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Effects of Combined Cognitive and Strength Training on Jump Shot Ability for Basketball Youth Athletes

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Abstract

Background and Aim: The integration of cognitive ability and strength training to enhance basketball shooting performance was a multifaceted approach that combines physical and cognitive ability. The research objective of this study was to examine the effects of combined cognitive and strength training on basketball jump shot ability for youth athletes and to compare the effects of the training program on basketball jump shot ability between the control and experimental groups.

Materials and Methods: This study was quasi-experimental research in simple random sampling of 40 youth basketball players, with systematic sampling based on jump shot ability, and divided into 10 participants in experimental and control groups. The combined cognitive and strength training was carried out with the experimental group, with an eight-week training duration, three days per week, while the control group followed the traditional training. Pre-tests were conducted to assess sample characteristics, jump shot ability, cognitive capacity, and strength test, followed by a training program, mid-test, and post-test. The data was analyzed using mean, t-test, one-way ANOVA, and Bonferroni post hoc, with significance set at $p < .05$.

Results: The results found that the mean comparison of jump shot ability, cognitive ability, and strength between experimental and control groups was significant difference (*p<.05). On the other hand, the mean compared within the experimental group's jump shot ability, cognitive, and strength of all pairwise were significant differences pretest, mid test and posttest (*p<.05).

Conclusion: The combined cognitive and strength training could improve the basketball jump shot ability for basketball youth athletes.

Keywords: Cognitive Training; Strength Training; Jump Shot Ability; Youth Basketball Athletes

Introduction

Winning a basketball competition was influenced by a variety of factors, as highlighted by multiple studies. At the NBA level, key determinants include field goal percentage and defensive rebounding, which significantly differentiate between winning and losing outcomes, accounting for a substantial portion of the variance in game results during both regular and postseason periods (Cabarkapa et al., 2022). Oliver's Four Factors shooting, turnovers, rebounding, and free throws were also critical, with model-based recursive partitioning showing these elements as pivotal in determining a team's success (Migliorati et al., 2022). In the context of 3x3 basketball, teamwork and technical execution, such as a high three-point shooting percentage, effective pick and roll assists, and strong rebounding, were essential for victory, as demonstrated by Latvia's success in the Tokyo Olympics (Li, X., & Phucharoen, 2024). Additionally, the competitive activity structure of highly skilled players reveals that successful teams often engage in longer attacking actions to optimize shooting positions, emphasizing the importance of tactical execution (Yatskovskyy et al., 2022).

In the development of China's youth basketball athletes, the field goal was a critical factor that could be enhanced through various training methodologies and considerations. Training methods that focus on improving shooting success percentages were essential, as they incorporate elements such as physical fitness, coordination, and psychological focus, which have been shown to significantly enhance shooting performance under both static and dynamic conditions (Cong, J., & Endozo, 2022). Additionally, cognitive tools like video feedback and questioning could improve decision-making and skill execution, which are crucial for developing sport expertise in young players (Gil-Arias et al., 2019). Visual strategies also play a significant role; youth players could benefit from focusing their attention on longer final fixations before releasing the ball, as this has been shown to improve shooting accuracy (Marques et al., 2023). Furthermore, the impact of biological maturation and training experience is significant, with early maturers often

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displaying superior physical and technical skills, including shooting, due to their advanced physical development (Guimarães et al., 2019). Finally, the relationship between lower-limb power, agility, and sprinting is crucial, as players with better single-leg jump outputs tend to have superior sprint and agility performances, which could indirectly influence shooting success by improving overall athleticism (Pamuk et al., 2023).

Research on training brain skills to enhance basketball players' abilities in perception, prediction, decision-making, and shooting has shown mixed results, with some promising yet inconclusive findings. The NeuroTracker 3D MOT training has been shown to significantly improve concentration among basketball athletes, although it does not significantly enhance game performance compared to conventional training methods (Komarudin et al., 2021). Meanwhile, noninvasive transcranial electrical stimulation (tES) has been explored as a method to boost cognitive functions such as decision-making and attention in sports, but the evidence remains insufficient to confirm its effectiveness as a standalone ergogenic aid (Perrey, 2023). A study integrating cognitive-motor dual-task training (CMDT) within a multi-component training (MCT) for elite basketball players demonstrated improvements in both physical performance and decision-making speed, suggesting that cognitive components could enhance training outcomes beyond physical exercises alone (Lucia et al., 2023). Additionally, high-definition transcranial direct current stimulation (HD-tDCS) has been found to alter brain activity in professional female basketball players, particularly benefiting those with less stable free-throw shooting performance, indicating potential for targeted cognitive enhancement (Moscaleski et al., 2022). While video-based training (VBT) has been effective in improving anticipation and decision-making skills in football players, its application in basketball remains underexplored, and further research is needed to assess its potential benefits in this context (Zhao et al., 2022).

