INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 06 Issue 09 September 2023

DOI: 10.47191/ijmra/v6-i9-43, Impact Factor: 7.022

Page No. 4275-4283

Effect of Plyometric Training Model and the Age towards the Reaction Time and the Agility of Muaythai Atheletes

Demson Hamonangan Saragih[1], Fauzi[2]

[1,2] Sport Coaching Education Study Program, Faculty of Sports and Health Science, Yogyakarta State University

ABSTRACT: This research aims to determine: (1) the effect of upper body and lower body plyometric training models towards the reaction time and agility, (2) the differences in the effect of age (17-20 years old and 21-24 years old) towards the reaction time and agility, (3) the interaction between upper body plyometric, lower body plyometric training models, and age (17-20 years old and 21-24 years old) towards the reaction time and agility.

This research was an experimental study. The research design was a "2x2 factorial" design. The number of research samples were 20 muaythai athletes selected by purposive random sampling. To measure reaction time the researcher used the whole body reaction II test and to measure the agility used the Illinois agility test instrument. The data analysis used the MANOVA (multivariate analysis of variance) test with a significance level of 0.05.

The results of this research indicate that: (1) there is a difference in the effect of upper body and lower body plyometric training models towards the reaction time of Muaythai athletes with a p significance of 0.000 < 0.05, and there is a difference in effect between upper body and lower body plyometric training models towards the agility of Muaythai athletes with a significance value of p 0.000 < 0.05. (2) There is a difference in the effect of age (17-20 years old and 21-24 years old) towards the reaction time with a significance value of p 0.002 < 0.05, and there is a difference in the effect of age (17-20 years old and 21-24 years old) towards the agility with a significance value of 0.002 < 0.05. (3) There is a significant interaction between the upper body plyometruc, lower body plyometric training models and age (17-20 years old and 21-24 years old) towards the reaction time with a significance value of 0.002 < 0.05, and there is a significant interaction between the training models of upper body plyometric, lower body plyometric and age (17-20 years old and 21-24 years old) towards the agility with a significance value of 0.001 < 0.05.

KEYWORDS: plyometric training model, age, reaction time, agility, muaythai

INTRODUCTION

The general purpose of training is to help coaches, trainers, sports teachers to be able to apply and have conceptual abilities and skills to help reveal the potential of sportsmen to reach peak performance. The general target of training is to improve the ability and readiness of athletes to reach peak performance (Harsono, 2018: 3). Training is a systematic process of practicing/working which is carried out repeatedly, increasing the amount of training load every day. Muaythai is an empty-handed martial art that originated in Thailand. A Muaythai fighter generally attacks his opponent's head, body and legs using fists, elbows, knees and shins. Basically, Muaythai has a form of punch that is almost the same as the type of punch in boxing like European martial arts. Muaythai today is also popular with another name "Thai Boxing". Muaythai (Journal of Muaythai, Ori Immanuel Hutama, 2014) is a martial art originating from the Kingdom of Thailand.

In Muaythai there are several basic technical movements including punches, kicks, locks, and also slams. In coaching and sports achievements there are several things that are important aspects, according to Soeharsono, in Budhiono (2004: 255) including: 1) Sports aspects, related to physical problems, physical development, techniques, tactics, maturity to compete, coaches, training programs and evaluation, 2) Medical aspects, related to problems with the functioning of organs (heart, lungs, nerves, muscles, senses, and others), nutrition, injuries, and examinations, 3) Psychological aspects; related to problems of mental resilience, confidence, self-control, discipline and enthusiasm, pressure, perseverance and accuracy, and motivation.

Bompa, Tudor O & G. Gregory Haff (2009) explains "athletic is dominated by combinations of strength, speed, and endurance which are bimotor abilities". Which is where every performance produced in sports activities is dominated by biomotor

components. According to Bompa (2015: 116), explains that variations in training and the selection of forms of training will keep athletes motivated and fresh in adapting to the various forms of training given. According to Harsono (2001: 1) that the physical condition in question is strength, endurance, flexibility, agility, reaction, speed, and power. According to Tirtawirya (2005:37), good skills consist of several combined aspects of biomotor components such as speed, endurance, and strength. So that the components of biomotor power, stamina, coordination, flexibility, balance, reaction and agility arise from the combination of basic biomotor components. Harsono (1988: 177) suggests that muscle strength is a very important component to improve overall physical condition. Aside from being a support for other biomotor factors, strength itself sometimes doesn't seem to be clearly used, but in fact every biomotor aspect is still influenced by strength.

