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The effects of hand-eye coordination training using the circuit method on the backhand drive skill in table tennis athletes aged 8-12 years

Hary Widodo[1*], Tomoliyus[1], Khairil Fajri[2], Muh Batistuta Fitoni[3]
[1]Sports Coaching Education, Faculty of Sports Science and Health, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Karangmalang, Depok, Sleman, Daerah Istimewa Yogyakarta, Indonesia.
[2]Physical Education, Health and Recreation, Faculty of Teacher Training and Education, Tadulako University, Palu-Indonesia
[3]Sports Education, Faculty of Sports Science and Health, Universitas Negeri Yogyakarta, Colombo Street No. 1, Karangmalang, Depok, Sleman, Special Region of Yogyakarta, Indonesia
[*]Corresponding Author. Email: harywidodo@uny.ac.id

Abstrak
The backhand drive is a basic table tennis stroke performed on the backhand side with a relatively compact swing in front of the body. This stroke requires the integration of observing the ball's trajectory, timing the contact, adjusting the racket angle, and coordinating the shoulders, elbows, forearms, and wrists so that the ball can be returned quickly and accurately. For athletes aged 8–12 years, the development of hand-eye coordination is crucial as it forms the foundation for consistent and accurate technique. This study aims to analyze the effects of hand-eye coordination training using a circuit method on the backhand drive skills of table tennis athletes aged 8–12 years.
The study employed a one-group pretest-posttest experimental design. Participants consisted of 20 table tennis athletes aged 8–12 years. The training program was conducted over four weeks at a frequency of three sessions per week. Each session included six coordination training stations performed in a circuit format. Backhand drive skills were measured through an accuracy test of 30 strokes using balls fed by a robot. Data were analyzed descriptively, followed by normality tests, homogeneity tests, and a paired-samples t-test at a significance level of 0.05.
The analysis results showed a significant difference between the pretest and posttest scores for the backhand drive, with a p-value of 0.000. These results indicate an improvement in performance following the intervention. These findings suggest that hand-eye coordination training using the circuit method can improve players' ability to track the ball, time their contact, and execute backhand strokes more consistently.
Four weeks of hand-eye coordination training using the circuit method effectively improved the backhand drive skills of table tennis athletes aged 8–12 years. This program can serve as a structured, varied, and appropriate alternative to basic training for the development of young athletes.

Kata kunci: hand-eye coordination; backhand drive; table tennis; circuit training; young athletes

INTRODUCTION

Table tennis is a fast-paced, open-skill sport that integrates physical, perceptual, technical, and tactical demands. A player's success is determined not only by physiological capacity but also by the ability to select and execute shots accurately within a very short time frame (Kondric et al., 2013; Malagoli Lanzoni et al., 2014). Analysis of world-class matches shows that technical and tactical patterns are constantly evolving, including an increased use of backhand strokes as a means of maintaining pressure and building attacks (Grycan et al., 2023; Li et al., 2025). Therefore, mastering basic techniques from an early age is a crucial part of the long-term development process.

The backhand drive is a basic stroke performed on the left side of a right-handed player or the right side if the player is left-handed; the backhand motion is generally performed in front of the body, progressing through the preparation phase, forward acceleration, ball contact, and follow-through. For players with a shakehand grip, the quality of the stroke is influenced by the coordination of trunk rotation, shoulder adduction, elbow movement, forearm rotation, and wrist control. This sequence of movements generates racket speed while controlling the direction and quality of ball contact (Iino &

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Kojima, 2016; Bankosz & Winiarski, 2018; Xia et al., 2020; Yam et al., 2021). Thus, the backhand drive is not merely an arm swing but a perception-action skill that requires the efficient integration of the entire kinetic chain.

Hand-eye coordination plays a role in linking visual information with motor responses to determine the position, timing, and direction of the racket's contact with the ball. In table tennis, this coordination ability is a key discriminating factor in identifying talent among young players, particularly in the 7–12 age group (Faber et al., 2014). When executing a backhand drive, players must recognize the ball's speed and trajectory, position their bodies correctly, and then coordinate the movements of their shoulders, elbows, and wrists so that contact occurs at the optimal point in space and time. Differences in kinematic patterns among players indicate that the quality of a backhand depends heavily on coordinated movement organization, rather than on arm strength alone (Bankosz et al., 2020; Bankosz & Winiarski, 2021).

Coordination exercises organized in a circuit format allow athletes to repeat various perceptual and motor tasks across multiple stations with controlled loads. Variations in ball-throwing and catching, coordination ladder drills, changes in direction, and coordination games are expected to enhance visual tracking ability, movement rhythm, balance, and response accuracy. The circuit format can also maintain engagement among young athletes because the activities are brief, varied, and progressive. Based on these principles, this study aims to determine the effects of hand-eye coordination training using the circuit method on the backhand drive skills of table tennis athletes aged 8–12 years.

METHOD

This study employed a quantitative approach with a one-group pretest-posttest design. Backhand drive skills were assessed before the intervention; participants then took part in a four-week hand-eye coordination training program using a circuit training method, followed by a final assessment. This design was used to evaluate changes in performance within the same group following the intervention.

Participants

The study participants were 20 table tennis athletes aged 8–12 years. All members of the training population who met the age criteria and were actively participating in the training program were included in the sample. The data analyzed consisted of pretest and posttest scores for the backhand drive skill. Before the assessment, participants received an explanation of the test procedures and performed a warm-up and familiarization with the ball feeds from the robot.

