 82 2 805 20 58 23 06

Based on Table 4, the average score of shooting accuracy increased from \(16.00 \pm 4.65 \) during the pretest to \(21.82 \pm 2.81 \) during the posttest, or an increase of 5.82 points (36.4%).
The confidence interval (95% CI) also shifted from 13.94–18.06 at the pretest to 20.58–23.06 at the posttest, indicating that the average estimate after the intervention was at a higher range of values with a good level of precision.
In addition, the decrease in the standard deviation value from 4.65 to 2.81 showed that the variation in ability between participants was smaller after participating in the High-Intensity Functional Training (HIFT) program.
These findings suggest that HIFT not only improves average accuracy of precise shooting, but also results in more consistent performance so that participants' abilities become more homogeneous than before the intervention.
These descriptive findings show a positive trend after the HIFT intervention; Therefore, an inferential statistical analysis is then performed to determine whether the observed increase is statistically significant.

Table 5.
Results of the Shapiro–Wilk Normality Test

Variable n Shapiro Wilk W p value Interpretation a 0 05

| Pretest | 22 | 0.946 | 0.276 | Normally distributed |

| Posttest | 22 | 0.930 | 0.126 | Normally distributed |

Figure 3.
Results of the Initial Test Normality

Figure 4.
Normality Test Results Final Test

The results of the Shapiro–Wilk test showed that the pretest scores (W = 0.946; p = 0.276) and posttest (W = 0.930; p = 0.126) had significance values greater than the set significance level (α = 0.05), so that the two data groups were declared to be normally distributed.
Thus, the assumption of normality is fulfilled and further analysis is carried out using paired t-tests.
In addition, the visualization of the distribution of the data through the Q–Q Plot in Figure 3 and Figure 4 shows that most of the points are in the vicinity and follow a diagonal line, which further reinforces that the distribution of data is close to the normal distribution.

Table 6.
Results of the Paired-Samples t-Test

| Comparison | Mean Difference | t | df | p | Interpretation |

| Pretest vs. Posttest | 5.82 | 5.41 | 21 | <0.001 | Significant |

The results of the paired-samples t-test showed a significant increase in shooting accuracy after participants participated in the High-Intensity Functional Training (HIFT) program.
The average shooting score increased by 5.82 points, with a value of t(21) = 5.41 and p < 0.001.
The findings showed that the shooting accuracy score after the intervention was consistently higher than before the intervention, so the HIFT training program had a positive influence on improving the shooting ability of the participants.

Table 7.
Effect Size Analysis Results

| Variable | Cohen's d | Interpretation |

| Shooting Accuracy | 1.15 | Large effect |

Cohen's d value of 1.15 indicates that the High-Intensity Functional Training (HIFT) program has a large effect on improving students' shooting accuracy.
The magnitude of the effect size shows that the intervention given not only produces a statistically significant difference, but also has a high practical significance in improving shooting accuracy.

DISCUSSION

The results showed that the implementation of High-Intensity Functional Training (HIFT) for eight weeks significantly improved the shooting accuracy of elementary school students who participated in futsal extracurricular activities.
The average shooting accuracy score increased by 5.82 points, from 16.00 at the time of the pretest to 21.82 at the time of the posttest, or equivalent to an increase of about 36.4% compared to the initial condition.
The increase showed that participants not only experienced statistically significant changes ($p < 0.001$), but also experienced an improvement in the quality of shooting technique implementation which was reflected in the ability to direct the ball to the target more accurately and consistently.
The magnitude of the effect size (Cohen's $d = 1.15$) showed that the HIFT intervention had a large practical effect, so the benefits of the exercise were not only statistically significant but also had high practical value in improving the performance of shooting techniques in elementary school students.
These findings support previous research that reported that exercise programs that integrate components of strength, coordination, balance, and neuromuscular control are able to result in improved motor skills and exercise performance in children and adolescents (Granacher & Behm, 2023; Li et al., 2025; Xiao et al., 2025).
Thus, the results of this study reinforce that the training approach that integrates physical capacity development and engineering skills is more effective than engineering training conducted separately.

