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The effect of exercise variation methods on leg muscle strength and its contribution to improving volleyball smash results

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Abstract

This research is based on the contribution of leg muscle strength to the results of volleyball smashes. So, it is necessary to increase strength through a training program to produce good smash results. This study aimed to determine the effect of burpee exercise variations on increasing leg muscle strength and volleyball smash results. This research method is a quasi-experimental research design experiment with a pretest-posttest. The subjects involved in this study were male volleyball players of North Sumatra Club, with purposive sampling and subject collection techniques, the total subjects involved amounted to 10 players. The instrument used in this study is leg muscle strength using the vertical jump test, which is usually done to determine the strength of the leg muscles or an athlete's explosive power while measuring smashing skills for fast and targeted target attacks using Lavage's smash skill test instructions. Analysis of research data Analysis of data using statistical formulas to prove whether the hypothesis data that has been proposed is accepted or rejected by the Liliefors test. Based on the results of the calculations, the hypothesis is that vertical jump = 6.026> 1.859, so burpee training variations significantly influence leg muscle strength. Smash results, hypothesis obtained count smash results = 8.664 ttable> 1.859, So there is a significant influence of burpee training variations on the smash. This study concludes that burpee variation exercises can be an alternative to increase leg muscle strength and volleyball smash results.

Keywords: Burpee, limb muscle power, smash, volleyball.

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Authors contribution: a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f - Editing the final version

INTRODUCTION

Volleyball is one of the most popular sports in the world. It is full of competition and fun. The movements are fast, tense, and fun to be the attraction of this game to enjoy. Volleyball is a big ball game carried out in teams that face and are separated (Bumburo et al., 2023). The characteristics of this volleyball game require biomotor components such

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as strength, speed, agility and endurance. Some of these components must be owned by the game because volleyball games are more likely to take place at a fast tempo. According to Nurfalah et al., (2019) volleyball games, a strong physique cannot be separated from the role of biomotor components, namely elements of speed, strength, agility, reaction time, and balance. However, volleyball players need more than a strong physique; they must be supported by correct and precise playing techniques such as hitting the ball, blocking punches, passing, and serving.

Looking at the characteristics of the game, the goal of the game of volleyball is to score points up to 25; if there are the same points, it is usually called a deuce, that is, to find a difference of two points. In order for the game to run, each game must master basic skills to be able to perform all the techniques in the game of volleyball. In volleyball games, there are basic techniques that must be mastered by players, namely passing, serving, smashing and blocking (Junedo, 2020). These four basic techniques are capital that must be learned before playing volleyball and determine whether a match wins or loses (Yusril Keswando et al., 2022). The ability to smash in a volleyball game is an ability that can generate points in a volleyball game, smash is the most important part in a volleyball game, because smash is one of the most widely used forms of attack for attacks in obtaining values or numbers. Therefore, the smash build must confuse the opposing team's blocker and make it unpredictable (Samsu Nurfalah et al., 2019). Based on the researchers' observations, the team's weakness is very visible in smash results, where the team makes many mistakes, such as the ball out or being stuck in the net. Therefore, there needs to be a serious and programmed effort to improve the results of smash skills.

There are several physical condition factors that influence the production of a strong and accurate smash, including the physical condition, namely arm muscle strength (Ahmad, 2021). These components are needed to do smashes, so the smashes expected by the trainer can

be done later. To improve smash ability, smash ability must pay attention to the principles of ability and muscle strength (Sulistiadinata & Aditya, 2021). Arm muscle strength plays a role in directing maximum energy when hitting the ball hard and purposefully. Conversely, if they do not have arm muscle strength, the resulting smash is not optimal or weak, making it easier for the opponent to block the attack made. Arm muscle strength is needed to smash in volleyball games (Sulistiadinata & Aditya, 2021). The strength of the arm muscles influences the severity of the blow, and producing a hard smash requires arm muscle strength (Nurfalah et al., 2019). Therefore, arm muscle strength is needed when making a hard blow or smashing. According to (Dede et al. Imron, 2020), someone with good arm muscle strength can provide power when making a volleyball stroke, if the power is given well, the ball will be hard and difficult to control by the opponent.