From the above, the researcher had a question to prove whether cognitive training could improve basketball players' jumping and shooting skills. Therefore, the researcher was interested in conducting a study on the effect of combined mental and strength training on jump shot ability in youth basketball athletes.

Objectives

The objective of this study is as follows:

1. To study the effects of combined cognitive and strength training on basketball Jump shot ability for youth athletes.

2. To compare the effects of a combined cognitive and strength training on Jump shot basketball ability for youth athletes between the control and experimental group.

3. To construct a combined cognitive and strength training on basketball Jump shot ability for youth athletes.

Literature review

Basketball jump shot ability: The ability to execute an effective jump shot in basketball is influenced by physiological, biomechanical, and psychological factors. Physiologically, maintaining an optimal heart rate is crucial, as higher rates could diminish accuracy, emphasizing the need for rest during game pauses (Zeng et al., 2023). Biomechanically, shot accuracy is affected by distance from the basket, necessitating adjustments in release height and angle, which could complicate execution (Marques et al., 2023). Kinematic variables, such as shoulder rotation and body alignment, further impact performance, particularly in longer shots (Shalom et al., 2023). Psychologically, the quiet eye technique, characterized by longer fixation durations, correlates with improved shooting accuracy, highlighting the importance of visual training (Marques et al., 2023). Additionally, structured training regimens, including block periodization, enhance jump shot capabilities by optimizing physical conditioning and explosive power (Lucia et al., 2023b; Shalom et al., 2023). Thus, a multifaceted approach integrating these elements is essential for optimizing jump shot performance in basketball.

Cognitive ability: Cognitive abilities significantly influence basketball shooting performance, as evidenced by various studies. Research indicates that perceptive analysis and logical conclusions are particularly impactful, showing a significant correlation with the shooting efficiency of professional basketball players (Jakovljević et al., 2015; Jakovljević et al., 2016). Reasoning ability also plays a crucial role, with female players exhibiting superior reasoning skills, demonstrating better field goal shooting performance compared to those with lower reasoning abilities (Singh & Agashe, 2014). Similarly,

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intellectual intelligence is positively correlated with free-throw shooting ability among high school students, suggesting that higher cognitive capabilities enhance shooting accuracy (Nur & Pradana, 2020). Working memory capacity (WMC) was another cognitive factor affecting shooting behavior; individuals with higher WMC tend to make fewer shooting errors and perform better in shooting tasks (Brewer et al., 2016). Mental arrangement in cognitive processes is essential for executing accurate shots, particularly in dynamic game situations, as it helps players process information effectively and respond with precision (Kumar & Amer, 2024). Cognitive strategies, such as visualization and relaxation, have been shown to improve free-throw performance, highlighting the importance of mental preparation in shooting tasks (Kearns & Crossman, 1992). However, mental fatigue could negatively impact shooting performance, as demonstrated by decreased shooting accuracy following cognitively demanding tasks (Daub et al., 2022). These findings underscore the importance of developing cognitive skills alongside physical training to enhance basketball shooting performance.

Strength training: Strength training to improve basketball shooting ability involves a multifaceted approach that integrates various training modalities to enhance physical attributes and skill performance. Core stability and neuromuscular control were crucial, as they contribute to efficient functional movements specific to basketball, although the direct translation to improved shooting performance remains under-researched (Zemková & Zapletalová, 2022). Creatine monohydrate supplementation combined with strength and conditioning training, including resistance and plyometric exercises, has been shown to enhance lower-limb power and scoring performance in young basketball players, suggesting a potential benefit for shooting ability (Vargas-Molina et al., 2022). Functional training (FT) also plays a significant role, improving muscle strength, balance, and endurance, which are essential for maintaining shooting accuracy under varying game conditions (Cao et al., 2024). Velocity-based resistance training (VBRT) has been found to enhance power and athletic performance, which could indirectly support shooting by improving overall physical capabilities (Zhang et al., 2023). Additionally, incorporating high-intensity sport-specific drills could help maintain shooting accuracy during high exertion, as expert players demonstrate better performance under such conditions (Marcolin et al., 2018). While isoinertial eccentric-overload training has shown benefits in other sports, its direct application to basketball shooting requires further exploration (Fiorilli et al., 2020). A combination of core stability exercises, resistance and plyometric training, and sport-specific drills, possibly supplemented with creatine, appears to be effective in enhancing the physical attributes that support improved basketball shooting performance.

