



A combination of split jumps and short sprints to increase the volleyball athletes' leg muscle power and agility

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Abstract: Applying the right training methods can lead to optimal athlete performance. The use of one training method is common, and the use of a combination of two training methods is something new in training. The purpose of this study was to reveal the effectiveness of the combination of split jump training as a plyometric exercise with short sprint training on the leg muscle power capacity and agility of volleyball players. The research method in this research is a quasi experiment involving 40 samples (age: 20.85 ± 0.89 years, height: 178.69 ± 6.51 cm, and weight: 72.47 ± 8.02 kg). This study used a modified randomized pre-test and post-test design without a control group. The population of this study were volleyball players at Universitas Pendidikan Ganesha (Undiksha). Purposive sampling was chosen to determine the sample, namely 40 male student players. The sample was given training combining split jumps with short sprints for 4 weeks with details of 12 training sessions (3 times a week). The Jumpa DF and agility t-test were chosen as instruments to measure leg muscle power and agility. The collected data was analyzed using a paired t-test with a significance level of 5%. Before testing the hypothesis, start by testing the normality of the data using the Kolmogorov-Smirnov^a test and the homogeneity of the data using Levene's with the help of SPSS 16.0. The results achieved show that there is a significant influence on the leg muscle power (sig <0.05) and agility (sig <0.05) of volleyball players. Based on the results of this data analysis, it can be concluded that the combination of split jump and short sprint training for 4 weeks has a significant effect on the results of leg muscle power and agility in male volleyball players. Seeing the findings above, it is hoped that volleyball coaches can apply this training method, specifically in the pre-competition phase, which requires a short time to improve leg muscle strength and agility at the same time.

Keywords: Split jump, short sprint, leg muscle power, agility.

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INTRODUCTION

Apart from football, a sport that is also popularly played and watched around the world is volleyball (Trajković et al., 2020). The characteristics of this sport are the games played by two teams on both sides of the field, which are different from the net barrier, and the fact that the ball always moves cyclically (Fortes et al., 2020; de Oliveira Castro et al., 2022). Playing this sport requires a combination of several elements, such as technique, tactics, and good physicality, to display optimal and consistent performance (Trajković et al., 2016; Carvalho et al., 2020; Karahan & Çolak, 2022). During the game, the players seem to be more dominant in moving quickly to change direction and jumping repeatedly, both when attacking and defending (Fuchs et al., 2019; Tai et al., 2021; de Leeuw et al., 2022; Chuang et al., 2022).

One of the jumping abilities is used when the player spikes. The jump when doing a spike is a specific and complex jumping motion, so leg strength and power are needed by each player (Bojanic et al., 2020). The higher the jump when spiked, the larger the visible size of the field and the steeper the ball's trajectory through the net (Fuchs, Menzel, et al., 2019). Moreover, previous findings stated that there was a strong relationship between jumping performance and competition level (Sattler et al., 2015). Apart from being useful when doing spikes, leg muscle power is also important to support performance when doing jump serves and block jumps (Fatahi et al., 2021). In fact, more than 100 high-intensity



jumps were recorded during athlete training and play, which coincided with other specific movements in volleyball (Sanders et al., 2021).

Another physical aspect that also supports the performance of volleyball players is agility, primarily as a predictor of success in the ability to jump or run repeatedly in various positions (Hale et al., 2019). Each player is required to be able to occupy a position when responding or carrying out an attack (Tramel et al., 2019). The movement of the ball or the arrival of the ball is very fast over a small area of the field, requiring players to have fast and explosive movements (Gulati et al., 2021). Therefore, agility is a must for every volleyball athlete (Sheppard et al., 2014; Thieschäfer & Büsch, 2022).

Athletes, coaches, parents (family), and other team members must understand the importance of implementing training patterns and a competitive culture so that athletes are able to reach a competitive level as well (Santos et al., 2019; Reynders et al., 2019). Ideal training is training that is organized and carried out systematically, structured, measurable and sustainable (Sidik et al., 2019; Nasrulloh & Wicaksono, 2020; Nugroho et al., 2021). It is also important to vary the types and methods of training so that athletes do not get bored while training and can maintain top performance when training and competing (Pratama et al., 2023).

Based on research findings or observations in the field when the Undiksha volleyball team carried out preparatory training for the Bali Province championship, researchers observed players during internal gaming sessions. It can be seen that the results of spikes, blocking, and fast movements in reaching the ball as a result of the previous player's touch were not good. The spike does not dive sharply across the net because the player's jump is not high enough. The blocking that is done is also often not done well because the jump is not high enough. And the speed of moving towards the incoming ball is too slow for a young player. The results of interviews with coaches stated that the short preparation that is often carried out before tournaments is one of the obstacles to implementing training methods that can improve players' physical performance.