In improving the results of smash punches, regular, systematic practice is needed that leads to accuracy (Kusuma et al., 2019). Judging from the body's movement, Smash requires very good arm muscle strength. By training arm muscle strength in volleyball players, volleyball players are expected to have good smash-hitting skills (Sulistiadinata & Aditya, 2021). Leg muscle strength is very necessary when jumping; it is necessary to increase the exercise in leg muscle strength training because the leg muscles will produce good jumps easily when blocked and smashed (Indrayana, 2018). Doing a smash requires leg muscle strength that functions to produce a good jump and leg muscle strength when the muscle contracts to provide strength so that the smash results become hard (Rachmi et al., 2021). Currently, exercises that can increase leg muscle strength to contribute to smash skills include using plyometric exercises. Plyometric standing jump exercises, box drills, and flexibility with low or high intensity also have the effect of increasing an athlete's foot strength (Fachreza & Indra, 2023). 6 weeks of plyometric training appears to be effective for improving strength and strength-related variables in untrained healthy children (Marta et al., 2022). In addition, the results of

research (Ethar, 2021) stated that there is an effect of weight training on the results of leg muscle strength in volleyball athletes.

This study is in accordance with exercise methods that are often used to increase leg muscle strength and contribute to smash skills by using other exercise methods that can improve leg muscle strength. Therefore, exercises that can develop leg muscle strength are (burpees), and burpees are exercises that utilize muscle groups throughout the body (Yohei Yamashita, 2023). Burpee exercises require the body to lift and push body weights (Georgiy et al., 2022). Based on the power training that has been described, one of the important factors in the process of mastering volleyball, especially smash, is the strength of leg muscles, arm muscles and technique (Amalia et al., 2015). When making direct observations, researchers found problems in athletes' leg muscles. Therefore, their smash results. Namely, it could have been better if the ball had come out stuck in the net and easily received by opponents (Yudiana et al., 2021). To increase leg muscle strength, it is necessary to have programmed exercises intended to train leg muscles, which are a variation of burpee training and are expected to be a form of burpee innovation in power training.

METHOD

This study used quasi-experimental with a pretest-posttest design. This research is an experimental study, said to be experimental because this study will examine the causal relationship of its effect on smash skills in the volleyball club of North Sumatra. The research design is as follows:

O1 X O2

Information:

O1 = pre-test (throwing-catching test),

X = experiment

O2 = post-test (test throwing-catching test).

The sampling technique in this study is purposive sampling, with considerations used including:

1. Subjects are selected for activeness during exercise according to the schedule programmed by the trainer.

2. Subjects are selected according to the core players who are projected to participate in the competition.
3. Subjects are selected based on health and injury-free prior to the study, and
4. Subjects are willing to participate in research activities and do not get a specific exercise program.

So, after adjusting according to the considerations that have been proposed, 10 samples were obtained that participated in the research activity. This sample consisted of 16-year-old North Sumatran volleyball athletes of the male gender. Leg muscle strength test The vertical jump test is a fitness test that is usually done to determine the strength of the leg muscles or the athlete's explosive power. Next, the data results on the strength of the limb muscles are classified by adjusting the norms of the test.

So, after adjusting per the considerations submitted, 10 samples were obtained that participated in the research activity. Leg muscle strength test instrument The vertical jump test is a fitness test that is usually done to determine the strength of the leg muscles or the athlete's explosive power. Furthermore, the limb muscle strength data results are classified by adjusting the test norms.

Table 1. Vertical jump test norms

Norms	Age									
	9	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18>**
Very Good	16”	16”	16”	20”	20”	20”	25”	25”	25”	26”
Good	14”	14”	14”	17”	17”	17”	23”	23”	23”	24”
Average	11”	11”	11”	14”	14”	14”	19”	19”	19”	19”
Less	9”	9”	9”	11”	11”	11”	12”	12”	12”	13”
Very Less	4”	4”	4”	5”	5”	5”	5”	5”	5”	8”

Next is the smash result test, which aims to measure the skill of smashing for fast and targeted target attacks. This study uses the smash skill test instructions from the laveage. The smash result skill data results are classified by adjusting the test norms.

Table 2. Smash result test norms

Score Interval	Category
80-100	Very Good
60-80	Good
40-60	Average
20-40	Not Good
-20	Not Very Good

After the data from the leg muscle strength show and smash results are collected, the next step is to manage and analyze the data using statistical formulas to prove whether the data hypothesis that has been proposed is accepted or rejected by the Liliefors test, Bartlet test, paired sample T-test and independent sample T test or combined test. At the beginning of the study, initial tests were carried out before experimental treatment (treatment) was given, Furthermore, the subjects were given treatment within a certain period of time. After the end of the treatment, a final test was carried out on the subject. To test the difference between the two mean data of the initial test results and the final test result data, researchers used the t-test analysis technique. This t-test calculation uses the help of the SPSS statistical application for Windows version 25.0 with the paired sample t-test method. A paired sample t-test is a different test of two paired samples, namely the same subject but subjected to different treatments.

RESULT

In measuring leg muscle strength using the Vertical Jump test, several statistical tests were used to analyze research data: 1) Descriptive Test. 2) Normality Test. 3) Test the hypothesis. The results obtained in this study will be explained as follows: Descriptive data analysis is carried out to obtain an overview of research data. Descriptive data is meant to interpret data.

