circuit training to optimise the performance of wrestlers: a comprehensive strength, speed and endurance programme

entrenamiento en circuito para optimizar el rendimiento de los luchadores: un programa integral de fuerza, velocidad y Resistencia

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Abstract

Background: Circuit training is a beneficial training method for wrestling athletes as it is able to develop different physical aspects needed. The aim of this study was to test the effectiveness of isokinetic and isometric circuit training programmes specifically designed for wrestling athletes to improve strength, speed and endurance. **Methods:** The study used a quasi-experimental approach to test the effectiveness of two types of isokinetic and isometric training. The study sample consisted of 20 wrestlers who were divided into isokinetic and isometric circuit training groups. The treatment was carried out for 8 weeks with 3 sessions per week and the athlete's development was observed every two weeks. The research instruments include lifting weights One Repetition Maximum for strength, running 30 metres for speed and VO2 max test using the Bruce protocol method for endurance. Data analysis was done with SPSS version 25.0, statistical test with t-test and Analysis of variance (ANOVA). **Results:** The isokinetic group increased strength by 20%, speed by 8.9% and endurance by 12%. The isometric group increased strength by 15%, speed by 5.3% and endurance by 9%. Statistical analysis showed a significant improvement in all variables in both groups ($p < 0.05$). **Conclusions:** Isokinetic and isometric circuit training are both effective in improving athlete performance, with isokinetic training being superior in achieving results. Future research could develop more targeted and effective training programmes to optimise strength, speed and endurance in wrestling athletes.

Keywords: Performance, wrestlers, circuit training, strength, speed, endurance.
Palabras clave: Rendimiento, luchadores, entrenamiento en circuito, fuerza, velocidad, resistencia

Introduction

Physical condition is the main factor that affects the performance of athletes in the sport of wrestling because it is closely related to optimal physical ability (Bekembetova et al., 2020; Sastra et al., 2022). In this regard, circuit training becomes one of the relevant methods of developing physical qualities because it involves the combination of different types of exercises in a series of sessions designed to comprehensively increase the strength, speed and endurance of the athlete. Optimal performance in the sport of wrestling is highly dependent on excellent physical abilities including strength, speed, and endurance (Bugaevsky, 2023; KA, 2024). As a very intense sport, wrestling requires athletes to have high endurance, strong muscles, and quick reflexes in order to face competitive situations so that effective training largely determines the success of athletes in achieving and maintaining optimal performance (Prieto-González et al., 2022). Circuit training has been shown to be an effective method of increasing the physical capacity of athletes because previous studies have shown that this method is able to increase strength and endurance (Annasai et al., 2023; Prasetyo et al., 2023). In addition, exercise intensity and recovery ability are also important factors in accelerating the increase in physical and mental capacity of wrestling athletes (Bachero-Mena et al., 2021; Semeniv et al., 2023). A comprehensive approach that combines different types of exercises in circuit training provides significant benefits for athletes primarily in the development of physical endurance and speed of movement.

Circuit training not only increases explosive strength and muscular endurance but also optimizes VO2 max which is critical for endurance (Martin et al., 2024; Wijaya et al.,

2024). High-intensity interval training combined in a training set provides optimal stimulation to the muscles thereby gradually increasing the adaptive capacity of the athlete (Keshavarz et al., 2023; Son et al., 2022). Expert opinion on the effectiveness of this method provides a solid foundation as an effective training strategy to support performance improvement in competitive sports especially wrestling.

Circuit training can be classified into two main types which are Isokinetic and isometric. Isokinetic exercises involve movements at a steady pace during the exercise in which the resistance varies according to the force exerted by the muscles (Chen et al., 2022; Nam et al., 2023; Rashid et al., 2020). This exercise uses a special machine that ensures the muscles move at a constant speed as well as providing balanced resistance throughout the movement. Isokinetic circuit training is very useful for wrestlers because it allows training with maximum load at a fixed speed similar to the competition situation and thus benefits in the development of explosive strength and muscular endurance.

Meanwhile, isometric exercises involve muscle contraction without changes in muscle length or joint movement. In this exercise, the athlete maintains a position against weight or pressure without moving the part of the body being trained so examples of this exercise include planks or static squats (Herrod et al., 2018; Ramania et al., 2022; Šarabon et al., 2021). Isometric circuit training helps build the static strength that is important for wrestlers when defending a position or resisting opponent pressure without moving much as well as strengthening the body's core stability and increasing resistance to muscle fatigue that is essential for maintaining performance when facing tough opponents.

Although research regarding circuit training has been widely conducted most focus on the general effectiveness of this method in increasing endurance or strength. But research specifically evaluating the effects of structured Isokinetic and isometric circuit training for wrestling-specific needs is limited. Though this sport requires the development of upper body strength, speed, as well as the ability to maintain endurance for a long period of time. This study therefore aims to fill that gap by providing circuit training programs specifically designed to optimize the performance of wrestling athletes.

