



The Effect of Plyometric Training on Improving Smash Ability in Volleyball Athletes: Meta-Analysis Study

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Abstract

This study aims to determine the effect of several plyometric exercises on improving smash skills in volleyball. Many studies have conducted this research in the field of sports. Various kinds of studies explain that plyometric training has a very positive effect on improving volleyball smash abilities, but the results of the data presented tend to be different, with this it is necessary to re-analyze the data in order to provide comprehensive information about plyometric training on improving volleyball smash abilities. The meta-analysis method used in this study was assisted by Jeffreys's Amazing Statistics Program (JSAP) software version 0.16.0.0 by collecting data from research results that already exist in databases such as Google Scholar. Literature search from Google Scholar using the keywords: "plyometric" OR "plyometric" AND "smash" with a range of 2010-2022. The sampling technique used in the search for articles is fulltext articles and article research is carried out in Indonesia. The results of the search with these keywords found a population of 979 articles and 11 samples used, then this data will be retrieved according to the inclusion and exclusion that have been determined. The results of this study indicate that the RE model was identified as 1.15 from the results of studies that have been analyzed and there is no publication bias, therefore it can be concluded that plyometric training has a high effect on volleyball smash ability.

Keywords: *plyometrics; volleyball; meta-analysis; effect size*

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INTRODUCTION

Sport is a routine activity for the community to be physically and mentally healthy (Setiawan et al., 2018). Sports activities, of course, must also adjust to a person's age such as the type of activity to be chosen as well as the facilities and infrastructure to be used (Pratiwi et al., 2013). There are so many sports activities that are very popular among people from an early age and teenagers such as football, volleyball and other sports.

The volleyball game can be said to be a game played in teams, each team has six players who are limited by a net, and each team must try to drop the ball into the opponent's area (Mustafa et al., 2016). The goal in this game is to attack the opponent's area and score points, the points in this game are 25 points (Yusmar, 2017). The volleyball game has four basic techniques that must

be known and mastered as the basis for playing volleyball, these basic techniques include passing, service, smash and block. These four basic techniques have different functions (Abrasyi et al., 2018). The basic technique that can be said to play an important role in the game of volleyball is the basic smash technique, because there are still a lot of people who have not done the basic smash technique correctly so it needs to be improved and trained again.

The basic technique of smash in volleyball is a basic technique that is very influential in volleyball games because the purpose of the volleyball smash is to attack the opponent with a very hard blow and dive into the opponent's area so that they can get points (Anggara & Yudi, 2019). By mastering the basic smash technique, the team can easily win the match (Sahabuddin, 2019). In smash, of course, athletes must have good muscle explosive power, so in this case it is necessary to do exercises that can increase muscle explosive power so that the results of the smash given can be maximized (Putra & Rifki, 2021). In addition to correct basic technical training, volleyball players must exercise consistently and gradually (Sahar, 2021). Exercises that are suitable for increasing muscle explosive power are plyometric exercises with this exercise able to improve volleyball smash abilities. Plyometric exercises are exercises to increase muscle explosive power with a combination of isotonic and isometric exercises. Plyometric exercises have often been done or used by several trainers to increase explosive power (Sulistiyana et al., 2017). Plyometric exercises can also increase lower leg muscle strength, so this exercise can provide changes to the neuromuscular system (Hamdani & Utomo, 2021). Therefore, this plyometric exercise is very effective if it is used to increase muscle explosive power, such as the basic smash technique in volleyball, because the basic smash technique in volleyball must have very good muscle explosive power (Sudarmanto et al., 2019).