Table 3. Descriptive statistics pre-test and post-test leg muscle strength

Result	n	Sum	mean	SD
Pre-test	10	**154**	15,4	3,204
Post-test	10	**181**	18,1	2,846

The pre-test results based on the analysis of the description of the leg muscle strength assessment data obtained the number 154 with an average value of 15.4, resulting in a standard deviation of 3.204 with a

range of 12 to 20. At the same time, The post-test results based on data analysis description of the assessment of leg muscle strength levels after participating in the burpee exercise variation program changed by 181 with an average value of 18.1, resulting in a standard deviation of 2.846 with a range of values of 14 to 22.

Table 4. Descriptive statistics pre-test and post-test smash result rates

Result	n	Sum	mean	SD
Pre-test	10	**515**	51,5	4,006
Post-test	10	**650**	65	3,858

The pre-test results based on the analysis of the description of the smash result rate assessment data obtained the number 515 with an average value of 51.5, resulting in a standard deviation of 4.006 with a range of 43 to 59. At the same time, the post-test results based on the analysis of the description of the smash result rate assessment data after participating in the burpee exercise variation program changed with the number 650 with an average value of 65 resulting in a standard deviation of 3.858 with a range of values of 60 to 71.

Table 5. Pre-test and post-test data normality test

Normality Test	Average/Standard Deviation	L_o	L_{table}	A	N	Conclusion
Pre-Test Vertical Jump	$\overline{X}$ = 15,4 S = 3,204	0,173	0,258	0,05	10	Normal
Post-Test Vertical Jump	$\overline{X}$ = 18,1 S = 2,846	0,161	0,258	0,05	10	Normal
Pre-Test Smash	$\overline{X}$ = 51,5 S = 4,006	0,166	0,258	0,05	10	Normal
Post-Test Smash	$\overline{X}$ = 65, S = 3,858	0,202	0,258	0,05	10	Normal

From Table 5, the vertical jump pre-test data in the previous table and the Lo normality test result data L_{count} = 0.173 L_{table} = 0.258 at a level significant >0.05. Therefore, Ho is accepted because L_{count} = 0.173 L_{table} = 0.258. The conclusion is that the data comes from a normally distributed population. L_{count} = 0.161 at the post-test result column, and L_{table} = 0.258 at level = 0.05. So, L_{count} = 0.161 and L_{table} = 0.258. The conclusion is that the data comes from a normally distributed population.

From Table 5 of the pre-test calculation results of smash ability in the previous table, the results of the data normality test at L_{count} = 0.166 and L_{table} = 0.258 at level = 0.05. Therefore, Ho is accepted because Lo = 0.166 L_{table} = 0.258. The conclusion is that the data comes from a normally distributed population. L_{count} = 0.202 is found in the post-test result column,

and L_{table} = 0.258 is found at level = 0.05. So L_{count} = 0.202 and L_{table} = 0.258. The conclusion is that the data comes from a normally distributed population

Table 6. Homogeneity test

Homogeneity Test	F_{count}	F_{table}	A	Dk (n-1)	Description
Variance Pre-Test And Post-Test Vertical Jump	1,25	3,18	0,05	9	Homogeneous
Variance Pre-Test And Post-Test Vertical Jump	1,07	3,18	0,05	9	Homogeneous

A change test complements homogeneity testing in each treatment at an interest rate of α = 0.05. F_{count} = 1.25 was calculated to test the homogeneity of leg muscle strength data and smash results between the pre-test and post-test vertical jump data. F_{count} = 1.25 obtained at level = 0.05 counter (dk n-1 = 9). Thus, F_{count} and F_{table} It can be concluded that the data comes from homogeneous variance if F_{count} is smaller than F_{table}.

Table 7. Summary of t-test calculation results of leg muscle strength and smash results

T-test	Pre-Test Vertical Jump	Pre-Test Smash	Post-Test Vertical Jump	Post-Test Smash	Different Vertical Jump	Different Smash	Dk (n-2)	t_{count} vertical jump	t_{count} Smash	t_{table} α = 0,05
N	10	10	10	10	10	10				
Σ	154	515	181	650	27	135	8	6,026	8,664	1,859
$\overline{X}$	15,4	51,5	18,1	65	2,7	13,5				
S	10,266	16,055	8,1	14,888	1,418	4,927				

N = value number of samples

Σ = number of data values

X = average value

S = standard deviation

Dk = degrees of freedom

Based on the results of the calculations, the hypothesis is obtained: t_{count} vertical jump = 6,026. Then, the value is compared with the value of t_{table} with dk = (10-2 = 8) at a significant level α = 0,05 is 1,859. So, it is concluded that variations in burpee training on leg muscle power for North Sumatra volleyball clubs have a significant effect.

