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# Effectiveness body weight strength training and plyometric in the speed and agility taekwondo athletes

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**Abstract**

From the observation of 24 athletes Taekwondo Jayabaya produced as much as 79.1% - 95.8% of athletes have the physical ability, especially the speed and agility under average value. This study aims to determine the effectiveness of exercises body weight strength training and plyometric to increase physical ability. The study used an experimental research method with a quasi-experimental type using a 2x2 factorial design. The sampling technique used purposive sampling based on inclusion criteria. The total number of samples used is 24 athletes who will be divided into 2 exercise groups. The study was conducted on the Jayabaya Taekwondo team for 6 weeks. Data collection techniques used 35 meters speed test and Illinois agility run test. Variable variance analysis using MANOVA test. In the MANOVA test, the value is obtained sig. multivariate test (0.00) and between subjects effects test of exercise on speed and agility (0.00). The results of descriptive statistics on exercises body weight strength training and plyometric on speed time (5.12)>(4.57), and agility time (19.53)> (17.64). The conclusion of this study is that body weight strength training and plyometric exercises significantly affect the physical ability of taekwondo athletes.training was Plyometric more effective in increasing the speed and agility of taekwondo athletes during the 6-week training program.

**Keywords:** Body weight strength training, Plyometric, Speed, Agility.

## INTRODUCTION

Taekwondo is one of the martial arts originating from Korea which was discovered 2000 years ago (Arazi *et al.,* 2016), Taekwondo has developed into a popular sport in the world (Ipekoglu *et al.,* 2018). Taekwondo was officially competed at the *Olympics* in Sydney, Australia in 2000 (Santos *et al.*, 2019). Taekwondo sport is favored by various age levels which aim to maintain fitness, train balance, flexibility, strength and health (Hammami *et al*., 2018). Movements in taekwondo have specifications for kicking techniques, body rotation and *pivoting* on one leg. The ability to produce fast kicks and strong as well as coordination and

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stability of movement to changes in body position when attacking and defending is strongly influenced by the level of physical fitness of athletes (Fong & Tsang, 2012). To get maximum speed, strength and dynamic control of body posture, an athlete needs to optimize the performance of muscles and the system *neuromuscular* (Jlid *et al.*, 2016).

Taekwondo sports include martial arts and sports *body contact* where an athlete has the goal of attacking an opponent with maximum strength (Johari & Bagherian, 2020), using *dynamic kicking* from various directions with strong movements (Santos *et al.*, 2019). Taekwondo has an performance form *intermittent* with a mechanism *short-term high-intensity* (Lopes-Silva *et al*., 2018). To achieve success in a match requires explosive muscle strength, the ability to produce force (Gorur & Alp, 2020), kick motion speed high motion acceleration, and *power* (Khayyat *et al.*, 2020). The high intensity of muscle work is influenced by metabolism *anaerobic* where energy production is supplied by the breakdown of *phosphocreatine* (PCr) and *glycolysis* (Lopes-Silva *et al*., 2018). In taekwondo, high-intensity strengthening exercises are needed to support the physical of each athlete. High-intensity exercise has an form of exercise *intense* with an intensity of >80% of the *maximal heart rate* (Marzuca-Nassr *et al*., 2020). The preparation of the exercise program is adjusted to the exercise variables which include frequency, *volume*, intensity and exercise design such as ratio *work-and-rest* , exercise type and method, and repetition acceleration (Kilen *et al*., 2020).

Physical fitness is an important factor for showing high performance. The physical ability of taekwondo athletes consists of several components including balance, agility, endurance (Fachrezzy *et al.,* 2021), strength *anaerobic*, flexibility, speed and muscle explosive power (Khayyat *et al*., 2020). This study focuses on increasing the physical ability of speed and agility in taekwondo athletes. Speed is the physical ability to move and change body positions quickly in one direction or change direction. These components are an important part in all sports (Bompa, 2019), including taekwondo. Taekwondo is famous for its high


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kicks (Khayyat *et al.*, 2020), and the speed of kick execution and has dynamic leg movements when attacking and defending, these three factors are basic components that athletes must have and play an important role in achieving success in sports taekwondo (Wazir *et al*., 2019). In a taekwondo competition, athletes must have the ability to move quickly and have high energy, and must have several other important components such as endurance *aerobic* and *anaerobic*, strength, explosive power, flexibility, speed and agility (Khayyat *et al*., 2020). Agility is a complex work system that is interconnected between one system and another in the body (Bompa, 2019) and is a basic component that taekwondo athletes must possess (Akin & Kesilmiş, 2020). Taekwondo sport requires an agility component to change body position, attack the opponent and defend by doing a lot of dynamic movements such as sideways, forward and backward which are done at high speed. To achieve success in changing positions quickly,need muscle flexibility, agility and endurance *anaerobic* taekwondo athletes (Goodarzi *et al.,* 2020).