Harsono (1988: 47) defines strength as an energy to fight against a resistance or the ability to generate tension or tension. According to Suharno (1985: 59) strength is the ability of the athlete's muscles to withstand loads with maximum strength and speed in one body movement. Explosive power or power according to Narlan & Juniar (2020: 87) there are two factors of physical condition that must support, namely maximum strength and speed, because when an athlete has the ability to make strong and fast movements it will produce high power (explosive power). Good. Based on observations that have been made in several muaythai gyms in Medan city and Simalungun district, several trainers have implemented forms of training models that are used to support and improve reaction time abilities that are more focused on athlete strokes such as exercises using dumbbles, wheelbarrows, push ups and pull ups, while to increase agility exercises are still carried out with simple forms of exercise and still seem like old forms of exercise and the lack of new variations of exercises that increase reaction time and agility skills performed in martial arts exercises.

Reaction time has benefits that greatly affect athletes and forms of training which can also increase muscle strength and capacity (Orsatto & Bezzera, 2020). Today, there are several demands that are not realized by coaches, including creating or developing several forms of training models that can be used to support better physical conditions of athletes and increase athlete performance in particular. With the existence of several problems in reaction time and agility in Muaythai athletes after observations, it is felt that it is necessary to develop and add several forms of training to increase reaction time and agility, therefore the authors will conduct a study entitled "The Effect of Plyometric Training Models and Age on Reaction Time and Agility in Muaythai Athletes".

METHODS

This research is a form of experimental research. Sugiyono (2015: 107) states that experimental research is a research method used to seek the effect of a treatment on other people in controlled conditions. The design in this study used a 2x2 factorial experimental research design. The independent variable consists of the plyometric training model which consists of two training models namely upper body plyometric and lower body plyometric and the dependent variable consists of reaction time and agility with the manipulative variable being leg muscle strength.

The data analysis technique used in this research is the MANOVA statistical technique (multivariate analysis of variance) which is used to test the hypothesis of the influence of the independent variable with the comparative dependent variable of the sample average. The MANOVA test in this study used a 2x2 factorial design, which was used to test a sample average hypothesis if the researcher carried out a categorization step for the sample.

a. Normality test

The normality test used in this study is to use the chi-square formula. According to Sugiyono (2017: 239) states that the normality test is used to examine the normality of the variables studied whether the data is normally distributed or not. This is important because if the data for each variable is not normal, then hypothesis testing cannot use parametric statistics. The normality test is carried out using the chi-square formula. This is to find out whether an implementation is normal or not by calculating if the significant value is > 0.05 then it is normal and if the significant value is <0.05 then it is not normal.

b. Homogeneity Test

Sujarweni (2015: 115) states that a group is said to be homogeneous if a significant value > 0.05 is obtained and if the group is said to be non-homogeneous if the significant value is < 0.05. The homogeneity test process is carried out with the aim of knowing the similarity of variations and to test the data obtained from the existence of a homogeneous population. Making a decision with a significant value > 0.05 is acceptable or significant.

c. Hypothesis testing

The steps involved in testing the hypothesis in this study were using MANOVA (multivariate analysis of variance). This is because the Manova test is a statistical calculation process in testing and calculating independent variable data that has been obtained in research. Ilhamzen (2013) MANOVA (multivariate analysis of variance) is a type of parametric statistical test that

aims to determine whether there is an average difference between more than two sample groups. If there is an interaction, then the next test will be carried out, namely the tukey test to find out an interaction that occurs for each frequency.

RESULTS AND DISCUSSION

A. Description of Research Data

The data on the results of this study are in the form of pretest data and post test data for reaction time and agility. The number of samples used in this study were 20 muaythai athletes. The process will take place in three stages. The first stage is to carry out group division based on age category and then carry out pretest reaction time and agility. The second stage of activity in this research is to do the treatment.

1. Description of Research Data

The data on the results of this study are in the form of pretest data and post test data for reaction time and agility. The number of samples used in this study were 20 muaythai athletes. The process will take place in three stages. The first stage is to carry out group division based on age category and then carry out pretest reaction time and agility. The second stage of activity in this research is to do the treatment.

