International Journal of Human Movement and Sports Sciences 11(1): 213-223, 2023 http://www.hrpub.org
DOI: 10.13189/saj.2023.110125

The Effectiveness of the Weight Training Method and Rest Interval on VO_2 max, Flexibility, Muscle Strength, Muscular Endurance, and Fat Percentage in Students

Rina Yuniana[1], Tomoliyus[1], BM Wara Kushartanti[1], Ahmad Nasrulloh[1,*], Kukuh Wahyudin Pratama[2], Maziah Mat Rosly[3], Manil Karakauki[3], Syed Kamaruzaman Syed Ali[3]

[1]Department of Sports Science, Faculty of Sport Science, Yogyakarta State University, Indonesia
[2]Institute of Advanced Science, Engineering, and Education (IASEE), Malaysia
[3]Department of Physical Education, Faculty of Education, University of Malaya, Malaysia

Received October 5, 2022; Revised January 19, 2023; Accepted February 15, 2023

Cite This Paper in the Following Citation Styles

(a): *[1] Rina Yuniana, Tomoliyus, BM Wara Kushartanti, Ahmad Nasrulloh, Kukuh Wahyudin Pratama, Maziah Mat Rosly, Manil Karakauki, Syed Kamaruzaman Syed Ali , "The Effectiveness of the Weight Training Method and Rest Interval on VO_2 max, Flexibility, Muscle Strength, Muscular Endurance, and Fat Percentage in Students," International Journal of Human Movement and Sports Sciences, Vol. 11, No. 1, pp. 213 - 223, 2023. DOI: 10.13189/saj.2023.110125.*

(b): *Rina Yuniana, Tomoliyus, BM Wara Kushartanti, Ahmad Nasrulloh, Kukuh Wahyudin Pratama, Maziah Mat Rosly, Manil Karakauki, Syed Kamaruzaman Syed Ali (2023). The Effectiveness of the Weight Training Method and Rest Interval on VO_2 max, Flexibility, Muscle Strength, Muscular Endurance, and Fat Percentage in Students. International Journal of Human Movement and Sports Sciences, 11(1), 213 - 223. DOI: 10.13189/saj.2023.110125.*

Abstract This study aims to examine the effectiveness of weight training methods and rest interval, maximum oxygen volume, flexibility, muscle strength, muscular endurance, and fat percentage in students. It employed a quasi-experimental design with 40 male undergraduate students as a sample divided into 4 groups. The instruments used the Multistage Fitness Test (MFT), sit and reach test, sit-ups, push-ups, leg and back dynamometer, and Omron karada scan body composition. The data analysis technique used the normality test, homogeneity test, and box test followed by hypothesis testing using multivariate analysis (MANOVA) with 2^2 factorial analysis. The results of the Multivariate Test calculations showed all groups had significant improvements of $p<0.05$, except for fat percentage (p=0,806). So that it can be said that weight training carried out according to the right exercise dose with the selection of appropriate exercise methods and by paying attention to rest between sets will be able to have a positive impact on cardiorespiratory endurance (VO_2 max), flexibility, muscle strength (legs, back), muscular endurance (upper body, abdomen), and no significant improvement in 'fat percentage'. But all weight training methods had a positive impact on fat percentage. The most effective exercise method for improving VO_2 max, flexibility, and lowering body fat is the superset method with a rest between sets of 30 seconds. The most effective method to increase muscle strength (legs and back) is the compound set method with a rest between sets of 120 seconds. While the most effective method to increase muscle endurance (upper body and abdomen) is a compound set method with a rest between sets of 30 seconds.

Keywords Weight Training, Rest Interval, VO_2 max, Flexibility, Muscle Strength, Muscular Endurance, Fat Percentage

1. Introduction

Health is a global primary need. A person is considered healthy if he/she already has good physical fitness. A person is said to be fit if he has been able to carry out the task charged effectively for a relatively long time without feeling excessive fatigue and still has the energy to do other activities in order to fill his free time [1]. Physical fitness can be obtained through effective exercise. Exercise can be effective if attention is given to the basic principles of exercise to achieve more optimal physical performance for each individual [2] [3]. Argued that the principle of exercise consists of overload, continuously increasing load, the individual, specificity, adaptation, variation periodization, opposites, moderate load, and exercises must be systematic.

In addition to the basic principles, the exercise should also pay attention to its components. The quality of an exercise is also influenced by the ability to carry out an exercise program that is by the principles of exercise, training components, and the right dose of exercise [4]. The training components that need to be considered are the frequency intensity,time, volume, rest between sets, intervals, repetitions, sets, circuits, density, exercise rhythm, and training sessions [5]. Exercise performed regularly can improve physical condition if it is carried out in accordance with an exercise program that has been prepared based on the basic principles of exercise and training components [6], [7].

One of the exercises known to improve physical ability is weight training [8]. It is one of the physical exercises performed with the help of weights, both internal and external of the body, which improves muscle ability and work productivity [9]. Weight training should be done in accordance with the right exercise program based on the basic principles and the dose of exercise [10]. Examples of weight training using (internal) body weight that are often done can include frog jump, skipping, squat trust, squat jump, pull-ups, plunk, push-ups, sit-ups, lunges, and back-ups [11]. While weight training using external weights such as dumbbells, barbells and machines, tends to have more variety according to the purpose of the exercise [12]. Training methods done during weight training include superset, compound set, block set, set system, giant set, tri set, pyramid system, pro set, and circuit [13].

Recent findings show that most people do weight training aimed at increasing muscle mass so that their body shape mirrors athletic looks [14]. However, the most important reason for one's body to exercise is to gain physical fitness [15]. A person can be said to have good physical fitness, not just by having large and athletic muscles, but must meet the good criteria of all components of physical fitness, namely cardiorespiratory endurance (VO_2 max), muscle endurance, muscle strength, flexibility, and body composition [16]. Martine F et al [17] state that health-related physical fitness consists of several components, namely: cardiorespiratory endurance, muscle strength and endurance, flexibility, and body composition.

There are some experts who argue that weight training cannot have a significant effect on increasing cardiorespiratory endurance (VO_2 max) [18]. [19] find that muscle strength training does not have a significant effect on increasing VO_2 max, after being given strength training in trained rowers. The opposite was found by [20] that there was a relative change in maximum oxygen intake in bicycle ergometer tests (VO_2 max) after a 21-week training, endurance, in training groups and control groups, VO_2 max increased by 12.5% in endurance training and 9.8% in a combination of strength and endurance training. This study suggests that weight training, endurance training, and a combination of weight training and endurance can have a significant effect on increasing VO_2 max. [21] suggest that weight training can help to prevent and manage type 2 diabetes and improve heart health by lowering blood pressure and has a positive effect on controlling cholesterol and lipoprotein levels.