Moreover, for smash results based on the calculations carried out, the hypothesis is obtained t_{count} results smash = 8,664. Then, the value is compared with the value of t_{table} with dk = (10-2 = 8) at a significant level α = 0,05 is 1,859. So, it is concluded that variations in burpee training significantly affect the smash of North Sumatra volleyball clubs.

Table 8. T-test calculation results in differences in burpee training variations on leg muscle strength and smash results

T-test	Different Vertical Jump	Different Smash	Dk (n–3)	t_{count} Combined	t_{table} α = 0,05
N	10	10			
Σ	27	135	7	1,36	2,36
$\overline{X}_B$	2,7	13,5			
B	1,418	4,927			

Table 8 summarizes the results of the Sig. (2-tailed) pre-test and post-test paired t-test variables of 0.005, if the p-value of <0.05 indicates that there is a significant difference. From the test results, it is known that the significance value is 0.005 <0.05, meaning that there is a difference in the results of leg muscle strength through vertical jump tests for the pre-test and post-test if the calculation results against (t-count) are smaller than tt (t-table), calculate tt >. This means that there is a post-test average that burpee exercise variations have similar values on leg muscle strength and smash results. The variety of burpee training does not have a significant difference in influence.

DISCUSSION

Increased leg muscle strength occurs due to the results of exercise. Where we know that progressive loading will result in better muscle strength development (Ayyub et al., 2023), this is in accordance with exercises that adopt variations to increase leg muscle strength training, such as Chen et al. (2022) exercises that provide training to increase leg muscle strength, which emphasizes more on providing exercise activities. Providing exercises to increase leg muscle strength and contribute to skills is inseparable from the combination of reps and sets given in this training. With a good and appropriate combination of reps will have a good effect on the results of the training program provided (Pires et al., 2020).

Arm muscle strength has a very important role in the success of smashing in order to produce points in volleyball games. Having good arm muscle strength can provide enough energy so that the ball can dive hard, purposefully, and precisely, and the opponent is difficult to accept. To produce a hard smash punch requires excellent power from the arm muscles and wrist flexibility (Chen et al., 2022). To be able to perform

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smash punches on target, strength must be taken from the arm muscles. This is in accordance with Anggriawan (2016), which concluded that the individual arm muscle strength factor has a significant contribution of 43.7%. This proves that there is a sufficient level of contribution between the variable arm muscle strength and the variable smash ability.

A smash is a fast and hard punch made by a volleyball player when the ball from his friend's pass soars high and is hit hard in the opponent's area (Probowo et al., 2022). To obtain the ability of good leg muscle strength a player must be supported by training so that his punch reaches the opponent's area and is deadly, the weakness of the leg muscle strength of a player who does not have leg muscle strength will not reach deep across the net and is even easily accepted by the opponent. Increased strength of the arm muscles can be achieved with effective training methods, one of which is a variety of exercise methods using burpees.

The athlete's training process is carried out repeatedly and systematically, and a training program that is arranged regularly and directed increases gradually and repeatedly in time (Masnunah, 2019). This can have a significant influence on the smash ability of volleyball athletes. This exercise is very influential because it is done repeatedly. Exercise is a person's effort to improve the organism and its function to optimize sports performance and performance (Sekulic et al., 2013).

This shows that in the implementation of volleyball smashes, physical training should be remembered in training because both exercises have a very big influence on volleyball. If the training mentioned above is often given to volleyball athletes, leg muscle strength and maximum smash results will be easily achieved during the game. From the findings that have been explained, using burpee exercises that are run in the exercise program given to volleyball players is very influential in increasing the results of volleyball smashes. This training program can continue to be implemented and developed so that the goal of training can be achieved, namely, maximum achievement for volleyball athletes. The results of this

study are inseparable from the existence of several limitations that affect the findings. These limitations include very few types of subjects and are homogeneous, affecting the skill level and results. In addition, due to limited area limitations, the subject's characteristics are considered equal. The very short time of conducting the study made the research team less sensitive to other possible influences of the findings contained.

CONCLUSION

Based on the results of statistical testing, it is known that there is no significant difference in the effect of burpee training variations between leg muscle strength and smash results of North Sumatra volleyball clubs. However, burpee training variations have an influence on leg muscle strength and volleyball club smash results. Therefore, when applying exercises to develop or improve leg muscle power, you must use appropriate and appropriate training methods. These findings can be used for the development of exercises in volleyball, significantly increasing smash results. So, in the future, studies need to do the same thing by providing alternative training methods that can improve technical skills in sports, especially smash results in volleyball.

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