Table 1. Results of statistical data on pre-test and post-test reaction time

Exercise Models	Age	Statistics	*Pre test*	*Post test*
Plyometric Upper Body	**21-24 years (A1B1)**	*Means*	0.301	0.271
		SD	0.023	0.021
	17-20 years (A1B2)	*Means*	0.344	0.306
		SD	0.016	0.015
Lower Body Plyometrics	**21-24 years old (A2B1)**	*Means*	0.308	0.243
		SD	0.035	0.021
	17-20 years old (A2B2)	*Means*	0.353	0.268
		SD	0.019	0.014

Table 2. The results of statistical descriptive data on pre-test and post-test agility athletes

Exercise Models	Age	Statistics	*Pre test*	*Post test*
Plyometric Upper Body	**21-24 years (A1B1)**	*Means*	16.70	16,14
		SD	0.197	0.218
	17-20 years (A1B2)	*Means*	17,12	16,22
		SD	0.262	0.184
Lower Body Plyometrics	**21-24 years old (A2B1)**	*Means*	16.60	15,36
		SD	0.259	0.216
	17-20 years old (A2B2)	*Means*	16.89	15,44
		SD	0.288	0.466

2. Prerequisite Test Results

a. Normality test

The data normality test used in this study was the Shapiro Wilk method. Analysis of data from the normality test results in each group using the SPSS software application with version 25 using a significance level of 5% (0.05). The normality test results are as follows;

Table 3. Muaythai athlete reaction time normality test results

Data		P	Sig	Information
Reaction Time	*Pretest*(A1B1)	0.902	0.05	Normal
	Post test(A1B1)	0.928		Normal
	Pretest(A1B2)	0.850		Normal

	Post test(A1B2)	0.886		Normal
	Pretest(A2B1)	0.015		Normal
	Post test(A2B1)	0.829	0.05	Normal
	Pretest(A2B2)	0.811		Normal
	Post test(A2B2)	0.734		Normal

Table 4. Results of the normality agility test for muaythai athletes

Data		**P**	**Sig**	**Information**
	Pretest(A1B1)	0.195		Normal
	Post test(A1B1)	0.478		Normal
Agility	*Pretest*(A1B2)	0.136		Normal
	Post test(A1B2)	0.535	0.05	Normal
	Pretest(A2B1)	0.251		Normal
	Post test(A2B1)	0.891		Normal
	Pretest(A2B2)	0.914		Normal
	Post test(A2B2)	0.423		Normal

Based on statistical data analysis using the normality test using the Shapiro Wilk test method, reaction time data and agility data obtained the data normality test results at a significance value of p> 0.05, so it can be concluded that the reaction time and agility ability data in Muaythai athletes are normally distributed .

b. Homogeneity Test

The prerequisite test that the researcher then carried out in this study was the homogeneity test which was used to test the samples in this study which had homogeneous variants (similarity) of data or did not have similar data. In the homogeneity test of this study was to use the SPSS levane test with version 25. The results of the homogeneity test of this study were as follows;

Table 5. Homogeneity Test

Sample Group		***Levene* Statistics**	**df1**	**df2**	**Sig.**	**Information**
Reaction Time	*Pre-test*	.807	3	16	.508	Homogeneous
	Post test	.486	3	16	.697	Homogeneous
Agility	*Pre-test*	.391	3	16	.761	Homogeneous
	Post test	3,309	3	16	047	Homogeneous

Based on the results of the data analysis output obtained in the table above using SPSS, the results of the data analysis for the reaction time group showed a pretest significance value of 0.508 > 0.05 and a post test significance value of 0.697 > 0.05. In the results of the analysis of homogeneity test data in the agility group, a significance value was obtained at the pretest of 0.761 > 0.05 and a post test significance value of 0.047 > 0.05, so from the results of the resulting data analysis, it can be concluded that the data groups used have the same variance or are homogeneous.

3. RESULTS OF HYPOTHESIS TESTING

The hypothesis test used in this study is based on data analysis to provide results and answers to the formulation of the problem using the MANOVA data analysis technique (multivariate analysis of variance). The description of the results of the hypothesis test is in accordance with what has been formulated as follows;

1. Differences in the Effect of Plyometric Upper Body and Plyometric Lower Body Training Models on Reaction Time and Agility in Muaythai Athletes.

