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The effect of barrier hops and bench jumping exercises on increasing Inkado athletes' speed in mawashi geri

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Abstract: This study aim to determine effect of barrier hops and bench jumping exercises on increasing the speed of mawashi geri Inkado athletes, Tanjungpinang City. This study employed an experimental method with a two groups pretest-posttest design. The research population was athletes form Inkado Tanjungpinang City. The sampling technique used purposive sampling, with the criteria that (1) attendance was at least 75% (actively participating in training), (2) sampel were athletes who participated in training at Dojo Inkado Tanjungpinang City with an age range of 9-19 years, (3) gender male and female. (4) the length of the training period is at least 6 months. Based on these criteria, there were 24 people. The barrier hops hypothesis test with a significant value of 0.000, jumping up and down the bench is 0.000, and the corparison of the two experiments is 0.119. The results showed that based on the T-test found a significant value of 0.119 greater than 0.05. These results explain that there is no significant difference between the posttest barrier hops exercise and bench jump exercises for mawashi geri in Karate. The posttest average of the barrier hops group was 72.83 and the group jumping up and down the benc had an average of 74.00 seen from the difference in the posttest value of barrier hop and jumping up and down the banch is 1.167. Thus the difference in the posttest shows that jumping up and down the bench is better than barrier hops exercise to improve mawashi geri in Karate.

Keywords: barrier hops exercise, jumping up and down the bench, mawashi geri speed

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INTRODUCTION

Sports performance in karate is influenced and determined by the ability of the athletes themselves as a whole, both in terms of physical, technical, tactical and psychological capabilities (Bompa & Buzzichelli, 2015; Ilham & Dimyati, 2021; Nasrulloh et al., 2021; Srianto et al., 2014; Sumaryanti et al., 2019; Weinberg & Gould, 2015). Athletes must have these four aspects of success, one of which is the ability of leg power fitness, it is also very important to be prepared if you want to achieve high achievements (Alp & Gorur, 2020; Ballesta-García et al., 2019; Bompa & Buzzichelli, 2015).The basic movement of karate has four elements namely Stance (Dachi), Punch (Tzuki), Kick (Geri) and Parry (Uke). One of the basic moves in karate is the kick, there are many types of kicks in karate which consist of Mae-Geri (forward kick with the target of belly or head), Mawashi-Geri (kick with the instep), Yoko Geri Kekome (kick with a leg knife while pushing), Yoko Geri Keange (kick with a leg knife while brushing it) , Usiro-Geri (kick with a backward direction) (Franchini et al., 2014; Loturco et al., 2017).

Kicking is one of the techniques used in matches to produce a high score (Fajar et al., 2023; Franchini et al., 2014; Ihsan et al., 2023; Latif et al., 2022; Rodríguez-Lorenzo et al., 2016). Kick is an attack performed using the leg as the attacking element. With high leg power, athletes will produce the right kick, and kick tactics, kicking ability will make the kick effective and targeted (Alborno et al.,

2017; Antonaccio et al., 2022; Atis et al., 2018; Lassalvia et al., 2021; Santos et al., 2021; Schwartz et al., 2015).

Based on observations as well as information from the field of directing and also from coaches, several karate championships between students and the general public in which INKADO karate athletes have participated in the city of Tanjungpinang, where during the fight the athletes lack the courage to kick effectively, especially the mawashi kick which is often used by all athletes, this attack will be easily anticipated by the opponent. Finally, these karatekas will often lose easily by getting points. At the time of training and testing, many mawashi geri were off target and the mawashi geri lacked speed. This is due to the lack of explosive power of the leg muscles when performing the mawashi kick. The training program that has been implemented so far has provided squirting exercises so that the explosive power of the leg muscles is not optimal when practicing mawashi geri and athletes lack confidence to perform these movements so that the achievements made by the Inkado athletes in Tanjungpinang City are not satisfactory and the athletes become bored to train.

Barrier Hops training aims to train strength and speed (power) together using the athlete's own core body weight, which aims to connect the maximum strength the athlete already possesses to the application fast and strong (powerful) movements according to nature. some sport. Barrier jumps are exercises that are performed in a series of rapid. Barrier Hops training is a movement performed on goal hurdles or high obstacles (between 30 and 90 cm) placed on a line with a distance determined by ability. The obstacle will fall if the athlete makes a mistake, the start begins by standing behind the obstacle, the movement of jumping over the obstacle with both feet together. The movement begins with stretching the waist and knees, then uses the swing of both arms to maintain balance and reach height.