Combining cognitive and strength training: Combining cognitive and strength training to enhance basketball shooting ability involves integrating cognitive tasks with physical exercises to improve both mental and physical aspects of performance. Research indicates that dual-task training, which involves simultaneous cognitive and physical exercises, could enhance cognitive functions such as decision-making and attention, which were crucial for basketball shooting (Lauenroth et al., 2016; Eggenberger et al., 2015). For instance, incorporating decision training programs that use video feedback and questioning could improve decision-making and skill execution in basketball players, suggesting that cognitive tools could enhance sport expertise (Gil-Arias et al., 2019). Additionally, functional training that mimics real-life activities, including basketball shooting, could be optimized by incorporating cognitive factors such as mental effort and attention, which were essential for motor learning and control (Ives & Shelley, 2003). Studies had shown that cognitive-physical training could lead to improvements in executive functions, such as shifting attention and working memory, which were beneficial for sports performance (Eggenberger et al., 2015). Moreover, the integration of cognitive and physical training has been shown to have greater positive outcomes than single training modes, suggesting that a combined approach could lead to better cognitive and physical fitness (Chow et al., 2022). This approach is supported by evidence that cognitive-motor interventions could improve physical functions, such as postural control and coordination, which were vital for effective shooting in basketball (Pichierri et al., 2011). Therefore, a training regimen that combines cognitive tasks, such as decision-making exercises, with strength training tailored to basketball-specific movements could potentially enhance shooting ability by improving both the cognitive and physical components of the skill.

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Conceptual Framework

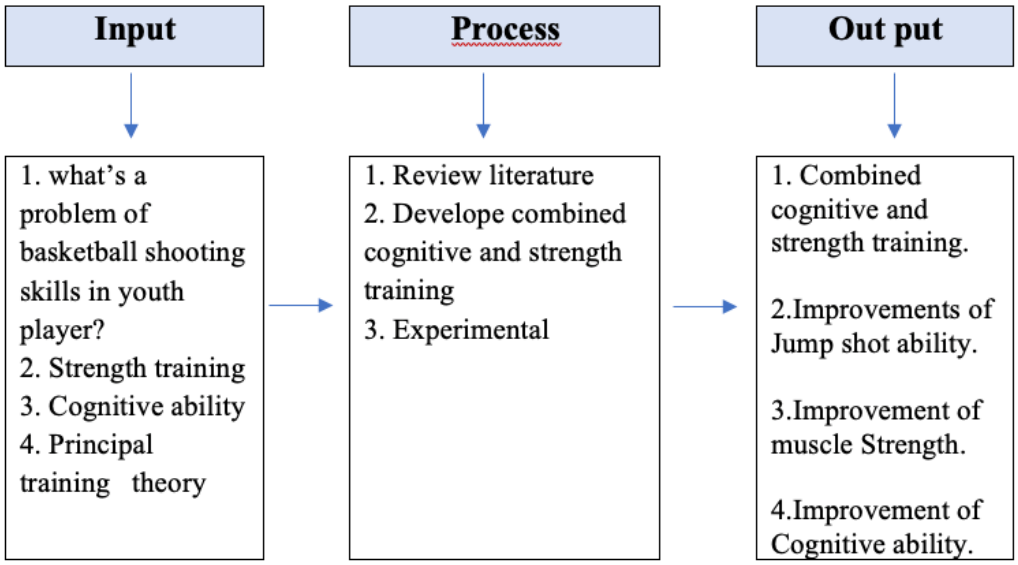

Figure 1 Conceptual Framework

Methodology

This study was quasi-experimental research that was approved by a research ethic in human by BTU Research Ethics Committee in 73/2567 on 1 May 2567. This research was conducted following a research methodology such as;

Population and sample

Population: This study involved 60 male basketball players in the academic year 2024 from Dongguan No. 4 Senior High School, Zhongtang Town, Dongguan City, Guangdong Province, China.

The sample was a simple random sampling of 20 male basketball players from Dongguan No. 4 Senior High School, then systematic sampling into two groups based on jump shot performance and slot method training in experimental and control groups, each with 10 people in each group.