The first hypothesis reads "There is a significant difference in the effect between the upper body plyometric training model and the lower body plyometric training model on reaction time in Muaythai athletes". If the results of the analysis produce a difference in effect, plyometric upper body and lower body plyometric exercises have an effect on reaction time and agility in Muaythai athletes. Based on the data analysis shown in table 14 as follows:

Table 6. The results of the Manova test differ the effect of upper body and lower body plyometric training models on reaction time and agility

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Model_ Plyometric	Pillai's Trace	.682	18.243[b]	2.000	17.000	.000
	Wilks' Lambda	.318	18.243[b]	2.000	17.000	.000
	Hotelling's Trace	2.146	18.243[b]	2.000	17.000	.000
	Roy's Largest Root	2.146	18.243[b]	2.000	17.000	.000

a. Design: Intercept + Model_Plyometric
b. Exact statistic

Based on the results of output data analysis with the Manova test in table 15 with upper body plyometric and lower body plyometric training models on reaction time and agility in Muaythai athletes. Through the 4 stages of the test carried out, namely the Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root tests, a significant p value of 0.000 <0.05 can be drawn, so it can be concluded that there are differences in the influence of upper body plyometric and lower body plyometric training models. on the ability of reaction time and agility in muaythai athletes.

The results of the analysis of the resulting data, for reaction time ability, the lower body plyometric training model gives a better effect when compared to the upper body plyometric training model with a mean value of 0.243 in the 21-24 year age group and a mean value of 0.268 in the 17 age group -20 years.

For agility abilities, the lower body plyometric training model gives a better effect when compared to the upper body plyometric training model with a mean value of 15.36 in the 21-24 year age group and a mean value of 15.44 in the 17-20 year age group. so that it can be concluded that "There are differences in the influence of upper body plyometric and lower body plyometric training modes on increasing reaction time and agility in Muaythai athletes".

2. Differences in Influence Between Age (21-24 years and 17-20 years) on Reaction Time and Agility in Muaythai Athletes.

The second hypothesis reads "There is a significant difference between age (21-24 years and 17-20 years) on reaction time and agility in Muaythai athletes". This can be seen in table 7 of data analysis as follows:

Table 7. Manova test results for differences in age (21-24 years and 17-20 years) on reaction time and agility

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Model_ Plyometric	Pillai's Trace	.682	18.243[b]	2.000	17.000	.000
	Wilks' Lambda	.318	18.243[b]	2.000	17.000	.000
	Hotelling's Trace	2.146	18.243[b]	2.000	17.000	.000
	Roy's Largest Root	2.146	18.243[b]	2.000	17.000	.000

a. Design: Intercept + Model_Plyometric
b. Exact statistic

The output results of the Manova test data as described in table 7 yield values of 21-24 years and 17-20 years of age for reaction time and agility in Muay Thai athletes. Through the 4 stages of the test carried out, namely the Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root tests, the resulting data for a significance value of p is 0.002 <0.05. So it shows that there is a significant age difference based on the age group of the sample used. The results of the analysis of the reaction time data obtained a better value with a mean of 0.243 in the 21-24 year age group compared to the 17-20 year age group with a mean value of 0.268. Agility data analysis obtained better values with a mean of 15.36 compared to the 17-20 year age group with a mean value of 15.44.

3. Is There an Interaction Between Plyometric Upper Body, Lower Body Plyometric Training Models and Age (21-24 years and 17-20 years) Against Reaction Time and Agility in Muaythai Athletes

Effect of Plyometric Training Model and the Age towards the Reaction Time and the Agility of Muaythai Atheletes

In the third hypothesis which reads "There is an interaction between upper body plyometric, lower body plyometric training models and age (21-24 years and 17-20 years) on reaction time and agility in Muaythai athletes. The results of the analysis can be seen in table 8 as follows:

Table 8. Interaction of upper body, lower body and age plyometric training models (21-24 years and 17-20 years) on reaction time and agility.