The barrier hops exercise emphasizes jumping to achieve maximum vertical height and leg movement speed. The barrier hops exercise trains power which is a combination of two elements, namely speed and strength (Ojeda-Aravena et al., 2021). Mawashi Geri uses more explosive power from the leg muscles, so it is necessary to provide training to these muscles. Barrier jumping is a workout to increase explosive power. The training performed in this study was barrier hop 5 reps 4 sets and 8 reps 2 sets. The purpose of this study was to compare barrier hop 5 reps 4 sets and 8 reps 2 sets to increase mawashi geri speed.

Bench jumping is also one of the plyometric exercises that can be used to improve the athlete's leg muscle power. It can be explained that plyometrics is a training method that focuses on high-speed movements. Plyometrics is a specific exercise to increase jumping ability which is complemented by stretching exercises and shortening the onset of muscle contractions, this elastic energy is then reused to shorten the activity of the muscles to become stronger (Fajar et al., 2023). To determine which exercises are most effective in increasing the speed of the mawashi geri therefore, the purpose of this study was to determine if there was a difference in the treatment administered between barrier hopss and stepping up and down from the bench on increasing the speed mawashi geri of Inkado karate athletes in the city from Tanjungpinang.

METHODS

This study used the quacy experimental method and designed with the two-group pre-test – post-test design (Montgomery, 2013). This research was conducted at the Tanjungpinang City Dojo in the Tanjungpinang City Temple Award Building, Riau. The implementation is carried out for one month, starting on March 27, 2023. The population of this study consisted of inkado karate athletes from Tanjungpinang city who were prepared for each championship in 2023, totaling 24 male and female athletes between the ages of 9 and 19, with details of 6 male athletes between the ages of 9 to 12 years old, 4 female athletes. 9-12 years old, 4 male athletes aged 13-15, 5 male athletes aged 16-18, 5 female athletes aged 16-19. The purposive sampling technique was used in this study with the following criteria: (1) Listing as an inkado athlete in Tanjungpinang City; (2) To have taken part in at least one event in a championship; (3) Attendance of at least 75% (active participation in TC); (4) Age range 9-19 years old; (5) Male and female sex. Based on these characteristics, the number of samples that meet the requirements is 20 male and female athletes. All samples divided into two treatment groups by ranking the value of the pretest results and matched using the A-B-A-B or called ordinal matching pattern. so that each group consists of 12 athletes. Ordinal matching is the division of groups with the goal that both groups have equal abilities (Montgomery, 2013; Rahman et al., 2018).

Table 1. Research Design

Group Name	Pretest	Treatment	Posttest
A	A1	X1	A2
B	B1	X2	B2

Information:

A and B = Treatment given to the group
A1 and B1 = Initial measurement (Pretest)
X1 and X2 = Treatment
A2 and B2 = Post measurement (Postest)

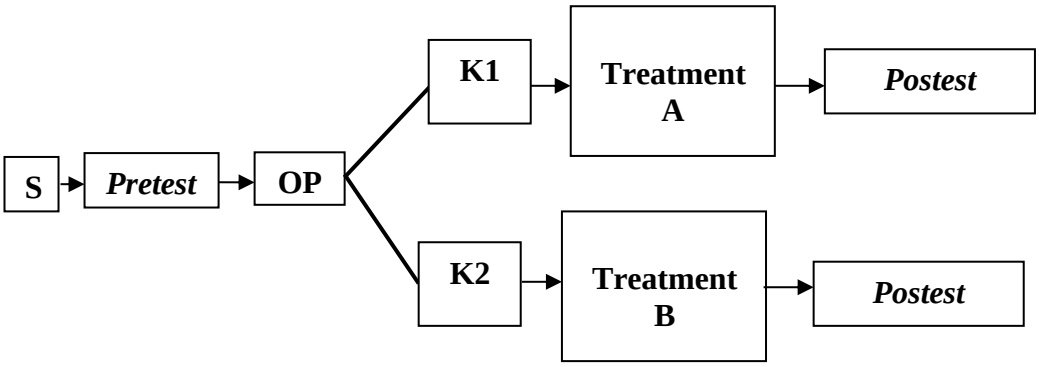

Figure 1. Research Design of Two Groups Pretest-Posttest Design

Information:
S : Participant
Pretest : Initial test of speed kick Mawashi performance
OP : Ordinally Matched Pairing of initial test (Pretest)
K1 : Group 1
K2 : Group 2
Treatment A : Barrier Hops methods
Treatment B : Bench jump method up and down
Posttest : Post-test Mawashi Geri performance

The data collection techniques were consistent with the research design, so there were two data points that need to be collected: data on the mawashi's ability to kick before and after treatment. To obtain data on the ability of the mawashi kick used in this study, a test of the ability of the mawashi kick was recorded within seconds (See Table 2).