A researcher examined the power of the test by G*power. Hu Junjia (2023) conducted an experimental study on the effect of core strength training on the shooting skills of teenagers. The standard for comparing the posttest results was between 6.90±0.57 and 8.20±0.63, with an effect size of -2.164, an error probability (α) of 0.05, power (1-β) of 0.729, and an allocation ratio (N2/N1) of 1. According to the sample size calculation by G*Power, a sample size of 4 was determined to be appropriate. Therefore, a sample size of 10 participants was considered suitable.

Inclusion criteria:

1. They were the students in Dongguan No. 4 Senior High School, basketball club, academic year 2024.
2. They were not injured and must be approved by a doctor.
3. In order to participate in the study, they must willingly sign a consent form.

Exclusion Criteria:

1. Participated in less than 80% of the 8-week experiment.
2. They were not thoroughly investigated; the researcher's dedication.
3. They were injured and unable to work out.
4. They request to exit the study project.

Research Design

This study was quasi-experimental research that invention on basketball players with systematic sampling under jump shot ability and divided into experimental and control groups.

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Control group	O_1	T_1	O_3	T_1	O_5
Experimental group	O_2	T_2	O_4	T_2	O_6

Note; O_1: pretest of the control group, O_2: pretest of the experimental group, O_3: Control group posttest after four weeks of regular training, O_4: Test of the experimental group after four weeks of combined cognitive and strength training, O_5: Test after regular training of the control group, O_6: Test after cognitive and strength training of the experimental group, T_1: Training program of control group, and T_2: Combined cognitive and strength training of experimental group.

Research Instrument

Instruments in this research were such as:

1. The combined cognitive and strength training to improve jump shot ability for basketball youth athletes that developed by researchers who combined the strength and cognitive training and specific training for 8 weeks of training duration, 3 days for once week. The content validity of training was IOC with 3 experts, and IOC was 1-0.88. The appropriate training intensity was conducted with a tryout of 3, 5 samples.

2. Strength test was followed as 1-RM bench press test, Plank test, and 1-RM Leg press test (Seo et al., 2012).

3. The cognitive ability battery test consisted simple reaction time test, a choice reaction time, trail making, flanker, design fluency, mental rotation, and spatial visualization (Department of Physical Education, 2020).

Data collection

The researchers had conducted the data collection process as follows:

1. Invite participants to collect basic information and data, and introduce the process of the experiment.
2. Collect participants' pre-test data.
3. Collect test data during the experiment
4. Collect data after four weeks of training and after completing the experimental
5. Systematically process data, analyze it, and write reports

Data Analysis

The researchers had analyzed the collected data statistically as follows:

1. The mean and standard deviation
2. Mean comparison between groups with a t-test for independent groups
3. Mean comparison within experimental group, Pre-test, after week 4, and post-test with one-way ANOVA repeated measurement, pairwise, post hoc with Bonferroni.
4. Significant differences between were set at $p < .05$.

Results

The findings of the study to answer the research hypothesis were as follows:

1. After training, the basketball jump shooting ability between the experimental and control groups showed a significant difference.
2. The basketball jump shot ability within experimental groups showed a significant difference Between pretest, midtest, and posttest training.

Table 1 The mean and standard deviation of the Basketball Jump shot test of the experimental and control groups.

Variables	Expr. G (n=10)			Cont. G (n=10)		
	pretest	Mid test	Post test	pretest	Mid test	Post test
	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD
Free throw line jump shot (score)	5.20±0.79	6.30±0.82	8.80±0.79	5.10±0.74	6.00±0.74	7.30±0.48
45-degree jump shot from the left side (score)	4.90±0.74	6.90±0.74	8.90±0.74	5.20±0.79	6.00±0.79	6.80±0.63

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Variables	Expr. G (n=10)			Cont. G (n=10)		
	pretest	Mid test	Post test	pretest	Mid test	Post test
	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD
45-degree jump shot from the right side (score)	4.90±0.74	7.40±0.51	9.30±0.67	5.10±0.74	5.90±0.67	7.00±0.67

Table 1 shows the shooting ability, pretest, midtest, and posttest.

Experimental group: free throw line jump shot (5.20±0.79, 6.30±0.82, and 8.80±0.79), 45-degree jump shot of the left side (4.90±0.74, 04.54±0:43, and 8.90±0.74), and 45-degree jump shot of the right side (4.90±0.74, 7.40±0.5, and 9.30±0.67).

Control group: Free throw line jump shot (5.10±0.74, 6.00±0.74, and 7.30±0.48), 45-degree jump shot of the left side (5.20±0.79, 6.00±0.79, and 6.80±0.63), and 45-degree jump shot of the right side (5.10±0.74, 5.90±0.67, and 7.00±0.67).