Improving the biomotor abilities of volleyball players depends on the selection and application of appropriate training methods. In general, plyometrics has been proven to be an effective method for increasing leg muscle power (Ramirez-Campillo et al., 2019; Bouteraa et al., 2020; Medeni et al., 2019). Even as a method in the rehabilitation phase of athletes with injuries to the anterior cruciate ligament (Buckthorpe & della Villa, 2021). The most important thing now is to combine training methods to produce more complex performance improvements. Researchers have not theoretically found the impact of combining the two training methods in a short period of time (4 weeks) to increase leg muscle power and agility in volleyball players. So the researchers consider the urgency of the above conditions and offer a solution to the problem for Undiksha men's volleyball players by providing a combination of split jump and short sprint training.

METHODS

This research is a quasi-experiment with a modified randomized pre-test and post-test design without a control group. Experimental research is used to uncover and find data about the effect of a treatment on certain groups (Sugiyono, 2017). The population in this study were all Undiksha volleyball players. The sampling technique used to determine the samples involved was purposive sampling, so 40 male students were selected (age: 20.85 ± 0.89 years, height: 178.69 ± 6.51 cm, and weight: 72.47 ± 8.02 kg).

The instrument used to measure leg muscle power is the Jump DF (Bewani, 2019). The vertical jump protocol using the DF jump tool begins with the testee standing on a rubber plate. After hearing a "tet" sound, the testee jumps up (vertically) and lands back on the rubber plate. After the "tet" sound is heard again, the testee jumps up again and lands on the rubber plate until the number (cm) appears. The best score between the two jumps used For more details, see Figure 1.



Figure 1. Vertical Jump Test Protocol

Meanwhile, the instrument used to measure agility is the agility t-test. The test protocol (see Figure 2) is in accordance with Semenick's recommendations (Čaušević et al., 2021), namely that each testee gets 2 opportunities with a rest break of 3 minutes. The testee stands behind the start sensor line, then sprints towards cone B. Next, towards cone C, reach using the left hand. Then, towards cone D, reach with your right hand. Return to cone B, touch cone B, then run backwards to the starting position (past the sensor). Best time to use. The pre-test was carried out one week before the sample was given training. The post-test was carried out one week after the 12th training session meeting.

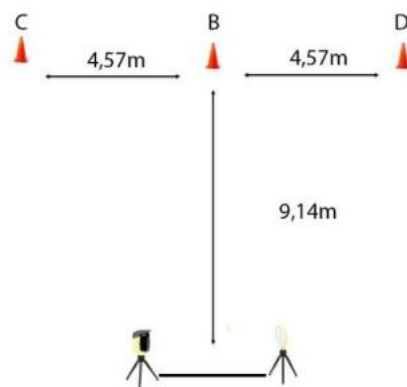


Figure 2. Agility T-Test Protocol

For 4 weeks (12 meetings), the sample was given a combination of split jump and short sprint exercises (Table 1). The sample did a split jump, then a short sprint (10 meters) according to the dose per session in Table 1. After the data was collected, data analysis was continued using the paired sample t-test ($p < 0.05$), assisted by SPSS 16.0. However, before testing the hypothesis, it begins with a data normality test using Kolmogorov-Smirnov^a and continues with a data homogeneity test using Levene's with a significance level of 5%.

Table 1. Training Program

Week	Day 1	Day 2	Day 3	Rest /set
1	6 reps x 3 set	6 reps x 3 set	6 reps x 3 set	90 seconds
2	6 reps x 4 set	6 reps x 4 set	6 reps x 4 set	90 seconds
3	5 reps x 5 set	5 reps x 5 set	5 reps x 5 set	90 seconds
4	5 reps x 6 set	5 reps x 6 set	5 reps x 6 set	90 seconds

RESULT AND DISCUSSION

The collected pre-test and post-test data were then analyzed. The first stage of the data was tested for normality using the Kolmogorov-Smirnov^a test (see Table 2). Based on the results of this analysis, the data is normally distributed because the sig value is > 0.05. After the data distribution was declared normal, a homogeneity test was carried out using Levene's (see Table 3). Looking at the data results in Table 3, the data is declared homogeneous because the sig value is >0.05.

Table 2. Test of Normality

Variable	Kolmogorov-Smirnov ^a		
	Statistic	df	Sig.
Pre-test of leg muscle power	.156	36	.912
Post-test of leg muscle power	.102	36	.249
Pre-test of agility	.146	36	.914
Post-test of agility	.119	36	.231*

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Table 3. Test of Homogeneity of Variance

Levene's	df1	df2	Sig.
4,628	2	36	0,008

After the data is declared normal and homogeneous, continue to carry out the paired t-test (see Tables 3 and 4). Looking at the data analysis in tables 3 and 4, it can be said that there is a significant effect on leg muscle power and agility after being given a combination of split jump and short sprint training because the sig value is <0.05.

