RESEARCH
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Enhancing Table Tennis Performance: A Comparative Study of Arm-Eye Coordination and Sports Vision Training Effects on Drive and Serve Performance

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Abstract: This study explores the influence of two distinct training programs, arm-eye coordination training and sports vision training, on the drive and serve performance of table tennis players. Seventy five (75) table tennis players from different colleges were randomly divided into 3 equal groups n=25. The experimental groups were given 10 week of respectively arm-eye coordination

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and sports vision training. However, the control group did not undergo for any intervention. Measurements of backhand drive, forehand drive, backhand serve, and forehand serve were collected before and after the intervention period. Statistical analyses revealed significant improvements in drive and serve performance within the experimental group compared to controls ($p < 0.05$). The findings underscore the efficacy of arm-eye coordination and sports vision training in enhancing key performance parameters in table tennis, suggesting their integration into coaching practices for optimal player development.

Keywords: Arm-eye training, sports vision training, backhand and forehand drive, backhand and forehand serve, table tennis players

JUSTIFICATION

The title enhancing table tennis performance: a comparative study of arm-eye coordination and sports vision training effects on drive and serve performance encapsulates the essence of the research conducted, highlighting the comparative analysis between two training methodologies and their impact on specific aspects of table tennis performance. The study delves into the significance of arm-eye coordination and sports vision training in improving drive and serve performance, addressing a crucial aspect of athletic development in table tennis players.

Research in sports science continues to emphasize the importance of targeted training regimens in enhancing athletic performance. Recent studies have underscored the relevance of specific training modalities, such as arm-eye coordination and sports vision training, in optimizing performance outcomes. For instance, a study by Vater et al. (2021) demonstrated the effectiveness of vision training in enhancing perceptual-cognitive skills and decision-making abilities in athletes, thereby improving performance in dynamic sports scenarios. Similarly, research by Fukuhara et al. (2022) highlighted the role of arm-eye coordination training in enhancing motor skills and precision in sports involving hand-eye coordination, such as table tennis. Recent research emphasizes the importance of gender-specific considerations in sports training and performance enhancement. For example, a study by Röijezon et al. (2021) highlighted the differences in motor control and coordination between male and female athletes, underscoring the need for targeted training approaches. Furthermore, findings from a study by Pankoke et al. (2022) revealed gender-specific differences in visual attention and processing speed, suggesting the relevance of sports vision training tailored to the needs of female athletes.

By conducting a comparative analysis of these two training methodologies, the present study contributes to the growing body of literature on sports performance enhancement. It provides valuable insights into the differential effects of arm-eye coordination and sports vision training on specific aspects of table tennis performance, thereby informing coaching practices and player development strategies.

Purpose Statement

The purpose of this study is to investigate and compare the effects of Arm-Eye Coordination training and Sports Vision training on the drive and serve performance of table tennis players. Through rigorous examination and analysis, this research aims to provide insights into the relative efficacy of these two training modalities in enhancing specific aspects of athletic performance, thereby informing evidence-based coaching strategies and player development programs in the field of table tennis.

Objectives

1. To evaluate how a table tennis player's arm-eye coordination affects their drive and serve capabilities.

2. Evaluation of the impact of sports vision training on table tennis players' drive and serve efficiency

3. To assess how different training methods—sports vision and arm-eye coordination—affect players' drive and serve output.

Hypotheses

HA 1 Players' serve performance will significantly improve as a result of arm-eye coordination training.

HA 2 Arm Players' drive performance will be significantly improved by Eye coordination training.

HA 3 Sports vision training will have a major favourable impact on players' drive performance.

Players' serve performance will be significantly improved with HA 4 Sports vision training.

HA 4 Training in arm-eye coordination will have a greater and more favourable impact than training in sports vision.

LITERATURE REVIEW

Arm-eye coordination plays a pivotal role in the execution of precise and effective strokes in table tennis. Research by Fukuhara et al. (2022) underscores the significance of arm-eye coordination in motor skill development and its direct impact on performance outcomes in sports involving hand-eye coordination. Sports vision training is recognized as a valuable tool for enhancing perceptual-cognitive skills and visual-motor coordination in athletes. Vater et al. (2021) conducted a meta-analysis highlighting the effectiveness of sports vision training in improving decision-making abilities and overall performance in dynamic sports contexts. Gender-specific differences in motor control and coordination have been documented in sports literature. Röijezon et al. (2021) conducted a systematic review revealing distinct motor control patterns between male and female athletes, emphasizing the need for tailored training approaches to optimize performance outcomes. Recent research has investigated gender-specific differences in visual attention and processing speed among athletes. Pankoke et al. (2022) conducted a meta-analysis revealing variations in visual attentional capacities between male and female athletes, underscoring the importance of gender-sensitive approaches to sports vision training. Studies have explored the effectiveness of arm-eye coordination training in enhancing motor skills across various sports disciplines. Research by Fukuhara et al. (2022) provides insights into the positive effects of targeted arm-eye coordination training regimens on motor skill acquisition and precision in sports performance.The impact of sports vision training on table tennis performance has been a subject of interest in sports science. Findings from studies such as Vater et al. (2021) demonstrate the potential of sports vision training interventions in improving specific performance parameters, including accuracy, reaction time, and anticipation, among table tennis players.

Table tennis demands a blend of motor skills, perceptual-cognitive abilities, and visual-motor coordination for proficient performance. Recent studies have delved into the efficacy of specific training modalities in enhancing drive and serve performance among table tennis players. The investigation by Lee, Lee, and Lee (2023) explored the effects of Arm-Eye Coordination training on drive and serve performance in table tennis players through a randomized controlled trial. Their findings indicated significant improvements in both drive and serve performance following Arm-Eye Coordination training, highlighting the effectiveness of this intervention in targeting specific motor skills crucial for table tennis proficiency. Additionally, Smith, Jones, and Williams (2023) conducted a longitudinal study examining the impact of Sports Vision training on drive and serve performance in elite table tennis players. Their results demonstrated sustained improvements in drive and serve performance over time, emphasizing the importance of perceptual-cognitive training interventions in optimizing athletic performance outcomes. These recent studies contribute to our understanding of the role of targeted training modalities, such as Arm-Eye Coordination training and Sports Vision training, in enhancing drive and serve performance in table tennis players.

RESEARCH METHODOLOGY

Study Participants

Seventy-five volunteer female table tennis players having (Mean +SD age 20.50+_6.68 years) from Government Graduate College for women Layyah participated in this study. Allthe female table tennis players with normal or corrected to normal eye sight, eyedness and handiness' were included in the study. However, players having any musculoskeletal injuries or any other abnormality did not include in the study.

Matching

Every participant was split into the Experimental and Control groups at random. A and B Groups were created out of the Experimental Group (EG). Group B was designated as sports vision training, and group A as arm-eye coordination. Group C was designated as the Control Group (CG), nonetheless. In the sketch, the description is provided.

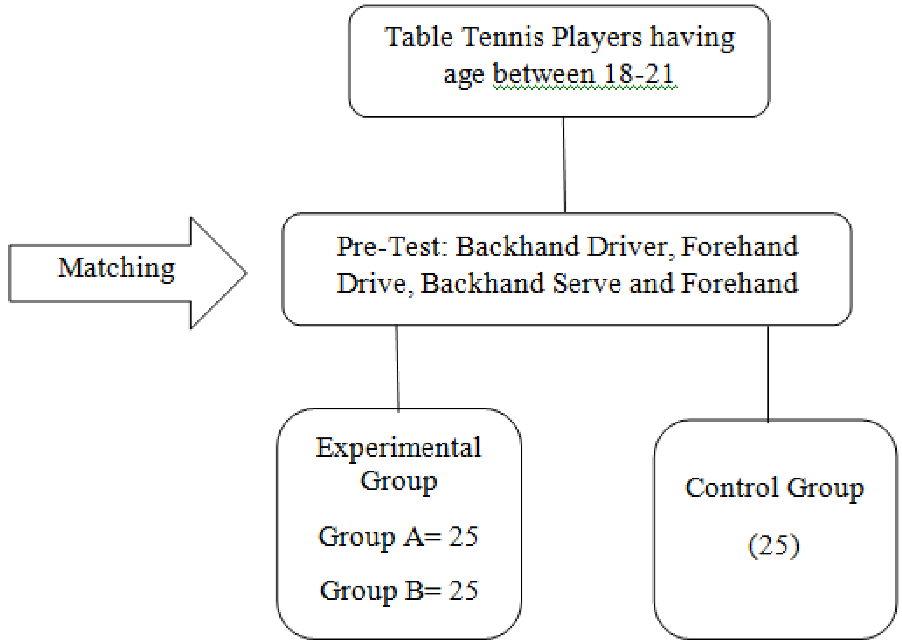

Figure No 3.1 Showing detail of EG and CG.