According to previous researchers, Hurdle Hops and Knee-Tuck Jump plyometric exercises have an effect on improving the smash ability of the volleyball athletes of the Guntur 1000 club in Padang city and obtaining a *t-count* value of 3.78 shows significant results (Anggara & Yudi, 2019). Plyometric exercises using the circuit method for volleyball athletes from the Hunter Club of Sawahlunto City obtained a *t-count* result of 12.81 showing a significant increase (Eriyaldi, 2019). The Box Drill plyometric exercise given to the male players of SMAN 1 Baso, Agam Regency, obtained a *t-count* value of 13.04 and had a significant effect on improving volleyball smash skills (Ricky, 2020a). The male volleyball players from Dharmas Indonesia University were given plyometric training in the form of Jump In Place obtaining a *t-count* value

of 8.93 so that it showed significant results for improving volleyball smash skills (Ricky, 2020b). Several plyometric exercises such as Skipping, Hurdle jump, Depth jump, and jump to box were also given to volleyball players at SMK Cersa Pasaman Barat who got a *t-count* value of 4.16 and showed significant and acceptable results to improve volleyball smash skills (Saputra & Judy, 2019).

After knowing the results of previous researchers who showed different results, it is necessary to do a special analysis to provide comprehensive information about how much influence plyometric training has on volleyball smash abilities. Plyometric exercise is a physical exercise that is beneficial for physical development, but it must also follow the existing principles, namely providing muscle stretch, increased load, specificity of training, reactive jump over hurdles plyometric exercises, and recovery (Wibiantoro, 2009).

Based on these problems, the purpose of this study was to determine whether plyometric training had an effect on volleyball smash ability through a meta-analysis study. This study examines studies with the theme of plyometric training and volleyball smash. The database used to browse articles is Google Scholar.

METHOD

The method used in this research is Meta-Analysis. Meta-Analysis is a method by reviewing and analyzing data from various pre-existing sources (Anugraheni, 2018). The meta-analysis method can solve some of the conflicting article findings, with this method it can be more systematic by using the Meta-Analysis method (Utami & Helmi, 2017). Meta-analysis is carried out by measuring quantitative data through Effect Size, Effect Size is a magnitude of the effect of one variable with another variable statistically (Dirman et al., 2021).

In 1904 there was someone who introduced Meta-Analysis as a research method in the field of medicine and health, he was named Karl Pearson. However, over time Meta-Analysis has become a research method used to examine various problems in various fields. In the world of education, starting to do Meta-Analysis in the 1970s, this method is very useful, especially among education, especially coaches and sports teachers who want to do research but do not go directly to the field, with this method it is very easy for researchers as well (Retnawati et al., 2018).

Data acquisition is done online through Google Scholar. Search articles by entering keywords: "plyometric" OR "plyometric" AND "smash" found 979 articles from 2010-2022 This

search was conducted on April 14, 2022. Determination of the sample was carried out using purposive random sampling and total sampling which is a sampling technique with using certain criteria. The sample selection criteria were using inclusion and exclusion criteria, after that 11 articles were found to be reviewed.

Inclusion criteria:

1. The research analyzed is the one with the theme of plyometric training and smash ability
2. The articles analyzed are articles that have full text and can be accessed
3. Articles are publications in national journals and proceedings, theses, and articles are stored in the repository.
4. Articles taken using a quantitative research structure, especially those using the t test and f test.
5. The article was published in 2010 to 2022, because research on the effect of plyometric training on smash ability, especially in athletes, began to be widely carried out in 2010.
6. Article sourced from Google Scholar
7. The subjects used in the study were volleyball athletes
8. Research conducted in Indonesia.

Exclusion criteria:

1. Research that is not available in full text.
2. Research with different operations (research that uses smash that is not in volleyball, for example in badminton)
3. Research that is not in accordance with the research question.

From the results of inclusion and exclusion of data obtained as many as samples that meet the requirements for analysis, the data selection stage can be seen in the following figure 1.