This study aims to test the effectiveness of an isokinetic and isometric circuit training programme specifically designed for wrestling athletes, focusing on improving strength, speed and endurance. This programme is expected to optimise the performance of wrestlers through an integrated training approach and to provide a strong scientific basis for the development of effective training methods in the context of competitive sport.

Material and Methods

The study used a quasi-experimental approach with a controlled group design to test the effectiveness of two types of training, namely isokinetic training and isometric training, on the performance of wrestlers in terms of strength, speed and endurance. A method was chosen to compare two training techniques and determine which is more effective in improving the performance of wrestlers (Latino et al., 2024; Wu et al., 2021; Yalfani et al., 2023). The research sample consisted of 20 student wrestlers from Makassar State University, aged between 19 and 23 years. Participants were selected using purposive sampling techniques with specific criteria such as excellent physical health and at least one year's experience in wrestling. The participants were divided into two groups, the isokinetic group and the isometric group, each consisting of 10 athletes. This division of groups was done randomly to maintain the validity of the results of the study and to reduce the possibility of group bias. This study uses an experimental design with pre- and post-test measurements. Each group underwent baseline measurements of strength, speed and endurance before the intervention began.

The treatment was carried out for 8 weeks with 3 sessions per week. Isokinetic circuit training

include: 1) Leg extension on the isokinetic machine trains the quadriceps muscles, helping to increase the strength and endurance of the thigh muscles, which are important in leg movements during defence and attack. 2) Leg curl exercises on Isokinetic machines train the hamstring muscles, increasing stability and preventing injuries to the posterior thigh area. 3) Arm curls on an isokinetic machine are effective in strengthening the biceps, which is so important for control and power in grappling techniques. Isometric exercises include: 1) The plank exercise, in which the athlete maintains a body position parallel to the floor, strengthens the core muscles and increases the stability of the body, which is very important for maintaining balance. 2) Wall sit, in which the athlete sits against a wall with the knees at a 90 degree angle, is an excellent way to train the strength and endurance of the thigh muscles. 3) Push-up hold is performed by holding the position in the middle of the push-up movement, training the chest, shoulder and triceps muscles to be stronger in the push. 4) Squat hold helps to strengthen the thigh and gluteal muscles by holding the squat position without movement, thus increasing the resistance and strength of the leg muscles. Observations and measurements were carried out every two weeks to monitor the athlete's progress on a regular basis.

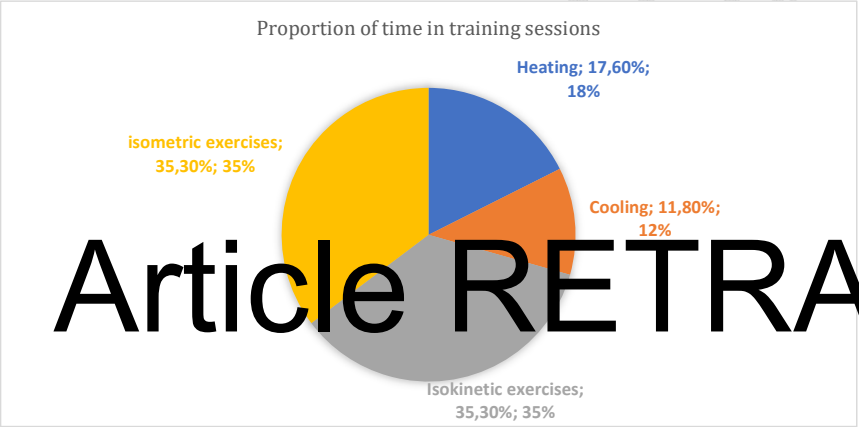

Figure 1. Training session diagram

Table 1. Research Sample Data

No.	Name (Initial)	Age (Years)	Gender	Fitness Level	Medical History	Experience (Years)	Commitment
1	AB	20	Male	Optimal	None	2	Fully committed
2	CD	21	Female	Optimal	None	3	Fully committed
3	EF	19	Male	Optimal	None	2	Fully committed
4	GH	22	Female	Optimal	None	4	Fully committed
5	IJ	23	Male	Optimal	None	5	Fully committed
6	KL	20	Male	Optimal	None	3	Fully committed
7	MN	21	Female	Optimal	None	4	Fully committed
8	OP	19	Male	Optimal	None	2	Fully committed
9	QR	22	Female	Optimal	None	3	Fully committed
10	ST	23	Male	Optimal	None	4	Fully committed
11	UV	20	Female	Optimal	None	3	Fully committed
12	WX	21	Male	Optimal	None	4	Fully committed
13	YZ	19	Female	Optimal	None	2	Fully committed
14	AA	22	Male	Optimal	None	3	Fully committed
15	BB	23	Female	Optimal	None	5	Fully committed
16	CC	20	Male	Optimal	None	3	Fully committed
17	DD	21	Female	Optimal	None	4	Fully committed
18	EE	19	Male	Optimal	None	2	Fully committed