Table 2 Mean comparison between the experiment and control groups with the posttest of the basketball jump shot test with a t-test for independent groups.

Variables	Expr. G	Cont. G	95% Confidence Interval of the Difference		t	p
	M+ SD	M+ SD	lower	Upper		
Free throw line jump shot	8.80±0.79	7.30±0.48	0.89	2.11	5.13	.05*
45-degree jump shot from the left side	8.90±0.74	6.80±0.63	1.45	2.75	6.83	.05*
45-degree jump shot from the right side	9.30±0.67	7.00±0.67	1.67	2.93	7.67	.05*

*P<.05

Table 2 showed that all of the variables pairwise showed a significant difference (*P<.05).

Table 3 The mean and standard deviation of the cognitive ability test of the experimental and control groups Groups.

Variable	Expr. G (n=10)			Cont. G (n=10)		
	Pre test	Mid test	Post test	Pre test	Mid test	Post test
	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD
Simple reaction time test (ms)	366.00±14.30	337.00±13.37	271.00±15.95	365.00±10.80	355.00±10.80	345.00±10.80
Choice reaction time test (ms)	415.00±12.69	376.00±14.30	308.00±15.23	415.00±10.80	405.00±10.80	383.00±11.60
Trail making test (score)	57.00±3.73	47.80±1.03	36.80±1.30	57.20±2.99	47.70±1.89	42.05±1.96
Flanker test (score)	534.50±57.94	425.75±4.57	335.25±12.12	540.50±51.99	490.00±113.92	322.00±27.70
Design fluency test (score)	5.70±1.34	14.50±0.71	22.40±2.12	6.90±1.45	9.20±1.55	20.90±1.45
Mental rotation test (score)	4.10±0.88	9.10±0.88	22.80±2.57	5.80±1.23	5.20±0.79	18.10±0.74
Spatial visualization test (score)	14.00±1.25	17.00±1.05	19.80±0.79	16.70±1.49	16.70±1.49	16.10±0.99

Table 3 shows that the cognitive ability test, pretest mid midtest, and posttest follow as,

Experimental group: Simple reaction time (415.00±12.69, 337.00±13.37, and 271.00±15.95), choice reaction time test (366.00±14.30, 376.00±14.30, and 308.00±15.23), trail making test (57.00±3.73, 47.80±1.03, and 36.80±1.30), flanker test (534.50±57.94 , 425.75±4.57, and 335.25±12.12), design fluency

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test (5.70±1.34, 14.50±0.71, and 22.40±2.12), mental rotation test (4.10±0.88, 9.10±0.88, and 22.80±2.57), and spatial visualization test (14.00±1.25, 17.00±1.05, and 19.80±0.79).

Control group: Simple reaction time test (365.00±10.80, 355.00±10.80, and 345.00±10.80), choice reaction time test (415.00±10.80, 405.00±10.80, and 383.00±11.60), trail making test (57.20±2.99, 47.70±1.89, and 42.05±1.96), flanker test (540.50±51.99, 490.00±113.92, and 322.00±27.70), design fluency test (6.90±1.45, 9.20±1.55, and 20.90±1.45). mental rotation test (5.80±1.23, 5.20±0.79, and 18.10±0.74), and spatial visualization test (16.70±1.49, 16.70±1.49, and 16.10±0.99).

Table 4 Mean comparison between the experimental and control groups with the pretest of the cognitive ability test, with a t-test for independent groups.

Variables	Expr. G	Cont. G	95% Confidence Interval of the Difference		t	p
	M+ SD	M+ SD	lower	Upper		
Simple reaction time	366.00±14.30	365.00±10.80	-10.91	12.91	0.18	0.28
Choice reaction time	415.00±12.69	415.00±10.80	-11.07	11.07	0.00	0.40
Trail making	57.00±3.73	57.20±2.99	-3.38	2.98	-0.13	0.31
Flanker	534.50±57.94	540.50±51.99	-57.72	45.72	-0.24	0.56
Design fluency	5.70±1.34	6.90±1.45	-2.51	0.11	-1.92	0.79
Mental rotation	4.10±0.88	5.80±1.23	-2.70	-0.70	-3.56	0.59
Spatial visualization	14.00±1.25	16.70±1.49	-3.99	-1.41	-4.39	0.65

*P<.05

Table 4 showed that all of the variables pairwise showed no significant difference.

Table 5 Mean comparison between the experimental and control groups with the posttest of the cognitive with a t-test for independent groups.