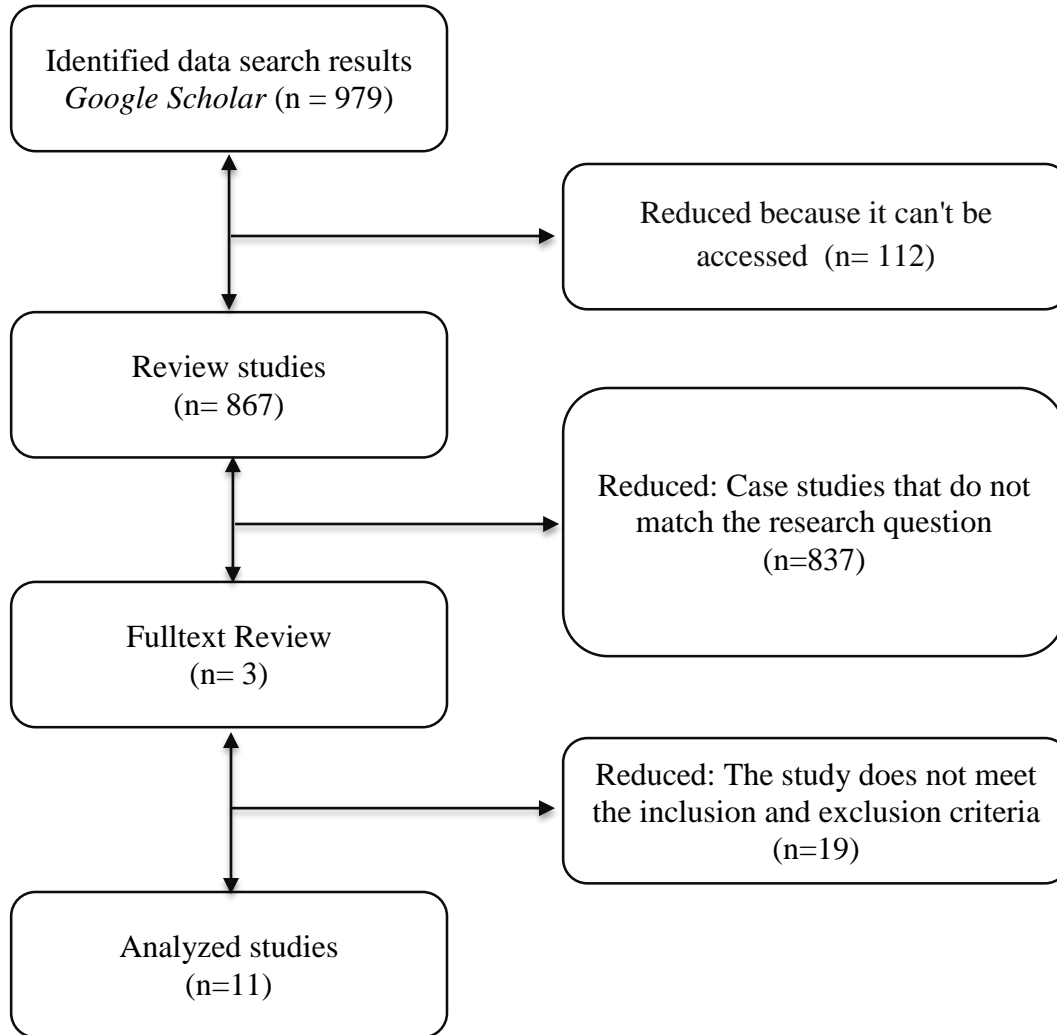


Figure 1. Flowchart in identifying case study data that are eligible for meta-analysis

The research was conducted from April to June 2022. After searching for data from various sources, the next stage is data analysis which will be carried out through (1) Identification of research variables, data entered into tables according to the variable column, (2) identification of the value of r in each article analyzed. If the research results reported only contain F or t values, then they are transformed into r values, using the equation:

$$1. F = t^2$$

$$2. t = \sqrt{F}$$

$$3. r = \frac{t}{\sqrt{t^2 + N - 2}}$$

(3) transforming the value of r into a z distribution which is the effect size of each study, then calculating the variance, (4) calculating the standard error of z , and (5) calculating the summary effect of the entire study (Nuraini et al., 2021). The summary effect calculation is carried out using meta analysis with the help of Jeffreys' Amazing Statistics Program (JASP) software version 0.16.0.0.