Body composition, indicated by the percentage of fat, should fall into the normal category [22]. If a person has an excessive fat percentage level, it can be said that the person is not fit [23]. There are many ways to reduce body fat, such as dieting, taking supplements, taking slimming drugs and exercising [24]. [25] said that a weight training program combined with consuming post-exercise recovery drinks containing creatine, protein, amino acids, and carbohydrates did not change body weight, body fat percentage, or fat mass compared to isocaloricdiets, which only controlled carbohydrates. Weight training combined with consuming creatine, protein, amino acids, and carbohydrate beverages cannot affect body weight and fat percentage [26]. [27] says that the combination of moderate-intensity resistance in a weight loss exercise program can significantly reduce body fat mass and mid-thigh composition, strength, and muscle quality in overweight and obese adults and older people.

Another important component of physical fitness related to health is flexibility [28]. Most people rule out exercise that involves flexibility, even though this component is very important to prevent the risk of injury during exercise [29], [30]. [31] notes that most medical professionals, coaches, and athletes consider aerobic conditioning, strength training and flexibility to be integral components in any conditioning program. Therefore, it is necessary to provide an exercise program to increase flexibility. As stated by [32] core strength training with a swiss-ball can improve strength, endurance, flexibility and balance in women.

In addition to cardiorespiratory endurance, body composition and flexibility, the physical fitness components that need to be trained also include muscle strength and endurance [33]. Many studies have proven the effect of weight training on muscle strength and endurance [34]. [35] says that weight training will be able to increase muscle strength, muscle endurance, neuromuscular coordination, and bone density (helping prevent osteoporosis). Weight training can improve performance determinants by increasing the athlete's strength, vertical jump ability without increasing total body mass and sacrificing VO_2 max development [36]. [37] adds that strength training programs are essential for the maintenance of functional performance of muscle strength and independence in adults. After the training period, strength training significantly improved ($p < 0.001$) knee extension of 1 RM (32%) and flexion strength (28%).

The superset and compound set training exercise methods are often used when doing weight training [38]. Superset is a weight training method in which a person performs two exercises to train opposite muscle groups and is carried out successively without resting in between, for example the arm superset, which is a set of bicep curl exercises, followed by a set of tricep push down exercises [39]. The superset training method is a form of weight training done by training the agonist and antagonist muscle groups sequentially and repeatedly without any rest when switching. The Super Set exercise method can provide benefits including: saving time, burning more calories, and increasing lactic acid production[40].

That includes doing two types of exercises for the same muscle group in succession, but with different types of exercises for each set and without rest between. Exercise with this method can provide maximum response to a group of muscles being trained so that the potential for muscle development is more optimal [41]. One form of physical activity is weight training. Weight training should be done using the right exercise program guidelines. An appropriate training program should be prepared by taking into account the basic principles and components of the exercise. The selection of the right exercise method can also affect the success rate of the exercise program. In addition, This is evidenced by previous research studies [42] which reveals that the rest time between sets needs to be considered because it is closely related to the energy use during weight training. Thus, weight training can have a significant effect on the body in accordance with the objectives of the exercise, especially physical fitness. Therefore, this study intends to examine several treatment in doing weight training by paying attention to the components of the exercise such as frequency, intensity, repetitions, sets, exercise rhythm, rest between sets, and exercise methods. This is supported by research [43] which explains that weight training that pays attention to training components such as frequency, intensity, time, and type, can improve physical fitness. In summary, the study's objectives intend to examine the effect of the supersets and compound set training methods with 30 and 120 second rest interval between sets on VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and fat percentage. If the interval rest is short then it can increase aerobic stamina [44].

The advantages of this study compared to previous research are the inclusion of more specific weight training methods, namely with superset and compound set methods included in order to train the muscles more thoroughly. In addition, the use of a relatively short rest time of 30 seconds and 120 seconds each respectively, allows the body to maximize aerobic energy and from fat metabolism as energy at the time of weight training[45]. Finally, this study also focuses on all components of physical fitness related to health. Thus, weight training with this method is expected to have a significant effect on VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and fat percentage. Therefore, it is necessary to research the effect of superset and compound set exercise methods with 30 and 120 second rest interval between sets on VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and fat percentage.

2. Materials and Methods

This study used a quasi-experimental method with a multifactorial experimental design. The sample was 40 male undergraduate students, with mean age 19.3 (0.6) years old, from Sport Science Department, Faculty of Sport Science selected through purposive sampling. The inclusion criteria of students as samples in this study include being an active student, physically and mentally healthy, never participated in a weight training program, and willing to be a research sample. All students must also be of low risk to vigorous exercise precluding safe and adequate test performance.

The study protocol was approved by the Universitas Negeri Yogyakarta Ethics Committee Board (No.T/1.1/UN34.21/TU/2021). The sample was divided into 4 groups, namely group 1 using a superset method with 30 seconds rest (SS30), group 2 using a superset method with 120 seconds rest (SS120), group 3 using a compound set method with 30 seconds rest (CS30), group 4 using a compound set method with a rest of 120 seconds (CS120), and each group consisted of 10 students. The instruments used were the Multistage Fitness Test (MFT), Sit and Reach test, Sit Up, Push Up, Leg and Back dynamometer, and Omron Karada scan body composition monitor [46]. The detail of the instrument can be seen in table 1 below. Each of the exercise methods has been previously validated for reliability in separate studies [47]. Test-retest reliability scores for each instrument revealed very good consistency with MFT, r=0.88; sit and reach test, r=0.89; sit up and push up, r=0.94 and r=0.95 respectively; leg and back dynamometer, r=0.90; and Omron karada scan body composition, r=0.99.

