



The Effect of Circuit Training and Fartlek Training on Increasing Vo2 Max in Taekwondo Athletes (Based on Gender)

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Abstract

This study aims to determine: (1) There is a significant effect of circuit training and fartlek training on increasing VO2 Max of male and female Taekwondo athletes of POPB DKI Jakarta 2023. (2) There is a significant difference in increasing VO2 Max of male and female Taekwondo athletes of POPB DKI Jakarta 2023. (3) There is a relationship between circuit training and fartlek training based on gender on increasing VO2 Max of Taekwondo athletes of POPB DKI Jakarta 2023. This type of research is an experiment with a "Two Group Pretest-Posttest Design" design. The population in this study were 28 athletes of POPB DKI Jakarta 2023. Sampling in this study was carried out using purposive sampling of 28 athletes. The instrument for measuring VO2 Max was a multistage fitness test. The data analysis technique used was the Two-Way ANOVA Test. The results of the study showed that: (1) Circuit training and fartlek training did not have a significantly different effect in terms of increasing VO2 Max in taekwondo athletes, but fartlek was superior in increasing VO2 Max. (2) The difference between male and female gender was significant in its effect on increasing VO2 Max in taekwondo athletes. (3) The circuit training method and fartlek training did not have a gender interaction in increasing VO2 Max in taekwondo athletes. Fartlek training was better than circuit training in increasing VO2 Max in taekwondo athletes at POPB DKI JAKARTA 2023.

How to Cite

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INTRODUCTION

The 2023 Jakarta Special Capital Region Sustainable Development Program (POPB DKI Jakarta) is a decentralized program for developing talented athletes in DKI Jakarta under 15 years old (U-15) through a Sports Science approach based on the athlete's growth characteristics and Long-Term Athlete Development (LTAD). Thus, it can be ensured that the intensity & volume are adjusted to the LTAD Stages of each athlete's Chronological Age. There are 37 sports in this program: Fencing, Weightlifting, Athletics, Cycling, Baseball, Basketball, Handball, Indoor Volleyball, Badminton, Cricket, Rowing, Golf, Wrestling, Judo, Karate, Diving, Archery, Rock Climbing, Pencak Silat, Petanque, Water Polo, Swimming, Synchronized Swimming, Aerobic Gymnastics, Artistic Gymnastics, Rhythmic Gymnastics, Football, Sepak Takraw, Ice Skating, Skateboarding, Water Skiing, Squash, Taekwondo, Tennis, Table Tennis, Boxing, Wushu.

Physical fitness is another crucial element or factor for success in sports. Physical ability is one of the most dominant components in achieving sporting success. Sports achievement is inseparable from tactics, technique, and physical fitness. A Taekwondo athlete requires excellent strength, endurance, flexibility, leg strength, speed, agility, and coordination (Burhaein, 2020; Firmansyah, 2021). These aspects are essential for effective movement and reaction during a match.

One of the most important physical qualities a Taekwondo athlete must possess is endurance. Endurance determines an athlete's performance, as good endurance allows them to apply techniques and tactics optimally. Therefore, with excellent endurance, the chances of achieving success are greater.

The main factor of success in training and sports competitions is influenced by the athlete's level of endurance. So, a person with good physical endurance will be able to perform their work optimally. Good physical endurance is the maximum ability to meet oxygen consumption which is indicated by the maximum oxygen volume level (VO₂ Max). (Burhaein, 2020). VO₂ Max is the maximum amount of oxygen in milliliters, which can be used in one minute per kilogram of body weight (Ashfaq, 2022; Auliadina, 2019; Buttar, 2019; Festiawan, 2021). A person who has good fitness has a higher VO₂ Max value and can perform more vigorous activities than those who are not in good condition.

Taekwondo is a branch of martial arts ori-

ginating from South Korea. Taekwondo comes from three words: "Tae," meaning to strike or break with the feet; "Kwon," meaning to strike or punch with the hands; and "Do," meaning system or method. Combined, Taekwondo is a method of self-defense using bare feet and hands. (Yoyok Suryadi, 2002). A book on martial arts called Muye Dobo Tongji states: "Martial arts without weapons (Taekwondo) is a martial art that builds strength by training the hands and feet to be integrated with the body so that they can move freely, so that they can be used when facing critical situations, which means Taekwondo can be used at any time." (Yoyok Suryadi, 2002). Taekwondo is a form of martial arts that holds the concept of combining strength, speed, and precision in defensive and offensive movements. All movements in Taekwondo require good physical components and are in accordance with what is required in Taekwondo itself. Therefore, the physical components of a Taekwondo practitioner, or commonly called taekwondoin, are very important to perform movements such as kicking, punching, and blocking perfectly.