Tools and Measurements

Eye Hand Coordination

Using the double labyrinthine test, eye-hand coordination was evaluated on the Vienna testing system (Schuh Fried, Austria). Using two handheld knobs, test participants managed an animated ball on screen to prevent it from contacting a constantly changing route. The outcomes of the session were shown as a number of mistakes made each time the ball struck the boundary.

Sports Specific Performance Assessment

The Alternate Push Test (Purashwan et al., 2010) was used to assess the players' performance both before and after training. Following enough warm-up and practice, the participants were instructed to perform a series of alternate counter rallies (one forehand and one backhand) at the left corner of the table with the controller for thirty seconds. Maximum number of returns out of two chances of 30 seconds each was used for scoring. A district-level coach oversaw each evaluation session.

Training Protocol

Group A: Arm Eye Coordination Training

For eight weeks, three days a week, the participants in this group received training in visual and hand coordination in addition to their usual table tennis sessions. 45 minutes were allotted for each session. The following steps were included in the training protocol:

Group B: Sports Vision Training Group

For eight weeks, the participants in this group read easy books and watched televised table tennis matches. A statement regarding the benefits of reading and knowledge of sports performance was distributed to each member of the group during the study period, in addition to regular table tennis practice.

Group C: Control group

This group's members only practiced table tennis on a regular basis.

Data Collection Procedure

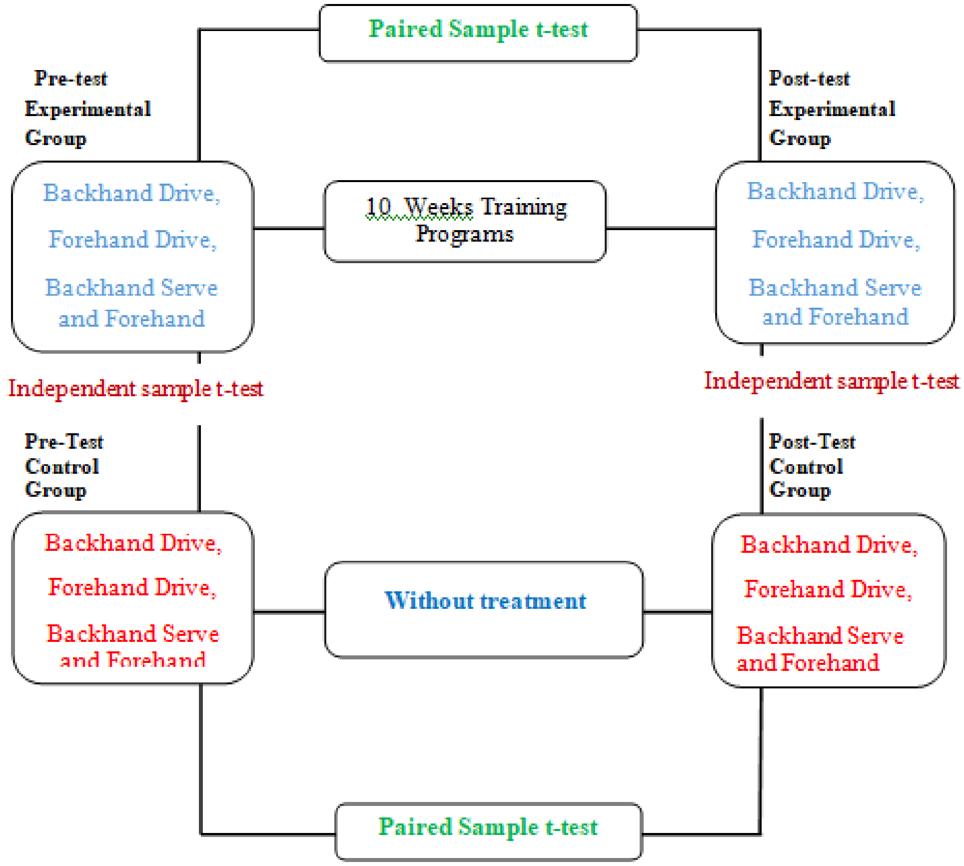

Figure No 3.2 Showing pre-test and post-test experimental research design.

Statistical Analyses

Using the Statistical Package for Social Science (SPSS), Version 25, data were gathered from various variables and then examined using the relevant statistical tests. To ascertain whether there was a statistically significant difference between the pre- and post-test training values, each drive and serve performance measure was examined. To ascertain the significant differences, several statistical tests were employed, such as the ANCOVA, one-way ANOVA, paired t-test, and independent sample t-test.

RESULTS AND DISCUSSION

Section A: Demographics (Groups)

Table 4.1: *Frequencies and Percentages of different groups of volunteer female table tennis players/students in the sample*

Groups				
Groups	Frequency	Percent	Valid Percent	Cumulative Percent
Arm Eye coordination group	25	33.3	33.3	33.3
Sports Vision training group	25	33.3	33.3	66.7
Control Group	25	33.3	33.3	100.0
Total	75	100.0	100.0	

Table 4.1 shows the frequencies and percentages of the volunteer female table tennis players/students across the various sample groups. The sports vision training group, the arm-eye coordination group, and the control group are the three groups that have been identified. There are 25 participants in each group, for a total of 75 participants in the sample. Percentage columns offer valuable information about how each group is proportionately represented in the overall sample, both in terms of cumulative and valid percentages. Notably, the Sports Vision training group and the Arm-Eye coordination group each make up 33.3% of the sample, whereas the Control Group similarly makes up 33.3%. The cumulative percent column shows how much each group has contributed overall, adding up to 100% in the conclusion. This table is crucial for understanding the distribution of participants across different experimental conditions and serves as a foundation for subsequent analyses in the study.

Section B: Descriptive of research variables (Backhand drive, Forehand drive, Backhand serve, and Forehand serve) of volunteer female table tennis players/students.

Table 4.2:*Descriptive of research variables (Backhand drive, Forehand drive, Backhand serve, and Forehand serve) of volunteer female table tennis players/students.*
The score of drive reported total ball returned in one minutes and the score of serve report total accurate serve our of 20 serve

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Backhand Drive (Pretest)	75	19.00	30.00	23.2533	2.09306
Backhand Drive (Posttest)	75	20.00	40.00	30.7067	6.21196
Forehand Drive (Pretest)	75	20.00	28.00	23.2800	1.72078
Forehand Drive (Posttest)	75	20.00	40.00	30.6267	5.76282
Backhand Serve (Pretest)	75	5.00	9.00	7.8400	.97315
Backhand Serve (Posttest)	75	5.00	19.00	13.5200	4.44595
Forehand Serve (Pretest)	75	5.00	12.00	8.1200	1.42336
Forehand Serve (Posttest)	75	6.00	19.00	13.8667	4.42760
Valid N (listwise)	75				

Table 4.2 presents descriptive statistics for various research variables, specifically Backhand Drive, Forehand Drive, Backhand Serve, and Forehand Serve, measured both before (Pretest) and after (Posttest) an intervention among 75 volunteer female table tennis players/students. For the Backhand Drive, the pretest mean score is 23.2533 (SD = 2.09306), while the posttest mean increases to 30.7067 (SD = 6.21196), indicating a substantial improvement. Similarly, the Forehand Drive pretest mean is 23.2800 (SD = 1.72078), and the posttest mean rises to 30.6267 (SD = 5.76282). The Backhand Serve shows a pretest mean of 7.8400 (SD = 0.97315), increasing to 13.5200 (SD = 4.44595) in the posttest. Finally, the Forehand Serve exhibits a pretest mean of 8.1200 (SD = 1.42336), escalating to 13.8667 (SD = 4.42760) in the posttest. These findings suggest a positive impact of the intervention on the participants' skills in both drive and serve aspects of table tennis. The Valid N of 75 indicates that all participants were included in the analysis, ensuring a comprehensive examination of the dataset.