RESULTS AND DISCUSSION

Result

The next stage is the meta-analysis study stage using research data that has passed the selection stage. A total of 979 data were obtained, and 968 data did not meet the inclusion or exclusion criteria for analysis. There were eleven research data that were ready to be continued for analysis which were obtained from the data base source used, namely Google Scholar. The studies to be analyzed are presented in the Table 1.

Table 1 . Data Study to be Conducted Meta-Analysis

No	Author	Sample characteristics	Exercise type	N	t	r	Effect Size	Standart Error
1	D. Anggara, A. Yudi (2019).	Atlet bolavoli klub Guntur 1000 Kota Padang.	Hurdle Hops dan Knee-Tuck Jump.	12	3,78	0,767	1,013	0,333
2	E. Eriyaldi (2019).	atlet bola voli Klub Hunter Kota Sawahlunto	Metode circuit	8	12,81	0,982	2,357	0,447
3	Z. Ricky (2020)	Pemain putera SMAN 1 Baso Kabupaten Agam	Box Drill	32	13,04	0,922	1,602	0,186
4	Z. Ricky (2020)	pemain bola voli putra Universitas Dharmas Indonesia.	Jump In Place	32	8,93	0,852	1,265	0,186
5	Saputra, A. Yudi (2019)	Pemain Bolavoli SMK Cersa Pasaman Barat	Skipping, Hurdle jump, Depth jump, dan jump to box	12	4,16	0,796	1,088	0,333
6	A.Bakar, Nasuka, Imam Santosa (2019)	Atlet UKM bola voli Universitas Tadulako Palu.	single tuck jump dan rim jump dan panjang tungkai	28	4,2913	0,644	0,765	0,200
7	A.Hearillah (2013)	pemain tim putra bolavoli PBV.Putra Voit Probolinggo	Barrier Hop	12	2,554	0,628	0,739	0,333
8	A.Hearillah (2013)	pemain tim putra bolavoli 9 PBV.Putra Voit Probolinggo	Skipping	12	2,832	0,667	0,806	0,333
9	S. Oktaviani, Donie (2020)	atlet bolavoli SMAN 01 Mukomuko	Latihan plyometric	12	17,39	0,984	2,406	0,333

10	B. Walidaini , S. Syahara (2019)	pemain Bolavoli SMPN 3 X Koto Singkarak Kabupaten Solok	knee tuck jump, Double leg hops, Box jump, Standing vertical jump, Hurdle hops dan But kick jump	16	2,27	0,519	0,575	0,277
11	B. Indrayana (2018)	pemain bola voli putra SMK N 1 Kota Jambi	knee tuck jump dan double leg bound	10	0,38	0,133	0,134	0,378

a. Heterogen Test

To determine the calculation model in the JASP application version 0.16.0.0, it is seen from the study to be analyzed if the study shows heterogeneous results or the *p-value* is less than significant 0.05 then the right model uses Random Effect while if the *p-value* is greater than significant 0.05 then the correct model uses Fixed Effect calculations (Table 2).

Table 2. Fixed and Random Effects

	Q	df	p
Omnibus test of Model Coefficients	33.163	1	< .001
Test of Residual Heterogeneity	45.833	10	0.001

It is known that the heterogeneous results from table 3 are ($Q = 45.833, p < 0.001$) because the *p-value* is less than a significant value of 0.05. Thus the Random Effect model is more suitable to be used to estimate the effect size of the eleven analyzed studies.

b. Summary Effect Results

After determining what model is right for estimating the results of the study, the next step is to find out whether the results from the data obtained have a positive effect or not.