Taekwondo athletes typically perform movements such as horse stances (steps), sudden stops and rapid movements again, jumping, kicking, punching, blocking, and even spinning without losing balance. These movements are repeated repeatedly and over long periods of time during a match. As a result, these movements can cause fatigue, which directly impacts the function of the heart, lungs, circulatory system, respiration, muscles, and joints.

Success in the training process depends heavily on the quality of the training implemented, as the training process is a combined activity involving various supporting factors. (Emral, 2017) states that the term training comes from English words that can have several meanings, such as: practice, exercises, and training. In Indonesian, these words all have the same meaning, namely practice. However, in English, in reality, each word has a different meaning. From these terms, when applied in the field, it is clear that the activity is the same, namely physical activity.

The definition of training derived from the word practice is an activity to improve skills (expertise) by using various equipment according to the goals and needs of the sport (Sukadiyanto, 2011). The definition of training derived from the word sport is the main tool in the daily training process to improve the quality of human body organ function, making it easier for athletes to improve their movements, (Sukadiyanto, 2011) adding that sports derived from the word training

are a process to improve sports skills that contain theoretical and practical materials, using methods and rules, so that goals can be achieved on time.

Circuit training is an exercise consisting of a number of exercise stations, where the exercises are implemented. One circuit training is declared complete if a person has completed the exercises at all posts according to the specified parts and time. One exercise is done in one round and during one round there are several exercise stations. Circuit training is a form of training method that involves physical fitness, physical training, and fat loss (Irianto, 2018). Circuit training with aerobic and anaerobic exercises has a synergistic positive effect on cardiovascular and strength (Benito, 2016; Haliq, 2015) states that the circuit training method improves general physical fitness and covers all physical aspects as well as cardiovascular fitness. According to (Harsono, 2015), circuit training is a training system that can improve overall body fitness, namely elements of strength, endurance, power, agility, speed, and other physical components. (Sonchan & Anek Sootmongkol, 2017) that the circuit training program increased muscle strength, agility, anaerobic capacity, and cardiovascular endurance of research subjects. This program can be used as a guide to selecting a series of exercises to improve physical fitness.

Fartlek training, which is often called playing at speed, is carried out in an open area by running, walking or jogging. Fartlek is an endurance training system, specifically VO₂ Max ability which is suitable for building, recovering and maintaining an athlete's body condition (Nala, 2015). (Manikandan, 2014) states that fartlek is similar to interval training, alternating short sprints with slow sprints or recovery intervals. However, in fartlek, the running takes place on roads, in parks, or on bush trails. There is no predetermined schedule to follow, but athletes determine their own interval length and pace based on their own workload. The advantage of fartlek is that athletes can fine-tune their speed judgment skills. Athletes are also free to experiment with speed and endurance, and experience variations in pace.

Endurance is one of the main biomotor components that is fundamental in every sport. The biomotor component Power is generally used as a wrong measure to determine the level of physical fitness of athletes. (Indrayana, 2012) states that "physical fitness" Endurance is a state or condition of the body that is able to work for a long time without experiencing excessive fatigue after doing work". Endurance is always associated with the length of work (duration) and

intensity of work, the longer the duration of training and the higher the intensity of work that an athlete can do, the athlete has good endurance.

The purpose of this study is to analyze the effects of circuit training and fartlek training, differences in VO₂Max increases based on gender, and the relationship between gender and training methods on increasing VO₂Max in Taekwondo athletes at the Jakarta Polytechnic University (POPB DKI Jakarta) in 2023. The novelty of this study lies in the simultaneous study of the effects of two training methods (circuit training and fartlek training) associated with gender in increasing VO₂Max in Taekwondo athletes, particularly in athletes at the Jakarta Polytechnic University (POPB DKI Jakarta), which has rarely been studied specifically and comparatively within a single research design.

METHODS

This study used an experimental approach with a 2x2 factorial design to test the effects of fartlek and circuit training on VO₂max in male and female taekwondo athletes. This design involved two groups (male and female athletes), each receiving a different training treatment: fartlek and circuit training.