Table 1. Pre-test and post-test instruments and tools

Measurement	Instruments	Tools
Cardiorespiratory	Multilevel Fitness Test (MFT)	Sound System and 20 meters running area
Flexibility	Sit and Reach Test	Sit and reach bench
Muscle Endurance	Sit Up and Push Up	Mattress
Muscle Strength	Leg and Back Dynamometer	Leg and back dynamometer
Body Composition	Omron karada scan body composition	Omron karada scan

The exercise training programs are described as follows: the weight training and rest interval were performed using the superset and compound set methods by combining 30 seconds and 120 seconds of the rest between sets. Frequency was done 3 times a week and carried out for 8 weeks. Training weights increased progressively with an intensity of 50% - 70% from 1 RM with details on 1-8 training sessions using 50% intensity, 9-16 training sessions using 60% intensity, and 17-24 training sessions using 70% intensity of 1 RM. The number of sets in these program was 2-4 sets, namely in the 1-8 training session, 2 sets were performed, the 9-16 training session was increased to 3 sets and the 17-24 training session was increased to 4 sets. The number of repetitions performed was 15-25 repetitions. The number of reps decreased as the intensity and number of sets increased. In the 1-8 practice sessions, the reps were conducted as many as 25 repetitions, the 9-16 training sessions were reduced to 20 repetitions and the 17-24 practice sessions were reduced to 15 repetitions.

The results of the study were then analyzed using SPSS program. The data analysis technique used is Kolmogorov Smirnov Z test for normality, Levene's test for homogeneity and box test as a prerequisite test. All tests for normality distribution showed no significance ($p>0.05$) and fulfilled the normality assumption. A one-way analysis of variance is used to determine the demographic profiles of participants in each training group. There were no significant differences seen in the demographic profiles of each training group. Hypothesis testing of outcomes between all 4 training types was analyzed using a one-way multivariate analysis of variance (MANOVA) with 2^2 factorial analysis.

3. Results

This study aims to examine the effect of superset and compound set training methods with 30 seconds and 120 seconds rest intervals between sets on VO_2 max, flexibility, muscle strength (legs and back), muscle endurance (upper body and abdomen), and fat percentage. The demographic profile of participants in each training group is described in Table 2.

The average score of the VO_2 max test, flexibility, leg muscle strength, back muscle strength, upper body muscle endurance, abdominal muscle endurance, and fat percentage results before and after treatment in each treatment group can be seen in table 3.

Table 2. Demographic profiles for each training group

No	Treatment Group	Age (years)	P value	BMI	P value
1	Group SS30	19.09 (0.33)		21.21 (1.79)	
2	Group SS120	19.34 (0.74)	0.380	21.31 (1.38)	
3	Group CS30	19.59 (0.67)		20.76 (2.15)	0.751
4	Group CS120	19.29 (0.70)		21.74 (2.51)	

*All units in mean (SD)

Table 3. Average data for each treatment group

No		Treatment Group	Pre-test	Post-test	Levels of Significance
1	VO_2 max	Group SS30	39.35	49.19	9.84
		GroupSS120	41.44	46,99	5.55
		GroupCS30	42.92	48.53	5.61
		Group CS120	40.26	41.00	0.74
2	Flexibility	Group SS30	38.95	50.85	11.9
		GroupSS120	36.30	43.45	7.15
		Group CS30	41.80	44.35	2.55
		Group CS120	41.05	42.05	1.00
3	Leg muscle strength	Group SS30	162.15	203.40	41.25
		GroupSS120	165.80	256.00	90.2
		Group CS30	156.80	249.30	92.5
		Group CS120	163.80	257.60	93.8
4	Back muscle strength	Group SS30	90.25	96.70	6.45
		GroupSS120	92.90	123.75	30.85
		Group CS30	89.40	117.15	27.75
		Group CS120	93.45	124.75	31.3
5	Upper body muscle endurance	Group SS30	26.20	45.80	19.6
		GroupSS120	21.50	29.50	8
		Group CS30	19.00	46.80	27.8
		Group CS120	24.90	43.80	18.9
6	Abdominal muscle endurance	Group SS30	37.50	46.00	8.5
		GroupSS120	35.30	40.90	5.6
		Group CS30	34.20	53.00	18.8
		Group CS120	32.80	41.10	8.3
7	Fat percentage	Group SS30	15.03	14.42	-0.61
		GroupSS120	13.24	12.68	-0.56
		Group CS30	13.27	13.00	-0.27
		Group CS120	13.01	12.90	-0.11

These results show that the superset and compound set training methods with 30 seconds and 120 seconds of rest between sets can increase VO_2max, flexibility, leg muscle strength, back muscle strength, upper body muscle endurance, endurance of the abdominal muscles, and reduce body composition, namely fat percentage. At VO_2 max, it was shown that the group that had the highest average yield was the SS30 group. On the flexibility variable, it was shown that the group that had the highest average yield was the SS30 group. On leg muscle strength, it was shown that the group that had the highest average yield was the CS120 group. On the strength of the back muscles, it was shown that the group that had the highest average yield was the CS120 group. On the endurance of the upper muscles, it was shown that the group that had the highest average yield was the CS30 group. On the endurance of the abdominal muscles, it was shown that the group that had the highest average yield was the CS30 group. On the percentage of fat, it was shown that the group that had the highest average yield, namely the percentage of fat that decreased the most, was found in the SS30 group.

Data were tested for normality using Kolmogorov Smirnov Z, it was found that all groups had a significance of $p>0.05$, which means the data is normally distributed. The homogeneity test using the F-test, found that all groups had a significant p-value (Sig.) > 0.05, so the data was homogeneous. The Box-Test was used to test the assumption of factorial analysis which requires that the variance matrix of the dependent variable is the same (or not different). The results of the Box Test obtained the Box M test value of 142.510, and the calculated F-value of 1.069 with a significance value of 0.316 ($p>0.05$), then it can be stated that the variance matrix of the dependent variable is the same. This means that the results of the Box Test on the data do not violate the assumption of the factorial test so that the reading of the factorial test results can be continued with the calculation of the one-way multivariate analysis of variance (MANOVA). The results of the Multivariate Test calculation show that all groups have $p < 0.05$, except for the fat composition change ($p=0.806$). These results can be interpreted that there are significant differences in the four training groups on the dependent variable which includes VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and fat percentage.

Based on Table 4, the most effective exercise method to increase cardiorespiratory endurance (VO2 max) and flexibility as well as reduce fat percentage is the superset method with 30 seconds of rest between sets. The most effective exercise method to increase muscle strength (legs and back) is the compound set method with a rest between sets of 120 seconds. While the most effective exercise method to increase muscle endurance (upper body and abdomen) is the compound set method with 30 seconds of rest between sets.