Table 2. Mawashi Kick Ability Assessment Standard

Time (second) Men	Category	Time (Secod) Women
<2.12	Very Good	<2.60
2.56 - 2.13	Good	3.14 – 2.61
3.01 - 2.57	Accetable	3.67 – 3.15
3.46 – 3.02	Poor	4.20 – 3.68
>3.47	Very Poor	>4.21

The treatment was to be a bridge for researchers to move from hypothesis to obtaining valid and scientific quasi-experimental results, the treatment was administered for 18 meetings in 4 weeks to Inkado athletes in Tanjungpinang city. The pre-test was held on March 27, 2023, by measuring the left-right mawashi geri for one minute how much Tanjungpinang city athlete Inkado got. Then, divided into two groups using the A-B-A-B pattern. Give a barrier hop treatment to group A and move up and down benches to group B starting March 29, 2023. The final test performed on April 20, 2023. In the final phase, the researcher performs an internal competition or commonly referred to as a simulation

and then collects and processes the data of the results of the pre-test and post-test to find the results of the hypothesis by looking for the class intervals, the pre-tests of normality and homogeneity and the tests of the hypothesis. To find the Mawashi Geri speed test interval class, the researchers used the 5 scales formula. To collect data on the ability of mawashi kicks called "test judge"

RESULT AND DISCUSSION

Preliminary data (pre-test) the effect of berrier hoops training on improving mawashi geri karate sports can be showed in Table 3.

Table 3. Barrier Hops Group Pre-test Data

Interval Class	Pre-est	Persentage
61-63	1	8%
64-66	4	33%
67-69	3	25%
70-72	2	17%
73-75	2	17%
Total	12	100%

Based on the results of the pre-test distribution of mawashi geri in the bay hoops group with a sample of 12 athletes above, there was 1 athlete who was in the 61-63 interval class with a percentage of 8 %. There were 4 athletes in the 64-66 interval class with a percentage of 33%, there were 3 athletes in the 67-69 interval class with a 25% percentage, there were 2 athletes in the class interval 70-72 with a percentage of 17%, while in the interval class 73-75 no athlete with a percentage of 17%. For more details, data from the hula-hoops group pretest on improvement in mawashi geri in karate can be seen in the Figure 2.

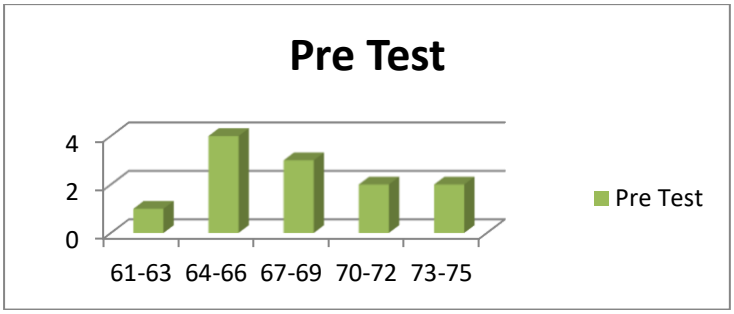

Figure 2. Pre-test of Berrier Hoops Training on Improving Mawashi Geri

Post-test) The effect of weight-bearing hoops training on improving Mawashi Geri in karate sports can be shown in Table 4.

Table 4. Post Test Data of Barrier Hops Group

Interval Class	Post-Test	Percentage
67-69	3	25%
70-72	3	25%
73-75	2	17%
76-78	2	17%
79-81	2	17%
Total	12	100%

Based on the results of the mawashi geri post-test distribution data in the bay hoops group with a sample of 12 athletes above, there were 3 athletes who were in the 67-69 interval class with a percentage of 25 %. There were 3 athletes in the 70-72 interval class with a percentage of 25%, there were 2 athletes in the 73-75 interval class with a 17% percentage, there were 2 athletes in the class interval 76-78 with a percentage of 17%, while in the interval class 79-81 there were no athletes with a percentage of 17%.

For more details, data from the hoop group wearer pretest on the improvement of mawashi geri in karate can be seen in the Figure 3.

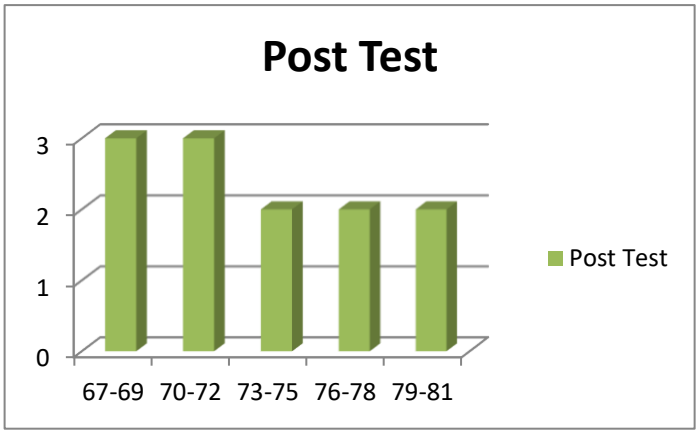

Figure 3. Post-test of Berrier Hoops Exercise on Improving Mawashi Geri

Preliminary data (pre-test) effect of up and down bench exercise on the improvement of Mawashi Geri in karate sports can bee seen in Table 5**.**