Source		*Type III Sum of Squares*	df	*Mean square*	F	Sig.
Model Latihan *Plyometric* dan Umur	*Reaction Time*	13.005	1	13.005	5.394	.002
	Agility	25.050	1	18.005	7.736	.001

Based on the results of the Manova test in table 8, the results of data analysis show that in reaction time the F value is 5.394 and the significance value of p is 0.002 <0.05, so from the results of the data analysis above it can be concluded that "There is an interaction between upper body plyometric training models, lower body plyometrics and age (17-20 years and 21-24 years) on reaction time in Muaythai athletes" has been proven. For the results of agility ability, an F value of 7,736 is obtained and a significance value of p is 0.001 <0.05, so from the results of the data analysis above it can be concluded that "There is an interaction between upper body plyometric training models, lower body plyometrics and age (17-20 years and 21-24 years) on agility in Muaythai athletes".

B. Discussion of Research Results

Discussion of the results of data analysis in research will provide a continuous and further interpretation of the results of the data analysis previously described. Based on testing the hypothesis, it produces an analysis conclusion, namely: (1) There is a significant difference in the influence of the main factor groups in the study. (2) There is no significant interaction between the main factors in the form of existing two-factor interaction. For further discussion of the results of the analysis are presented further as follows;

1. The Significant Effect of Plyometric Upper Body and Plyometric Lower Body Training Models on Reaction Time and Agility in Muaythai Athletes

Based on the results of the two-way analysis of variance data test which showed the results of the proposed hypothesis were proven by the conclusion that there was a significant difference in the effect of the plyometric upper body and plyometric lower body training models on reaction time and agility in Muaythai athletes. The resulting ability with an F value of 16.984 with a significance value of 0.001 <0.05, so it can be concluded that in reaction time there is a difference in the effect of upper body plyometric and lower body plyometric training on reaction time in Muaythai athletes. Whereas for the results of agility ability, the F value is 35.147 with a significance value of 0.001 <0.05,

In this study, the ability to react time showed that both models of plyometric training between the upper body model obtained an average value of 0.289 while the lower body model obtained an average value of 0.255 with the results of the analysis showing a difference of 0.034. Based on the difference in data obtained between upper body plyometric and lower body plyometric models, a conclusion can be drawn that upper body plyometric and lower body plyometric training models both provide an increase in reaction time with lower body plyometrics contributing a greater increase.

Whereas the results of data analysis on agility abilities show that the upper body plyometric training model obtained an average value of 16.18 and the lower body plyometric model obtained an average value of 15.40 with a data difference of 0.78, so that a conclusion can be drawn that the plyometric upper body and lower body plyometric training models both provide an increase in agility abilities in Muaythai athletes with the plyometric lower body training model providing a more significant effect.

The results of previous research (Campillo, et al, 2022: 274) implementing the plyometric training model provided an increase in reaction time ability in athletes. (Chaudhry & Jadon, 2017) states that the provision of plyometric training models provides a stimulus as well as a significant increase in agility results. (Both & Mark, 2016) the plyometric lower body training model provides stimulation to the athlete's physical condition as well as reaction time and agility abilities. The results of several

previous studies stated that in general, the lower body plyometric model will have a greater impact on the goal of increasing reaction time and agility.

2. Differences in Influence Between the Ages of 17-20 Years and 21-24 Years on Reaction Time and Agility in Muaythai Athletes

The results of the reaction time ability of muaythai athletes in this study showed that there was a significant difference in the effect of high leg muscle strength and low leg muscle strength on reaction time ability in muaythai athletes. Based on the results of data analysis using the Manova test, it was obtained that the significance value of p was 0.002 <0.05, so it can be concluded that there was a significant influence between the age groups 17-20 years and 21-24 years.

The results of the data analysis show that the average score for muayhai athletes who are 21-24 years old in reaction time is 0.257, while the average score for athletes who are 17-20 years old is 0.287 with a difference in value of 0. 03, with the results of a small difference in data so that it can be concluded that there is a significant difference between the ages of 17-20 years and 21-24 years in the ability of reaction time in Muaythai athletes.

For the agility ability of muaythai athletes, a significance value of 0.002 was obtained > 0.05, so it can be concluded that there is a significant difference in the influence of athletes in the age group 17-20 years and 21-24 years on agility in muaythai athletes. Based on the results of data analysis which showed that the average value of athletes in the age group of 17-20 years for agility abilities obtained a value of 15.75, while for the average value of athletes in the age group of 21-24 years the average value was obtained 15.83 with a difference in value of 0.08.