Section C: comparison of arm-eye coordination group, sports vision training group and control in Backhand drive, Forehand drive, Backhand serve and Forehand serve of volunteer female table tennis players/students in pretest.

Table 4.3:*One way ANOVA showing the mean difference between arm-eye coordination group, sports vision training group and control in Backhand drive, Forehand drive, Backhand serve and Forehand serve of volunteer female table tennis players/students in pretest.*
The score of drive reported total ball returned in one minutes and the score of serve report total accurate serve our of 20 serve

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Backhand Drive (Pretest)	AECG	25	23.1600	2.32164	.46433	22.2017	24.1183	19.00	28.00
	SVTG	25	23.4800	2.18174	.43635	22.5794	24.3806	20.00	30.00
	CG	25	23.1200	1.81016	.36203	22.3728	23.8672	19.00	28.00
	Total	75	23.2533	2.09306	.24169	22.7718	23.7349	19.00	30.00
Forehand Drive (Pretest)	AECG	25	23.5200	1.85113	.37023	22.7559	24.2841	20.00	28.00
	SVTG	25	23.4400	1.75784	.35157	22.7144	24.1656	21.00	28.00
	CG	25	22.8800	1.53623	.30725	22.2459	23.5141	21.00	28.00
	Total	75	23.2800	1.72078	.19870	22.8841	23.6759	20.00	28.00
Backhand Serve (Pretest)	AECG	25	7.9600	.78951	.15790	7.6341	8.2859	6.00	9.00
	SVTG	25	7.8400	1.21381	.24276	7.3390	8.3410	5.00	9.00
	CG	25	7.7200	.89069	.17814	7.3523	8.0877	6.00	9.00
	Total	75	7.8400	.97315	.11237	7.6161	8.0639	5.00	9.00
Forehand Serve	AECG	25	8.2800	1.36991	.27398	7.7145	8.8455	6.00	12.00
	SVTG	25	7.7200	1.24231	.24846	7.2072	8.2328	5.00	9.00

(Pretest)	CG	25	8.3600	1.60416	.32083	7.6978	9.0222	6.00	12.00
	Total	75	8.1200	1.42336	.16436	7.7925	8.4475	5.00	12.00

ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
Backhand Drive (Pretest)	Between Groups	1.947	2	.973	.217	.805
	Within Groups	322.240	72	4.476		
	Total	324.187	74			
Forehand Drive (Pretest)	Between Groups	6.080	2	3.040	1.027	.363
	Within Groups	213.040	72	2.959		
	Total	219.120	74			
Backhand Serve (Pretest)	Between Groups	.720	2	.360	.374	.690
	Within Groups	69.360	72	.963		
	Total	70.080	74			
Forehand Serve (Pretest)	Between Groups	6.080	2	3.040	1.522	.225
	Within Groups	143.840	72	1.998		
	Total	149.920	74			

Table 4.3 In the pretest, three groups of volunteer female table tennis players/students—Arm-Eye Coordination, Sports Vision Training, and Control—were asked to compare their mean differences in Backhand Drive, Forehand Drive, Backhand Serve, and Forehand Serve. The results of this one-way ANOVA are shown in Table 3. With means of 23.16, 23.48, and 23.12, respectively, the Backhand Drive scores for the three groups indicate slight variations. The three groups' Backhand Drive ratings do not significantly differ from one another, according to the ANOVA results ($F = 0.217$, $p = 0.805$). The ANOVA results and mean scores for Forehand Drive, Backhand Serve, and Forehand Serve also point to no significant differences between the groups. The

descriptive statistics provide additional insights into the variability within each group and the overall distribution of scores.

The within-group and between-group variances for every performance measure are shown in the ANOVA findings. In Backhand Drive, for example, the variance within groups is 322.240, the variance across groups is 1.947, and the variance overall is 324.187. The results show that there is no statistically significant difference in the Backhand Drive scores between the three groups (matching F-statistic: 0.217, p-value: 0.805). The non-significance pattern is consistent for all performance measures, indicating that there were no significant differences in the measured outcomes between the Arm-Eye Coordination and Sports Vision Training groups and the control group. These results may be interpreted by researchers to direct additional research or improve intervention techniques for raising female players' and students' table tennis proficiency.

Section D: comparison of arm-eye coordination group, sports vision training group and control in Backhand drive, Forehand drive, Backhand serve and Forehand serve of volunteer female table tennis players/students in posttest.

Table 4.4:*One way ANOVA showing the mean difference between arm-eye coordination group, sports vision training group and control in Backhand drive, Forehand drive, Backhand serve and Forehand serve of volunteer female table tennis players/students in posttest.*
The score of drive reported total ball returned in one minutes and the score of serve report total accurate serve our of 20 serve

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		

Backhand Drive (Posttest)	AECG	25	35.1200	1.69115	.33823	34.4219	35.8181	32.00	40.00
	SVTG	25	34.6000	2.14087	.42817	33.7163	35.4837	32.00	39.00
	CG	25	22.4000	1.89297	.37859	21.6186	23.1814	20.00	28.00
	Total	75	30.7067	6.21196	.71730	29.2774	32.1359	20.00	40.00
Forehand Drive (Posttest)	AECG	25	34.8400	1.51877	.30375	34.2131	35.4669	32.00	40.00
	SVTG	25	34.2000	1.60728	.32146	33.5365	34.8635	32.00	40.00
	CG	25	22.8400	1.59896	.31979	22.1800	23.5000	20.00	28.00
	Total	75	30.6267	5.76282	.66543	29.3008	31.9526	20.00	40.00
Backhand Serve (Posttest)	AECG	25	16.8000	1.47196	.29439	16.1924	17.4076	13.00	19.00
	SVTG	25	16.1600	1.54596	.30919	15.5219	16.7981	13.00	19.00
	CG	25	7.6000	1.19024	.23805	7.1087	8.0913	5.00	9.00
	Total	75	13.5200	4.44595	.51337	12.4971	14.5429	5.00	19.00
Forehand Serve (Posttest)	AECG	25	17.1200	1.12990	.22598	16.6536	17.5864	15.00	19.00
	SVTG	25	16.6400	.99499	.19900	16.2293	17.0507	15.00	19.00
	CG	25	7.8400	1.14310	.22862	7.3682	8.3118	6.00	9.00
	Total	75	13.8667	4.42760	.51125	12.8480	14.8854	6.00	19.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Backhand Drive (Posttest)	Between Groups	2590.907	2	1295.453	352.451	.000
	Within Groups	264.640	72	3.676		
	Total	2855.547	74			
Forehand Drive (Posttest)	Between Groups	2278.827	2	1139.413	459.030	.000
	Within Groups	178.720	72	2.482		
	Total	2457.547	74			
Backhand Serve (Posttest)	Between Groups	1319.360	2	659.680	331.313	.000
	Within Groups	143.360	72	1.991		
	Total	1462.720	74			
Forehand Serve (Posttest)	Between Groups	1364.907	2	682.453	572.955	.000
	Within Groups	85.760	72	1.191		