Table 4. The Effect of Increasing Significance of Dependent Variables

Dependent Variable	Exercise Method	Rest between set	Mean	Std. Error	95% Confidence Interval		P value (between groups)
					Lower Bound	Upper Bound	
VO_2 max (ml/kg/min) (Post-test)	Superset	30 second	49.19	1.077	47.00	51.37	0.004
		120 second	46.99	1.077	44.80	49.17	
	Compound set	30 second	48.53	1.077	46.34	50.71	
		120 second	41.00	1.077	38.81	43.18	
Flexibility (cm) (Post-test)	Superset	30 second	50.85	1.215	48.38	53.31	0.012
		120 second	43.45	1.215	40.98	45.91	
	Compound set	30 second	44.35	1.215	41.88	46.81	
		120 second	42.05	1.215	39.58	44.51	
Leg Muscle Strength (kg) (Post-test)	Superset	30 second	203.40	9.919	183.28	223.51	0.001
		120 second	256.00	9.919	235.88	276.11	
	Compound set	30 second	249.30	9.919	229.18	269.41	
		120 second	257.60	9.919	237.48	277.71	
Back Muscle Strength (kg) (Post-test)	Superset	30 second	96.70	4.493	87.58	105.81	0.000
		120 second	123.75	4.493	114.64	132.86	
	Compound set	30 second	117.15	4.493	108.04	126.26	
		120 second	124.75	4.493	115.64	133.86	
Upper body muscle endurance (times) (Post-test)	Superset	30 second	45.80	3.24	39.22	52.37	0.000
		120 second	29.50	3.24	22.92	36.07	
	Compound set	30 second	46.80	3.24	40.22	53.37	
		120 second	43.80	3.24	37.22	50.37	
Abdominal muscle endurance (times) (Post-test)	Superset	30 second	46.00	1.636	42.68	49.31	0.000
		120 second	40.90	1.636	37.58	44.21	
	Compound set	30 second	53.00	1.636	49.68	56.31	
		120 second	41.10	1.636	37.78	44.41	
Fat Percentage (%) (Post-test)	Superset	30 second	14.42	1.161	12.06	16.77	0.806
		120 second	12.68	1.161	10.32	15.03	
	Compound set	30 second	13.00	1.161	10.64	15.35	
		120 second	12.90	1.161	10.54	15.25	

4. Discussion

Exercise methods must meet good criteria for all components of physical fitness related to health, namely VO2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and fat percentage. The results of this study overall proved that there is a significant effect on the superset and compound set exercise methods with 30 and 120 second rest intervals between sets on VO2 max, flexibility, muscle strength (legs, back), muscular endurance (upper body, abdomen). Weight training, using the SS or C method, resulted in a significant reduction in fat by 1.55%.

Weight training with the superset method is carried out to train the muscles of opposing antagonist agonists so that the entire muscle groups given the treatment can work optimally. The superset training method with 30 seconds of rest interval between sets had a significant effect on increasing VO_2 max, flexibility, muscle strength (legs, back), and muscle endurance (upper body, abdomen), and also significantly lowered the percentage of fat. The significant effect of this training method can be seen from the magnitude of the minimum increase in the 95% Confidence Interval in Table 4 by looking at the lower bound. The results of this study indicate that weight training performed with the SS30 method is an exercise method that can be used to increase VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and fat percentage.

The SS30 exercise method is the most effective method for increasing VO_2 max and in significant flexibility as well as reducing fat percentage. The SS30 exercise method can effectively increase VO_2 max, because when viewed physiologically, the 30-second rest period is only able to restore 70% of ATP, thus allowing the body to use aerobic energy as energy to carry out the exercise properly. In addition, this method is also effective for increasing, flexibility, because the movements during weight training super sets are the flexion-extension movements of opposing agonist and antagonist muscle groups so that there will be an increase in flexibility in these muscles. Other results show that the SS30 exercise method is also significantly effective for reducing fat percentage According to [48], this happens because at the time of doing this exercise method is only given a fairly short rest time between sets and a total treatment time of about 60 minutes, thus allowing the body to use energy from fat metabolism in the body.

The linear periodization weight training program and nonlinear daily periodization significantly increased muscle strength on bench press 15RM (175 and 219%), leg press 15RM (395 and 455%), oxygen consumption maximum (VO_2 max) (9 and 10%), and reduced free fat mass (2.8 and 3%), while nonlinear daily periodization also showed a significant increase in flexibility after 8 and 12 weeks of training compared to before training [49]. While [50] stated that weight training in the form of bench press, seated row, shoulder press, chest press, lateral pull down, abdominal crunches, leg press, leg extension, triceps pushdown, and seated biceps curls performed 2-3 times per week with an intensity of 60%-80 1 RM, performed in 3 sets and 8-10 repetitions with a rest time between sets of 30-120 seconds. The measurement of 1 RM is carried out when you want to determine the intensity of weight training that is only able to be lifted once aimed at increasing muscle strength.

The increase in results in this study occurred due to the influence of exercises conducted regularly three times a week and performed for eight weeks. Loading technique with increasing exercise load progressively using 50-70% intensity of 1RM, number of sets: 2-4 sets, repetitions: 15-25 repetitions. This shows weight training carried out with the right dose of exercise will be able to have an effect on increasing fitness and health.

Superset training method with 120 seconds rest between sets (SS120) is expected to make a better contribution to increasing VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and decreased fat percentage, because with a longer rest period, the muscles are given a longer opportunity to recover so they will be better prepared to perform the next movement with more energy [51].

The SS120 exercise method has a significant effect on increasing VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), and a slight decrease in fat percentage. The magnitude of the influence of the SS120 training method on increased cardiorespiratory endurance (VO_2 max), flexibility, muscle strength (limbs, back), muscle endurance (upper body, abdomen), can be seen from the magnitude of the minimum increase in 95% Confidence Interval which is the lower bound. [52] said that weight training carried out for 12 weeks with the superset method, with treatment carried out 2 times per week, the number of sets of 3-4 sets, 8-12 repetitions and an intensity of 70% -80% 1RM can significantly increase muscle strength, muscular endurance, and cross-sectional area of the vastus lateralis.

The biggest increase in the SS120 training method group was in muscle strength, there was a big difference when compared to the results of muscle strength in the SS30 method group. This happens because the actual resting time between sets of 120 seconds will give the muscles a longer chance to recover so that the muscles will be better prepared to perform the next movement using ATP-PC which has returned about 84%[53]. At the time of rest between sets of 120 seconds, it uses less aerobic energy and less energy from fat metabolism, which can affect cardiorespiratory endurance results and fat percentage [54]. When compared to the CS120 method, it shows the results are still smaller, because the use of muscles trained between the superset method and compound set is different [55].