To achieve an optimal increase in athletes' physical abilities, one of the components that need to be fostered and trained is physical condition. Physical condition is the most important factor in achieving the highest achievement for athletes (Paramitha *et al.,* 2020). So that an effective training method is needed to improve the physical abilities of taekwondo athletes, one of which is *body weight strength training* and *plyometrics*. Exercise *and body weight strength training* is one method of exercise that can increase the power capacity in taekwondo athlete (Marzuca-Nassr *et al.*, 2020). *Body weight strength training* has the characteristics of the basic movements to push and pull the body against gravity. The gravitational pull during exercise increases the load on the body optimally so that it can progressively provide resistance during exercise (Chaabene *et al*., 2020). From the results of research, exercises *body weight strength training* as much as 6-8 repetitions for 8-12 weeks can affect the improvement of adaptation *neuromuscular* and increase *hypertrophic*

muscle in taekwondo athletes (Roussel *et al.*, 2020). This research is also supported by the results of *body weight strength training* for 20 minutes with an intensity of 80-95% of the *maximal heart rate* can reduce fat mass in the legs and increase muscle mass in taekwondo athletes (Carneiro *et al*., 2018). Another benefit of *body weight strength training training* 2 times a week for 8 weeks results in an increase in the speed of running *sprint,* and the speed of change in the direction of motion (Makhlouf *et al.,* 2018). Another study conducted on 55 Korean Taekwondo Association athletes with an age range of 15-18 years, with a *body weight strength training program* using the HIIT method for 4 weeks can have an impact on increasing the ability of *stroke volume* in the system *cardiovascular* and improving performance *musculoskeletal* which is characterized by increased *recruitment. motor unit* on *muscle fiber* so that it can significantly increase the strength of muscle contraction (Seo., 2019).

Researchers observed 24 athletes of the Taekwondo Jayabaya Kediri team with an age range of 12 to 20 years, which resulted in 95.8% of speed and 79.1% of agility having scores below the average. From the results of these observations and analysis of the physiology and working mechanism of exercises *body weight strength training* and *plyometric,* the researchers aimed to determine the effectiveness of the exercise caused to increase physical ability, especially in speed and agility in taekwondo athletes. Speed and agility are important factors in the sport of taekwondo. Speed is needed in kick acceleration (Wazir *et al.*, 2019). In addition, the agility component also plays a role in changing body position when attacking and defending from opponents (Goodarzi et al., 2020). So that this research is expected to provide new insights and increase knowledge in the preparation of training programs and be able to significantly improve the physical abilities of taekwondo athletes. In addition, this research is also expected to provide information on the effectiveness of appropriate training methods to improve the physical abilities of taekwondo athletes.


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## METHODS

This study used an experimental method with atype of research *quasi-experimental* and a 2x2 factorial research design consisting of twovariables *independent* includingexercises *body weight strength training* and *plyometric* and twovariables *dependent* including speed and agility.

**Table 1.** Factorial research design 2x2

| A \ B | $B_1$ | $B_2$ |
|---|---|---|
| $A_1$ | $A_1 B_1$ | $A_1 B_2$ |
| $A_2$ | $A_2 B_1$ | $A_2 B_2$ |

Explanation :

**A** **:** Variable independent

$A_1$ : Body weight strength training

$A_2$ : Plyometric

**B** **:** Variable dependent

$B_1$ : Speed

$B_2$ : Agility

$A_1B_1$ : Results of *body weight strength training* against speed

$A_1B_2$ : Results of *body weight strength training* on agility

$A_2B_1$ : results *Plyometric* on speed

$A_2B_2$ : results *Plyometric* on agility

This research already has permission from the Faculty of Sports, Sebelas Maret University Surakarta with letter number 851/UN27. 11/PK.03.08/2021. The place of research was carried out on the Jayabaya Taekwondo team located in Kediri Regency for 6 weeks, starting on February 3 to March 14, 2021. The sampling technique was *purposive sampling,* with the number of samples taken as many as 24 athletes, the criteria used included the age range 12-24. 20 years old, has no history of injury to the lower limbs, does not consume doping or energy drinks before exercise and measurements. The distribution of the sample was done

randomly by dividing the sample into 2 exercise groups, the first group would receive a *body weight strength training program* and the second group would receive training *plyometric*. The techniques used in *body weight strength training* include *wall squats, static lunges* and *single leg Romanian deadlifts.* In exercises *plyometric* using techniques *standing broad jump, squat jump* and *skipping.*

