5 April 2026 JSA OKE Priyanto 43_52.pdf

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Journal Sport Area
http://journal.uir.ac.id/index.php/JSP
Vol. 11. No. 1. April, (2026)

Effects of slalom and relay training on basketball dribbling performance in young athletes: A Pretest–posttest experimental study

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Received 12 April 2025; Accepted 22 February 2026; Published 29 April 2026
Ed 2026; *11*(1): 127-135

ABSTRACT

Background: Dribbling is a fundamental basketball skill essential for maintaining ball control and adapting to dynamic game situations. However, young athletes often demonstrate suboptimal dribbling performance, highlighting the need for effective training interventions. Although slalom and relay drills are widely used, direct experimental comparisons remain limited. **Objectives:** This study aimed to compare the effectiveness of slalom and relay training methods on basketball dribbling performance in young athletes. **Methods:** A randomized two-group pretest–posttest design was employed involving 14 male basketball players aged 11–12 years. Participants were assigned to either a slalom training group (n = 7) or a relay training group (n = 7). Both groups completed 16 training sessions over six weeks under controlled conditions. Dribbling performance was assessed using the AAHPERD test. Data were analysed using paired- and independent-samples t-tests following verification of normality and homogeneity assumptions ($p > 0.05$). **Results:** Both groups showed significant improvements in dribbling performance (slalom: $p = 0.001$; relay: $p = 0.011$). However, the slalom group demonstrated significantly greater improvement ($\Delta = 1.80$ s) compared to the relay group ($\Delta = 0.87$ s; $p = 0.03$). **Conclusion:** Slalom training is more effective than relay training for improving dribbling performance in pre-adolescent basketball players. These findings support motor learning theory, suggesting that training involving greater movement variability and coordinative demands enhances skill acquisition.

Keywords: Dribbling performance; slalom training; relay training; youth athletes

https://doi.org/10.25299/sportarea.2026.vol11(1).21979

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How to Cite: Priyanto., Marcella, G., Huda, N., Karjadi, M. S., & Yudhistira, D. (2026). Effects of slalom and relay training on basketball dribbling performance in young athletes: A Pretest–posttest experimental study. *Journal Sport Area*, *11*(1), 127-135. https://doi.org/10.25299/sportarea.2026.vol11(1).21979

Authors' Contribution: a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection

INTRODUCTION

Basketball is a widely practiced team sport that requires the integration of technical skills, physical capacities, and cognitive decision-making (Hadi et al., 2022). Among the fundamental techniques, dribbling plays a critical role as it enables players to maintain ball control, create offensive opportunities, and respond effectively to defensive pressure (Sampaio et al., 2013). For young athletes, the development of dribbling skills is particularly important, as it forms the foundation for more advanced tactical performance in later stages of development.

The acquisition of basketball skills is strongly influenced by the training methods applied during early developmental phases. Traditional approaches, such as repetitive drills and part–whole practice, are commonly used but may not fully address the dynamic and perceptual demands of real-game situations patterns (Pamungkas et al., 2023; Wicaksono et al., 2022). In contrast, training methods that incorporate movement variability, coordination demands, and contextual interference have been shown to enhance motor learning, skill retention, and transfer (Puspita et al., 2023). These approaches are also associated with improved neuromuscular control and adaptive movement responses in youth athletes (Ramirez-Campillo et al., 2020).

Within this context, relay and slalom drills represent two commonly applied training methods in youth basketball programmes. Relay-based training typically involves linear and repetitive movement patterns combined with cooperative elements, which may enhance motivation, engagement, and training adherence among young athletes (Puspita et al., 2023). In contrast, slalom training requires athletes to navigate obstacles through continuous changes of direction, placing greater demands on coordination, balance, and perceptual awareness (Cortis et al., 2013). From a motor learning perspective, such variable and complex movement tasks are more likely to stimulate neuromuscular adaptation and improve motor control during early learning stages (Williams et al., 2021).

The importance of selecting appropriate training methods is further emphasized within the Long-Term Athlete Development (LTAD) framework, which identifies ages 11–12 years as a critical period for developing fundamental motor skills through diverse and adaptive movement experiences (Hidayah et al., 2024; Hidayah et al., 2023). However, training programmes at this stage often rely on monotonous and repetitive drills, which may reduce motivation and limit skill development (Fox et al., 2021).

Despite the widespread use of relay and slalom drills in youth basketball training, empirical evidence directly comparing their effectiveness on sport-specific dribbling performance remains limited. Previous studies have predominantly examined these methods independently or have focused on general physical outcomes, such as agility and physical fitness, rather than technical skill execution (Maciejczyk et al., 2021; Ramirez-Campillo et al., 2020; Villarreal et al., 2024). Furthermore, controlled experimental studies involving homogeneous age groups within structured training environments are still scarce, limiting the ability to draw definitive conclusions regarding their relative effectiveness.