The results of previous studies from (Hidayat, et al, 2021), (Akbar, et al, 2021), suggest that there are differences in the results for athletes who have significantly different age ranges. (Isnanto, 2021), (Mawarni, 2021), argues that athletes who have a more mature age are significantly more mature than athletes who are relatively old for increased abilities and physical conditions. In accordance with the results of previous studies that in this study there was a significant difference between the ages of 17-20 years and 21-24 years in the reaction time of agility abilities in Muaythai athletes.

3. Interaction Between Plyometric Upper Body, Lower Body Plyometric Training Models and Age (Adults and Youth) Against Reaction Time and Agility in Muaythai Athletes

Based on the results of the analysis of research data on the reaction time ability of Muaythai athletes, the hypothesis is that there is a significant interaction between plyometric upper body, plyometric lower body and age (17-20 years and 21-24 years) on reaction time ability in Muaythai athletes and the hypothesis on agility ability which reads that there is no significant interaction between upper body plyometric, lower body plyometric and age (17-20 years and 21-24 years) on agility ability in Muaythai athletes.

In this study, the results of the interaction between paired group factors showed that there was no interaction between upper body, lower body plyometric training models and age (17-20 years and 21-24 years) on reaction time and agility. This is because there is a significant value for reaction time of 0.002 <0.05 and a significance result for agility of 0.001 <0.05 so it can be concluded that there is an interaction between upper body, lower body plyometric training models and age (17- 20 years and 21-24 years) on reaction time and agility in muaythai athletes.

CONCLUSSION

Based on the results of the research data analysis above that has been carried out, by researchers, the following research conclusions can be drawn: (1) There is a significant influence between upper body and lower body plyometric training models on reaction time and agility in Muaythai athletes, from the results of data analysis obtained the F value is 16.284 with a significance value of 0.001 <0.05, in the upper plyometric training model body obtained a pretest value of 0.301 and a post test of 0.271 while in the lower body plyometric training model a pretest value of 0.308 was obtained and a post test value of 0.243. For the agility ability of muaythai athletes, from the results of data analysis the F value was 35.147 and the significance value was 0.001 <0.05. In the upper body plyometric training model, the pretest value is 16.70 and the post test value is 16. (2) There is a significant difference between age (17-20 years and 21-24 years) in reaction time ability in Muaythai athletes, with the results of data analysis obtained an F value of 13.171 and a significance value of 0.002 <0.05. And there is a significant influence between age (17-20 years and 21-24 years) on agility abilities in Muaythai athletes with the results of data analysis with an F value of 0.380 and a significance value of 0.002 > 0.05 so it can be concluded that there is a significant influence significant relationship between high leg muscle strength and low leg muscle strength on agility in muaythai athletes. (3) There is a significant interaction between upper body plyometric, lower body plyometric training models and age (17-20 years and 21-24 years) on reaction time. The results of the data analysis were obtained at the reaction time which showed a significance value of 0.002 <0.05. And there is a significant interaction between upper body plyometric, lower body plyometric training models and age (17-20 years and 21-24 years) on agility. By obtaining the value of the results of data analysis with a significance value of 0.001

<0.05, it can be concluded that there is a significant interaction between upper body plyometric training models, lower body plyometrics and age (17-20 years and 21-24 years) low on agility.