Variables	Expr. G	Cont. G	95%Confidence Interval of the Difference		t	p
	M+ SD	M+ SD	lower	Upper		
Simple reaction time	271.00±15.95	345.00±10.80	-86.80	-61.20	-12.15	.05*
Choice reaction time	308.00±15.23	383.00±11.60	-87.72	-62.28	-12.39	.05*
Trail making	36.80±1.30	42.05±1.96	-6.81	-3.69	-7.06	.05*
Flanker	335.25±12.12	322.00±27.70	-6.83	33.34	1.39	.05*
Design fluency	22.40±2.19	20.90±1.45	3.21	0.21	-1.85	.05*
Mental rotation	22.80±2.57	18.10±0.74	6.48	2.92	-5.55	.05*
Spatial visualization	19.80±0.79	16.10±0.99	2.86	4.54	9.22	.05*

*P<.05

Table 5 showed that all of the variables had significant pairwise differences (*p<.05).

Table 6 The mean and standard deviation of strength tests for the experimental and control group

Variables	Expr. G (n=10)			Cont. G (n=10)		
	Pretest	Mid test	Post test	Post test	Mid test	Posttest
	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD	M+ SD
1-RM bench press test(kg)	59.00±8.76	59.00±8.76	65.00±7.32	59.00±7.38	63.00±7.32	69.40±8.17
Plank test (min)	03:56±00:41	03:56±00:41	04:54±00:43	04:07±00:31	04:30±00:30	05:40±00:42
1-RM Leg press test(kg)	134.00±9.66	134.00±9.66	149.90±12.76	123.00±14.18	130.00±10.36	141.90±14.20

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From table 6 showed that: the strength test, pretest, mid test and posttest, Experimental group: 1-RM bench press test (59.00±8.76, 65.00±7.32, and 81.50±8.83), Plank test (03:56±00:41, 04:54±00:43, and 06:31±00:23) and 1-RM Leg press test (134.00±9.66 in the pretest, 149.90±12.76, and 154.00±13.02).

Control group: 1-RM bench press test (59.00±7.38, 63.00±7.32, and 69.40±8.17), plank test (04:07±00:31, 04:30±00:30, and 05:40±00:42), and 1-RM leg press test (130.00±10.36, 130.00±10.36, and 141.90±14.20).

Table 7 Mean comparison between the experiment and control groups with the pretest of the strength test, with a t-test for independent samples.

Variables	Expr. G	Cont. G	95% Confidence Interval of the Difference		t	p
	M+ SD	M+ SD	lower	Upper		
1-RM bench press (kg)	59.00±8.76	59.00±7.38	-7.61	7.60	0.00	1.00
Plank test (min)	03:56±00:41	04:07±00:31	-1.55	00:23	-0.65	0.52
1-RM Leg press (kg)	134.00±9.66	123.00±14.18	-0.40	22.40	2.03	0.06

*P<.05

Table 7 showed that all of the variables strength test showed no significant difference.

Table 8 Mean comparison between the experiment and control groups with the posttest of the strength test, with a t-test for independent groups.

Variables	Expr. G	Cont. G	95% Confidence Interval of the Difference		t	p
	M+ SD	M+ SD	lower	Upper		
1-RM bench press (kg)	81.50±8.83	69.40±8.17	20.09	4.10	3.18	.04*
Plank test (min)	06:31± 0:23	05:40± 0:42	00:18	01:22	3.30	.05*
1-RM Leg press (kg)	154.00±13.02	141.90±14.20	0.30	25.30	2.05	.04*

*P<.05

Table 8 showed that all of the variables strength test showed a significant difference (*P<.05).

Table 9 Mean comparison of basketball jump shooting ability within the experimental group by using one-way ANOVA repeated measurement and Bonferroni post hoc.

Dependent variables	Test		Bonferroni Mean Difference	Std. Error	p	M+SD	F	p
Free throw line jump shot	Pre test	Mid test	-1.10	0.31	.05*	5.20±0.79		
		Post test	-3.60	0.31	.05*			
	Mid test	Pre test	1.10	0.31	.05*	6.30±0.82		
		Post test	-2.50	0.22	.05*		1232.16	.05*
	Post test	Pre test	3.60	0.31	.05*	8.80±0.79		
		Mid test	2.50	0.22	.05*			
45-degree jump shot from the left side	Pre test	Mid test	-2.00	0.21	.05*	4.90±0.74		
		Post test	-4.00	0.26	.05*			
	Mid test	Pre test	2.00	0.21	.05*	6.90±0.74		
		Post test	-2.00	0.26	.05*		1372.39	.05*
	Post test	Pre test	4.00	0.26	.05*	8.90±0.74		
		Mid test	2.00	0.26	.05*			
	Pre test	Mid test	-2.50	0.31	.05*	4.90±0.74		
		Post test	-4.40	0.27	.05*		2916.00	