Compound set exercise method with 30 seconds rest between sets (CS30) significantly increased VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen), The minimum increase can be seen in the 95% Confidence Interval, namely the lower bound (table 4). The results indicate that there is a significant effect of the CS30 exercise method on increasing VO_2 max, flexibility, muscle strength (legs, back), and muscle endurance (upper body, abdomen).

The biggest increase in this group was in–muscle endurance (upper body and abdomen), so it can be said that weight training using the CS30 method is the most effective for increasing muscle endurance. When viewed from a physiological point of view, when doing weight training with the compound set method, movements occur repeatedly in the same muscle group using different exercises. The large number of repetitions and the provision of short rest periods between sets of 30 seconds cause the muscles to work optimally and repeatedly so that the ability of the muscles to perform repeatedly without feeling tired means that they can be trained properly[56]. In addition, the energy used is as much as 70% of the ATP-PC recovery, allowing the body to use energy aerobically. [57] state that weight training with moderate intensity (65-85%) which is done 3 times per week for 12 weeks can have a significant effect on muscle endurance with a significance level of $p<0{,}05$.

Compound set exercise method with 120 seconds rest between sets (CS120) has a significant effect on increasing VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen). The minimum increase can be seen in the 95% Confidence Interval, namely the lower bound (table 4). Overall, the results of this study showed that the CS120 method had an effect on increasing VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen).

The biggest increase in this group was in muscle strength (legs and back), so it can be said that weight training using the CS120 method is the most effective for increasing muscle strength. This study showed that there was an increase in muscle strength in each group, but the compound set group with a rest time of 120 seconds showed the greatest increase in muscle strength compared to other groups. These results indicate that weight training with the compound set method can be used as an effective exercise to increase muscle strength. This can happen because at rest for 120 seconds there will be the restoration of ATP and PCr as much as 84%, allowing the muscles to be able to use energy from ATP and PCr as much as 84% when performing the next movement. Although it is true that ATP and PCr restoration will return to 100% after 3-8 minutes of rest, so to be able to train maximum strength, it is better to use rest time between sets of more than 3 minutes [58]. In addition to the long rest periods, to train maximum muscle strength, it is also necessary to pay attention to the intensity of the exercise, because to increase muscle strength maximally, it should be done with an intensity of 70% - 80% of 1 RM for medium levels, 80% - 90% of 1 RM for medium levels weight, 90% - 100% of 1 RM for maximum load and above 105% of 1 RM for supermaximum [59].

The group that has the greatest training effect on muscle strength is given treatment in the form of weight training by training a certain muscle group using two different exercises. Repeated exercises during 24 sessions over 8 weeks by increasing the intensity of the exercise between 50%-70% 1RM and decreasing reps between 15-25 repetitions in each of these 8 sessions can have an effect on the increased strength of the leg muscles and back muscles. A relatively long rest time of 120 seconds can give muscles the opportunity to recover ATP and PC so that the muscles are ready to make their next move without feeling fatigue [60]. In line with the opinion of Joao et al., (2014), it suggests that linear periodization weight training with an intensity of 65% - 95% 1 RM which is applied to weightlifters can increase muscle strength significantly, namely on bench presses by 30%, squats 33% and deadlifts by 76.9%.

The results of this study indicate that there is the most effective training method to increase VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (upper body, abdomen). The most effective exercise method to increase VO_2 max and flexibility, is the SS30 method. This happens because this training method optimizes movement to train agonist and antagonist muscles with a combination of short rest periods so that when doing weight training, energy will be used aerobically and from fat metabolism[62]. The most effective training method for increasing muscle strength (legs, back) is the CS120 method. This happens because weight training with this method tends to maximize exercise in one muscle group using two different tools with a relatively long rest time combination, allowing the body to use energy from ATP/PCr because with the rest of 120 seconds ATP/PCr has returned to 84%.[63] The most effective exercise method for increasing muscle endurance (upper body, abdomen) is the CS30 method. This happens when weight training with this method occurs repeatedly in a group of muscles that are trained using two different exercises with short rest periods between sets so that these muscles will have more endurance [64].

5. Conclusions

This study indicates that superset and compound set training methods, with rest intervals between sets of 30 and 120 seconds, have a significant effect on VO_2 max, flexibility, muscle strength (legs, back), muscle endurance (lower body, upper, stomach), except for fat percentage. This significant interaction indicates that in the four groups, combining the superset and compound set training methods with 30 and 120-second rest between sets can have an effect on fitness. It can be inferred that weight training carried out according to the right exercise dose with the selection of appropriate exercise methods and by paying attention to rest between sets will have a positive impact on health components, including cardiorespiratory endurance (VO_2 max), flexibility, muscle strength (legs, back), muscular endurance (upper body, abdomen). The most effective exercise method for improving VO_2 max, flexibility, is the superset method with a rest between sets of 30 seconds. The most effective method to increase muscle strength (legs and back) is the compound set method with a rest between sets of 120 seconds. While the most effective method to increase muscle endurance (upper body and abdomen) is a compound set method with a rest between sets of 30 seconds.

REFERENCES

[1] R. Fayazmilani, A. Abbasi, F. Hovanloo, and S. Rostami, "The effect of TRX and bodyweight training on physical fitness and body composition in prepubescent soccer athletes," *Sport Sci. Health*, pp. 1–9, 2022, doi: 10.1007/s11332-022-00908-1.

[2] E. Wegierska, I. A. Charitos, S. Topi, M. A. Potenza, M. Montagnani, and L. Santacroce, "The Connection Between Physical Exercise and Gut Microbiota: Implications for Competitive Sports Athletes," *Sport. Med.*, pp. 1–15, 2022, doi: 10.1007/s40279-022-01696-x.

[3] K. N. Mileva and L. Zaidell, "Sport and Exercise Science and Health," in *Health Studies*, Springer, 2022, pp. 85–124.

[4] Nasrulloh, P. Deviana, R. Yuniana, and K. W. Pratama, "The Effect of Squat Training and Leg Length in Increasing the Leg Power of Volleyball Extracurricular Participants," *Teorìâ ta Metod. Fìzičnogo Vihovannâ*, vol. 21, no. 3, pp. 244–252, 2021.

[5] Nasrulloh *et al.*, "Tricet Method to Increase the Hypertrophy Muscle," in *Journal of Physics: Conference Series*, 2020, vol. 1529, no. 3, p. 32006.