Comentado [J1]: other inclusion criteria

19	FF	22	Female	Optimal	None	4	Fully committed
20	GG	23	Male	Optimal	None	5	Fully committed

The training sessions in Table 2 in this study were designed with attention to detailed protocols to ensure the effectiveness and safety of the exercises. Recovery time between exercises is given as 2 minutes between each set or type of exercise. This duration is intended to allow participants ' heart rates to return to the normal range and ensure they can continue training at optimal intensity. Thus, sufficient recovery time to help prevent excessive fatigue as well as maintain the quality of execution of each exercise. Before starting the main session, a 10-minute warm-up is performed to prepare the participant's body and prevent injury. The warm-up involves a combination of dynamic stretching, high knees and lunges, as well as light cardio activities such as jogging on the spot. This activity aims to increase body temperature, loosen muscles and prepare the cardiovascular system for the next training intensity.

After the training session was completed, participants were directed to cool down for 5-10 minutes. Cool-down activities include static stretches, such as hamstring stretches and quad stretches. Cooling down aims to help the body recover gradually, reduce heart rate slowly, and prevent muscle stiffness or pain after exercise. The protocol is designed to ensure optimal recovery so that participants are ready to continue with the next session without the risk of injury or cumulative fatigue.

Comentado [J2]: Explanation of the training session
- Recovery time between workouts
- Heating and cooling protocols

Table 2. Series of Isokinetic and isometric exercises

Training Type	Exercise	Target Muscles	Repetitions/Exercise	Training Intensity	Exercise Duration	Recovery Time	Warm-up	Cool-down
Isokinetic	Leg extension	Quadriceps (front thigh)	3 sets x 12-15 reps	60-75% of 1RM	-	60-90 seconds/set	Dynamic leg stretches	Static quadriceps stretches
	Leg curl	Hamstrings (back thigh)	3 sets x 12-15 reps	60-75% of 1RM	-	60-90 seconds/set	Dynamic leg stretches	Static hamstrings stretches
	Arm curl	Biceps	3 sets x 12-15 reps	60-75% of 1RM	-	60-90 seconds/set	Dynamic arm stretches	Static biceps stretches
Isometric	Plank	Core muscles	-	-	30-60 seconds	60 seconds/set	Dynamic upper body stretches	Lower back stretches
	Wall sit	Quadriceps (front thigh)	-	-	30-60 seconds	60 seconds/set	Dynamic leg stretches	Static quadriceps stretches
	Push-up hold	Chest, shoulders, triceps	-	-	20-40 seconds	60 seconds/set	Dynamic arm stretches	Shoulder and triceps stretches
	Squat hold	Quadriceps, gluteal muscles	-	-	30-60 seconds	60 seconds/set	Dynamic leg stretches	Gluteal and thigh stretches

In the isometric and isokinetic groups, measurements were made by means of a weight lifting test One Repetition Maximum (1RM), while speed was assessed by means of a 30-metre running test. Endurance athletes were measured by a VO2 max test using the Bruce protocol method. A survey of the athletes was conducted to determine the degree of fatigue and physical recovery after a training session. A sample size of 20 athletes is considered sufficient to achieve a precision level of 95% with a margin of error of 5%. Data analysis was performed using SPSS statistical software, version 25.0. Statistical tests used were paired t-tests to see changes in the same group between pre-test and post-test, and independent t-tests to see differences between the isokinetic and isometric groups. To assess the effectiveness of each method, an analysis of variance (ANOVA)was also carried out to determine the significant influence of these two training methods. The level of significance was set at 0.05.

Results

The results of a study of isokinetic and isometric circuit training on the performance of wrestlers in terms of strength as measured by a 1RM weightlifting test. Based on the results of statistical analysis, both groups experienced significant improvements in strength aspects after participating in the 8-week training programme. The isokinetic group showed a 20% increase in strength, while the isometric group showed a 15% increase.

Paired t-tests showed significant differences in the changes in strength in both groups ($p < 0.05$), however the independent t-test showed that the difference between the isokinetic and isometric groups was not significant ($p > 0.05$), indicating that both types of training can effectively increase strength, although isokinetics tends to provide a greater improvement.