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Dependent variables	Test		Bonferroni Mean Difference	Std. Error	p	M+SD	F	p
45-degree jump shot from the right side	Mid test	Pre test	2.50	0.31	.05*	7.40±0.51		
		Post test	-1.90	0.23	.05*			.05*
	Post test	Pre test	4.40	0.27	.05*	9.30±0.67		
		Mid test	1.90	0.23	.05*			

*P<.05

Table 9 showed that all Jump shooting ability within the experimental group had a significant difference (*p<.05) between pretest-mid test, and posttest.

Table 10 Mean comparison of cognitive ability test within experimental group with one-way ANOVA repeated measurement and Bonferroni post hoc, between pretest, midtest, and posttest.

Dependent variables	Test		Bonferroni Mean Difference	Std. Error	p	M+SD	F	P
Simple reaction time	Pre test	Mid test	29.00	1.00	.05*	366.00±14.30	7091.43	.05*
		Post test	95.00	5.22	.05*			
	Mid test	Pre test	-29.00	1.00	.05*	337.00±13.37		
		Post test	66.00	5.42	.05*			
	Post test	Pre test	-95.00	5.22	.05*	271.00±15.95		
		Mid test	-66.00	5.42	.05*			
Choice reaction time	Pre test	Mid test	39.00	1.00	.05*	415.00±12.69	9812.43	.05*
		Post test	107.00	4.90	.05*			
	Mid test	Pre test	-39.00	1.00	.05*	376.00±14.30		
		Post test	68.00	5.59	.05*			
	Post test	Pre test	-107.00	4.90	.05*	308.00±15.23		
		Mid test	-68.00	5.59	.05*			
Trail making	Pre test	Mid test	9.20	0.87	.05*	534.50±57.94	10590.09	.05*
		Post test	20.20	1.39	.05*			
	Mid test	Pre test	-9.20	0.87	.05*	425.75±4.57		
		Post test	11.00	0.64	.05*			
	Post test	Pre test	-20.20	1.39	.05*	335.25±12.12		
		Mid test	-11.00	0.64	.05*			
Flanker	Pre test	Mid test	108.75	16.97	.05*	534.50±57.94	4556.73	.05*
		Post test	199.25	19.52	.05*			
	Mid test	Pre test	-108.75	16.97	.05*	425.75±4.57		
		Post test	90.50	4.52	.05*			
	Post test	Pre test	-199.25	19.52	.05*	335.25±12.12		
		Mid test	-90.50	4.52	.05*			
Design fluency	Pre test	Mid test	-8.80	0.55	.05*	5.70±1.34	4920.03	.05*
		Post test	-15.20	0.53	.05*			
	Mid test	Pre test	8.80	0.55	.05*	14.50±0.71		
		Post test	-6.40	0.62	.05*			
	Post test	Pre test	15.20	0.53	.05*	22.40±2.12		
		Mid test	6.40	0.62	.05*			
Mental rotation	Pre test	Mid test	-5.00	0.00	.05*	4.10±0.88	1833.10	.05*
		Post test	-14.00	0.21	.05*			
	Mid test	Pre test	5.00	0.00	.05*	9.10±0.88		
		Post test	-9.00	0.21	.05*			
	Post test	Pre test	14.00	0.21	.05*	22.80±2.57		
		Mid test	9.00	0.21	.05*			
Spatial visualization test	Pre test	Mid test	-3.00	0.33	.05*	14.00±1.25		
		Post test	-5.80	0.33	.05*			
	Mid test	Pre test	3.00	0.33	.05*	17.00±1.05		
		Post test	-2.80	0.20	.05*			

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Dependent variables	Test		Bonferroni Mean Difference	Std. Error	p	M+SD	F	P
	Post test	Pre test	5.80	0.33	.05*	19.80±0.79	3540.51	.05*
		Mid test	2.80	0.20	.05*			

*P<.05

Table 10 showed that all variables pairwise within the experimental group showed a significant difference (*p<.05).

Table 11 Mean comparison of strength test within experimental group with one-way ANOVA repeated. Measurement and Bonferroni post hoc, pretest, mid-test, and posttest.