Table 5. Pre-test Data of Up and Down Bench Groups

Interval Class		Pre-test	Percentage
62	64	3	25%
65	67	3	25%
68	70	2	17%
71	73	4	33%
74	76	0	0%
Total		12	100%

Based on the results of the Mawashi Geri pre-test distribution data in the high and low bench group with a sample of 12 athletes above, there were 3 athletes who were in the 62-64 interval class with a percentage of 25%. There were 3 athletes in the 65-67 interval class with a 25% percentage, there were 2 athletes in the 68-70 interval class with a 17% percentage, there were 4 athletes in the class interval 71-73 with a percentage of 33%, while in the interval class 74-76 there were no athletes with a percentage of 0%. For more details, the pretest data for the hula-hoops group on the increase in mawashi geri in karate can be seen in the Figure 4.

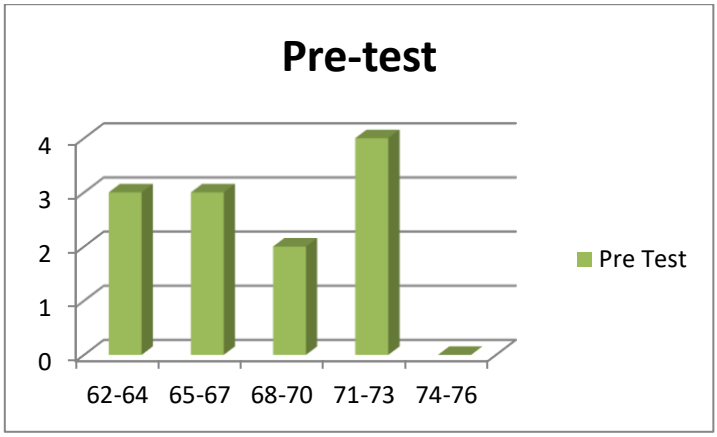

Figure 4. Pre-Test of Bench Up and Down Exercise on Improvement in Mawashi Geri

Preliminary data (post-test) The effect of up and down bench exercise on improving Mawashi Geri karate sports can be seen in Table 6.

Table 6. Post-test Data of Up and Down Bench Groups

Interval Class	Pre-test	Percentage
68-70	3	25%
71-73	3	25%
74-76	2	17%
77-79	4	33%
80-81	0	0%
Total	12	100%

Based on the results of the mawashi geri post-test distribution data in the high and low bench group with a sample of 12 athletes above, there were 3 athletes in the 68-70 interval class with a percentage of 25%. There were 3 athletes in the 71-73 interval class with a percentage of 25%, there were 2 athletes in the 74-76 interval class with a 17% percentage, there were 4 athletes in the class interval 77-79 with a percentage of 33%, while in the interval class 80-81 there were no athletes with a percentage of 0%. For more details, data from the hula-hoops group pretest on improvement in mawashi geri in karate can be seen in the histogram below.

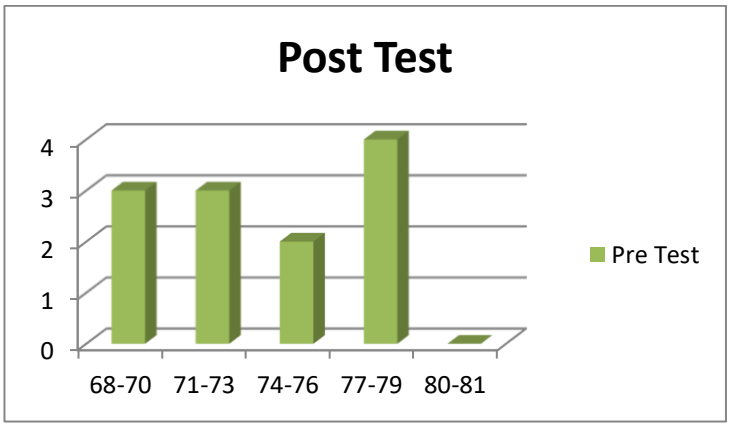

Figure 5. Post-test of Bench up and down exercise on improving Mawashi Geri

Before performing the hypothesis test, a preliminary test was performed, namely, to determine whether the data has a normal distribution, it was necessary to perform a normality test using the Kolmogorv Smirnov formula using the SPSS 25 software with the results in Table 10.