Tabel 3. Coefficients

	Estimate	Standard Error	z	p	95% Confidence Interval	
					Lower	Upper
intercept	1.147	0.199	5.759	< .001	0.757	1.537

The results above (Table 3) show the estimated value of 1.147 and do not show negative results. This means that plyometric training has a positive effect on increasing volleyball smash abilities. To see whether plyometric training has a significant effect or not, it can be seen from the value ($z = 5.759, p < 0.001, 95\% \text{ CI}, (0.757; 1.537)$). Because the *p-value* is less than a significant value of 0.05. To determine the effect or not the effect plyometric training into high, medium or low categories, using the norms of high (0.5), moderate (0.3), low (0.1) (Cohen, 1992). It can be

concluded that plyometric training has a positive effect and also affects high on volleyball smash ability.

The results of the analyzed studies can be viewed in their entirety using the Forest Plot (Figure 2) so that readers can understand more easily.

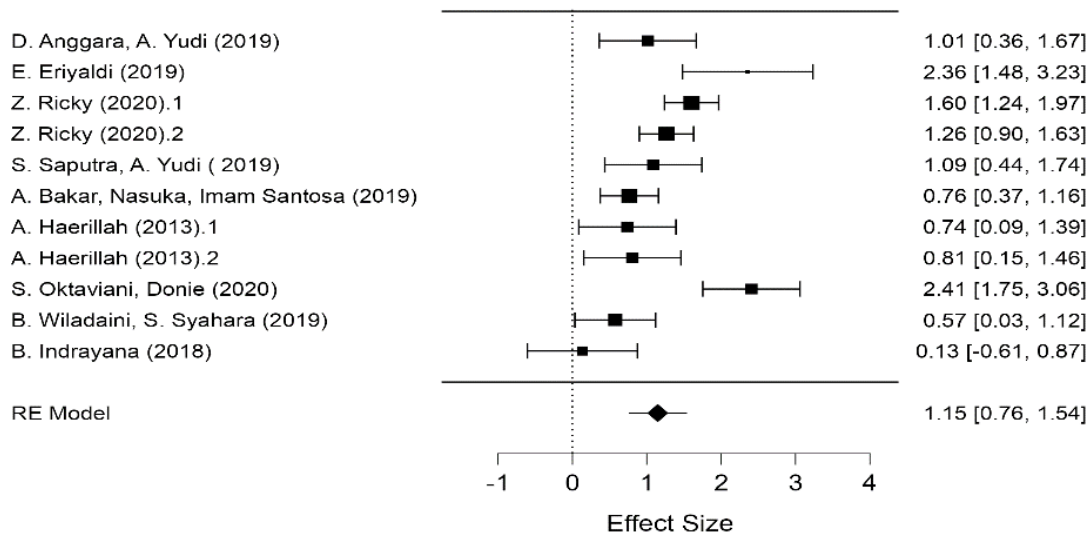


Figure 2. Forest Plot

Forest Plot contains information on the names of the studies as well as the Effect Sizes that have been analyzed. The black box represents the size of the Effect Size, the more to the right the higher the value and vice versa. The size of the box shows the significance of the Effect Size. The diamond shape indicates that the value of the Summary Effect/ Mean Effect Size has been analyzed. While the *RE* model shows that the Summary Effect value is estimated using a random model (Prasiska, 2014).

The results from table 4 above can be seen that the *RE* model was identified as 1.15 and the effect size of the analyzed studies varied between 0.13 to 2.41. It is known that the effect size value of Oktaviani Donie is higher by 2.41 in the article it is stated that using plyometric exercises has a significant effect on volleyball smash ability, but it is not stated which exercises are used. While the effect size value of B. Indrayana is lower because the researcher uses the knee tuck jump and double leg bound plyometric training methods. These exercises actually have an effect on improving volleyball smash skills, but the percentage in improving is very low.

c. Publication Bias Test

Publication bias analysis was carried out to determine whether there was bias in each of the analyzed studies.