Training Program

Week	Pertemuan	Materi Latihan	Training Frequency
1-2	1-6	a. Coordination exercises with a ball b. Ladder drill with a ball c. Shuttle run with a ball d. Ladder drill with a balloon e. Throw-and-catch with a ball f. Coordination games	Frequency: 3 times per week Intensity: moderate Sets: 3 Workout duration: 30 seconds Rest between exercises: 30 seconds Rest between circuits: 3 minutes
3-4	7-12	a. Coordination exercises with a ball b. Ladder drill with a ball c. Shuttle run with a ball d. Ladder drill with a balloon e. Throw-and-catch with a ball f. Coordination games	Frequency: 3 times per week Intensity: moderate Sets: 4 Work: 30 seconds Rest between exercises: 30 seconds Rest between circuits: 4 minutes

Instrument

Backhand drive skill was measured using a repeated-shot accuracy test adapted for the backhand side. The use of a robot aimed to standardize the direction, speed, frequency, and characteristics of the serves, as used in studies on the kinematics of the backhand drive (Xia et al., 2020; Yam et al., 2021).

Test procedure: (1) participants warm up and familiarize themselves with the setup; (2) the robot serves the ball at a moderate speed and at regular intervals to the backhand area; (3) participants execute 30 backhand drives toward a target on the right side of the opponent's table; and (4) one evaluator records the score for each valid ball. Balls landing in the general target area earn 1 point, those landing in the 60 cm × 60 cm area earn 3 points, and those landing in the 30 cm × 30 cm area earn 5 points. The final score is the sum of the points from the 30 attempts. A stroke is considered valid if the ball crosses the net and bounces on the target table surface.

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Data Analysis

Data analysis was performed using SPSS version 25. Descriptive statistics were used to describe the minimum, maximum, and standard deviation values. Data distribution was examined using the Shapiro-Wilk test, while homogeneity of variances was examined using Levene's test. Differences between pretest and posttest scores were analyzed using a paired-samples t-test at a significance level of 0.05. The magnitude of the change was reported as the difference in means and a 95% confidence interval.

RESULTS AND DISCUSSION

Results

Table 1. Descriptive Statistics

Variable	Partisipan (n=20)		
	Min.	**Maks.**	**SD**
Pretest Backhand Drive	25	81	17.03
Posttest Backhand Drive	34	92	16.14

Table 2. Normality Test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistik	**df**	**Sig.**	**Statistik**	**df**	**Sig.**
Pretest Backhand Drive	.121	20	.200*	.952	20	.401
Posttest Backhand Drive	.116	20	.200*	.966	20	.676

The results of the Shapiro-Wilk test showed that the pretest backhand drive score had a p-value of 0.401 and the posttest score had a p-value of 0.676. Both values were greater than 0.05, so the data were deemed to be normally distributed and met the prerequisites for parametric analysis.

Table 3. Paired Sample t Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval**				
					Lower	**Upper**			
Pair 1	Pretest Backhand Drive - Posttest Backhand Drive	-10.750	3.998	.894	-12.621	-8.879	-12.024	19	.000

Based on the table above, the pretest results were obtained before the intervention which consisted of hand-eye coordination exercises using the circuit training method was administered. After the intervention, the children took a posttest, and the results showed a Sig. value of 0.000. Since this Sig. value is less than 0.05, it can be concluded that there is a significant difference between the pretest and posttest results.

Discussion

Research findings indicate that four weeks of hand-eye coordination training using a circuit method can improve the backhand drive skills of table tennis athletes aged 8–12 years. This improvement can be explained by the nature of the backhand drive as an interceptive skill that requires players to rapidly link visual information with motor responses. The ability to track the ball, predict the point of bounce, and time contact are crucial components of table tennis performance in young players (Faber et al., 2014). When coordination tasks are presented repeatedly and in varied forms, athletes gain more opportunities to adjust their hand responses to changes in visual information.

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Biomechanically, the success of the backhand drive is determined by an efficient sequence of movements from the trunk through the shoulder, elbow, forearm, wrist, and racket. Iino and Kojima (2016) demonstrated that the production and transfer of mechanical energy in the striking arm contribute to racket speed during a backhand topspin stroke. Bankosz and Winiarski (2018) also found a relationship between the angular velocity of several joints and racket speed in the backhand stroke. Other studies confirm that the preparation, execution, and follow-through phases involve organized movement patterns of the shoulder, elbow, and wrist (Xia et al., 2020; Yam et al., 2021). Therefore, improving overall coordination through training stations can help stabilize body posture and synchronize body segments when executing a strike.

Circuit training offers practical advantages because it allows coaches to combine exercises for rhythm, footwork, ball handling, balance, and visual response into a single session. Research in precision sports has shown that specifically designed circuit training can improve balance and accuracy (Prasetyo et al., 2023). In the context of table tennis, the use of robotic feeders also helps provide consistent stimuli so that athletes can focus on the quality of contact and the direction of their shots (Tahki et al., 2022). The combination of coordination exercises and standardized backhand repetitions is a relevant approach for training young athletes.

The study results should be interpreted with several limitations in mind. The study did not include a control group, the number of participants was relatively small, and the intervention lasted only four weeks. The analysis also did not account for gender, grip style, experience level, ball speed, or the kinematic qualities of each stroke phase. Future research is recommended to use a randomized controlled design, report on the reliability of the backhand drive test, and combine accuracy scores with measurements of racket speed, ball speed, and motion analysis. Nevertheless, these results provide preliminary evidence that circuit-based coordination training can be used to strengthen backhand drive skills in athletes aged 8–12 years.

CONCLUSION

A four week hand-eye coordination training program using a circuit method, conducted three times per week, significantly improved the backhand drive skills of table tennis athletes aged 8–12 years. A program that integrates ball-handling drills, coordination ladders, changes of direction, and coordination games can serve as an alternative to basic training to improve visual tracking, timing of contact, and shot accuracy. The implementation of the program must still be tailored to the athletes' skill levels, developmental stages, and the principles of progressive training.

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