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RESEARCH ARTICLE

The Effect of Small-Sided Games Training on Cognitive Intelligence and Basic Skills of Junior Volleyball Athletes

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ABSTRACT

Small-sided games (SSG) in volleyball were adopted to increase the amount of contact with the ball, speeding up the application of specific techniques. SSG is modified by manipulating the number of players, area configuration, allowed actions, or relevant factors during training. This study aimed to examine the effectiveness of small-sided games-based exercise delivery in improving junior volleyball athletes' cognitive intelligence and basic skills. The research design is quasi-experimental, which applies a non-equivalent control group design. Digit span tests from WAIS measure cognitive intelligence measurements. The digit span test consists of two types, precisely, forward digits and backward digits. The validity test is 0.94, while the reliability test is 0.93. Basic volleyball skills include upper service, lower service, upper passing, lower passing, and smash, with a validity value of 0.94 and reliability of 0.84. The results revealed that providing 2v2 and 3v3 small-sided games training in high- and low-intelligence male and female junior volleyball athletes significantly improved basic volleyball skills. Providing small-sided exercises effectively improves the basic skills of junior volleyball athletes. This research contributes to developing methods of training and coaching junior volleyball athletes, especially technical and tactical improvements of the game.

INTRODUCTION

Volleyball athletes are characterized by having strong, agile, and aerobically fit muscle components. The characteristics of the volleyball game are included in intermittent sports with low-intensity periods followed by short and high-intensity attacks (Gabbett et al., 2006). It certainly requires maximum performance from an athlete, with the cognitive and psychomotor aspects being an essential part of volleyball (Closs et al., 2020).

Basic volleyball skills are a significant factor in supporting the success of achieving game goals. It is essential due to the technical factor as the primary control for producing sufficiently psychomotor movements (Sabiston et al., 2019). Technical factors are a continuous sector that requires the cognitive domain to comprehend suitable psychomotor aspects (Otero-Saborido et al., 2020). Volleyball sports include several techniques and skills, such as serving, passing, blocking, and smashing. Mastery of techniques and playing intelligence can be achieved effectively through the stages of the coaching process regarding the necessities of athletes and their age (Pizarro et al., 2019).

Mastery of basic techniques is a crucial part of volleyball. In volleyball games, basic techniques consisting of passing, serving, smashing, and blocking must be mastered progressively and become the basics to master at an early age to support the success of mastering advanced techniques (Kitsiou et al., 2014; Kitsiou et al., 2020). An alternative to improve the mastery of basic skills for junior

athletes is small-sided games. This training is an effective exercise because it directly integrates physical aspects, techniques, and tactics during the training process (Moran et al., 2019).

Previous research results stated that the innovation of small-sided game training improved players' perceptions of technical and tactical problems in physiological and physical stimuli (Khurrohman et al., 2021). The volleyball shows the involvement of cognitive demands and specialized motor actions to adapt to the environment during the game (Trecroci et al., 2021). It will also affect the psychology of an athlete (Englert & Seiler, 2020). For this reason, improving athletes' ability at an early age needs to be accomplished, especially by improving cognitive aspects and mastery of basic skills, which include serving, passing, and smashing on an ongoing basis through small-sided games training for a sustainable achievement coaching process.

An adequate coaching process is based on continuous, progressive, and systematic training. The stages of the training process are carried out by adjusting the athlete's age level and regarding the training principles. The beginner athlete aged 6-15 years old enters the stage of multilateral movement or the training process with overall development (Irianto, 2002). At this stage, the training process emphasizes developing fun basic skills. Align with the research result of Wijayanti & Kushartanti (2014), the coaching process for beginner athletes is focused on technical refinement, enrichment of movement skills, and preparation for increased training that goes hand in hand with the educational plan. Coaches try to find a method to improve volleyball players' performance through a series of coaching sessions using a smaller focus and arena. This method is known as Small Sided Games (SSG).