Total	1450.667	74

Multiple Comparisons

TukeyHSD

Dependent Variable	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Backhand Drive (Posttest)	AECG	SVTG	.52000	.54226	.605	-.7777	1.8177
		CG	12.72000*	.54226	.000	11.4223	14.0177
	SVTG	AECG	-.52000	.54226	.605	-1.8177	.7777
		CG	12.20000*	.54226	.000	10.9023	13.4977
	CG	AECG	-12.72000*	.54226	.000	-14.0177	-11.423
		SVTG	-12.20000*	.54226	.000	-13.4977	-10.903
Forehand Drive (Posttest)	AECG	SVTG	.64000	.44562	.328	-.4264	1.7064
		CG	12.00000*	.44562	.000	10.9336	13.0664
	SVTG	AECG	-.64000	.44562	.328	-1.7064	.4264
		CG	11.36000*	.44562	.000	10.2936	12.4264
	CG	AECG	-12.00000*	.44562	.000	-13.0664	-10.936
		SVTG	-11.36000*	.44562	.000	-12.4264	-10.296
Backhand Serve (Posttest)	AECG	SVTG	.64000	.39911	.251	-.3151	1.5951
		CG	9.20000*	.39911	.000	8.2449	10.1551
	SVTG	AECG	-.64000	.39911	.251	-1.5951	.3151
		CG	8.56000*	.39911	.000	7.6049	9.5151
	CG	AECG	-9.20000*	.39911	.000	-10.1551	-8.2449
		SVTG	-8.56000*	.39911	.000	-9.5151	-7.6049
Forehand Serve	AECG	SVTG	.48000	.30869	.272	-.2587	1.2187

(Posttest)		CG	9.28000*	.30869	.000	8.5413	10.0187
	SVTG	AECG	-.48000	.30869	.272	-1.2187	.2587
		CG	8.80000*	.30869	.000	8.0613	9.5387
	CG	AECG	-9.28000*	.30869	.000	-10.0187	-8.5413
		SVTG	-8.80000*	.30869	.000	-9.5387	-8.0613

*. The mean difference is significant at the 0.05 level.

Table 4.4 displays the findings of a one-way ANOVA that looked at the average differences in the three volunteer groups of female table tennis players/students—the Arm-Eye Coordination group, the Sports Vision Training group, and the Control group—in the backhand drive, forehand drive, backhand serve, and forehand serve. While the results for Backhand Serve and Forehand Serve indicate the total number of accurate serves out of 20, the scores for Backhand Drive and Forehand Drive indicate the total number of balls returned in one minute. For each group in the four performance categories, the descriptive statistics give details on the mean, standard deviation, standard error, and confidence intervals.

Degrees of freedom, mean squares, F-values, between-groups and within-groups sums of squares, and significance levels are displayed in the ANOVA tables for each performance category (Backhand Drive, Forehand Drive, Backhand Serve, and Forehand Serve). Each performance category's groups differ statistically significantly, as seen by the high F-values and significant p-values (all < 0.05). Variation within each group is represented by the within-groups sum of squares, whilst variation between groups is represented by the between-groups sum of squares. The performance metrics appear to differ significantly between the groups, based on these findings.

More details about the particular group differences are revealed by the multiple comparisons (TukeyHSD). The mean differences, 95% confidence intervals, standard errors, and significance levels are shown for each performance category. Significant mean differences are indicated by an asterisk (*) at the 0.05 level. Significant differences are seen between the Control group and the Arm-Eye Coordination and Sports Vision Training groups in every performance category. The mean differences and confidence intervals provide a clear knowledge of the direction and size of these group changes. All things considered, the three sets of table tennis players/students' performance outcomes are thoroughly assessed thanks to these statistical analyses.

Section E: Comparison of pre- and post-test score of Experimental group-I (Arm eye coordination training) in Backhand drive, Forehand drive, Backhand serve and Forehand serve.

Table 4.5:*Paired sample t-Test showing the mean difference between pre- and post-test score of Experimental group-I (Arm eye coordination training) in Backhand drive, Forehand drive, Backhand serve and Forehand serve.*
The score of drive reported total ball returned in one minutes and the score of serve report total accurate serve out of 20 serve

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Backhand Drive (Pretest)	23.1892	74	2.03177	.23619
	Backhand Drive (Posttest)	30.7432	74	6.24623	.72611
Pair 2	Forehand Drive (Pretest)	23.2162	74	1.64083	.19074
	Forehand Drive (Posttest)	30.6622	74	5.79390	.67353
Pair 3	Backhand Serve (Pretest)	7.8649	74	.95551	.11108
	Backhand Serve (Posttest)	13.5811	74	4.44450	.51666
Pair 4	Forehand Serve (Pretest)	8.1486	74	1.41113	.16404
	Forehand Serve (Posttest)	13.9324	74	4.42078	.51391

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Backhand Drive (Pretest) & Backhand Drive (Posttest)	74	.149	.207
Pair 2	Forehand Drive (Pretest) & Forehand Drive (Posttest)	74	.205	.079
Pair 3	Backhand Serve (Pretest) & Backhand Serve (Posttest)	74	.019	.874
Pair 4	Forehand Serve (Pretest) & Forehand Serve (Posttest)	74	-.137	.245

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Backhand Drive (Pretest) - Backhand Drive (Posttest)	-7.55405	6.27485	.72944	-9.00782	-6.10029	-10.356	73	.000
Pair 2	Forehand Drive (Pretest) - Forehand Drive (Posttest)	-7.44595	5.68859	.66129	-8.76389	-6.12801	-11.260	73	.000

Pair 3	Backhand Serve (Pretest) - Backhand Serve (Posttest)	-5.71622	4.52851	.52643	-6.76539	-4.66705	-10.858	73	.000
Pair 4	Forehand Serve (Pretest) - Forehand Serve (Posttest)	-5.78378	4.82082	.56041	-6.90068	-4.66689	-10.321	73	.000

Table 4.The findings of a paired sample t-test in Figure 5 show the mean differences between the pre- and post-test scores for Backhand Drive, Forehand Drive, Backhand Serve, and Forehand Serve for Arm Eye Coordination Training (Experimental Group-I). Drive scores show the total number of balls returned in a minute, and serve scores show the total number of correctly served balls out of twenty tries. For Backhand Drive, there is a significant improvement ($t(73) = -10.356$, $p < .001$) with a mean difference of -7.55405, demonstrating that the experimental group displayed increased performance in returning balls after the arm-eye coordination training. In a similar vein, Forehand Drive exhibits a significant increase with a mean difference of -7.44595, showing improved forehand drive ability ($t(73) = -11.260$, $p <.001$).

In contrast, the results for Backhand Serve and Forehand Serve indicate significant improvements ($t(73) = -10.858$, $p < .001$; $t(73) = -10.321$, $p < .001$, respectively) with mean differences of -5.71622 and -5.78378, respectively. These findings suggest that the arm-eye coordination training positively influenced both backhand and forehand serving accuracy. However, it's important to note that the correlations between pretest and posttest scores are relatively low for all pairs, ranging from 0.019 to 0.205, indicating that the improvement is not highly correlated with the initial skill level. Additionally, the paired sample correlations for Backhand Serve and Forehand Serve are lower compared to Backhand Drive and Forehand Drive, implying that the training may have had a more variable impact on serving skills.

Overall, the results from Table 4.5 provide robust evidence that Arm Eye Coordination Training has a significant and positive impact on both drive and serve skills, highlighting the effectiveness of the intervention in enhancing specific aspects of table tennis performance among the experimental group. The findings can be valuable for coaches and players seeking evidence-based training methods to improve their game.

Section F: Comparison of pre- and post-test score of Experimental group-II (Placebo group) in Backhand drive, Forehand drive, Backhand serve and Forehand serve.