REFERENCES

1) Akhmad, I., Supriadi, A., Dewi, R., & Swara, D. (2018). Pengaruh Pelatihan SAQ Terhadap Kecepatan dan Kelincahan Atlet Muda di X-Trail 14. Medan: Jurnal Sains dan Penelitian Internasional (IJSR).
2) Ahyar, H., Maret, U. S., Andriani, H., Sukmana, D. J., & Mada, U, G. (2020). *Buku Metode Penelitian Kualitatif & Kuantitatif* (H. Abdi (ed); Issue April). CV. Pustaka Ilmu.
3) Azmi, K & Kusnanik, N. W. (2018). *Effect of exercise program speed, agility, and quickness (SAQ) in improving speed, agility, and acceleration. Journal of Physics*. No. 947.
4) Bafirman, H. B., & Wahyuni, A.S. (2019). *Pembentukan Kondisi Fisik.* Depok: Raja Grafindo Persada.
5) Bazyler, C. D., Abbott, H. A., Bellon, C. R., Taber, C. B., & Stone, M. H. (2015). *Strength Training for Endurance Athletes*. *Strength and Conditioning Journal*, 37(2), 112. doi:10.1519/ssc.0000000000000131.
6) Bompa, T. O., & Carrera, M. (2015). *Conditioning young athletes. Champaign : Human Kinetic.*
7) Bompa, T. O. & Buzzichelli, C.A. (2018). *Periodezation: Theory and methodology of training (6th ed). Champaign, IL; Human Kinetics.*
8) Bompa, . O. (1994). *Theory and methodology of training. Toronto: Kendall/ Hunt Publishing Company.*
9) Bompa, T. O., & Haff, G. (2019). *Periodization theory and methodology of training*. USA: Sheridan Books.
10) Booth, A. M., Rhonda, O. (2016). *Effects of Plyometrics Training on Sports Performance. University of Sydney, Australia.*
11) Budiwanto Setyo, 2012. *Metodologi Latihan Olahraga*. Malang.
12) Breamaker, M.D. (2013). *Pylolfelx: Plyometrics and flexibility training for explosive martial arts kicks and performance sports. Turtle Press Washington DC.*
13) Cahyadi, M., Pudjianto, D., & Arwin, A. (2018). *Pengaruh Latihan Plyometric di Pasir Terhadap Power Otot Tungkai Siswi di SMKN 1 Kota Bengkulu Tahun 2017/2018*. Kinestetik: Jurnal Ilmiah Pendidikan, 2(1), 67-74.
14) Chu, D. A. P., & Myer, G. D. P. (2013). *Plyometrics (Heather Healy and Cynthia McEntire (ed.)). Human Kinetics.*
15) Delavier, F. (2015). *Strength Training Anatomy, Journal of Human Kinetics.*
16) Davies, G., Riemann, B. L., & Manske, R. (2015). *Current conceps pf plyometric exercise. Internasional Journal of Sports Phsyical Therapy,* 10(6), 760.
17) Danardono (2012) *Perbedaan pengaruh program latihan berbeban dan plyometrics terhadap peningkatan kime atlet karate dalam bermain kata ditinjau dari kekuatan otot tungkai (*studi eksperimen pada atlet karate di unit kegiatan mahasiswa karate inkai Universitas Negeri Yogyakarta).
18) Emral, E. (2017). *Pengantar Teori dan Metodologi Pelatihan Fisik*. Depok. Penerbit Kencana.
19) Faisal, A. D, Imam, H. Purnami, S. (2019). *Pengaruh Latihan Speed Ladder Terhadap Peningkatan Kelincahan*. *Indonesia Performance Jurnal.* 3(1), 33-38).
20) Garlock, S. (2013). Concepts of plyometric exercise. Retrieved from http://www.prorehabpc.com /…concepts-of-plyometric.
21) Hansen, D., Kennelly, S. (2017). *Plyometric Anatomy.* United States of America: *Human Kinetics.*
22) Harmandeep, S., Satinder, K., Amita, R., & Anupriya, S. (2015). *Effecta of Six Week Plyometrics on Vertical Jumping Ability of Volleyball Players. Research Journal of Phsyical Education Sciences ISSN Res. J. Physical Education,* 3(4), 2320-9011.
23) Harsono. (2015). *Kepelatihan Olahraga: Teori dan Metodologi*. Bandung: PT. Remaja Rosdakarya.
24) Hasyim, & Saharullah. (2019). *Dasar-Dasar Ilmu Kepelatihan* (Cetakan Pertama). Badan Penerbit Universitas Negeri Makassar.
25) Hidayat, R. A. (2021). *Pengaruh Latihan Ladder Drill dan Hurdle Drill Terhadap Kelincahan dan V02max Ditinjau Dari Daya Tahan Otot Tungkai Pada Atlet Bulutangkis.* Univesitas Negeri Yogyakarta.
26) Irianto, D. P. (2017). *Dasar-dasar latihan olahraga untuk menjadi atlet juara.* Yogyakarta : Pohon Cahaya .
27) Irianto, D. P. (2018). Dasar Kepelatihan. Bantul; Pohon Cahaya.
28) Jakni. (2016). *Metofologi Penelitian Eksperimen Bidang Pendidikan.* Bandung: Alfabeta.
29) Johnson B.A., C.L., S., & D.A., S. (2011). *A systematic review*: *Plyometric training programs for young children. In Journal of Strength and Conditioning Research.*
30) Jurna Ilmu Keolahragaan, Fakultas Ilmu Keolahragaan, UNIMED. 13(1). 2014.