Small-sided games (SSG) in volleyball were adopted to increase the amount of contact with the ball, accelerating the application of specific techniques (de Oliveira Castro et al., 2022). SSGs are modified by manipulating the number of players, the area's configuration, the actions allowed, or other modifications during training. It requires players to adapt to new game scenarios with different contexts. Several works of literature have shown the relation of small-sided games to an athlete's performance, as Khurrohman et al. (2021) stated that improvised small-sided games can significantly improve athletes' cognitive performance and basic skills in futsal. Furthermore, (Trajković et al., 2020) study's results reveal that small-sided games could reduce cholesterol levels and increase the cardiovascular fitness of volleyball athletes. Other research indicates that small-sided games can improve forearm passing ability with the help of mobile phone applications in the training process (Ningrum et al., 2021).

Small-sided games can identify players' skill levels, providing practical contextual and situational behavior training. Volleyball coaches need to consider developing an appropriate training program for the development of athletes. According to the researcher’s observations constructed by seven volleyball coaches in Banyumas Regency through distributing questionnaires, 62.5% still adopt a conventional training process by prioritizing the main physical aspects. In addition, the achievements of Banyumas Regency volleyball athletes over the past five years have yet to reach maximum achievements in the provincial arena.

Researchers focused on volleyball in this study and proposed a new training system to improve junior athletes' cognitive intelligence and basic skills. Improving the effectiveness ratio of intelligence and skills through a systematic training process is essential. It requires a training model identical to actual game scenarios to support the success of athletes and a better coaching process. This study aimed to determine the effect of giving small-sided games training on cognitive speed, lower serves, and lower passes for junior volleyball athletes. This study examines the effectiveness of providing small-sided games-based training in increasing the speed of thinking and basic skills of junior athletes as a basis for a better coaching process.

METHOD

a. Research design

The research design is quasi-experimental with a non-equivalent control group design. This study involved 40 volleyball athletes consisting of 10 male 2v2 method, ten male 3v3 method, ten female 2v2 method, and ten female 3vs3 method.

b. Data collection instruments

1. Cognitive intelligence (speed of thinking)

The digit span test uses WAIS to measure short-term memory ability. The digit span test consists of two types, precisely, forward digits and backward digits. This test consists of forward numbers and backward numbers, carried out separately. The sum of the total values is obtained by adding the highest value obtained and correctly mentioning the numbers from the two ranges of numbers that have been mentioned. The validity test of this test is 0.94, while the reliability test is 0.93 (Jaeger, 2018).

2. Basic skills of volleyball

The basic skills of volleyball include bottom serve, top serve, passing, upper, bottom passing, and smash. From Nurhasan, the validity value was 0.94, and the reliability was 0.84 (Sulistya et al., 2022). The primary football skills test consists of the following:

3. Passing

The ability of the passing technique is carried out by bouncing the ball to the target or target that has been made. The test implementation is carried out by first standing facing the target with a ball in hand. After the start whistle signal, the test began to throw the ball against the wall. The ball bounces off the wall at the hit (down pass) into the target area. The counters counted the balls that were on target. If the ball is released, it can be held and then started again by throwing it against the wall to be hit again until the time runs out. The implementation time is 60 seconds. Until the whistle sounds to indicate that the test is over, every ball that bounces off the wall, which uses all the parts of our body that are by the rules of the game, the ball enters the target area and hits the boundary line of the target area is given a score of 1. A test score is the sum of the scores over 60 seconds. This test is given 1 (one) chance.

4. Service

The essential technical ability of the lower and upper serve of volleyball was measured using a measuring tool referring to previous research by Nurhasan (Ertanto et al., 2021). Serving is accomplished using upper-serve and lower-serve techniques. The service was carried out in as many as six strokes. The reference for determining the assessment is based on scoring. The score of each serve is determined by the height of the ball when it goes beyond the distance and the number of goals where the ball falls. If a ball is played unauthorizedly, or the ball touches the net and falls outside the part of the court where there is a target, The score is 0. The "score" for service is the sum of the four best stroke scores. The highest score is 5, and the lowest score is 0. The value calculation is based on the position of the ball falling in the field, as observed in the Figure 1.