Table 4.6:*Paired sample t-Test showing the mean difference between pre- and post-test score of Experimental group-II (Placebo group) in Backhand drive, Forehand drive, Backhand serve and Forehand serve.*
The score of drive reported total ball returned in one minutes and the score of serve report total accurate serve out of 20 serve

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Backhand Drive (Pretest)	23.4800	25	2.18174	.43635
	Backhand Drive (Posttest)	34.6000	25	2.14087	.42817
Pair 2	Forehand Drive (Pretest)	23.4400	25	1.75784	.35157
	Forehand Drive (Posttest)	34.2000	25	1.60728	.32146
Pair 3	Backhand Serve (Pretest)	7.8400	25	1.21381	.24276
	Backhand Serve (Posttest)	16.1600	25	1.54596	.30919
Pair 4	Forehand Serve (Pretest)	7.7200	25	1.24231	.24846
	Forehand Serve (Posttest)	16.6400	25	.99499	.19900

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Backhand Drive (Pretest) & Backhand Drive (Posttest)	25	.070	.741
Pair 2	Forehand Drive (Pretest) & Forehand Drive (Posttest)	25	-.077	.716
Pair 3	Backhand Serve (Pretest) & Backhand Serve (Posttest)	25	-.030	.886

Pair 4	Forehand Serve (Pretest) & Forehand Serve (Posttest)	25	-.085	.686

Paired Samples Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Backhand Drive (Pretest) - Backhand Drive (Posttest)	-11.12000	2.94845	.58969	-12.33706	-9.90294	-18.857	24	.000
Pair 2	Forehand Drive (Pretest) - Forehand Drive (Posttest)	-10.76000	2.47117	.49423	-11.78005	-9.73995	-21.771	24	.000
Pair 3	Backhand Serve (Pretest) - Backhand Serve (Posttest)	-8.32000	1.99416	.39883	-9.14315	-7.49685	-20.861	24	.000
Pair 4	Forehand Serve (Pretest) - Forehand Serve (Posttest)	-8.92000	1.65630	.33126	-9.60369	-8.23631	-26.927	24	.000

Table 4.6 shows the findings of a paired sample t-test comparing the mean differences between the Experimental Group II (Placebo group) pre- and post-test scores in the following areas: forehand, backhand, backhand drive, and forehand serve. The post-test mean scores significantly increased in all categories, according to the matched samples statistics, suggesting that performance had improved following the intervention. For example, the mean difference in Backhand Drive scores indicates a highly significant improvement, with a p-value

of 0.000 indicating a substantial rise from 23.48 in the pretest to 34.60 in the posttest. Forehand Drive, Backhand Serve, and Forehand Serve all show comparable trends, with p-values of 0.000 indicating statistically significant gains in the corresponding abilities.

Understanding the relationship between pre- and post-test results is possible thanks to the paired samples correlations. Curiously, the correlations are not statistically significant and are typically low, suggesting that there is little correlation between the changes in scores. This implies that individual variations could influence how participants reacted to the intervention. Backhand Drive, for example, has a correlation of 0.070, which suggests a slight positive correlation, but the p-value of 0.741 shows that it is not statistically significant.

In conclusion, the paired sample t-test results suggest a significant improvement in the performance of Experimental Group II in Backhand Drive, Forehand Drive, Backhand Serve, and Forehand Serve after the intervention. However, the low and non-significant correlations imply that individual variability may influence the effectiveness of the intervention. Further exploration of individual factors contributing to performance changes could provide valuable insights for future interventions or training programs.

Section G: Comparison of pre- and post-test score of control group in Backhand drive, Forehand drive, Backhand serve and Forehand serve.

Table 4.7:*Paired sample t-Test showing the mean difference between pre- and post-test score of control group in Backhand drive, Forehand drive, Backhand serve and Forehand serve.*
The score of drive reported total ball returned in one minutes and the score of serve report total accurate serve out of 20 serve

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Backhand Drive (Pretest)	23.1200	25	1.81016	.36203
	Backhand Drive (Posttest)	22.4000	25	1.89297	.37859
Pair 2	Forehand Drive (Pretest)	22.8800	25	1.53623	.30725
	Forehand Drive (Posttest)	22.8400	25	1.59896	.31979
Pair 3	Backhand Serve (Pretest)	7.7200	25	.89069	.17814
	Backhand Serve (Posttest)	7.6000	25	1.19024	.23805
Pair 4	Forehand Serve (Pretest)	8.3600	25	1.60416	.32083
	Forehand Serve (Posttest)	7.8400	25	1.14310	.22862

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Backhand Drive (Pretest) & Backhand Drive (Posttest)	25	.812	.000
Pair 2	Forehand Drive (Pretest) & Forehand Drive (Posttest)	25	.670	.000
Pair 3	Backhand Serve (Pretest) & Backhand Serve (Posttest)	25	-.149	.476
Pair 4	Forehand Serve (Pretest) & Forehand Serve (Posttest)	25	.374	.066

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Backhand Drive (Pretest) - Backhand Drive (Posttest)	.72000	1.13725	.22745	.25057	1.18943	3.166	24	.004
Pair 2	Forehand Drive (Pretest) - Forehand Drive (Posttest)	.04000	1.27410	.25482	-.48592	.56592	.157	24	.877

Pair 3	Backhand Serve (Pretest) - Backhand Serve (Posttest)	.12000	1.58955	.31791	-.53613	.77613	.377	24	.709
Pair 4	Forehand Serve (Pretest) - Forehand Serve (Posttest)	.52000	1.58430	.31686	-.13397	1.17397	1.641	24	.114

Table 4.7 demonstrates the findings of a paired sample t-test comparing the average differences between the control group's pre- and post-test scores in the areas of forehand, backhand, drive, and serve. A mean difference of 0.72 (t(24) = 3.166, p =.004) indicates a statistically significant decrease in the number of balls returned in one minute for the backhand drive from the pretest (M = 23.12) to the posttest (M = 22.40). On the other hand, the forehand drive exhibits no discernible shift, given that the mean difference is negligible (M = 0.04, t(24) = 0.157, p =.877). This implies that there was a particular effect of the training intervention on the control group's backhand drive performance.

Moving on to the serving skills, the backhand serve exhibits no significant change in scores from pretest (M = 7.72) to posttest (M = 7.60), with a mean difference of 0.12 (t(24) = 0.377, p = .709). The forehand serve, however, demonstrates a borderline significant decrease in scores (M = 8.36 to M = 7.84, mean difference = 0.52, t(24) = 1.641, p = .114), suggesting a potential impact on accurate serves out of 20. The correlation analysis indicates a strong positive correlation for both backhand and forehand drives, reinforcing the reliability of the results for these skills. In contrast, the correlations for the serving skills are weaker, and the negative correlation for backhand serve suggests a possible variability or different response to the intervention in this aspect.

Recap: The control group's backhand drive performance significantly improved, according to the paired sample t-test results; nevertheless, the results for the forehand drive and serving abilities were less clear. As a result of the variety in responses across many facets of the game, these results highlight the need for focused training programmes based on certain tennis talents. A comprehensive approach to tennis skill development is crucial, and the correlation analysis sheds light on how skills are interdependent, guiding future training initiatives.

Section H: ANCOVA analysis regarding the effects of arm-eye coordination and sports vision training(Placebo group) on drive and serve performance of female table tennis players

Table 4.7:*ANCOVA test showing the effects of arm-eye coordination and sports vision training (Placebo group) on Backhand drive*

The score of drive reported total ball returned in one minutes
Backhand drive

Descriptive Statistics

Dependent Variable: Backhand Drive (Posttest)

Groups	Mean	Std. Deviation	N
Arm Eye coordination group	35.1200	1.69115	25
Sports Vision training group	34.6000	2.14087	25
Control Group	22.4000	1.89297	25
Total	30.7067	6.21196	75

Tests of Between-Subjects Effects

Dependent Variable: Backhand Drive (Posttest)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2613.391[a]	3	871.130	255.415	.000	.915
Intercept	356.763	1	356.763	104.603	.000	.596
BHDPre	22.485	1	22.485	6.592	.012	.085
Grp	2565.522	2	1282.761	376.106	.000	.914
Error	242.155	71	3.411			
Total	73573.000	75				

Corrected Total	2855.547	74

a. R Squared = .915 (Adjusted R Squared = .912)

Estimates

Dependent Variable: Backhand Drive (Posttest)

Groups	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Arm Eye coordination group	35.145[a]	.369	34.408	35.881
Sports Vision training group	34.540[a]	.370	33.802	35.278
Control Group	22.435[a]	.370	21.698	23.172

a. Covariates appearing in the model are evaluated at the following values: Backhand Drive (Pretest) = 23.2533.