Table 7. Normality Test of the Data

Group	*P*	Significant	Information
Pre-test of Barrier Hop	0,200	0,005	Normal
Post-test of Barrier Hop	0,200	0,005	Normal
Pre-test Bench up and down exercise	0,200	0,005	Normal
Post-test Bench up and down exercise	0,200	0,005	Normal

Based on the results of the normality test in Table 7, it was found that all data had a significance value > 0.05 with these results, the data was normally distributed. Since all the data was normally distributed, the analysis can be continued with the home cognitive test.

Homogeneity test was a requirement test because a sample tester has uniformity or not. The rule of the sample homogeneity test was that if it was significant > 0.05, the test data was said to be homogeneous and if it was significant, 0.05, the test data was said to be inhomogeneous. The results of the homogeneity test are visible in Table 8 below.

Table 8. Homogenity Testing Result

Group	Df1	Df2	Significant	Information
Group X1	1	22	0.847	Homogen
Group X2	1	22	0,732	Homogen

Based on the analysis of the homogeneity test in the variable group X1 and the variable group X2 (see Table 8), the results found a significant value > 0.05 so that it can be said to be homogeneous.

Test the hypothesis of this study using the paired t test which aims to know if there was a difference between the two paired samples with two different data and the independent test which aims to know if there was a mean difference in the two groups of variables. In carrying out this test, it was performed using the SPSS 25 program.

Comparison of initial and final tests of Berrier Hoops training on increasing the speed of Mawashi Geri karate sports

Based on the paired t test in Table 9, a significant value of 0.000 was found which was less than 0.05, so this result indicated that there was a significant difference. Thus, training with the barrier hoops of the alternative hypothesis (Ha) has a significant effect on mawashi geri karate. With the pre-test having an average of 67.50 and the post-test having an average of 72.83. The magnitude of the effect of training with barrier hoops on mawashi geri karate sports with an average value of 5.333 with a total percentage of 7.3%.

Table 9. Paired T-test Berrier Hoops Group Test

Group	Mean	T-test		
		Significant	Difference	Percentage
Pre-test	67,50	0,000	5,333	7,3%
Post-test	72,83			

Comparison of the initial test and the final test of the practice of going up and down on the bench to increase the speed of Mawashi Geri Karate.

Based on the paired t test in Table 10, a significant value of 0.000 was found which was less than 0.05, so this result indicated that there was a significant difference. Thus, the alternative hypothesis (Ha) the exercise of going up and down from the bench has a significant effect on mawashi geri karate. With the pre-test having an average of 67.92 and the post-test having an average of 74.00. The magnitude of the effect of training with barrier hoops on mawashi geri karate sports with an average value of 6.083 with a total percentage of 8.2%.

Table 10. Bench Up and Down Group Paired t test

Group	Mean	T-test		
		Significant	Difference	Percentage
Pre-test	67,92	0,000	6,083	8,2%
Post-test	74,00			

Comparison of Barrier Hoops Final Test and Bench Up and Down Exercises on Mawashi Geri Speed Improvement

Based on the t-test in Table 11, a significant value of 0.119 was found, greater than 0.05. These results explained that there was no significant difference between the post-test exercise of the barrier hoops and the climbing and descending exercises on the mawashi geri in karate. The post-test average for the barrier hopps group was 72.83 and the up and down group had an average of 74.00. Judging by the difference in the post-test value of the barrier hoops exercise and the bench exercise was 1.167. Thus, the difference in the post-test results shows that the stepping up and down bench exercise was better than the barrier hoops exercise for improving mawashi geri in karate.

Table 11. Paried Test Final Barrier Hoops Drills and Drills

Group	Percentage	T-test	
		Significant	Difference
Barrier Hoops	7,3%	0,119	1,167
Bench up and down	8,2%		

The objective goal obtained in this research was to increase the speed of kicking in the sport of karate, namely Mawashi Geri, by providing a combination of power training programs. The novelty in this research was found in each of the variables studied, for example, typically barrier hops and bench jumping training programs were used separately, and there was minimal variation in the training program provided.

Based on the results of the known t-test analysis, several things can be concluded, there is an increase in mawashi speed as a result of processing the training method of barrier jumps and up and down jumps from the bench which was performed for 18 games against Inkado athletes in the city of Tanjungpinang. Based on the research results of barrier hop training method which showed a significant effect in increasing the speed of mawashi geri athletes from Inkado, Tanjungpinang City, with a 7 percent increase 3%.