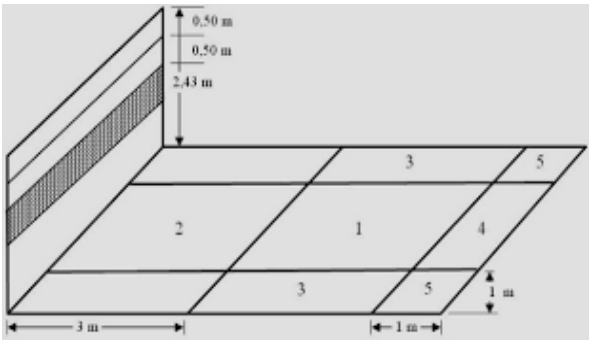

Figure 1: Scoring based on passing ball position

(Source: Ertanto, Supriyadi & Safotra, 2021)

5. Smash

This test aims to measure the skill of smashing over the net to the target quickly and purposefully. The test is carried out by being in the attack area or accessible on the volleyball field. The ball is tossed or passed near the net towards the teste, with or without the prefix; the teste jumps and hits the ball over the net into the field opposite where a target with a number is. The stopwatch is activated when the teste's hand touches the ball and is stopped when the ball touches the ground.

The value calculation is based on the position of the ball falling in the field, as observed in the Figure 2.

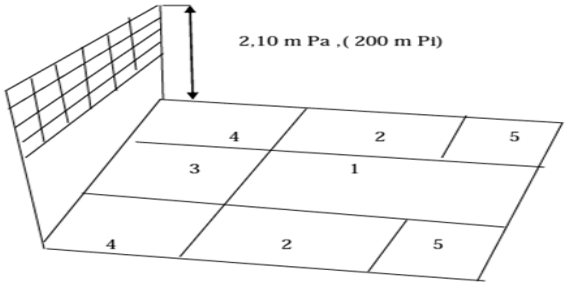

Figure 2: Scoring based on smash ball position

(Source: Ertanto, Supriyadi & Safotra, 2021)

The scoring provision is that the score consists of two inseparable parts: the target number plus the time of the speed of the ball. Score time is in seconds to tenths. The ball that touches the target limit is counted as having entered the target with a more significant number. Score = 0 if the batsman touches the net or falls off target. The score for the spike of the goal number merge plus time.

The application of small-sided games training adopts the training program of Halouani et al. (2023) with the mechanism of reducing the number of players and the area of the field operated, which tests the physiological response of athletes. The differences are listed in the aspects studied; the research were analyze the effectiveness of the two SSG exercises on five dependent variables related to basic volleyball skills, as described in Table 1.

Table 1: SSG exercise program

SSG	**Area**	**Duration**	**Recovery**
2 vs 2 3 vs 3	18 x 4,5 m^2	4-5 minute	1 minute

c. Data Analysis Procedure

The data analysis utilized a normality test, homogeneity test, and hypothesis testing. The normality test aims to determine the normality distribution of data. The test utilizes the Shapiro-Wilk test with a significance level of 0.05. The homogeneity test aims to determine the similarity of the variants of the groups studied. The test utilized is the Levene test, with a significance level of 0.05. Hypothesis testing aims to answer the existing research hypothesis. It uses a paired sample t-test and an independent t-test with a significance level of 0.05.

RESULTS

a. Description data on improving 2v2 and 3v3 treatment in the male group

Table 2 and Figure 2 below display the analysis results of the improvements obtained from the research data based on the mean and percentage (%) obtained. This data provides a comprehensive image of the distribution or improvement of the variables studied, including upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence through the Treatment given to athletes in the planned program.

Table 2: Description of the male group improvement a1a2b1b2 on the dependent variable

Test	**Upper Service**	**Lower Service**	**Upper Passing**	**Lower Passing**	**Smash**	**Cognitive Intelligent**
	Gain ± %	**Gain ± %**	**Gain ± %**	**Gain ± %**	**Gain ± %**	**Gain ± %**
a1	3,17 ± 40%	2,67 ± 33%	3,17 ± 7%	7,33 ± 20%	3,83 ± 55%	4,17 ± 40%
a2	2,00 ± 29%	2,33 ± 40%	12,67 ± 44%	6,67 ± 25%	1,67 ± 26%	2,00 ± 19%
b1	3,17 ± 31%	3,00 ± 33%	19,33 ± 54%	13,33 ± 51%	3,50 ± 46%	3,17 ± 42%
b2	5,17 ± 79%	1,67 ± 22%	10,17 ± 27%	9,50 ± 39%	2,67 ± 47%	1,00 ± 13%