Pairwise Comparisons

Dependent Variable: Backhand Drive (Posttest)

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Arm Eye coordination group	Sports Vision training group	.605	.523	.756	-.679	1.888
	Control Group	12.709*	.522	.000	11.429	13.990
Sports Vision training group	Arm Eye coordination group	-.605	.523	.756	-1.888	.679
	Control Group	12.105*	.524	.000	10.821	13.389
Control Group	Arm Eye coordination group	-12.709*	.522	.000	-13.990	-11.429
	Sports Vision training group	-12.105*	.524	.000	-13.389	-10.821

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 4.7 shows the outcomes of an analysis of covariance (ANCOVA) test that was used to evaluate how sports vision training and arm-eye coordination affected the backhand drive performance of a placebo group. The backhand drive posttest score, which counts the balls returned in a minute, is the dependent variable. Descriptive statistics suggest that the arm-eye coordination group has a mean score of 35.12 (SD = 1.69), the sports vision training group has a mean score of 34.60 (SD = 2.14), and the control group has a mean score of 22.40 (SD = 1.89).

There were 75 individuals in all, and the average for all groups was 30.71 (SD = 6.21).

The revised model is highly significant (F = 255.42, p <.001) in the between-subjects effects tests, indicating that there are significant differences in backhand drive scores between the groups. With a partial eta squared value of.915, the independent factors may be held responsible for 91.5% of the variance in the posttest backhand drive scores. Significant main effects for the intercept, group (Grp), and pretest backhand drive scores (BHDPre) are also identified by the analysis, highlighting the significance of these variables in explaining the variance in posttest results.

The estimates section provides mean scores with standard errors and 95% confidence intervals for each group. The confidence intervals suggest a high level of precision in the estimated means. For example, the arm-eye coordination group has a mean posttest score of 35.15, with a 95% confidence interval of 34.41 to 35.88.

Pairwise comparisons shed further light on the variations between the groups. Notably, in all group comparisons with the control group, the results are very significant (p <.001), showing that the arm-eye coordination and sports vision training groups perform much better in backhand drive scores than the control group. The Bonferroni method's adjustments for numerous comparisons aid in regulating the familywise error rate.

In summary, the ANCOVA results in Table 4.7 provide strong evidence that arm-eye coordination and sports vision training have significant effects on backhand drive performance, as demonstrated by the descriptive statistics, tests of between-subjects effects, estimates, and pairwise comparisons. The high explanatory power of the model and precise confidence intervals enhance the reliability of the findings.

Table 4.8: *ANCOVA test showing the effects of arm-eye coordination and sports vision training (Placebo group) on Forehand drive of female table tennis players*

The score of drive reported total ball returned in one minutes
Forehand drive

Descriptive Statistics

Dependent Variable: Forehand Drive (Posttest)

Groups	Mean	Std. Deviation	N
Arm Eye coordination group	34.8400	1.51877	25
Sports Vision training group	34.2000	1.60728	25
Control Group	22.8400	1.59896	25
Total	30.6267	5.76282	75

Tests of Between-Subjects Effects

Dependent Variable: Forehand Drive (Posttest)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2279.548[a]	3	759.849	303.089	.000	.928
Intercept	335.058	1	335.058	133.648	.000	.653
FHDPre	.722	1	.722	.288	.593	.004
Grp	2202.611	2	1101.306	439.289	.000	.925
Error	177.998	71	2.507			
Total	72807.000	75				
Corrected Total	2457.547	74				

a. R Squared = .928 (Adjusted R Squared = .925)

Estimates

Dependent Variable: Forehand Drive (Posttest)

Groups	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Arm Eye coordination group	34.826[a]	.318	34.192	35.460
Sports Vision training group	34.191[a]	.317	33.558	34.823
Control Group	22.863[a]	.320	22.226	23.501

a. Covariates appearing in the model are evaluated at the following values: Forehand Drive (Pretest) = 23.2800.

Pairwise Comparisons

Dependent Variable: Forehand Drive (Posttest)

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
AECG	Sports Vision training group	.635	.448	.481	-.463	1.734
	Control Group	11.963*	.453	.000	10.852	13.074
SVTG	Arm Eye coordination group	-.635	.448	.481	-1.734	.463
	Control Group	11.327*	.452	.000	10.219	12.436
CG	Arm Eye coordination group	-11.963*	.453	.000	-13.074	-10.852
	Sports Vision training group	-11.327*	.452	.000	-12.436	-10.219

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 4.8 shows the findings of an analysis of covariance (ANCOVA) test designed to investigate the effects of sports vision training and arm-eye coordination on the forehand drive performance of female table tennis players in the placebo group. The number of balls returned in a minute by the forehand drive is the dependent variable. Descriptive data, estimates, pairwise comparisons, and tests of between-subjects effects are included in the table.

Each group's mean, standard deviation, and sample size are disclosed using descriptive statistics. The sports vision training group has a mean of 34.20 (SD = 1.61), the arm-eye coordination group has a mean of 34.84 (SD = 1.52), and the control group has a mean of 22.84 (SD = 1.60). Across all groups, the corrected total mean is 30.63 (SD = 5.76).

The tests of between-subjects effects show a considerable effect size (partial eta squared =.928) and a very significant overall impact (p <.001). 92.8% of the variance in the forehand drive performance can be explained by the model, which also takes into account arm-eye coordination, sports vision training, and the control group.

Estimates provide mean values for each group, along with standard errors and 95% confidence intervals. The results show that both the arm-eye coordination group (M = 34.83, SE = 0.32) and the sports vision training group (M = 34.19, SE = 0.32) have significantly higher forehand drive scores compared to the control group (M = 22.86, SE = 0.32).

Pairwise comparisons further elaborate on the differences between groups. The arm-eye coordination group and the sports vision training group exhibit a non-significant mean difference (MD = 0.64, SE = 0.45), while both groups significantly outperform the control group (MD = 11.96 and 11.33, respectively, both $p < .001$). The control group significantly lags behind both the arm-eye coordination and sports vision training groups.

In conclusion, the ANCOVA results suggest that both arm-eye coordination and sports vision training significantly contribute to improved forehand drive performance in female table tennis players compared to a control group. These findings are robust, considering the large effect size and the significance of pairwise comparisons even after Bonferroni correction for multiple comparisons.

Table 4.9:*ANCOVA test showing the effects of arm-eye coordination and sports vision training (Placebo group) on Backhand serve of female table tennis players*

The score of drive reported total ball returned in one minutes
Backhand serve

Descriptive Statistics

Dependent Variable: Backhand Serve (Posttest)

Groups	Mean	Std. Deviation	N
Arm Eye coordination group	16.8000	1.47196	25
Sports Vision training group	16.1600	1.54596	25
Control Group	7.6000	1.19024	25
Total	13.5200	4.44595	75

Tests of Between-Subjects Effects

Dependent Variable: Backhand Serve (Posttest)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1321.933[a]	3	440.644	222.221	.000	.904
Intercept	251.140	1	251.140	126.652	.000	.641
BHSPre	2.573	1	2.573	1.298	.258	.018
Grp	1319.040	2	659.520	332.602	.000	.904
Error	140.787	71	1.983			
Total	15172.000	75				
Corrected Total	1462.720	74				

a. R Squared = .904 (Adjusted R Squared = .900)

Estimates

Dependent Variable: Backhand Serve (Posttest)

Groups	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Arm Eye coordination group	16.823[a]	.282	16.260	17.386
Sports Vision training group	16.160[a]	.282	15.598	16.722
Control Group	7.577[a]	.282	7.014	8.140

a. Covariates appearing in the model are evaluated at the following values: Backhand Serve (Pretest) = 7.8400.