31) Lievens, M., Bourgois, J., & Boone, J. (2020). *Periodezation of plyometric: is there an optimal overload principle. Journal of medicine and science sport*, 19,413-417.
32) Lumintuarso, R. (2013). Pembinaan Multilateral Bagi Atlet Pemula. Yogyakarta; UNY Press.
33) MacDonald, C. J. (2013). Plyometrics improve performance? The truth (guide to plyometrics) feeds. Retrieved June 11, 2015 from http://thicksolidtight.me.web
34) Nasruloh, A., Prasetyo, Y., Apriyanto, K. D. (2018). Dasar-dasar Latihan Beban. Yogyakarta: UNY Press.
35) Pomatahu, A. R. (2018). *Box Jumpa, Depth Jump Sprint, Power Tungkai Pada Cabang Olahraga Pencak Silat. 55.*
36) Pratama Dwi Rizki (2018) *Pengaruh latihan plyometrics front jump dan single leg bound terhadap peningkatan power tungkai atlet pencak silat merpati puti* SMA negeri 6 Cirebon.
37) Samodra, Y. T. J.(2021). *Analisis Kesamaan Antara Kekuatan Tungkai dan Togok. Musamus Journal of Physical Education and Sport*, 3(02), 116-124
38) Shenoy, K. B. (2019). *Effect of Plyometrics and Plyometrics Combined With Dynamic Streching on Vertical Jump in Male Collegiate Volleyball Players* 8(1).
39) Silva, A. F, Clemente, F. M. (2019). *Effect of Plyometric Training in Volley Ball in Sistematics. Journal Internasional. Environmental and Public Health Research.*
40) Sihombing, P. (2021). Pengaruh Metode Latihan *Core Strength and Stability* dan *Plyometric* Terhadap *Power* Ditinjau Dari Kekuatan Pemain Sepak Bola UNY Yogyakarta.
41) Singh, A. (2017). *Comparative study of agility, reaction time, strength and flexibility measures of volleyball and basketball players. Internasional Journal of Physiology, Nutrition and Physical Education.* Vol. 2, 270-272.
42) Sugiyono. (2015). *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.
43) Suharjana. (2018). *Latihan beban untuk kebugaran kesehatan dan performa atlet.* Yogyakarta: Pohon Cahaya.
44) Sukadiyanto. (2010). *Pengantar Teori Dan Metodologi Melatih Fisik*. Bandung: CV Lubuk Agung.
45) Susilawati, D. (2018). *Tes dan Pengukuran*. UPI. Sumedang Press.
46) Sumarsono, A. (2017). *Pengaruh Metode Latihan Agility Hurdle Drill dan Agility Leader Terhadap Koordinasi Kaki Anggota UKM Futsal Universitas Musamus Merauke*. Jurnal Pengaruh Metode Latihan (Volume 6: 1). Halaman 4..
47) Tirtawirya, D. (2005). *Metode Latihan Teknik dan Taktik Taekwondo*. Yogyakarta: Jurusan Kepelatihan Olahraga UNY.
48) Uzor, T. N & Emeahara, G. O. (2017). *Effetcs Lower and Upper Body Plyometric Training on Cardiovascular Variavles of Atheletes. Department of Human Kinetics and Health Education, Awka.*
49) Walker, B. (2014). Plyometric workouts and plyometrics exercises use plyometric exercises to develop maximum power and strength for your favorite sport. Retrieved from http://www.injuryfix.com /archives/plyometrics.
50) Wiyarto, G. (2015). Panduan Olahraga Untuk Kesehatan dan Kebugaran. Yogyakarta: Graha Ilmu.
51) Widoyoko, S. E. (2017). Evaluasi Program Pelatihan. Yogyakarta: Pustaka Pelajar.
52) Yudhistira, D. (2021). Modifikasi Model Latihan *Plyometric Upper Body* dan *Lower Body* Untuk Atlet Karate Junior. Yogyakarta: UNY Press.