Table 4. Paired Sample Test (Leg Muscle Power)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test – Post Test	-13.05128	7.51122	1.20276	-15.48614	-10.61643	-10.851	38	.000

Table 5. Paired Sample Test (Agility)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test – Post Test	-9.32500	4.57074	.72270	-10.78679	-7.86321	-12.903	39	.000

The aim of this research is to reveal the effectiveness of applying the split jump combination method as part of plyometric training with short sprints within 4 weeks on the leg muscle power and agility of volleyball players. Based on the study above, the combination of split jump and short sprint training has a significant impact on increasing leg muscle power and agility in male volleyball players. The combination of two training methods has actually been revealed in previous research, such as the combination of resistance training with plyometrics, which is more effective than just training using plyometrics alone (Zghal et al., 2019), and produces almost similar effects in terms of muscle hypertrophy in the lower extremity muscle groups (Grgic et al., 2021). So the current findings reinforce that a combination of training methods appears to be more effective in improving athlete performance.

Split jumps, which are a form of plyometric training, have been proven to be beneficial for athletes performance (Ramirez-Campillo et al., 2014; Lum, 2016; Lum et al., 2019). The main characteristic of plyometric exercises is the existence of ballistic stretching movements that aim to increase power production in the muscles (Ramirez-Campillo et al., 2018; Suchomel et al., 2019). This form of plyometric training includes training with continuous explosive jumps with short (<250 ms) or long (>250 ms) ground contact times (Suchomel et al., 2018).

The current findings corroborate previous findings, which state that plyometric training for 12 weeks can improve agility (Fischetti et al., 2019). Leg muscle power has been shown to have a strong correlation with the agility level of athletes (Ferreira et al., 2019; Dietze-Hermosa et al., 2020; Suarez-Arrones et al., 2020). At a competitive game level, volleyball players make fast movements to do blocking and defense, and for that reason, it is important that every player has agility (Toselli & Campa, 2018). Explosive player movements in all directions on the field occur repeatedly (Tramel et al., 2019), which is one indicator that volleyball players must have leg muscle power, acceleration, and agility (Lockie et al., 2020).

The impact of short sprint training, which increases acceleration and agility, is influenced by the explosive movement of the short sprint (Rey et al., 2023). The running speed of changing direction is produced by strong and fast leg muscle contractions from structured strength and speed training interventions (Yoda & Mashuri, 2023). Acceleration and speed of changing direction are used by volleyball players when responding to the arrival of the ball (defending) or when moving without the ball before making a spike. The combination of plyometrics and short sprints by changing direction also affects the athlete's performance, including agility and power (Aloui, Hermassi, et al., 2021).

The combination of two training methods has actually been widely revealed, such as a combination of plyometric training with short sprints for 8 weeks, which can improve jumping performance, acceleration speed, running speed, changing direction, and balance in U-19 football players (Aloui, Souhail, et al., 2021), and handball players (Hammami et al., 2018). Training using this combination method for 6 weeks has also been revealed, and the results showed an increase in leg power, acceleration, and agility in football players (Tvrdý et al., 2023).

The current novelty is an attempt to reveal the frequency of training for 4 weeks (12 training sessions) on increasing leg muscle power and agility in volleyball players. The current results are not much different from previous findings, namely that plyometric training at a frequency of 1-3 times per week has an impact on leg muscle power and agility (Sánchez et al., 2020; Maciejczyk et al., 2021; Lievens et al., 2021). The 48-hour recovery process is also important in selecting the frequency of plyometric and speed training (Ling et al., 2020; Galán-Rioja et al., 2023).

The application of a combination of plyometric training, one of which is split jumping, with short sprints has been recorded as effective in increasing leg muscle power and agility in volleyball players. Determining the number of 12 training sessions for 4 weeks must certainly ensure the loading of the training itself. The frequency of training as above is recommended for light intensity and is carried out in the main pre-competition phase. The pre-competition phase is characterized by a shorter time than general preparation or special preparation in training periodization (Bompa & Buzzichelli, 2019). The determination of intensity and recovery time, both between sets and between sessions (days), also has an influence on athlete performance. Limitations of this research include not controlling training status (experience), leg muscle strength, and the control group in the experiment. So that in future research, this can be taken into account so that the results obtained are more comprehensive and in-depth than the current findings.

CONCLUSION

The characteristics of the game of volleyball are that it requires each player to make jumps repeatedly and move quickly to change direction. So the right training method is needed to improve the player's jumping ability and agility in a short time. An alternative solution that can be given is to provide a combination of split jump and short sprint training for Undiksha men's volleyball players for 4 weeks. Current findings show that there was an increase in leg muscle power and agility in Undiksha male volleyball players after being given a combination of split jump and short sprint training within 4 weeks (3 sessions per week). In a training periodization, the pre-competition phase has the characteristic that the training time (volume) is shorter than the general preparation and special preparation phases. So the

current findings can be used as a reference in applying training methods in this phase. However, caution is needed in interpreting these results because this study did not use a control group and did not identify training experience or the strength capacity of the sample's leg muscles. Muscle strength capacity, especially maximum strength, has a strong correlation with muscle power capacity. Apart from that, there are also aspects of training experience that can differentiate between trained and untrained individuals. So that this limitation becomes an opportunity for future researchers to reveal by involving the control group, considering training experience and leg muscle strength capacity.

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