*Description: a1 = High cognitive intelligence group; 2v2, a2 = High cognitive intelligence group 3v3, b1 =Low cognitive intelligence group 2v2, b2 = Low cognitive intelligence group 2v2

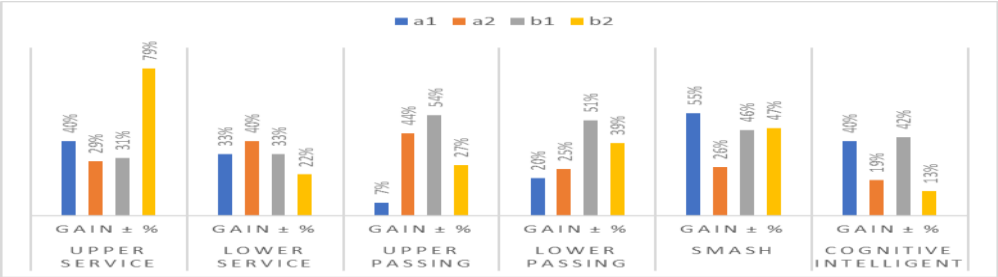

Figure 1: Diagram of pretest-posttest of male group improvement

Figure 1 reveals an increase in pretest-posttest results in each group of males through the Treatment of small-sided games 2v2 and 3v3. It is listed in the diagram that the low cognitive intelligence group 3v3 (b2) experienced the highest increase than other groups, which was 79%. In the lower service variable, the high cognitive intelligence group 3v3 (a2) experienced the highest percentage increase of 40%. In the upper passing variable, the low cognitive intelligence group 2v2 (b1) experienced the highest percentage increase with a value of 54%. Furthermore, the 2x2 (b1) low cognitive intelligence group experienced the highest percentage increase in lower passing with a value of 51%. In the smash variable, the high cognitive intelligence group 2v2 (a1) experienced the highest percentage increase of 55%. While in the cognitive intelligence variable, the 2v2 low cognitive intelligence group (b1) experienced the highest percentage increase of 42%.

1. Data on improving 2v2 and 3v3 treatment in the female group.

Table 3 and Figure 2 below display the analysis results of the improvements acquired from the research data based on the mean and percentage (%) obtained. This data helps provide a comprehensive image of the distribution or improvement of the variables studied, including upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence through the treatment given to athletes following the planned program.

Table 3: Description of the increase in female group *a1a2b1b2* on the dependent variable

Test	Upper Service	Lower Service	Upper Passing	Lower Passing	Smash	Cognitive Intelligent
	Gain ± %	Gain ± %	Gain ± %	Gain ± %	Gain ± %	Gain ± %
a1	2,43 ± 29%	2,17 ± 33%	20,83 ± 60%	9,00 ± 27%	3,17 ± 46%	3,17 ± 36%
a2	1,50 ± 27%	1,83 ± 35%	13,83 ± 37%	5,50 ± 19%	1,50 ± 29%	0,67 ± 7%
b1	2,50 ± 45%	2,83 ±52%	20,83 ± 62%	8,50 ± 25%	3,33 ± 47%	1,83 ± 26%
b2	1,67 ± 38%	1,17 ± 13%	9,00 ± 24%	8,50 ± 32%	2,33 ± 39%	2,17 ± 45%

*Description: a1 = High cognitive intelligence group 2v2, a2 = High cognitive intelligence group 3v3, b1 = Low cognitive intelligence group 2v2, b2 = Low cognitive intelligence group 2v2