Independent Variables: Circuit training (A1) and fartlek training (A2). Dependent Variable: VO₂max of male athletes (B1) and female athletes (B2).

This research was conducted at Ragunan Sport Centre, Jakarta, from September to October 2023. The training program consisted of 18 sessions, held three times a week on Tuesdays, Thursdays, and Saturdays.

Circuit Training: A form of physical exercise consisting of seven repetitions. Station drills vary, including sprints, knife jerks, lunges, running in place, walking, relay races, and back-and-forth runs. Fartlek Training: Combines running training with various speeds and movements such as jogging, sprinting, and changing direction on a 400 meter track. VO₂max : The maximum total oxygen that can be consumed during intense physical activity, measured using the Multi-Stage Fitness Test.

The population of this study consisted of 28 Taekwondo athletes of POPB DKI Jakarta in 2023, consisting of 14 male athletes and 14 female athletes. The sample was selected using purposive sampling based on predetermined criteria. Participants were divided into two experimental groups (Group A: circuit training; Group B: fartlek training) after a pre-test to ensure comparable

initial abilities.

VO₂max was measured using the Multistage Fitness Test, which assesses aerobic capacity through a 20-meter back-and-forth run according to an audio signal ("sound") . (beeps). This test has a validity of 0.72 and a reliability of 0.81.

Normality: Performed using the Kolmogorov-Smirnov test with SPSS; data are considered normally distributed if $p > 0.05$. Homogeneity: Performed using the F test to ensure homogeneous variance ($p > 0.05$). Were analyzed using Two-Way ANOVA to determine the effect of training method and gender on VO₂max. If an interaction effect was found, a Tukey post-hoc test was performed. All analyses were performed using SPSS version 25.0 with a significance level of 0.05.

RESULTS AND DISCUSSION

The data from this study consists of pretest and posttest VO₂ Max data. The research process will take place in three stages. The first stage is a pretest to obtain baseline VO₂ Max data for the athletes. The second stage of this research activity is treatment, which will last for 18 sessions. Treatment will last for 6 weeks, with a frequency of 3 times a week. The results of the pretest and posttest of the VO₂ Max of the Taekwondo athletes of the 2023 DKI JAKARTA POPB (Indonesian Sports Week) Taekwondo Championships are described as follows:

Pretest-Posttest VO₂ Max Circuit Training Group The results of the VO₂ Max pretest and posttest of the 2023 Taekwondo Athletes of POPB DKI JAKARTA in the circuit training group are presented shows the individual pretest and posttest scores of the 14 subjects. All subjects experienced an increase in their scores from pretest to posttest, with score increases ranging from ****0.3 to 6.9 points****. Subject 12 showed the largest increase (6.9 points), while Subject 13 showed the smallest increase (0.3 points). Overall, the data indicate that each subject demonstrated a positive change in performance after the intervention.

Descriptive statistics of the pretest and posttest VO₂ Max of Taekwondo Athletes of POPB DKI JAKARTA 2023 circuit training group are presented, both the pretest and posttest involved 14 participants. The mean score increased from 40.05 in the pretest to 41.87 in the posttest, indicating improvement after the intervention. The median score also slightly increased from 40.70 to 41.50, while the mode changed from 42.90 to 41.50. The standard deviation decreased from 6.54 to 5.84, indicating more consistent post-

test scores. Furthermore, the minimum score increased from 30.60 to 33.70 and the maximum score increased from 52.00 to 53.00, indicating an overall positive change in performance.

The bar graph of VO₂ Max pretest and posttest of Taekwondo athletes of POPB DKI JAKARTA 2023 in the circuit training group is presented in **Figure 1**.

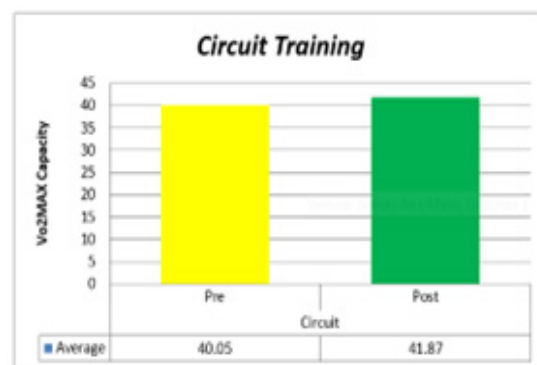


Figure 1. Bar Chart of Pretest and Posttest of Circuit Training Group

Based on **Figure 1**, it can be seen that the average VO₂ Max pretest in the circuit training group was 40.05 and increased during the posttest to 41.87.