The increase in shooting ability obtained by participants can be explained based on the characteristics of neuromuscular development of elementary school-age children who still have a high level of neuroplasticity so that the adaptation response to training stimuli is more optimal.
In this phase of development, the child is in a transition period from mastery Fundamental Movement Skills To Sports-specific skills, so that exercises that integrate strength, coordination, balance, agility, and movement control are more effective than technique exercises performed separately (Granacher & Behm, 2023; Li et al., 2025).
In this study, various forms of exercises such as shuttle run, agility ladder, cone drill, high knee, and squat jump not only increase physical capacity, but also train change of direction, lower extremity coordination, dynamic balance, and neuromuscular control which are important components in the implementation of shooting.
These adaptations allow participants to produce more efficient movement patterns, maintain body stability when in contact with the ball, and direct the ball to the target with a better level of accuracy.
These findings are in line with the long-term approach to athlete development which emphasizes that at a young age, the priority of exercise is directed at the development of movement quality, motor competence, and neuromuscular capacity before entering the stage of sports specialization (Granacher & Behm, 2023; Lesinski et al., 2020; Li et al., 2025).

The characteristics of the High-Intensity Functional Training (HIFT) program applied in this study are one of the main factors that explain the increase in the shooting ability of the participants.
The training program is structured based on the principle of Frequency, Intensity, Time, and Type (FITT) by applying Progressive overload gradually over eight weeks.
The intensity of the exercise was systematically increased from 60–65% HRmax in the first week to 80–85% HRmax in the eighth week, accompanied by an increase in the volume of exercise, complexity of movements, and a reduction in rest time according to the participants' adaptability.
This progressive approach allows participants to obtain an exercise stimulus capable of inducing physiological conditions without causing chronic fatigue (chronic fatigue) or increase the risk of injury, so that it is still within

the recommended range for high-intensity training in children if carried out gradually, prioritized by competent trainers, and adjusted to the stages of biological development of the participants (Granacher & Behm, 2023; Stricker et al., 2020).
In contrast to conventional technique exercises that generally only emphasize shooting reflexes, the HIFT program in this study integrates squat jump, walk lunge, shuttle run, and Agility ladder training, mountain climbing, front plank, side plank, and modified burpees in a series of exercises so that several biomotor components develop simultaneously.
From the point of view of

exercise physiology, the series of exercises is suspected to improve the ability of the neuromuscular system through increasing the recruitment of motor units, synchronizing the activation of motor units, and rate coding, which is the ability of the nervous system to increase the frequency of impulses to muscle fibers so that muscle contractions become faster, stronger, and more coordinated.
The adaptation contributes to improved neuromuscular control, postural stability, dynamic balance, and the efficiency of interjoint coordination necessary to maintain body position during the execution of the shoot (Williams et al., 2021; Zemková et al., 2022).
Thus, the increase in shooting ability in this study is not only due to the increase in the ability of the ball kicking technique, but also by the development of neuromuscular capacity that allows participants to produce more stable, efficient, and consistent movements during the shooting process.

Biomechanically, the increase in shooting precision in this study can be explained through the interaction of various biomotor components that work sequentially during the implementation of shooting movements, namely the preparation phase, the execution phase, and the stabilization phase.
In the preparation phase, exercises such as Walking Lunge, shuttle run, and Agility ladder training.
Improve dynamic balance, step coordination, and the ability to change direction so that participants are able to build a more stable footwork position before kicking.
This stability is an important foundation for producing optimal soil reaction forces when the feet are in contact with the field surface.
The energy produced is then transferred sequentially through the ankles, knees, pelvis, torso, to Kicker Attractions through a kinetic chain mechanism, resulting in a more efficient and coordinated swing (Augustus et al., 2024; Shan & Zhang, 2022).
In the execution phase, the squat jump exercise improves the ability to leg muscles.
Generates explosive force so that the swing speed and the speed of the foot when in contact with the ball become higher.
However, the explosive force can only be transferred optimally when balanced with torso stability.
In this study, the front plank and side plank exercises are suspected to play a role in maintaining corestability during the force transfer process so that the energy derived from the ground reaction force is not lost due to excessive torso movement.
As such, the explosive power generated by the climate and core stability muscles do not work separately, but complement each other to produce a powerful kick while staying directed towards the target.
The integration of the two components allows participants to maintain their balance during the follow-up phase, so that the movement of the Precise Shooting Become more accurate, efficient, and consistent (Augustus et al., 2024; Nazari & Fatahi, 2023).