[6] E. Lattari *et al.*, "Effects on Volume Load and Ratings of Perceived Exertion in Individuals' Advanced Weight Training After Transcranial Direct Current Stimulation," *J. strength Cond. Res.*, vol. 34, no. 1, pp. 89–96, Jan. 2020, doi: 10.1519/JSC.0000000000002434.

[7] M. I. Sabillah, A. Nasrulloh, and R. Yuniana, "The effect of plyometric exercise and leg muscle strength on the power limb of wrestling athletes," *J. Phys. Educ. Sport*, vol. 22, no. 6, pp. 1403–1411, 2022, doi: 10.7752/jpes.2022.06176.

[8] S. C. Glass, S. Ahmad, and T. Gabler, "Effectiveness of a 2-Week Strength Training Learning Intervention on Self-selected Weight-Training Intensity," *J. strength Cond. Res.*, vol. 34, no. 9, pp. 2443–2448, Sep. 2020, doi: 10.1519/JSC.0000000000003729.

[9] M. D. Jones, M. A. Wewege, D. A. Hackett, J. W. L. Keogh, and A. D. Hagstrom, "Sex Differences in Adaptations in Muscle Strength and Size Following Resistance Training in Older Adults: A Systematic Review and Meta-analysis," *Sports Med.*, vol. 51, no. 3, pp. 503–517, Mar. 2021, doi: 10.1007/S40279-020-01388-4.

[10] F. Shabkhiz, M. Khalafi, S. Rosenkranz, P. Karimi, and K. Moghadami, "Resistance training attenuates circulating FGF-21 and myostatin and improves insulin resistance in elderly men with and without type 2 diabetes mellitus: A randomised controlled clinical trial," *Eur. J. Sport Sci.*, vol. 21, no. 4, pp. 636–645, 2021, doi: 10.1080/17461391.2020.1762755.

[11] G. Coratella *et al.*, "Effects of in-season enhanced negative work-based vs traditional weight training on change of direction and hamstrings-to-quadriceps ratio in soccer players," *Biol. Sport*, vol. 36, no. 3, pp. 241–248, 2019, doi: 10.5114/BIOLSPORT.2019.87045.

[12] J. Schroeder, L. Lueders, M. Schmidt, K. M. Braumann, and K. Hollander, "Foam rolling effects on soft tissue tone, elasticity and stiffness in the time course of recovery after weight training," *Sport. Orthop. Traumatol.*, vol. 35, no. 2, pp. 171–177, Jun. 2019, doi: 10.1016/J.ORTHTR.2018.11.003.

[13] K. S. Mohamed, K. Mohamed, S. Mohammed, D. Mokrani, and A. Belkadi, "The Effect of Heavy Weight Training on Physiological Abilities of Soccer Players Under the Age 21 Years Old," *Acta Fac. Educ. Phys. Univ. Comenianae*, vol. 59, no. 1, pp. 33–43, May 2019, doi: 10.2478/AFEPUC-2019-0004.

[14] M. Smith *et al.*, "Variable resistance training versus traditional weight training on the reflex pathway following four weeks of leg press training," *Somatosens. Mot. Res.*, vol. 36, no. 3, pp. 223–229, Jul. 2019, doi: 10.1080/08990220.2019.1659238.

[15] N. Schott, B. Johnen, and B. Holfelder, "Effects of free weights and machine training on muscular strength in high-functioning older adults," *Exp. Gerontol.*, vol. 122, pp. 15–24, Jul. 2019, doi: 10.1016/J.EXGER.2019.03.012.

[16] V. H. De Oliveira Segundo, G. Piuvezam, K. P. M. De Azevedo, H. J. De Medeiros, J. C. Leitão, and M. I. Knackfuss, "Can people self-select an exercise intensity sufficient to enhance muscular strength during weight training?: A systematic review protocol of intervention studies," *Medicine (United States)*, vol. 98, no. 38. 2019, doi: 10.1097/MD.0000000000017290.

[17] F. M. Martins *et al.*, "High-intensity body weight training is comparable to combined training in changes in muscle mass, physical performance, inflammatory markers and metabolic health in postmenopausal women at high risk for type 2 diabetes mellitus: A randomized controlled cl," *Exp. Gerontol.*, vol. 107, pp. 108–115, Jul. 2018, doi: 10.1016/J.EXGER.2018.02.016.

[18] R. Mora-Rodriguez, J. F. Ortega, F. Morales-Palomo, and M. Ramirez-Jimenez, "Weight loss but not gains in cardiorespiratory fitness after exercise-training predicts improved health risk factors in metabolic syndrome," *Nutr. Metab. Cardiovasc. Dis.*, vol. 28, no. 12, pp. 1267–1274, Dec. 2018, doi: 10.1016/J.NUMECD.2018.08.004.

[19] Nasrulloh, R. Yuniana, and K. W. Pratama, "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," *J. Keolahragaan*, vol. 9, no. 2, pp. 220–230, 2021, doi: 10.21831/jk.v9i2.41678.

[20] G. Z. Schaun, S. S. Pinto, M. R. Silva, D. B. Dolinski, and C. L. Alberton, "Whole-Body High-Intensity Interval Training Induce Similar Cardiorespiratory Adaptations Compared

With Traditional High-Intensity Interval Training and Moderate-Intensity Continuous Training in Healthy Men," *J. strength Cond. Res.*, vol. 32, no. 10, pp. 2730–2742, 2018, doi: 10.1519/JSC.0000000000002594.

[21] S. Afrasyabi, S. M. Marandi, and M. Kargarfard, "The effects of high intensity interval training on appetite management in individuals with type 2 diabetes: influenced by participants weight," *J. Diabetes Metab. Disord.*, vol. 18, no. 1, pp. 107–117, Jun. 2019, doi: 10.1007/S40200-019-00396-0.

[22] F. Campa, S. Toselli, M. Mazzilli, L. A. Gobbo, and G. Coratella, "Assessment of Body Composition in Athletes: A Narrative Review of Available Methods with Special Reference to Quantitative and Qualitative Bioimpedance Analysis," *Nutrients*, vol. 13, no. 5, May 2021, doi: 10.3390/NU13051620.

[23] Jakše, B. Jakše, I. Čuk, and D. Šajber, "Body Composition, Training Volume/Pattern and Injury Status of Slovenian Adolescent Female High-Performance Gymnasts," *Int. J. Environ. Res. Public Health*, vol. 18, no. 4, pp. 1–12, Feb. 2021, doi: 10.3390/IJERPH18042019.