The barrier hop training method is the process of giving pre-tested athletes a treatment to increase explosive power, ankles, strength, endurance and speed so they can do the mawashi geri correctly and perfectly so that there is an increase in speed mawasi geri. Plyometric training (barrier jumps) is an exercise that aims to increase the speed and strength required by an athlete (Bompa & Buzzichelli, 2015; Fearnbach et al., 2020; Klug et al., 2018; Pinto et al., 2019; Reisberg et al., 2021; Sidik & Rosdiana, 2023; Streb et al., 2019). This means that to perform well, an exercise must be done with a series of exercises such as the barrier jumping exercise which is done repeatedly in order to increase the speed of the mawashi geri.

The training form given is not just one form of exercise, but there were several forms of barrier jump training. The barrier hops training form provided includes barrier jump training with forward facing with two legs, one leg, side facing, different jump distances, variable barrier jump height, kicks with jumps barrier in front of the feet with a training intensity of 70-90%. The increase in mawashi geri speed occurs because there is a source of knowledge that the athlete gets in the first meeting and with this new knowledge the athlete is excited to do the exercise at many times.

Based on the research results of the jump training method which showed a significant effect in increasing the speed of mawashi geri athletes from Inkado, Tanjungpinang City, with an increase of 8 percent, 2%. The up and down jump training method is also a treatment process for athletes who have pretested to increase explosive power, ankles, feet, strength, endurance and speed so that they can do the mawashi geri correctly and perfectly so that there is an increase in speed mawasi geri (Wang & Zhang, 2016). Plyometric training (jumping off the bench) is an exercise that aims to increase the speed and strength required by an athlete (Agostini et al., 2017; Ramirez-Campile et al., 2019; Watkins et al., 2021). Exercise to develop endurance with the characteristics of 60%-80% load intensity, with high load volume and high repetitions, 45-90 seconds of rest intervals per set, and the effect of the resulting workout is an increase in endurance and strength. It means that the bench jumping up and down form is performed the same way as the barrier jumping exercise and the difference in this exercise is that the exercise intensity is 60-80%, 5 to 8 repetitions and the number of sets is 4. This exercise is performed repeatedly in order to increase the speed mawashi geri.

Based on the results of the study, it showed that the top-down jumping bench training method was better than the barrier jumping training method on increasing the speed of mawashi geri with an average difference of 1.167. Based on the number of samples to be the main condition to be considered in the concept of generalization. The number and variety of barrier jumping exercises must be added in order to avoid boredom. The use of safer facilities is recommended given the explosive nature of training activities. Based on the study results, it showed that the barrier jumping exercise and the bench jumping up and down both had a significant effect, but the bench jumping exercise was better and faster. to

increase the speed of mawashi geri than the barrier jumping exercise with an average. difference of 1.167. Therefore, it can be considered by trainers and future researchers to increase the speed of mawashi geri karate athletes.

CONCLUSSION

From the description and results of data analysis of Inkado athletes' mawashi geri speed in Tanjungpinang city, it can be concluded that there was a significant effect of barrier jump training on the increased mawashi geri speed of Inkado athletes in Tanjungpinang City. There was a significant effect of jumping up and down on the bench to increase the speed of mawashi geri athletes from Inkado, Tanjungpinang City. Jumping up and down the bench was better than barrier jumping exercise in increasing the speed of mawashi geri athletes from Inkado, Tanjungpinang City, with an average difference of 1.167%. Articles should use at least 30 recent primary references (high impact factor international references recommended).

REFERENCES

Agostini, B. R., Palomares, E. M. D. G., Andrade, R. D. A., Uchôa, F. N. M., & Alves, N. (2017). Analysis of the influence of plyometric training in improving the performance of athletes in rhythmic gymnastics. *Motricidade*, *13*(2), 71–80. https://doi.org/10.6063/motricidade.9770

Alborno, P., De Giorgis, N., Camurri, A., & Puppo, E. (2017). Limbs synchronisation as a measure of movement quality in Karate. *ACM International Conference Proceeding Series*, *Part F1291*. https://doi.org/10.1145/3077981.3078027

Alp, M., & Gorur, B. (2020). Comparison of Explosive Strength and Anaerobic Power Performance of Taekwondo and Karate Athletes. *Journal of Education and Learning*, *9*(1), 149. https://doi.org/10.5539/jel.v9n1p149

Antonaccio, R. F., Machado, F. S. M., & da Silva Santos, J. F. (2022). Kinesiology & Coaching. *Ido Movement for Culture*, *22*(3), 1–5. https://doi.org/10.14589/ido.22.3.1

Atis, E., Gelen, E., & Yildiz, S. (2018). The acute effect of different frequencies of whole-body vibration on range of motion and jump performance in preadolescent karate athletes. *Turkish Journal of Sport and Exercise*, 122–126. https://doi.org/10.15314/tsed.418996

Ballesta-García, I., Martínez-González-Moro, I., Rubio-Arias, J. Á., & Carrasco-Poyatos, M. (2019). High-Intensity Interval Circuit Training Versus Moderate-Intensity Continuous Training on Functional Ability and Body Mass Index in Middle-Aged and Older Women: A Randomized Controlled Trial. *International Journal of Environmental Research and Public Health*, *16*(21). https://doi.org/10.3390/ijerph16214205

Bompa, T., & Buzzichelli, C. (2015). *Periodization training for sports, 3e*. Human kinetics.