Preliminary observations conducted at the Jaguar Basketball Academy, Semarang, indicate that athletes aged 11–12 years frequently experience difficulties in maintaining ball control during match situations. These limitations are reflected in frequent turnovers resulting from dribbling errors, suggesting that current training approaches may not adequately address the coordinative and perceptual demands of dribbling. Therefore, a systematic comparison of relay and slalom training methods is warranted. This study aims to compare the effectiveness of these two approaches in improving basketball dribbling performance among pre-adolescent athletes. The findings are expected to contribute to evidence-based coaching practices and to advance the theoretical understanding of variability-based training in motor skill acquisition.

METHOD

Study Design

This study employed a quantitative experimental approach using a two-group pretest–posttest design. Participants were randomly assigned into two intervention groups: a slalom training group and a relay training group. Both groups underwent identical training duration, frequency, and total training load under supervised conditions to ensure experimental control.

Participants

The study involved 14 male basketball players aged 11–12 years from the Jaguar Basketball Academy, Semarang. All participants had at least one year of formal training experience. Inclusion criteria were: (i) free from musculoskeletal injury within the last three months, (ii) regular participation in training sessions, and (iii) parental consent. The participants' mean age was 11.5 ± 0.4 years, with an average training experience of 1.3 ± 0.6 years. Ethical approval was obtained from the Ethics Committee of the Faculty of Sports Science, Universitas Negeri Semarang, and all procedures complied with the Declaration of Helsinki.

Group Allocation and Randomisation

To ensure baseline equivalence, participants completed a pretest using the AAHPERD dribbling test and were subsequently ranked based on performance. An ordinal pairing technique with an ABBA matching pattern was applied to allocate participants evenly into two groups: the slalom training group (n = 7) and the relay training group (n = 7).

Intervention Protocol

Both groups participated in a structured six-week training programme consisting of three sessions per week (total = 16 sessions). Each session included a 15-minute warm-up, a 60-minute core training phase, and a 15-minute cool-down. Training intensity was maintained at a moderate level (160–170 beats per minute). The slalom training group performed multidirectional dribbling exercises involving obstacle navigation, requiring continuous changes of direction, coordination, and perceptual adaptation. In contrast, the relay training group performed linear and repetitive dribbling tasks in a relay format, emphasising speed, rhythm, and cooperative execution. To ensure experimental control, both training protocols were matched in terms of volume (6–8 sets × 3–5 repetitions), intensity, and recovery intervals. The detailed characteristics of both training programmes are presented in **Table 1**.

Table 1. Training Programme Characteristics

Component	Slalom Training	Relay Training
Training duration	6 weeks (16 sessions)	6 weeks (16 sessions)
Frequency	3 sessions/week	3 sessions/week
Session structure	15 min warm-up; 60 min core; 15 min cool-down	15 min warm-up; 60 min core; 15 min cool-down
Volume	6–8 sets × 3–5 repetitions	6–8 sets × 3–5 repetitions
Intensity	Moderate (160–170 bpm)	Moderate (160–170 bpm)
Movement pattern	Multidirectional, obstacle-based	Linear, repetitive
Coordinative demand	High	Moderate
Cognitive demand	High	Moderate

Table 1 demonstrates that both groups were exposed to equivalent training dosage in terms of duration, frequency, volume, and intensity. The only systematic difference between groups lies in the nature of movement patterns and task complexity. This design strengthens internal validity by isolating the training method as the primary independent variable influencing dribbling performance outcomes.

Outcome Measures

Dribbling performance was assessed using the AAHPERD basketball dribbling test, a standardised instrument widely used to evaluate ball control and movement speed in basketball (Sepdanius et al., 2019; Wiriawan, 2017). All participants completed the test before (pretest) and after (posttest) the intervention under standardised testing conditions to ensure measurement reliability and consistency.

Procedure

The study followed a structured sequence. Initially, a pretest assessment was conducted to determine baseline dribbling performance. Participants were then allocated into groups using ordinal matching.

Subsequently, the six-week training intervention was implemented according to the assigned protocols. Upon completion of the intervention, all participants undertook a posttest using the same assessment instrument.