The research data collection technique used *a instrument* 35 *meter speed test* to measure speed and the *Illinois agility run test* to measure agility in taekwondo athletes. Measurements of speed and agility are carried out every 2 weeks starting from week 1 to week 6 which aims to monitor the development of the athlete's physical ability every week. In the 35 *meter speed test, the* athlete was asked to run for 35 meters and was judged the fastest time, the shorter the travel time, the better the measurement results. In the *Illinois agility run test,* athletes were asked to run through a *cone* that was 10 meters long and 5 meters wide which was divided into 3 areas. Areas 1 and 3 are for speed lanes and area 2 for agility areas where arranged *cones are* every 3.3 meters. Next will be judged the fastest time. The shorter the travel time, the better the score given. The data that has been collected will be tested for prerequisites which include the normality test using the *Shapiro-wilk* because it has the testability to test data for less than 50 samples, and the homogeneity test using test *Levene's*. The *multivariate test* and the *between-effect subject test* used the MANOVA test. All data testing uses the IBM SPSS version 20 application.

## RESULTS

After a 6-week training program and measurements are taken every 2 weeks, the data received will be tested. The tests carried out include the normality test using thetest *Levene,* the homogeneity test using the *Shapiro-Wilk* test and the *multivariate test* and the *between-effect subject test* using MANOVA. The following are the results of testing the data :


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**Table 2.** The results of the normality test

| *Shapiro-wilk* | | | |
|---|---|---|---|
| Group | Variable | Sig. | Description |
| Body weight strength trainig | Speed | 0.30 | Normal distribution |
| | Agility | 0.64 | Normal distribution |
| Plyometric | Speed | 0.44 | Normal distribution |
| | Agility | 0.72 | Normal distribution |

From the results of the normality test using *Shapiro-wilk* in (table 2) the *sig.* exercises *body weight strength training* on speed (0.30) and agility (0.64) is greater than α = 0:05. The result of the value of *sig.* exercises *plyometric* at speed (0.44) and agility (0.72) greater than = 0.05. So it can be concluded that all the data in the two exercise groups came from a normally distributed population.

**Table 3.** Homogeneity Test

| *Lavene* | | | | | | |
|---|---|---|---|---|---|---|
| Group | Variable | df1 | df2 | Sig. | Sig.α | Description |
| Body weight strength trainig | Speed | 1 | 22 | 0.75 | >0.05 | Homogeneous |
| | Agility | 1 | 22 | 0.53 | >0.05 | Homogeneous |
| Plyometric | Speed | 1 | 22 | 0.39 | >0.05 | Homogeneous |
| | Agility | 1 | 22 | 0.35 | >0.05 | Homogeneous |

From the results of the homogeneity test of data using *Levene* in (table 3), it is obtained sig value exercises *body weight strength training* on speed (0.75) and agility (0.53) is greater than α = 0:05. The result of the value of *sig.* training *plyometric* at speed (0.39) and agility (0.35) greater than = 0.05. So it can be concluded that all the data in the two exercise groups came from a homogeneous population.

**Table 4.** Result multivariate test

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Exercise | Pillai's Trace | 0.50 | 22.31[b] | 2.00 | 43.00 | 0.00 |
| | Wilks' Lambda | 0.49 | 22.31[b] | 2.00 | 43.00 | 0.00 |
| | Hotelling's Trace | 1.03 | 22.31[b] | 2.00 | 43.00 | 0.00 |
| | Roy's Largest Root | 1.03 | 22.31[b] | 2.00 | 43.00 | 0.00 |

The results of the exercise effect test with a *multivariate test* exercise on physical ability (table 4) obtained a sig value. (0.00) is smaller than = 0.05.

So it can be concluded that there is an effect before and after *body weight strength training training* and *plyometric* on speed and agility in taekwondo athletes.

**Table 5.** Result between-subjects effect test

| | *Dependent* | df | F | *Sig.* |
|---|---|---|---|---|
| Latihan | Speed | 1 | 41.92 | 0.00 |
| | Agility | 1 | 23.94 | 0.00 |

The results of the *between-subject effect test of* exercise on physical ability (table 5) obtained a value *sig*. at speed (0.00) and agility (0.00) less than = 0.05. So it can be concluded that there is a significant interaction between before and after training with increased speed and agility in taekwondo athletes.