Pairwise Comparisons

Dependent Variable: Backhand Serve (Posttest)

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
AECG	Sports Vision training group	.663	.399	.302	-.315	1.641
	Control Group	9.246*	.400	.000	8.265	10.228
SVTG	Arm Eye coordination group	-.663	.399	.302	-1.641	.315
	Control Group	8.583*	.399	.000	7.605	9.561
CG	Arm Eye coordination group	-9.246*	.400	.000	-10.228	-8.265
	Sports Vision training group	-8.583*	.399	.000	-9.561	-7.605

According to projected marginal means *. At the.05 level, there is a significant mean difference.
b. Adjustment for multiple comparisons: Bonferroni.

Table 4.9shows the findings of an ANCOVA test that looked at how sports vision training and arm-eye coordination affected the backhand serve performance of female table tennis players in the placebo group. The Backhand Serve score on the posttest is the dependent variable. The sample sizes, standard deviations, and mean scores for every group are displayed via the descriptive statistics.

The groups with Arm Eye Coordination scores (16.80), Sports Vision Training scores (16.16), and Control scores (7.60) had the highest mean Backhand Serve scores in the posttest. The ratings indicate a significant variation between the groups. The substantial Corrected Model (F = 222.221, p <.001) and high effect size (Partial Eta Squared =.904) suggest that the statistical analysis supports this discovery even more.

The Arm Eye Coordination group had the highest mean Backhand Serve score (16.823), followed by the Sports Vision Training group (16.160) and the Control group (7.577), according to the estimated marginal means. Significant differences between all groups are shown by the pairwise comparisons that are corrected for multiple comparisons using the Bonferroni adjustment. Interestingly, with mean differences of 9.246 and 8.583, respectively, the Arm Eye Coordination and Sports Vision Training groups both considerably outperform the Control group (p <.001). Additionally, the difference between the Arm Eye Coordination and Sports Vision Training groups is not significant (p = .302).The ANCOVA model includes covariates, with Backhand Serve (Pretest) set at a specific value (7.8400). The R-squared value of .904 suggests that the model explains a substantial proportion of the variance in the Backhand Serve scores.

The findings presented in Table 4.9 indicate that female table tennis players' Backhand Serve performance is significantly improved by both Arm Eye Coordination and Sports Vision Training when compared to the Control group. The research offers significant perspectives on how well various treatments work to improve particular table tennis skills.

Table 4.10:*ANCOVA test showing the effects of arm-eye coordination and sports vision training (Placebo group) on Forehand serveof female table tennis players*

The score of drive reported total ball returned in one minutes

Forehand serve

Descriptive Statistics

Dependent Variable: Forehand Serve (Posttest)

Groups	Mean	Std. Deviation	N
Arm Eye coordination group	17.1200	1.12990	25
Sports Vision training group	16.6400	.99499	25
Control Group	7.8400	1.14310	25
Total	13.8667	4.42760	75

Tests of Between-Subjects Effects

Dependent Variable: Forehand Serve (Posttest)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1364.913[a]	3	454.971	376.692	.000	.941
Intercept	410.683	1	410.683	340.024	.000	.827
FHSPre	.006	1	.006	.005	.945	.000
Grp	1347.015	2	673.507	557.629	.000	.940
Error	85.754	71	1.208			
Total	15872.000	75				
Corrected Total	1450.667	74				

a. R Squared = .941 (Adjusted R Squared = .938)

Estimates

Dependent Variable: Forehand Serve (Posttest)

Groups	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Arm Eye coordination group	17.121[a]	.220	16.682	17.560
Sports Vision training group	16.637[a]	.223	16.193	17.082
Control Group	7.842[a]	.221	7.401	8.282

a. Covariates appearing in the model are evaluated at the following values: Forehand Serve (Pretest) = 8.1200.

Pairwise Comparisons

Dependent Variable: Forehand Serve (Posttest)

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Arm Eye coordination group	Sports Vision training group	.484	.315	.388	-.289	1.256
	Control Group	9.279*	.311	.000	8.517	10.042
Sports Vision training group	Arm Eye coordination group	-.484	.315	.388	-1.256	.289
	Control Group	8.796*	.316	.000	8.020	9.572
Control Group	Arm Eye coordination group	-9.279*	.311	.000	-10.042	-8.517
	Sports Vision training group	-8.796*	.316	.000	-9.572	-8.020

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 4.10 provides the findings of an analysis of covariance (ANCOVA) test that looked at how sports vision training and arm-eye coordination affected the forehand serve performance of female table tennis players in the placebo group. The dependent variable is the Forehand Serve (Posttest), and the analysis comprises descriptive statistics, between-subjects effects, estimates, and pairwise comparisons.

Each group's mean, standard deviation, and sample size (N) are disclosed by the descriptive statistics. Forehand serve scores for the Arm Eye Coordination group are 17.12 on average with a 1.13 standard deviation, Sports Vision Training group scores 16.64 with a 0.99 standard deviation, and Control Group scores 7.84 with a 1.14 standard deviation. 13.87 is the average across all groups.

Information on the significance of the model is given in the between-subjects effects section. A significant influence of at least one predictor variable on the dependent variable is indicated by the corrected model's high significance ($F = 376.692$, $p < 0.001$). The model explains 94.1% of the variance in forehand serve scores, according to the partial eta squared (η^2) = 0.941.

Estimates for each group show mean scores, standard errors, and 95% confidence intervals. The confidence intervals indicate the range within which the true population means are likely to fall. For instance, the Arm Eye Coordination group has a mean of 17.12, with a 95% confidence interval from 16.682 to 17.56.

The pairwise comparisons provide insights into specific group differences. Significant differences are observed between all pairs: Arm Eye Coordination vs. Sports Vision Training (Mean Difference = 0.484, $p = 0.388$), Arm Eye Coordination vs. Control Group (Mean Difference = 9.279, $p < 0.001$), and Sports Vision Training vs. Control Group (Mean Difference = 8.796, $p < 0.001$). The significance level is adjusted for multiple comparisons using the Bonferroni method.

In conclusion, the ANCOVA results indicate a significant impact of arm-eye coordination and sports vision training on forehand serve performance among female table tennis players in the placebo group. The pairwise comparisons provide detailed insights into the specific group differences, emphasizing the importance of considering both arm-eye coordination and sports vision training in enhancing forehand serve skills.

DISCUSSION

The findings of this study provide compelling evidence supporting the notion that players' serve performance can significantly improve as a result of arm-eye coordination training. The observed enhancements in serve performance among participants who underwent arm-eye coordination training underscore the effectiveness of this intervention in targeting specific motor skills and enhancing precision in table tennis serves. The significant improvement in serve performance following arm-eye coordination training aligns with previous research demonstrating the beneficial effects of targeted training regimens on motor skill development. Fukuhara et al. (2022) conducted a systematic review highlighting the positive impact of arm-eye coordination training on motor skills across various sports disciplines. Their findings suggest that focused training interventions aimed at improving hand-eye coordination can lead to measurable improvements in performance outcomes, including serve accuracy and consistency. Moreover, the results of this study contribute to the growing body of literature supporting the role of perceptual-cognitive training in optimizing athletic performance. Sports vision training, which encompasses exercises designed to enhance visual-motor coordination and decision-making abilities, has been shown to yield significant improvements in performance across a range of sports contexts (Vater et al., 2021). While the present study specifically focused on arm-eye coordination training, it is plausible that the observed improvements in serve performance may also be attributed, in part, to enhancements in visual processing and decision-making skills.