The findings of this study support the results of Systematic review and Meta-analysis Wang et al. (2023) which shows that High-Intensity Functional Training (HIFT) is able to improve various biomotor components, including muscle strength, explosiveness, coordination, balance, and Sport-special performance. In contrast to conventional exercises that generally develop strength, endurance, or engineering skills separately, HIFT provides Integrated stimulus through functional movements that involve various muscle groups and movement patterns that resemble the demands of the game of futsal.
These characteristics provide higher ecological validity because the exercises take place in the context of movements that are close to the match situation, such as acceleration, deceleration, change of direction, stabilization of the body, and the execution of shooting after movement.
Thus, the adaptations obtained by participants are easier to transfer to game performance than statistical drill exercises that focus only on the repetition of techniques.
This approach is particularly relevant in elementary school futsal extracurricular activities that generally have a limited training duration (45–60 minutes), as various components of abilities can be developed simultaneously without increasing the training time.
Therefore, the precise shooting accuracy in this study not only reflects the improvement of kick technique capabilities, but also shows the success of HIFT in transforming biomotor conditions into more effective technical performance in game situations.

When compared to previous studies, this study shows that the mechanism of increasing precision Precise Shooting through HIFT is conceptually different from Drill Method and resistance bands.
Pratama et al. (2024) reports that Drill Method Improves accuracy Precise Shooting through the repetition of technical movements so that participants improve specific movement patterns.
Meanwhile, Mahyuddin & Siregar (2024) It shows that resistance band training increases the strength of the cooling muscles that support the stability and accuracy of the kick.
While both approaches are effective, the development of physical and technical abilities is still carried out separately, so the transfer of abilities to game situations has the potential to be less than optimal.
In contrast, HIFT

integrates strength training, coordination, balance, agility, core stability, and engineering skills in a single training session so as to provide Integrated stimulus to various physiological and neuromuscular systems simultaneously. This approach is not only more efficient than a single workout time, but it also increases the involvement of various muscle groups and movement patterns that directly resemble the demands of the game of futsal.
Thus, HIFT has the potential to generate Training Transfer which is larger than the training method that develops each component separately.

This study resulted in a large effect size (Cohen's d = 1.15), suggesting that HIFT had a strong practical impact on improving accuracy Precise Shooting.
Nevertheless, the research Pratama et al. (2024) and Mahyuddin & Siregar (2024) does not report effect size values, so direct quantitative measurements cannot be carried out.
Nevertheless, the magnitude of Cohen's d value in this study shows that the HIFT approach provides substantial practical benefits and deserves to be considered as an alternative training model in elementary school futsal extracurricular activities.

Based on these findings, this study makes a conceptual contribution to the development of futsal training models for elementary school students.
In contrast to most previous studies that positioned High-Intensity Functional Training (HIFT) as a training method to improve physical fitness in adolescent and adult athletes, this study shows that HIFT is also effectively applied to elementary school extracurricular activities to improve specific technical skills in the form of shooting accuracy.
These findings expand the scope of HIFT's application from an approach focused on physical capacity building to a training model capable of integrating the development of biomotor abilities and engineering skills in a single training program.
Thus, this study provides a new perspective that futsal training at elementary school age does not have to separate physical training and technical training, but can develop both in an integrated manner through a functional training approach that is in accordance with the development characteristics of students.

From a practical perspective, the results of this study show that HIFT is worthy of being considered as an alternative training model in elementary school futsal extracurricular activities.
Exercise characteristics that integrate strength, coordination, balance, agility, body stability, and technical skills in a single session allow physical education teachers and trainers to optimize relatively limited training time without compromising the quality of training.
This approach provides an opportunity to develop various components of abilities simultaneously so that the training process becomes more efficient and more in line with the demands of modern futsal games that demand physical and technical abilities simultaneously.

Overall, the average increase in precise shooting accuracy of 5.82 points (36.4%), supported by a very strong significance value ($p < 0.001$) and a large effect size (Cohen's $d = 1.15$), suggests that the implementation of HIFT has a statistically and practically significant impact on the overall improvement of accurate shooting.
These findings reinforce the evidence that HIFT is not only relevant to adolescent and adult athletes, but also effective as a sports training model for primary school students.
Therefore, this research is expected to be the basis for the development of a more integrated, effective, and developmental futsal training program in schools, as well as open opportunities for future research to examine the application of HIFT to more diverse technical skills and age groups.