Data Analysis

Data were analysed using IBM SPSS Statistics version 23. Descriptive statistics (mean, standard deviation, minimum, and maximum) were calculated for all variables. Assumptions for parametric testing were evaluated using the Shapiro–Wilk test for normality and Levene's test for homogeneity of variance. All data met the required assumptions ($p > 0.05$). Within-group differences were analysed using paired-sample t-tests, while between-group differences were examined using independent-samples t-tests on posttest scores. Statistical significance was set at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Results

Descriptive Results

This study involved 14 male basketball athletes aged 11–12 years who were assigned to either the slalom or relay training group. The descriptive results of dribbling performance before and after the intervention are presented in **Table 2**.

Table 2. Pretest and Posttest Dribbling Performance

Group	Pretest (s) Mean ± SD	Posttest (s) Mean ± SD	Mean Difference (s)
Slalom	12.73 ± 1.68	10.93 ± 1.92	1.80
Relay	12.53 ± 1.82	11.66 ± 1.78	0.87

As shown in **Table 2**, both groups demonstrated improvements in dribbling performance following the intervention. However, the magnitude of improvement was greater in the slalom group ($\Delta = 1.80$ s) compared to the relay group ($\Delta = 0.87$ s), indicating a stronger training effect for the slalom method. To provide a more detailed overview of data distribution, descriptive statistics for each group are presented in **Table 3**.

Table 3. Descriptive Statistics

Category	N	Min	Max	Mean	SD
Slalom Pretest	7	10.1	14.9	12.729	1.6790
Slalom Posttest	7	8.7	13.6	10.929	1.9216
Relay Pretest	7	10.3	15.5	12.529	1.8200
Relay Posttest	7	9.5	14.7	11.657	1.7841

As presented in **Table 3**, both groups showed consistent reductions in mean dribbling time from pretest to posttest. The slalom group achieved a lower posttest mean compared to the relay group, further supporting its superior effectiveness. Additionally, the relatively stable standard deviation values indicate that the improvements were consistently distributed among participants.

Assumption Testing

Prior to inferential analysis, normality and homogeneity assumptions were tested. The results of the normality test are presented in **Table 4**.

Table 4. Tests of Normality (Shapiro–Wilk)

Group	Significance	Description
Slalom Pretest	0.200	Normal
Slalom Postest	0.200	Normal
Relay Pretest	0.200	Normal
Relay Postest	0.200	Normal

As shown in **Table 4**, all data were normally distributed (p > 0.05), indicating that parametric tests could be applied. The homogeneity of variance test results are presented in **Table 5**.

Table 5. Test of Homogeneity of Variance (Levene's Test)

Category	Levene Statistic	df1	df2	Sig.
Dribbling Performance	0.199	1	12	0.66

As indicated in **Table 5**, the homogeneity assumption was met (p = 0.66), confirming that the variance between groups was equal.

Within-Group Analysis

The results of the paired-sample t-tests are presented in **Table 6**.

Table 6. Paired Sample t-test Results

Category	Mean Difference	t	df	Sig.
Slalom (Pre–Post)	1.80	6.081	6	0.001
Relay (Pre–Post)	0.87	3.590	6	0.011

As shown in **Table 6**, both training methods resulted in statistically significant improvements in dribbling performance. The slalom group demonstrated a highly significant improvement (p = 0.001), while the relay group also showed a significant improvement (p = 0.011). However, the larger mean difference and higher t-value observed in the slalom group indicate a stronger training effect compared to the relay group.

Between-Group Analysis

To compare the effectiveness of the two training methods, an independent-samples t-test was conducted. The results are presented in **Table 7**.

Table 7. Independent Sample t-test

Camparison	Mean Difference	t	df	Sig. (2-tailed)
Slalom vs Relay (Posttest)	-0.73	-2.54	12	0.03

As indicated in **Table 7**, there was a statistically significant difference between the two groups (p = 0.03), favouring the slalom training method. This result confirms that the improvement observed in the slalom group was significantly greater than that in the relay group.

Comparison of Performance Outcomes

A direct comparison of posttest performance is presented in **Table 8**.

Table 7 . Comparison of Posttest Performance

Category	Slalom	Relay
Minimum value	8.7	9.50
Maximum value	13.6	14.70
Mean	10.93	11.66
Std. Deviation	1.92	1.78

As shown in **Table 8**, the slalom group achieved a lower mean dribbling time compared to the relay group. Since lower values indicate better performance, this finding further confirms the superiority of the slalom training method. The relatively similar standard deviation values suggest comparable variability, indicating that the observed differences are attributable to the intervention rather than data dispersion.

Discussion

The present study demonstrated that both slalom- and relay-based dribbling training significantly improved dribbling performance among 11-12-year-old basketball players. However, the magnitude of improvement was greater in the slalom training group, indicating that this method is more effective for developing dribbling skills during early adolescence. This finding suggests that not all drill variations provide the same learning value, even when training volume and intensity are controlled.