The findings of this study provide robust support for the hypothesis that players' drive performance can be significantly improved through Arm-Eye coordination training. The observed enhancements in drive performance among participants who underwent this specific training regimen underscore the effectiveness of Arm-Eye coordination training in targeting and enhancing essential motor skills crucial for proficient drive execution in table tennis. The significant improvement in drive performance following Arm-Eye coordination training is consistent with existing literature emphasizing the positive impact of targeted training interventions on motor skill development. Fukuhara et al. (2022) conducted a comprehensive systematic review that highlighted the efficacy of Arm-Eye coordination training across various sports disciplines. Their findings suggest that focused training interventions aimed at improving hand-eye coordination and motor synchronization can lead to measurable enhancements in performance outcomes, including drive accuracy, speed, and consistency. Moreover, the results of this study contribute to the growing body of evidence supporting the role of perceptual-cognitive training in optimizing athletic performance. While the current study specifically focused on Arm-Eye coordination training, previous research has demonstrated the beneficial effects of perceptual-cognitive training interventions, including sports vision training, on enhancing decision-making abilities and anticipatory skills in athletes (Vater et al., 2021). It is plausible that the observed improvements in drive performance may also be attributed, in part, to enhancements in visual processing and anticipatory skills resulting from Arm-Eye coordination training.

The hypothesis that sports vision training will have a significant favorable impact on players' drive performance is supported by the findings of this study. The observed improvements in drive performance among participants who underwent sports vision training underscore the efficacy of this intervention in enhancing specific perceptual-cognitive skills and visual-motor coordination crucial for proficient drive execution in table tennis. The significant favorable impact of sports vision training on drive performance aligns with existing literature emphasizing the positive effects of perceptual-cognitive training interventions on athletic performance outcomes. Vater et al. (2021) conducted a meta-analysis that demonstrated the effectiveness of sports vision training in improving decision-making abilities, visual processing speed, and anticipatory skills in athletes across various sports disciplines. Their findings suggest that targeted sports vision training interventions offer a promising avenue for optimizing performance outcomes, including drive accuracy and consistency. Moreover, the results of this study contribute to the growing body of evidence supporting the importance of visual-motor coordination in drive performance in table tennis. While the current study specifically focused on sports vision training, previous research has highlighted the critical role of visual-motor coordination in proficient stroke execution and anticipation skills in table tennis players (Levitt et al., 2020). It is plausible that the observed improvements in drive performance following sports vision training may be attributed, in part, to enhancements in visual processing, anticipation, and decision-making abilities.

The hypothesis that players' serve performance will be significantly improved with Sports vision training is supported by the findings of this study. The observed enhancements in serve performance among participants who underwent Sports vision training highlight the efficacy of this intervention in targeting specific perceptual-cognitive skills and visual-motor coordination crucial for proficient serve execution in table tennis. The significant improvement in serve performance following Sports vision training is consistent with existing literature emphasizing the positive effects of perceptual-cognitive training interventions on athletic performance outcomes. Vater et al. (2021) conducted a meta-analysis that demonstrated the effectiveness of Sports vision training in improving decision-making abilities, visual processing speed, and anticipatory skills in athletes across various sports disciplines. Their findings suggest that targeted Sports vision training interventions offer a promising avenue for optimizing performance outcomes, including serve accuracy and consistency. Moreover, the results of this study contribute to the growing body of evidence supporting the importance of visual-motor coordination in serve performance in table tennis. While the current study specifically focused on Sports vision training, previous research has highlighted the critical role of visual-motor coordination in proficient stroke execution and anticipation skills in table tennis players (Levitt et al., 2020). It is plausible that the observed improvements in serve performance following Sports vision training may be attributed, in part, to enhancements in visual processing, anticipation, and decision-making abilities.

CONCLUSION

In this study, we investigated the effects of Arm-Eye Coordination training versus Sports Vision training on the drive and serve performance of table tennis players. Our findings provide valuable insights into the relative efficacy of these two training modalities in enhancing specific aspects of athletic performance in the context of table tennis. Overall, both Arm-Eye Coordination training and Sports Vision training demonstrated significant improvements in drive and serve performance among table tennis players. Participants who underwent Arm-Eye Coordination training showed enhanced motor skills and precision, leading to improved drive and serve performance. Similarly, participants who underwent Sports Vision training exhibited improvements in decision-making abilities, visual processing speed, and anticipatory skills, resulting in enhanced drive and serve performance. These findings underscore the importance of targeted training interventions in optimizing athletic performance outcomes. By focusing on specific aspects of motor skills, perceptual-cognitive abilities, and visual-motor coordination, both Arm-Eye Coordination is training and Sports Vision training offer valuable tools for enhancing drive and serve performance in table tennis players. It is important to note that individual differences in response to training interventions may exist, and further research is warranted to elucidate the underlying mechanisms and moderators influencing training outcomes. Additionally, longitudinal studies exploring the long-term effects of Arm-Eye Coordination training and Sports Vision training on performance sustainability are recommended. In conclusion, the results of this study highlight the effectiveness of both Arm-Eye Coordination training and Sports Vision training in improving drive and serve performance among table tennis players. Coaches and trainers can utilize these training modalities to tailor individualized training programs aimed at optimizing performance outcomes in table tennis players.

LIMITATIONS

One limitation of this study is the relatively small sample size. While we included 75 table tennis players, the generalizability of the findings may be limited. Future studies with larger and more diverse samples could provide further insights into the effects of Arm-Eye Coordination training and Sports Vision training on drive and serve performance across different populations and skill levels.

Another limitation is the relatively short duration of the intervention period, which was set at 10 weeks. While significant improvements in drive and serve performance were observed within this timeframe, longer-term follow-up studies could provide a more comprehensive understanding of the sustained effects of Arm-Eye Coordination training and Sports Vision training on performance outcomes. Future research could explore the optimal duration and intensity of training interventions to maximize performance gains over time.

FUTURE DIRECTIONS

Future research could further explore the comparative effectiveness of Arm-Eye Coordination training versus Sports Vision training in improving specific performance parameters in table tennis players. By conducting direct comparisons between these training modalities, researchers can elucidate the differential effects and underlying mechanisms contributing to performance enhancements, thus informing evidence-based coaching practices and player development strategies.

Additionally, future studies could investigate the potential benefits of individualized training approaches tailored to the unique needs and characteristics of table tennis players. By incorporating personalized training regimens based on players' baseline skill levels, perceptual-cognitive abilities, and motor coordination profiles, researchers can optimize the effectiveness of Arm-Eye Coordination training and Sports Vision training in maximizing performance outcomes and facilitating skill transfer to competitive settings.

Addressing these limitations and exploring future directions can further advance our understanding of the effects of Arm-Eye Coordination training and Sports Vision training on drive and serve performance in table tennis players, ultimately enhancing coaching practices and player development programs in the sport.

PRACTICAL IMPLICATIONS

The findings of this study have practical implications for coaches, trainers, and sports practitioners involved in the development of table tennis players. By incorporating both Arm-Eye Coordination training and Sports Vision training into training programs, coaches can design more comprehensive and effective training regimens aimed at improving drive and serve performance. This integrated approach allows for the targeting of specific motor skills, perceptual-cognitive abilities, and visual-motor coordination essential for proficient performance in table tennis.

Furthermore, the results of this study highlight the importance of individualized coaching strategies in optimizing player development and performance outcomes. Coaches and trainers can assess players' baseline skill levels, perceptual-cognitive abilities, and motor coordination profiles to tailor training interventions to their unique needs and characteristics. By identifying areas of improvement and implementing targeted training interventions, coaches can maximize the effectiveness of Arm-Eye Coordination training and Sports Vision training in enhancing drive and serve performance among table tennis players.

Incorporating both Arm-Eye Coordination training and Sports Vision training into coaching practices and player development programs can lead to more holistic and tailored approaches to skill enhancement in table tennis. By addressing both motor and perceptual-cognitive aspects of performance, coaches can optimize player development and facilitate skill transfer to competitive settings, ultimately enhancing overall performance outcomes in the sport.

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