Fajar, M. K., Rusdiawan, A., & Ar Rasyid, M. L. S. (2023). Improving leg power and Dolyo Chagi kick speed in Taekwondo using plyometric, SAQ, and circuit training methods. *Jurnal Keolahragaan*, *11*(1), 87–94. https://doi.org/10.21831/jk.v11i1.57955

Fearnbach, S. N., Martin, C. K., Heymsfield, S. B., Staiano, A. E., Newton, R. L. J., Garn, A. C., Johannsen, N. M., Hsia, D. S., Carmichael, O. T., Ramakrishnapillai, S., Murray, K. B., Blundell, J. E., & Finlayson, G. (2020). Validation of the Activity Preference Assessment: a tool for quantifying children's implicit preferences for sedentary and physical activities. *The International Journal of Behavioral Nutrition and Physical Activity*, *17*(1), 108. https://doi.org/10.1186/s12966-020-01014-6

Franchini, E., Loturco, I., Artioli, G. G., Kobal, R., & Gil, S. (2014). Predicting Punching Acceleration From Selected Strength and Power Variables in Elite Karate Athletes:Amultiple Regression Analysis. *Journal of Strength and Conditioning Research*, *28*, 1826–1832.

Ihsan, N., Satria, R., Sazeli Rifki, M., Komaini, A., & Ilham, I. (2023). Development of a Digital-Based Tool to Measure Volleyball Players' Upper Limb Muscle Explosive Power. *Sport Mont*, *21*(1),

87–97. https://doi.org/10.26773/smj.230214

Ilham, I., & Dimyati, D. (2021). The Effect of Visualization, Relaxation, and Self-efficacy on the Performance of Men Speed World Record Athletes Category. *International Journal of Human Movement and Sports Sciences*, *9*(1), 48–55. https://doi.org/10.13189/saj.2021.090107

Klug, L., Mähler, A., Rakova, N., Mai, K., Schulz-Menger, J., Rahn, G., Busjahn, A., Jordan, J., Boschmann, M., & Luft, F. C. (2018). Normobaric hypoxic conditioning in men with metabolic syndrome. *Physiological Reports*, *6*(24), e13949. https://doi.org/10.14814/phy2.13949

Lassalvia, C. E., Julio, U. F., & Franchini, E. (2021). Effects of simulated kata competition on upper- and lower-body power tests performance. *Revista de Artes Marciales Asiaticas*, *16*(2), 89–99. https://doi.org/10.18002/rama.v16i2.6389

Latif, R. A., Yusoff, Y. M., Tumijan, W., Linoby, A. F. L. R., & Yoyok, S. (2022). Injury in Martial Art Activities: Focusing on Pencak Silat Athletes. *Ido Movement for Culture*, *22*(2), 53–62. https://doi.org/10.14589/ido.22.2S.7

Loturco, I., Nakamura, F. Y., Lopes-Silva, J. P., Silva-Santos, J. F., Pereira, L. A., & Franchini, E. (2017). Physical and physiological traits of a double world karate champion and responses to a simulated kumite bout: A case study. *International Journal of Sports Science and Coaching*, *12*(1), 138–147. https://doi.org/10.1177/1747954116684395

Montgomery, D. C. (2013). Design and Analysis of Experiments. In L. Ratts, L. Buonocore, A. Melhorn, C. Ruel, H. Nolan, & M. Eide (Eds.), *Design* (8th ed., Vol. 2). John Wiley & Sons, Inc. http://cataleg.uab.cat/record=b1764873~S1*cat

Nasrulloh, A., Yuniana, R., & Pratama, K. W. (2021). The effect of skipping combination with body weight training on cardiorespiratory endurance and body mass index (BMI) as a covid-19 prevention effort for overweight adolescents. *Jurnal Keolahragaan*, *9*(2), 220–230. https://doi.org/10.21831/jk.v9i2.41678

Ojeda-Aravena, A., Herrera-Valenzuela, T., Valdés-Badilla, P., Martín, E. B. S., Cancino-López, J., Gallardo, J. A., Zapata-Bastías, J., & García-García, J. M. (2021). Effects of High-Intensity Interval Training With Specific Techniques on Jumping Ability and Change of Direction Speed in Karate Athletes: An Inter-individual Analysis. *Frontiers in Physiology*, *12*(November). https://doi.org/10.3389/fphys.2021.769267