**Table 6.** Result descriptive statistic

| Physical ability | Metode Latihan | Latihan | Mean | N |
|---|---|---|---|---|
| Speed | Body weight strength training | Week 6 | 5.12 | 12 |
| | Plyometric | Week 6 | 4.57 | 12 |
| Agility | Body weight strength training | Week 6 | 19.53 | 12 |
| | Plyometric | Week 6 | 17.64 | 12 |

Test results of *Descriptive statistical* exercise methods and physical abilities in (table 6) it can be interpreted that exercises are *plyometric* more effective in increasing speed and agility in taekwondo athletes. The conclusion is drawn from the results of the average time value of speed and agility ofexercises *plyometric* is smaller than the average time of *body weight strength training*.

## DISCUSSION

Purpose of this study was to determine the effectiveness of exercises *body weight strength training* and *plyometric* on speed and agility in taekwondo athletes. The results of the *multivariate test* exercise on physical abilities in (table 4) obtained the value of sig. (0.00) is smaller

than = 0.05, these results indicate that exercises are *body weight strength training* and *plyometric* effective in increasing speed and agility in taekwondo athletes. Other studies that support the exercise *body weight strength training* with an intensity of 70% carried out for 2-3 weeks as many as 3 *sets* with 10 repetitions resulted in increased *self-efficacy*, increased muscle strength and *rate force development* (RFD) (Cherup *et al.*, 2019). Another study that supports the results of the study is research on exercises *plyometric* given for 4-6 weeks resulted in an increase in *peak high velocity* (PHV) on the ability of muscle fiber contraction (Peitz *et al.*, 2018), which is the result of increased activity of the system *neuromuscular* (Bompa, 2019).

The results of the comparison of the effectiveness of exercises *body weight strength training* and *plyometric.* In (table 6) the average value of exercise speed *plyometric* (4.57) seconds is smaller than the average speed time value *body weight strength training* of (5.12) seconds, so it can be concluded that exercise has *plyometric* a greater influence and is effective in increasing speed time in taekwondo athletes as measured by the 35 *meter speed test*. The average value of exercise agility time *plyometric* (17.64) seconds is smaller than the average agility time value *body weight strength training* (19.53) seconds so it can be concluded that training has *plyometric* a greater effect and is effectively used to increase agility time in the measurement. *Illinois agility run test*. The results of other supporting studies show that exercises *plyometric* have the concept of a movement *stretch shortening cycle* (SSC) so that they are able to accelerate the increase in stimulation of the system *proprioceptive* and *motor end plate* which results in an increase in the *recruitment of motor units* in *muscle fibers* which will have an impact on increasing the force and strength when doing the movement (Hansen & Kennelly, 2017).

This study has limitations in developing an exercise program that is suitable for the specific physical needs of each individual taekwondo athlete. Limited time in each training period results in a combination of physical training and taekwondo techniques at one time, this condition is

very high risk of increasing athlete fatigue, reducing performance of muscle strength and can increase the risk of injury. Taekwondo has the characteristics of a fast and dynamic movement that requires a high release of ATP through metabolism *anaerobic* to provide sufficient energy supply. The *recovery* phase is a very important phase that aims to resynthesize ATP through the system *oxidative* (Santos *et al*., 2019). Muscle contractions with high intensity with a long duration of time without any phase are *recovery* very at risk of causing injury to athletes during training or competition. From the results of the study the greatest risk of injury to taekwondo athletes as much as 38% occurred in the knee and 32% occurred in the ankle (Johari & Bagherian, 2020). Another study showed that 88% of 144 taekwondo athletes had injuries due to fatigue. The most frequent injuries to the lower limbs were 48%, head and neck 24% (Ranaweera *et al.*, 2020). So for further research, it is recommended to separate the practice of taekwondo techniques with physical exercise. These conditions are very important to improve the physical ability of athletes optimally.

## CONCLUSION

Exercise *and body weight strength training* and *plyometric* significantly affect the increase in the speed and agility of movement on taekwondo athletes. In the results of the effectiveness test of the training method on speed and agility, exercises *plyometric* provide a better and more effective effect than *body weight strength training* for a 6-week training program. The novelty of the results of this study is that exercises are *body weight strength training* and *plyometric* not only specific for increasing muscle strength and explosive power but also have a *multilateral effect*, which is able to have a significant effect on increasing speed and agility in taekwondo athletes. From the results of the research that has been obtained, the authors thank the Faculty of Sport at Sebelas Maret University Surakarta and the management and coaches of the Taekwondo Jayabaya Kediri team who have given permission to conduct research for 6 weeks safely and smoothly. Furthermore, I would like to


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