Pre-Post-Test VO₂Max Fartlek Group Training Test. The pretest and posttest results of VO₂ Max from the 2023 POPB DKI JAKARTA Taekwondo Athletes in the fartlek training group are presented, all 14 subjects showed an increase in their scores from pretest to posttest. The difference in scores ranged from 0.4 to 6.2 points, with the largest increase observed in Subject 6 (6.2 points) and the smallest in Subject 8 (0.4 points). Overall, the data indicate a positive effect of the intervention, as each participant's posttest score was higher than their pretest score.

Descriptive statistics of VO₂ Max pretest and posttest of Taekwondo Athletes of POPB DKI JAKARTA 2023 in the fartlek training group are presented in full, the pretest and posttest scores of the 14 participants showed overall improvement. The mean increased from 40.10 to 42.27, the median increased from 40.70 to 42.65, and the mode shifted from 33.39 to 36.80. The standard deviation increased slightly from 5.58 to 5.96, indicating a slightly wider distribution of posttest scores. The minimum score also increased from 33.30 to 35.40, reflecting an overall positive trend in participant performance.

The bar graph of VO₂ Max pretest and posttest of Taekwondo Athletes of POPB DKI JAKARTA 2023 fartlek training group is present-

ed in **Figure 2**.

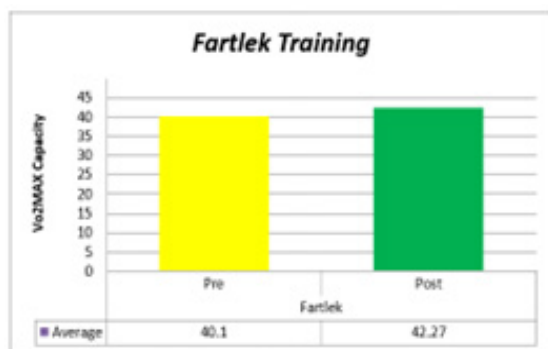


Figure 2. Bar Diagram of Pretest and Posttest Fartlek Group Practice

Based on **Figure 2** above, it can be seen that the average VO2 Max pretest in the fartlek training group was 40.10 and increased to 42.27 during the posttest.

The normality test aims to determine whether the variables under study have a normal distribution. This normality test is calculated using the Shapiro-Wilk formula. The results are presented in **Table 1**.

Table 1. Normality Test Results

Data	p-value	Signature.	Information
VO2 Max A1B1 training group	0.206	0.05	Normal
VO2 Max Training group A1B2	0.202	0.05	Normal
VO2 Max A2B1 training group	0.154	0.05	Normal
VO2 Max A2B2 training group	0.230	0.05	Normal

Based on **Table 1** above, it can be seen that the VO2 Max pretest-posttest data of POPB DKI Jakarta Taekwondo Athletes 2023 has a p-value > 0.05 , so the variable is normally distributed.

The homogeneity test is useful for testing sample similarity, namely whether the variance of samples taken from a population is uniform or not. The homogeneity rule states that if $p > 0.05$, the test is considered homogeneous; if $p < 0.05$, the test is considered inhomogeneous. The results of the homogeneity test can be seen in **Table 2**.

Table 2. Results of Homogeneity Test

Data	p-value	Information
Pre-test and post-test VO2 Max group exercise series training (A1B1, A2B1)	0.800	Homogeneous
Pre-test and post-test VO2 Max group exercise fartlek training (A1B2, A2B2)	0.873	Homogeneous

Based on **Table 2**, it can be seen that the VO2 Max pretest-posttest data for POPB DKI Jakarta Taekwondo Athletes in 2023 obtained a p value > 0.05 , so the data is homogeneous.

Based on the analysis results Hypothesis Test 1, which produces a calculated F value of 1.080 which is greater than the F table of 3.38 and sig 0.817 > 0.05 , then this result shows no significant difference. Thus the alternative hypothesis (H_a) which states "There is a significant effect of circuit training & fartlek training on increasing VO2 Max of male & female Taekwondo athletes POPB DKI Jakarta 2023.", is not accepted.