This study has several limitations that need to be considered in interpreting the results of the study.
First, the study used a one-group pretest–posttest design without a control group so that the influence of external factors outside the intervention could not be completely eliminated even though various internal validity control procedures had been implemented.
Second, the number of participants is relatively small and all participants come from one school, so generalization of research results to the wider population still needs to be done carefully.
Third, the study only spreads the influence of HIFT on shooting accuracy so that its effectiveness on other futsal skills, such as passing, dribbling, and overall game performance cannot be concluded.
Therefore, further research is recommended to use a stronger experimental design with a control group, a larger number of participants, and involve multiple schools in order to increase the validity of external and generalization of findings.

CONCLUSION

This study shows that the implementation of High-Intensity Functional Training (HIFT) for eight weeks effectively increases the shooting accuracy of elementary school futsal extracurricular participants.
The mean increase of 5.82 points (36.4%), accompanied by a very strong significance value ($p < 0.001$) and a large effect size (Cohen's $d = 1.15$), suggests that HIFT not only produces a statistically significant difference, but also provides a high practical benefit in improving the performance of shooting techniques.
These findings suggest that the integrated development of various biomotor components through HIFT is more effective than the training approach that only emphasizes many techniques, as the improvement of physical ability can be transferred directly to the implementation of shooting skills in the context of futsal games.

The main contribution of this study lies in the provision of empirical evidence that High-Intensity Functional Training (HIFT) can be applied effectively to elementary school-age learners, while previous research has focused more on adolescent and adult athletes or physical fitness improvement.
These findings expand the use of HIFT as a training model that not only focuses on physical capacity building, but is also able to integrate the development of biomotor abilities and engineering skills in elementary school futsal extracurricular activities.
Therefore, HIFT can be considered as an alternative training model that is effective, efficient, and in accordance with the characteristics of the student's development.

FAQs

What is GPTZero?

GPTZero is the leading AI detector for checking whether a document was written by a large language model such as ChatGPT. GPTZero detects AI on sentence, paragraph, and document level. Our model was trained on a large, diverse corpus of human-written and AI-generated text with support for English, Spanish, French, German, and other languages. To date, GPTZero has served over 17 million users around the world, and works with over 100 organizations in education, hiring, publishing, legal, and more.

When should I use GPTZero?

Our users have seen the use of AI-generated text proliferate into education, certification, hiring and recruitment, social writing platforms, disinformation, and beyond. We've created GPTZero as a tool to highlight the possible use of AI in writing text. In particular, we focus on classifying AI use in prose. Overall, our classifier is intended to be used to flag situations in which a conversation can be started (for example, between educators and students) to drive further inquiry and spread awareness of the risks of using AI in written work.

Does GPTZero only detect ChatGPT outputs?

No, GPTZero works robustly across a range of AI language models, including but not limited to ChatGPT, GPT-5, GPT-4, GPT-3, Gemini, Claude, and AI services based on those models.

What are the limitations of the classifier?

The nature of AI-generated content is changing constantly. As such, these results should not be used to punish students. We recommend educators to use our behind-the-scene Writing Reports as part of a holistic assessment of student work. There always exist edge cases with both instances where AI is classified as human, and human is classified as AI. Instead, we recommend educators take approaches that give students the opportunity to demonstrate their understanding in a controlled environment and craft assignments that cannot be solved with AI. Our classifier is not trained to identify AI-generated text after it has been heavily modified after generation (although we estimate this is a minority of the uses for AI-generation at the moment). Currently, our classifier can sometimes flag other machine-generated or highly procedural text as AI-generated, and as such, should be used on more descriptive portions of text.

I'm an educator who has found AI-generated text by my students. What do I do?

Firstly, at GPTZero, we don't believe that any AI detector is perfect. There always exist edge cases with both instances where AI is classified as human, and human is classified as AI. Nonetheless, we recommend that educators can do the following when they get a positive detection: Ask students to demonstrate their understanding in a controlled environment, whether that is through an in-person assessment, or through an editor that can track their edit history (for instance, using our Writing Reports through Google Docs). Check out our list of several recommendations on types of assignments that are difficult to solve with AI.

Ask the student if they can produce artifacts of their writing process, whether it is drafts, revision histories, or brainstorming notes. For example, if the editor they used to write the text has an edit history (such as Google Docs), and it was typed out with several edits over a reasonable period of time, it is likely the student work is authentic. You can use GPTZero's Writing Reports to replay the student's writing process, and view signals that indicate the authenticity of the work.

See if there is a history of AI-generated text in the student's work. We recommend looking for a long-term pattern of AI use, as opposed to a single instance, in order to determine whether the student is using AI.