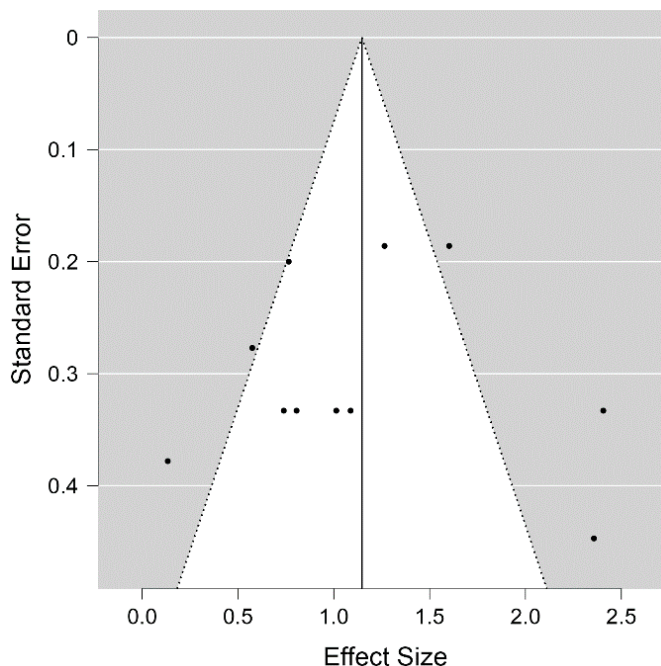


Figure 3. Funnel Plot

The results of the analysis of Figure 3 above are not yet known that it is difficult to know whether the funnel plot is symmetrical or not, so an Egger's test formula is needed to find out whether the funnel plot is symmetrical or no.

The Egger's test is used when the Funnel Plot does not depict a symmetrical pattern or cannot be seen. To determine whether the Funnel Plot is symmetrical or not, it can be seen from the *p-value* greater or less than the significance value of 0.05, if the *p-value* is greater than the significant value, it can be concluded that the funnel plot forms a symmetrical pattern so that there is no publication bias problem.

Tabel 4. Regression test for Funnel plot asymmetry ("Egger's test")

	z	p
sei	0.361	0.718

It can be seen that the z value in table 4 is 0.361, while the p-value has a value of 0.718 which means it is greater than the significant value of 5% (0.05). It can be concluded that there is no indication of publication bias and the funnel plot is above symmetrical.

The results of the file drawer analysis in Table 5 show that there may be 742,000 whose results are suspected to be biased or not reported or published. In addition to using the Egger's test if you want to know whether there is publication bias or not, you can use the 5K+ 10 formula. The

criteria when the safe N value is greater than that formula, it can be concluded that there is no publication bias.

Tabel 5. File Drawer Analysis

	Fail-safe N	Target Significance	Observed Significance
Rosenthal	742.000	0.050	< .001

It is known that $K= 11$ so $5K+10 = 5(11) + 10 = 65$. The value of fail-safe N obtained is 742,000, with a significant target of 0.050 and $p < 0.001$, because the value of fail-safe $N > 5K + 10 = 742,000 > 65$ if the value of fail-safe N is greater than the result obtained from the formula (Azzahrah et al., 2021). It can be concluded that there is no publication bias problem in the meta-analysis study.

Although the results of the publication bias analysis in the funnel plot diagram cannot show clear and specific results, the egger's test and fail safe N analysis shows that there is no publication bias. This shows that the meta-analysis of the data carried out in this study can be accepted as data that is not vague and in accordance with current conditions.

Discussion

Volleyball is a sport that is already popular among the public, volleyball games are played in teams with each team of 6 people. The goal of the volleyball game is to score as many points as possible so as to reach the points that have been set, the points in this game are 25 points with a rally system. The size of the volleyball court is 18 m x 9 m which is limited by a net or net with a net height of 2.43 m for men and 2.24 m for women (Latar, 2015). In volleyball, there are several basic techniques that must be mastered, namely passing, smash, block and service. With these basic techniques, it can support the athlete's performance for the better, therefore basic techniques must be learned and carried out in a good and correct way. The basic technique of volleyball has different functions. One of the basic techniques that must be mastered is the basic smash technique.