Based on the analysis results Hypothesis Test 2, it can be seen that the calculated F value is 432.929 and the F table is 3.238 with a p value of 0.000. Because the calculated F 432.929 $>$ F table 3.38, and the p value of 0.000 < 0.05 , then this result indicates a significant difference. Thus, the alternative hypothesis (H_a) which states "There is a significant difference in the increase in VO2 Max of male & female Taekwondo athletes POPB DKI Jakarta 2023", is accepted.

Based on the analysis results Hypothesis Testing 3, it can be seen that the calculated F value is 0.260 and the F table is 3.38 with a p value of 0.909. Because the calculated F value of 0.260 $>$ F table 3.38, and the p value of 0.909 > 0.05 , these results indicate no relationship. Thus, the alternative hypothesis (H_a) which states "There is a relationship between circuit training and fartlek training with gender on increasing VO2 Max of Taekwondo Athletes POPB DKI Jakarta 2023", is not accepted.

The results of this study indicate that circuit training and fartlek training both increase VO2 Max in Taekwondo athletes from POPB Jakarta 2023, with no significant difference in effectiveness between the two training methods. Although fartlek training resulted in a slightly higher percentage increase in VO2 Max (0.91%) than circuit training (0.76%), the difference was not statistically significant. This suggests that fartlek training tends to be more effective, but both methods are beneficial for increasing aerobic capacity. This finding is consistent with previous studies reporting that circuit training and fartlek training significantly improve lung capacity and cardiovascular endurance when performed systematically and consistently.

Gender-specific analysis revealed significant differences in VO2 Max increases between male and female athletes, with male athletes showing greater increases than female athletes. This difference is likely due to physiological factors such as greater muscle mass, higher oxygen

delivery capacity, and hormonal differences, which generally result in higher VO₂ Max values in males, particularly after puberty.

Furthermore, the study results showed no significant interaction between training method and gender in increasing VO₂. This suggests that the effectiveness of circuit training and fartlek training is not influenced by gender. Differences in VO₂ Max are more closely related to age-related physiological growth and development. VO₂ Max increases progressively from childhood to late adolescence, with similar growth patterns in boys and girls until early adolescence, after which boys tend to experience a continuous increase while girls reach a more stable level.

This research is also relevant to the research results conducted by (Iskandar, 2023), namely Based on the research findings, it can be concluded that (1). The Fartlek training method is better used to increase the VO2Max capacity of SSB Alam Sakti Kerinci players (A2) = 40.85 better, compared to the Circuit training method (A1) = 39.87, (2). There is an interaction between the training method and the vital capacity of the heart in increasing the VO2max capacity which seems acceptable, (3). At high vital lung capacity, the Fartlek training method is better used to increase the VO2Max capacity of SSB Alam Sakti Kerinci players (A2B1) = 46.76, better than the Circuit training method (A1B1) = 41.30, (4). At low vital lung capacity, the circuit training method is better used to increase the VO2Max capacity of SSB Alam Sakti Kerinci players (A1B2), = 41.30 better, compared to the Fartlek training method (A2B2) = 34.94. Based on the fact that circuit training shows better results than fartlek training, the above opinion can be concluded that the final results of cardiorespiratory endurance that show good results are influenced not only by fitness levels but also by the ability to adapt to training and adaptation to the environment (Almy, M. A., & Sukadiyanto, S. (2014). The effect of circuit training on VO2max is an adaptation effect, because this exercise is repeated, which improves the cardiorespiratory system. Research by Sumosardjono in Satria (2018) states that: "If the training has been going on for a long enough period, at least 4-8 weeks, and you have been training regularly for a sufficient amount of time, then a training effect occurs."

Despite careful consideration, this study has several limitations. The athletes were not housed in dormitories, making it difficult to control for training activities outside of the prescribed program. Furthermore, other factors such as individual physical condition, psychological

state, and lifestyle could not be fully controlled and may have influenced the study results.

CONCLUSION

Based on the results of data analysis, description, testing of research results, and discussion, it can be concluded that circuit training and fartlek training do not have a clear effect on increasing VO2 Max in taekwondo athletes, in addition there are differences between male and female gender. The effect is successful in increasing VO2 Max in taekwondo athletes and finally the circuit training method and fartlek training do not have an interaction with gender in increasing VO2 Max in taekwondo athletes.

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