Dependent variables	Test		Bonferroni Mean Difference	Std. Error	p	M+SD	F	p
1-RM bench Press test	Pre test	Mid test	-6.00	1.30	.05*	59.00±8.76	684.71	.05*
		Post test	-10.40	1.57	.05*			
	Mid test	Pre test	6.00	1.30	.05*	65.00±7.32		
		Post test	-4.40	0.54	.05*			
	Post test	Pre test	10.40	1.57	.05*	81.50±8.83		
		Mid test	4.40	0.54	.05*			
Plank test	Pre test	Mid test	-58.40	3.70	.05*	03:56±00:41	909.22	.05*
		Post test	-154.70	12.35	.05*			
	Mid test	Pre test	58.40	3.70	.05*	04:54±00:430		
		Post test	-96.30	12.17	.05*			
	Post test	Pre test	154.70	12.35	.05*	06:31±00:23		
		Mid test	96.30	12.17	.05*			
1-RM Leg Press Test	Pre test	Mid test	-15.90	4.00	.05*	134.00±9.66	2040.77	.05*
		Post test	-20.40	4.16	.05*			
	Mid test	Pre test	15.90	4.00	.05*	149.90±12.76		
		Post test	-4.50	0.54	.05*			
	Post test	Pre test	20.40	4.16	.05*	154.00±13.02		
		Mid test	4.50	0.54	.05*			

*P<.05

Table 11 showed that the strength test within the experimental group showed a significant difference (*p<.05).

Discussion

The summary result found that the basketball jump shot ability of the experimental group was better than the control group, and within the experimental group, post-training was better than pre-training.

The findings across multiple studies indicate that cognitive training significantly enhances basketball jump shot ability compared to traditional training methods. For instance, a study demonstrated that integrating cognitive-motor dual-task training (CMDT) within a multi-component training framework improved both physical performance and decision-making speed in elite players, suggesting that cognitive engagement could enhance motor skills like shooting (Lucia et al., 2023a). Similarly, another study found that balance training, which incorporates cognitive elements, led to a notable increase in shooting accuracy among basketball players, with a 53.04% improvement in shooting rates (Jing, 2023). Furthermore, cognitive-motor training has been shown to enhance dribbling and cognitive performance, reinforcing the idea that cognitive training could lead to better overall athletic performance (Lucia et al., 2023b).

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Collectively, these studies support the conclusion that cognitive training positively influences basketball shooting skills, outperforming conventional training approaches (Oktaviasari, 2020).

There was also strength training involved, which strength training, particularly through plyometric and resistance training, significantly enhances basketball jump shot ability. Radenković, et al. (2022) demonstrated that a combination of plyometric and shooting training improved vertical jump performance metrics in young male basketball players, with the experimental group showing marked enhancements compared to the control group Similarly, Chotemiya, et al. (2021) found that resistance training effectively increased explosive power among basketball players, which was crucial for jump shot performance. Collectively, these studies underscore the positive impact of strength training on basketball performance, particularly in enhancing jump shot capabilities (Corte et al., 2020).

The research indicates that a combined cognitive and strength training program significantly enhances basketball jump shot ability, as evidenced by notable differences in performance across pretest, midtest, and post-test assessments. For instance, a study demonstrated that an experimental program focusing on explosive strength led to substantial improvements in lower limb power, crucial for jump performance, with significant differences observed between experimental and control groups (Radulović et al., 2022). Additionally, core training was shown to positively impact vertical jump performance in basketball players, further supporting the notion that targeted training could yield measurable benefits (Şahiner & Koca, 2021). Moreover, cognitive training methods had been linked to improved coordination and reaction times, which were essential for executing effective jump shots in basketball (Kozina & Zaichenko, 2022). Collectively, these findings underscore the importance of integrating cognitive and strength training to optimize athletic performance in basketball.

Conclusion

The researchers concluded that combining cognitive and strength training, along with specific instruction, could improve jump shot ability in young basketball players. They found that the experimental group, which received the combined training, had better jump shot ability than the control group, which received traditional training. Within the experimental group, jump shot ability was significantly improved after training compared to before training. The researchers recommend that cognitive and strength training should be integrated and linked to basketball skills. They also suggest that training involving the nervous system or brain should be done before strength and endurance training.

Recommendation

Suggestions of this study

1. Cognitive ability training and strength training should be designed to be integrated and linked to basketball skills.
2. Training involving the nervous system or brain should be designed before strength and endurance training.

Suggestion for future research

1. The relationship between cognitive ability and team play skills in basketball should be studied.
2. A study should be conducted on the appropriate cognitive ability training model for youth basketball.

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