Pinto, R., Angarten, V., Santos, V., Melo, X., & Santa-Clara, H. (2019). The effect of an expanded long-term periodization exercise training on physical fitness in patients with coronary artery disease: study protocol for a randomized controlled trial. *Trials*, *20*(1), 208. https://doi.org/10.1186/s13063-019-3292-9

Rahman, M. S., Helgadóttir, B., Hallgren, M., Forsell, Y., Stubbs, B., Vancampfort, D., & Ekblom, Ö. (2018). Cardiorespiratory fitness and response to exercise treatment in depression. *BJPsych Open*, *4*(5), 346–351. https://doi.org/10.1192/bjo.2018.45

Ramirez-Campile, R., Alvarez, C., Felipe, G.-P., Garcia-Ramos, A., Loturco, I., Chaabene, H., & Granacher, U. (2019). Eeffetcs of Cimbined Surfaces vs Single Surface Plyometric Training on Soccer Players' Physical Fitness. *Journal of Strength and Conditioning Research*, *34*(9), 2644–2653.

Reisberg, K., Riso, E.-M., & Jürimäe, J. (2021). Physical Activity, Fitness, and Cognitive Performance of Estonian First-Grade Schoolchildren According Their MVPA Level in Kindergarten: A Longitudinal Study. *International Journal of Environmental Research and Public Health*, *18*(14). https://doi.org/10.3390/ijerph18147576

Rodríguez-Lorenzo, L., Fernandez-Del-Olmo, M., & Acero, R. M. (2016). Strength and Kicking Performance in Soccer: A Review. *Strength and Conditioning Journal*, *38*(3), 106–116. https://doi.org/10.1519/SSC.0000000000000223

Santos, M. A. P. dos, Cabido, C. E. T., Silvino, V. O., Mesquita, A. R. de, Nascimento, F. L. S. do,

Neto, S. L. de A., Goulart, K. N. de O., Szmuchrowski, L. A., & Pena, B. C. (2021). Validity of the Polar V800 to measure vertical jump performance in taekwondo athletes. *Ido Movement for Culture*, *21*(1), 12–18. https://doi.org/10.14589/ido.21.1.3

Schwartz, J., Takito, M. Y., Del Vecchio, F. B., Antonietti, L. S., & Franchini, E. (2015). Health-related physical fitness in martial arts and combat sports practitioners. *Sport Sciences for Health*, *11*(2), 171–180. https://doi.org/10.1007/s11332-015-0220-6

Sidik, D. Z., & Rosdiana, F. (2023). Reverse Periodization Model to Increase Anaerobic and Aerobic Capacity. *International Journal of Human Movement and Sports Sciences*, *11*(1), 65–70. https://doi.org/10.13189/saj.2023.110108

Srianto, W., Sd, P., Mulia, B., Yogyakarta, D., & Yogyakarta, U. N. (2014). Pengembangan Model Latihan Karate Kids Pada Anak Usia Sekolah Dasar Kelas Atas Developing A Karate Kids Training Model For Higher Primary School Age Children. *Jurnal Keolahragaan*, *2*(2), 228.

Streb, A. R., da Silva, R. P., Leonel, L. D. S., Tozetto, W. R., Gerage, A. M., Benedet, J., Delevatti, R. S., Turnes, T., & Del Duca, G. F. (2019). Comparison of linear periodized and non-periodized combined training in health markers and physical fitness of adults with obesity: Clinical trial protocol. *Contemporary Clinical Trials Communications*, *15*, 100358. https://doi.org/10.1016/j.conctc.2019.100358

Sumaryanti, Tomoliyus, & Ndayisenga, J. (2019). Circuit training intervention for adaptive physical activity to improve cardiorespiratory fitness, leg muscle strength static and balance of intellectually disabled children. *Sport Mont*, *17*(3), 97–100. https://doi.org/10.26773/smj.191019

Wang, Y. C., & Zhang, N. (2016). Effects of plyometric training on soccer players. *Experimental and Therapeutic Medicine*, *12*(2), 550–554. https://doi.org/10.3892/etm.2016.3419

Watkins, C. M., Storey, A. G., McGuigan, M. R., & Gill, N. D. (2021). Implementation and Efficacy of Plyometric Training: Bridging the Gap between Practice and Research. *Journal of Strength and Conditioning Research*, *35*(5), 1244–1255. https://doi.org/10.1519/JSC.0000000000003985

Weinberg, R. S., & Gould, D. (2015). Foundations of Sport and Exercise Psychology. In M. Schrag, A. S. Ewing, C. A. Gentis, & A. Cole (Eds.), *Human Kinetics* (6th ed.). Human Kinetics. https://doi.org/10.1123/jsep.20.3.336