Smash is a very complex basic technique because it requires maximum strength. This basic technique is one of the most lethal attacks carried out hard, fast, sharp, and swooping (Pranopik, 2017). In the basic smash technique, maximum leg muscle power is needed so that with good power, during competition, the automatic smash ability will be good (Hariadi & Mardela, 2020).

The supporting factor to produce maximum smash is serious and consistent practice. One of the exercises provided is plyometric exercises, this exercise has been widely carried out in various other sports (Supriyanto, 2018).

Plyometric exercise is a series of exercises to maximize muscle ability, plyometric training must also be done gradually and repeatedly, especially training on leg muscle explosive power (Gusnelia et al., 2022). Plyometric exercises can be divided into three parts, namely lower limb, trunk and upper limb exercises. That the principle of pre-stretching plyometric exercises is involved in the completion stage of the response when working (Ashari, Sepdanius, Indika, 2019). Plyometric exercises that can improve leg muscles such as Hurdle Hops, Knee-Tuck Jump, Skipping, Hurdle jump, Depth jump, jump to box and Jump In place (Rohendi & Budiman, 2020).

According to previous researchers, plyometric exercises given to volleyball athletes at SMAN 01 Mukomuko got significant results so that they could improve volleyball smash abilities (Oktaviani & Donie, 2020). In a study conducted at SMPN 3 X Singkrak City, Solok Regency by providing plyometric knee tuck jump exercises, Double leg hops, Box jumps, Standing vertical jumps, Hurdle hops and But kick jumps gave significant results because these exercises can improve smash accuracy (Walidaini & Syahara, 2019). Researchers who examined male volleyball players at SMKN 1 Jambi City were given plyometric exercises in the form of knee tuck jumps and double leg bounds which had significant results for improving volleyball smash skills (Indrayana, 2018).

From the results of the explanation above, it is shown that the results analyzed using the Random Effect model and the RE model are known to be 1.15. The results of the Funnel Plot publication bias test cannot provide clear information so that the results cannot be known, it can be seen from the analysis of Egger's Test and Fail Safe N which shows that publication bias is not identified. Plyometric exercises in the above analysis have a positive and significant effect. The results of this analysis are classified in the high category.

The weakness in this study is to find the criteria for the sample and the subject to be studied in the Google Scholar database. There are many categories of subjects that exist in the study such as SMK, SMA, SMP, SD, and Athletes, however, in this study only athletes were used because the athlete category was found more than the others without classifying athletes according to their level.

Plyometric exercises have been carried out in various sports, however, volleyball is very rarely done in Indonesia. This can be a reference for the same researcher to research plyometric exercises, especially in other basic techniques for volleyball so that they can create the latest research.

CONCLUSION

The findings show that plyometric training has a significant effect on volleyball smash ability. This study also recommends to all coaches to use plyometric training as an effort to increase the leg muscle power of their athletes which will directly have an impact on increasing smash ability. This research only uses one database, it is hoped that further research can use other databases such as DOAJ, Scencedirect, Scopus, and Web of Science (WoS) in order to get many articles to be analyzed.

As a coach, you must be able to know the purpose of training to improve tactics, techniques, and strategies. In the explanation above, it is a factor to improve volleyball smash ability, although above it is explained that the results of plyometric training have a high effect on increasing high volleyball smash ability. There are so many factors that can have a high and positive influence on improving volleyball smash abilities. For this reason, to find out or explore what factors are higher in improving smash abilities, further research needs to be carried out.

Because this research is about the effect of plyometric training on volleyball smash skills, for researchers who are the same as the information that has been presented, it can be used as a reference to conduct research on other basic techniques so that there are creative updates.

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