[24] Ashtary-Larky *et al.*, "Effects of resistance training combined with a ketogenic diet on body composition: a systematic review and meta-analysis," *Crit. Rev. Food Sci. Nutr.*, vol. 62, no. 21, pp. 5717–5732, 2022, doi: 10.1080/10408398.2021.1890689.

[25] Langton and J. King, "UTILIZING BODY WEIGHT TRAINING with YOUR PERSONAL TRAINING CLIENTS," *ACSM's Heal. Fit. J.*, vol. 22, no. 6, 2018, doi: 10.1249/FIT.0000000000000433.

[26] Johnen and N. Schott, "Feasibility of a machine vs free weight strength training program and its effects on physical performance in nursing home residents: a pilot study," *Aging Clin. Exp. Res.*, vol. 30, no. 7, pp. 819–828, Jul. 2018, doi: 10.1007/S40520-017-0830-8.

[27] M. Wewege, R. van den Berg, R. E. Ward, and A. Keech, "The effects of high-intensity interval training vs. moderate-intensity continuous training on body composition in overweight and obese adults: a systematic review and meta-analysis," *Obes. Rev.*, vol. 18, no. 6, pp. 635–646, Jun. 2017, doi: 10.1111/OBR.12532.

[28] P. T. Nikolaidis, T. Rosemann, and B. Knechtle, "Force-Velocity Characteristics, Muscle Strength, and Flexibility in Female Recreational Marathon Runners," *Front. Physiol.*, vol. 9, no. NOV, Nov. 2018, doi: 10.3389/FPHYS.2018.01563.

[29] D. Lima, L. E. Brown, Y. Li, N. Herat, and D. Behm, "Periodized versus Non-periodized Stretch Training on Gymnasts Flexibility and Performance," *Int. J. Sports Med.*, vol. 40, no. 12, pp. 779–788, 2019, doi: 10.1055/A-0942-7571.

[30] R. Yuniana, Tomoliyus, B. Wara Kushartanti, N. Intan Arovah, and A. Nasrulloh, "Effectiveness of massage therapy continued exercise therapy against pain healing, ROM, and pelvic function in people with chronic pelvic injuries," *J. Phys. Educ. Sport* ®, vol. 22, no. 6, pp. 1433–1441, 2022, doi: 10.7752/jpes.2022.06180.

[31] R. G. Lockie, J. J. Dawes, C. L. Kornhauser, and R. J. Holmes, "Cross-Sectional and Retrospective Cohort Analysis of the Effects of Age on Flexibility, Strength Endurance, Lower-Body Power, and Aerobic Fitness in Law Enforcement Officers," *J. strength Cond. Res.*, vol. 33, no. 2, pp. 451–458, Feb. 2019, doi: 10.1519/JSC.0000000000001937.

[32] J. Fináncz, Á. Nyitrai, J. Podráczky, and M. Csima, "Connections between Professional Well-Being and Mental Health of Early Childhood Educators.," *Int. J. Instr.*, vol. 13, no. 4, pp. 731–746, Oct. 2020, doi: 10.29333/iji.2020.13445a.

[33] R. A. Tibana *et al.*, "Local Muscle Endurance and Strength Had Strong Relationship with CrossFit® Open 2020 in Amateur Athletes," *Sport. (Basel, Switzerland)*, vol. 9, no. 7, Jul. 2021, doi: 10.3390/SPORTS9070098.

[34] Boullosa, J. Esteve-Lanao, A. Casado, L. A. Peyré-Tartaruga, R. Gomes da Rosa, and J. Del Coso, "Factors affecting training and physical performance in recreational endurance runners," *Sports*, vol. 8, no. 3, p. 35, 2020, doi: 10.3390/sports8030035.

[35] B. J. McKinlay *et al.*, "Effects of Plyometric and Resistance Training on Muscle Strength, Explosiveness, and Neuromuscular Function in Young Adolescent Soccer Players," *J. strength Cond. Res.*, vol. 32, no. 11, pp. 3039–3050, 2018, doi: 10.1519/JSC.0000000000002428.

[36] J. A. Vitale, A. La Torre, G. Banfi, and M. Bonato, "Effects of an 8-Week Body-Weight Neuromuscular Training on Dynamic Balance and Vertical Jump Performances in Elite Junior Skiing Athletes: A Randomized Controlled Trial," *J. strength Cond. Res.*, vol. 32, no. 4, pp. 911–920, 2018, doi: 10.1519/JSC.0000000000002478.

[37] Kruse, C. Schranz, M. Svehlik, and M. Tilp, "The Effect of Functional Home-Based Strength Training Programs on the Mechano-Morphological Properties of the Plantar Flexor Muscle-Tendon Unit in Children with Spastic Cerebral Palsy," *Pediatr. Exerc. Sci.*, vol. 31, no. 1, pp. 67–75, Feb. 2019, doi: 10.1123/PES.2018-0106.

[38] J. J. Merrigan, M. T. Jones, and J. B. White, "A Comparison of Compound Set and Traditional Set Resistance Training in Women: Changes in Muscle Strength, Endurance, Quantity, and Architecture," *J. Sci. Sport Exerc.*, vol. 1, no. 3, pp. 264–272, Nov. 2019, doi: 10.1007/S42978-019-00030-8.

[39] M. Krzysztofik, M. Wilk, G. Wojdała, and A. Gołaś, "Maximizing Muscle Hypertrophy: A Systematic Review of Advanced Resistance Training Techniques and Methods," *Int. J. Environ. Res. Public Health*, vol. 16, no. 24, Dec. 2019, doi: 10.3390/IJERPH16244897.

[40] M. A. Brentano *et al.*, "Muscle damage and muscle activity induced by strength training super-sets in physically active men," *J. Strength Cond. Res.*, vol. 31, no. 7, pp. 1847–1858, 2017, doi: 10.1519/JSC.0000000000001511.

[41] C. T. Haun *et al.*, "Effects of Graded Whey Supplementation During Extreme-Volume Resistance Training," *Front. Nutr.*, vol. 5, p. 84, Sep. 2018, doi: 10.3389/FNUT.2018.00084/FULL.

[42] M. B. La Monica, D. H. Fukuda, T. M. Starling-Smith, N. W. Clark, and V. L. G. Panissa, "Alterations in energy system contribution following upper body sprint interval training," *Eur. J. Appl. Physiol.*, vol. 120, no. 3, pp. 643–651, 2020, doi: 10.1007/s00421-020-04304.