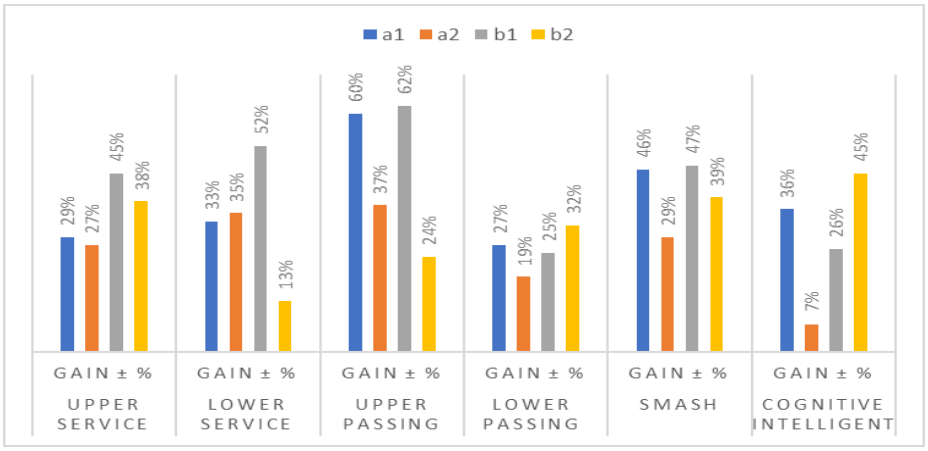

Figure 2: Diagram of female group pretest-posttest improvement

Table 3 and Figure 2 reveal an increase in pretest-posttest results in each group of females through the Treatment of small-sided games 2v2 and 3v3. It is enumerated in the diagram that the low cognitive intelligence group 2v2 (b1) experienced the highest increase of 45% in the upper service variable. In the lower service variable, the low cognitive intelligence group 2v2 (b1) experienced the highest percentage increase of 52%. In the upper passing variable, the low cognitive intelligence group 2v2 (b1) experienced the highest percentage increase with a value of 62%. Furthermore, the 3v3 (b2) low cognitive intelligence group experienced the highest percentage increase in lower passing with a value of 32%. In the smash variable, the low cognitive intelligence group 2v2 (b1) experienced the highest percentage increase of 47%. In the cognitive intelligence variable, the 3v3 (b2) low cognitive intelligence group experienced the highest percentage increase of 45%.

2. Independent t-test

This test compares the average of two groups through the analyzed post-test results. The interpretation of the results of this test is as follows:

Table 4: Independent t-test results for male group

Independent Samples Test			
	t-test for Equality of Means		
	t	**df**	**Sig. (2-tailed)**
An Upper Service – M	2,346	10	,041
	2,346	7,747	,048
A Lower Service – M	2,414	10	,036
	2,414	9,716	,037
A Lower Passing Bawah – M	3,316	10	,008
	3,316	7,424	,012
An Upper Passing Atas – M	3,639	10	,005
	3,639	5,749	,012
A Smash – M	2,708	10	,022
	2,708	8,675	,025
A Cognitive Intelligence – M	3,078	10	,012
	3,078	8,167	,015
B Upper Service – M	2,803	10	,019
	2,803	9,800	,019
B Lower Service – M	3,456	10	,006
	3,456	9,308	,007
B Lower Passing – M	3,989	10	,003
	3,989	9,233	,003
B Upper Passing – M	3,623	10	,005
	3,623	9,057	,005
B Smash – M	3,296	10	,008
	3,296	8,973	,009
B Cognitive Intelligence – M	3,078	10	,012
	3,078	9,757	,012

Based on the results of the independent t-test in Table 4, it can be concluded that the test data as a whole has a sig. $p < 0.05$. It shows a significant difference between groups a1 and a2, as well as groups b1 and b2, in improving the upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence of male group athletes. Furthermore, the results of this test on the female group are as follows:

Table 5: Independent t-test results for female group

Independent Samples Test					
	Levene's Test for Equality of Variances		**t-test for Equality of Means**		
	F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**
An Upper Service – F	1,250	,290	2,712	10	,022
			2,712	8,550	,025
A Lower Service – F	1,250	,290	2,712	10	,022
			2,712	8,550	,025
A Lower Passing – F	,111	,746	3,733	10	,004
			3,733	9,961	,004
An Upper Passing – F	4,274	,066	2,251	10	,048
			2,251	8,462	,050
A Smash – F	2,857	,122	3,492	10	,006
			3,492	8,232	,008
A Cognitive Intelligence – F	1,250	,290	3,796	10	,004
			3,796	9,204	,004
B Upper Service – F	,625	,448	2,928	10	,015
			2,928	8,448	,018
B Lower Service – F	1,245	,291	2,643	10	,025
			2,643	9,059	,027
B Lower Passing – F	,029	,868	4,366	10	,001
			4,366	9,844	,001
B Upper Passing – F	,026	,875	4,453	10	,001
			4,453	9,772	,001
B Smash – F	1,494	,250	3,081	10	,012
			3,081	9,269	,013
B Cognitive Intelligence – F	2,703	,131	3,379	10	,007
			3,379	7,696	,010

Based on the results of the independent t-test in Table 5, it can be concluded that the test data as a whole has a sig. $p < 0.05$. It indicates a significant difference between groups a1 and a2, as well as groups b1 and b2, in improving the upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence of female group athletes.

DISCUSSION

The results showed that groups experiencing Small Sided Games (SSG) 2v2 and 3v3 training experienced significant improvements in all research variables, specifically upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence. The results are evidenced by statistical analysis using the t-test. It shows a significant difference between each group's pretest and post-test results by obtaining an overall significance value of $p<0.05$.

Furthermore, the comparison of each group has significant differences, especially in the intervention of small-sided games between 2v2 and 3v3, both in high and low-intelligence groups. These results can be noticed in the overall mean results; i.e., the provision of 2v2 small-sided games training provides the highest results compared to 3v3 in all variables of upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence in both the male and female groups. These results indicate an improvement in the techniques of upper service, lower service, upper passing,

lower passing, and smash after SSG training consistent with motor development theory. Training in a small game format encourages players to continue to apply learned techniques in more dynamic situations, improving understanding and mastery of those techniques (de Oliveira Castro et al., 2022).

The significant increase in cognitive intelligence variables suggests SSG training positively impacts athletes' cognitive aspects. SSG's fast and dynamic game situations require quick speculation, instant decision-making, and reading and responding to game situations. It supports previous research linking intensive physical activity with improved cognitive function (Khurrohman et al., 2021). The research result stated that the application of SSG significantly improved athletes' cognitive performance. In addition, López-Fernández et al. (2019) stated that applying modified SSG can quickly improve athletes' game responses. It is undoubtedly sustainable and strengthens the results of this study that the application of SSG 2v2 and 3v3 can significantly improve cognitive intelligence in volleyball athletes.

These findings provide positive implications for the renewal of training methods in volleyball, especially the application of SSG drills. Coaches can integrate these drill methods in structured training programs to achieve holistic improvement in technique and skills. With the improvements in technical and cognitive aspects from the research findings, providing SSG training can play a role in the holistic development of volleyball athletes. Athletes improve physical prowess and the ability to think and respond better in real-game situations.

CONCLUSION

Based on the results of data analysis and discussion in this study, it can be concluded that the provision of small-sided games 2v2 training both in the high and low-intelligence male groups has a significant impact on improving the upper-service, lower-service, upper-passing, lower-passing, smash, and cognitive intelligence. Giving small-sided games 2v2 training in the high and low-intelligence female groups significantly increases the upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence. Disseminating small-sided games 3v3 training to high and low-intelligence male groups significantly increases the upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence. Giving small-sided games 3v3 training to both high and low-intelligence female groups significantly increases the upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence. There is a significant difference between the provision of SSG training between 2v2 and 3v3 in the high and low cognitive intelligence male groups on the upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence. There is a significant difference between the provision of SSG training between 2v2 and 3v3 in the female group of high and low cognitive intelligence on the upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence.

This research synthesizes improvements and synergistic interactions between SSG 2v2 and 3v3 training on improving volleyball athletes' upper service, lower service, upper passing, lower passing, smash, and cognitive intelligence. The implications of these findings can be applied in developing training methods and coaching volleyball for junior athletes, especially for the game's overall technical and tactical improvement.

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