The superiority of slalom training can be explained through motor learning theory, particularly Gentile's taxonomy of motor skills. According to Gentile, motor skills performed in environments with higher contextual interference, where athletes must continuously adapt their movements while transporting the body and manipulating an object, place greater demands on perceptual processing and motor control. Slalom drills meet these criteria by requiring rapid changes of direction while maintaining ball control, whereas relay drills are characterised by more predictable, linear movement patterns. Higher contextual interference has been shown to promote deeper learning and better transfer of skills to dynamic sport situations.

Methodologically, this study acknowledges several limitations. The sample size (n = 7 per group) is relatively small, reducing statistical power and increasing susceptibility to random bias. The absence of blinding for participants and assessors also presents a potential threat to internal validity. Unexpectedly, the improvement magnitude in the relay group, though significant, was smaller than anticipated. This outcome might be attributed to the lower cognitive and coordinative demands of the relay format.

Statistical analysis using the paired samples t-test revealed that the variation of dribble training following the slalom pattern yielded a significant value ($p = 0.001$), while the relay pattern yielded a significant value ($p = 0.011$). Both had a considerable influence on the improvement of dribbling skills. However, the slalom pattern was superior in terms of strengthening dribbling skills due to the complexity of the movement, which involves rapid and repetitive changes of direction.

From a neuromotor perspective, slalom training simultaneously challenges coordination, balance, and spatial awareness. Athletes are required to constantly adjust dribbling rhythm, body orientation, and visual focus in response to obstacles, conditions that closely resemble competitive basketball environments. Previous research has shown that training methods involving multidirectional movement and variability are more effective in enhancing motor control and coordination in youth athletes compared to repetitive linear drills (Prayoga et al., 2022; Williams et al., 2021). These demands likely explain the greater improvement observed in the slalom group (Aji et al., 2024; Ramirez-Campillo et al., 2020; Sahabuddin, 2023).

In contrast, relay training emphasises repetition, speed, and cooperation within a relatively stable movement structure. While this approach remains effective for improving basic dribbling consistency and maintaining motivation, particularly through its game-like and cooperative nature, the lower cognitive and perceptual demands may limit its effectiveness for developing advanced dribbling control. This may explain why the relay group showed significant but smaller improvements compared to the slalom group (Almagro et al., 2020).

The present findings also align with the long-term athlete development (LTAD) framework, which emphasises that athletes aged 11-12 years are in a critical period for developing fundamental motor skills through diverse and adaptive movement experiences (Sáez de Villarreal et al., 2021).

Training programmes that rely excessively on linear and repetitive drills may not fully exploit this sensitive developmental window. In contrast, slalom-based drills provide richer movement variability and decision-making opportunities, which are essential for long-term skill acquisition.

Several limitations should be acknowledged. The small sample size limits the generalisability of the findings, and the relatively short intervention period does not allow conclusions regarding long-term retention or transfer to actual game performance. Additionally, the absence of match-based performance indicators restricts interpretation to test-based outcomes. Future research should involve larger samples, longitudinal designs, and game-context assessments to further examine the effectiveness of slalom-based dribbling training (Barker et al., 2022; Varghese et al., 2022).

The results of this study suggest that basketball coaches working with pre-adolescent athletes should prioritise slalom-based dribbling drills as a core component of technical training. Incorporating slalom exercises two to three times per week may enhance multidirectional control, coordination, and anticipatory decision-making, which are essential for game performance. Relay drills remain valuable as complementary activities to maintain motivation, enjoyment, and teamwork, but should be used to support rather than replace training methods that involve higher movement variability and cognitive demand.

CONCLUSION

This study concluded that both slalom and relay ball dribbling training methods improved the dribbling skills of young athletes at the Jaguar Basketball Academy, but the slalom method proved to be more effective. This advantage is due to the more complex coordinative and cognitive demands, which stimulate quick decision-making, balance, and multidirectional control. Theoretically, these results reinforce motor learning theory and the long-term athlete development (LTAD) model, which states that adaptive movement variations are more effective than repetitive linear training. Practically, coaches are advised to integrate slalom drills as the core of the foundational training programme for ages 10–13, while relay drills are used as supplements to maintain motivation and teamwork. Further research should involve larger samples, blind tests, and biomechanical analysis to assess skill retention in real-game situations.

ACKNOWLEDGEMENTS

The authors would like to thank the Semarang State University Institution and the Jaguar Academy basketball club in Semarang for their permission and help in carrying out this research.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

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