[43] S. Adi, "Benefits of Sports Activities with FITT Principles During the Covid-19 Pandemic in a 'New Normal' Life for Health," in *4th International Conference on Sports Sciences and Health (ICSSH 2020)*, 2021, pp. 121–126, doi: 0.2991/ahsr.k.210707.028.

[44] P. Hough, "High-intensity interval training," in *Advanced Personal Training*, Routledge, 2021, pp. 171–203.

[45] T. Guiraud, A. Nigam, V. Gremeaux, P. Meyer, M. Juneau, and L. Bosquet, "High-intensity interval training in cardiac rehabilitation," *Sport. Med.*, vol. 42, no. 7, pp. 587–605, 2012, doi: 10.2165/11631910-000000000-00000.

[46] V. S. R. Raju, R. Sherikar, and C. H. Srinivas, "Body fat distribution and its effect on vital capacity index in young adults," *Indian J. Clin. Anat. Physiol.*, vol. 6, no. 3, pp. 291–294, 2019, doi: 10.18231/j.ijcap.2019.064.

[47] N. P. Utami, C. E. Ayuningtyas, and W. Hariyono, "Association of Body Composition and Anthropometric Measurement with Hypertension among Workers in Universitas Ahmad Dahlan.," *Electron. J. Gen. Med.*, vol. 17, no. 5, 2020, doi: 10.29333/ejgm/7880.

[48] P. R. P. Nunes *et al.*, "Effect of high-intensity interval training on body composition and inflammatory markers in obese postmenopausal women: a randomized controlled trial," *Menopause*, vol. 26, no. 3, pp. 256–264, 2019, doi: 10.1097/GME.0000000000001207.

[49] J. W. Evans, "Periodized Resistance Training for Enhancing Skeletal Muscle Hypertrophy and Strength: A Mini-Review," *Front. Physiol.*, vol. 10, no. JAN, 2019, doi: 10.3389/FPHYS.2019.00013.

[50] M. Barbalho, P. Gentil, R. Raiol, F. B. Del Vecchio, R. Ramirez-Campillo, and V. S. Coswig, "Non-Linear Resistance Training Program Induced Power and Strength but Not Linear Sprint Velocity and Agility Gains in Young Soccer Players," *Sports*, vol. 6, no. 2, Jun. 2018, doi: 10.3390/SPORTS6020043.

[51] Myrkos *et al.*, "Effects of Work and Recovery Duration and Their Ratio on Cardiorespiratory and Metabolic Responses During Aerobic Interval Exercise," *J. Strength Cond. Res.*, vol. 36, no. 8, pp. 2169–2175, 2022, doi: 10.1519/JSC.0000000000003578.

[52] H. Arazi, K. Sotoudeh, M. Sadeghi, S. Mohammadi, and T. Saeedi, "Influence of Upper-Body Exercise Order on Repetition Performance and Ratings of Perceived Exertion during a Super-Set Resistance Training Session," *Sport Sci.*, vol. 11, no. 1, pp. 35–38, 2018.

[53] T. Bompa and C. Buzzichelli, *Periodization of Strength Training for Sports*. Human Kinetics Publishers, 2021.

[54] J. M. González-Ravé, F. González-Mohino, V. Rodrigo-Carranza, and D. B. Pyne, "Reverse Periodization for Improving Sports Performance: A Systematic Review," *Sport. Med.*, vol. 8, no. 1, pp. 1–14, 2022, doi: 10.1186/s40798-022-00445-8.

[55] H. R. Ghanim and G. A. Abd Al Hassan, "The Effect of Proprioceptive Neuromuscular Facilitation Exercises Combined with Superset Pyramid on Maximal Strength in Classic Physique Athletes' Lower Extremities," *J. Phys. Educ.*, vol. 34, no. 2, 2022, doi: 10.37359/JOPE.V34(2)2022.1284.

[56] H. M. Dantas *et al.*, "Criteria for identifying and assessing sports training periodization models (Criterios para identificar y evaluar modelos de periodización de entrenamiento deportivo)," *Retos*, vol. 45, pp. 174–183, 2022, doi: 10.47197/retos.v45i0.90837.

[57] C. Costa *et al.*, "Effects of High-Intensity Interval Training Versus Moderate-Intensity Continuous Training On Blood Pressure in Adults with Pre- to Established Hypertension: A Systematic Review and Meta-Analysis of Randomized Trials," *Sports Med.*, vol. 48, no. 9, pp. 2127–2142, Sep. 2018, doi: 10.1007/S40279-018-0944-Y.

[58] M. Á. Galán-Rioja, J. M. Gonzalez-Ravé, F. González-Mohíno, and S. Seiler, "Training Periodization, Intensity Distribution, and Volume in Trained Cyclists: A Systematic Review," *Int. J. Sports Physiol. Perform.*, vol. 1, no. aop, pp. 1–11, 2023, doi: /10.1123/ijspp.2022-0302.

[59] T. J. Suchomel, S. Nimphius, C. R. Bellon, and M. H. Stone, "The importance of muscular strength: training considerations," *Sport. Med.*, vol. 48, no. 4, pp. 765–785, 2018.

[60] A. V. Conceiçao and H. Affonso, "Programing and Periodization for Individual Sports," in *Resistance Training Methods*, Springer, 2022, pp. 259–278.

[61] A. Joao *et al.*, "Effect of 16 weeks of periodized resistance training on strength gains of powerlifting athletes," *J. Exerc. Physiol. Online*, vol. 17, no. 3, pp. 102–110, Jun. 2014.

[62] J. M. Griffo, M. Jensen, C. C. Anthony, T. Baghurst, and P. H. Kulinna, "A decade of research literature in sport coaching (2005–2015)," *Int. J. Sports Sci. Coach.*, vol. 14, no. 2, pp. 205–215, 2019, doi: 10.1177/1747954118825058.

[63] A. Paz, E. Iglesias-Soler, J. M. Willardson, M. de Freitas Maia, and H. Miranda, "Postexercise hypotension and heart rate variability responses subsequent to traditional, paired set, and superset resistance training methods," *J. Strength Cond. Res.*, vol. 33, no. 9, pp. 2433–2442, 2019, doi: 10.1519/JSC.0000000000002353.

[64] Fink, B. J. Schoenfeld, M. Sakamaki-Sunaga, and K. Nakazato, "Physiological Responses to Agonist–Antagonist Superset Resistance Training," *J. Sci. Sport Exerc.*, vol. 3, no. 4, pp. 355–363, 2021, doi: 10.1007/s42978-020-00092-z.