The mean strength of the isokinetic group showed a greater increase in 1RM than the isometric group. The significance of the change in strength in both groups was significant ($p < 0.05$). Here are the results of the strength comparison between the isokinetic and isometric groups:

Table 1. 1RM weight lifting test result

Groups	Pretest (1RM)	Posttest (1RM)	Difference (%)	P-Value
Isokinetics	80 ± 8 kg	96 ± 10 kg	+20%	0.002
Isometric	82 ± 7 kg	94 ± 9 kg	+15%	0.004

Speed was measured using a 30-meter run test in the isokinetic group. Post-test results showed an 8% decrease in running time, while the isometric group showed a 5% decrease in time. Paired t-test analysis revealed significant changes in running time in both groups (p-value < 0.05), indicating that both isokinetic and isometric training are effective in increasing speed in athletes. However, when comparing the two groups using an unpaired t-test, significant differences were found, with the isokinetic group showing a greater improvement than the isometric group (p-value < 0.05).

The average speed demonstrated an increase in running speed, with the isokinetic training group showing a greater improvement (8.93%) compared to the isometric group (5.26%). The changes in speed were significant in both groups (p-value < 0.05). However, the unpaired t-test showed significant differences between the groups with the isokinetic group exhibiting a greater increase (p-value < 0.05).The running time of 30 metres was recorded as follows:

Table 2. 30 meter running test results

Groups	Pretest (seconds)	Posttest (seconds)	Difference (%)	P-Value
Isokinetics	5.6 ± 0.2	5.1 ± 0.1	+8.93%	0.003
Isometric	5.7 ± 0.3	5.4 ± 0.2	+5.26%	0.021

Endurance was measured using the Bruce protocol VO2 max test, which showed an increase in the athlete's aerobic capacity. The isokinetic group had a 12% increase in VO2 max, while the isometric group had a 9% increase. The results of the paired t-test showed a significant increase in endurance in both groups ($p < 0.05$). However, the unpaired t-test showed that the difference between the isokinetic and isometric groups was significant ($p < 0.05$), with the isokinetic group showing a greater increase in endurance.

The mean endurance of the isokinetic group showed a greater increase in VO2 max than the isometric group. The significance of the change in endurance in both groups was significant ($p < 0.05$), with the isokinetic group showing a greater increase ($p < 0.05$):

Table 3. VO2 max test results

Groups	Pretest (ml/kg/min)	Posttest (ml/kg/min)	Difference (%)	P-Value
Isokinetics	42.5 ± 3.4	47.5 ± 3.0	+12%	0.001

Isometric	43.0 ± 3.0	46.9 ± 2.8	+9%	0.005

The results of a survey on the level of fatigue and physical recovery of the athlete at the end of the training session. The results showed that athletes who trained isokinetically had higher levels of fatigue and faster recovery times than those in the isometric group. These data are due to the isokinetic nature of training, which involves constant movement and the use of resistance that adapts to the speed of movement, which can accelerate muscle recovery. The results of the survey showed differences in the level of fatigue and physical recovery between the two groups. The isokinetic group reported a higher level of fatigue than the isometric group, who performed at a higher intensity. Fatigue recovery time Isokinetic group athletes higher levels of fatigue, they also reported faster recovery times than the isometric group as follows:

Table 4. Observation of fatigue level

Groups	Fatigue level (scale 1-10)	Recovery time (minutes)
Isokinetics	7.5 ± 1.2	25 ± 3
Isometric	6.8 ± 1.1	30 ± 4

An analysis of variance (ANOVA) was performed to assess the significant influence of both training methods on changes in athlete performance. There were significant differences in changes in strength, speed and endurance between the two groups ($p < 0.05$). Isokinetic training showed more significant results in improving performance of wrestlers than isometric training. The results of the ANOVA showed that there was a significant effect of both types of training on the strength, speed and endurance of the athlete ($p < 0.05$), confirming that both isokinetic and isometric training can significantly improve the performance of athletes.

Table 5. Results Of Anova Analysis

Variable	F-Value	P-Value
Strength	2.69	0.119
Speed	4.55	0.036
Endurance	6.72	0.015

Discussion

Optimal performance of wrestlers is an important aspect of achieving the best results in competitions. Wrestlers need to master various physical aspects that support performance during the match (Billew, 2022; Juhanis et al., 2024; Latief et al., 2024). Circuit training programmes can enhance and improve the overall performance of athletes, covering aspects of strength, speed and endurance (Bekbossynov et al., 2023; Zanada et al., 2023). Circuit training, as a form of exercise that is comprehensive and has been shown to be effective in improving the performance of athletes (Kastrena et al., 2023; Nurhadi et al., 2023). Muscle strength is a fundamental aspect of wrestling that plays an important role in every movement, be it offensive or defensive. Muscle strength is used not only to generate power in an attack, but also to control body position, maintain balance and prevent the opponent from overcoming an advantageous position (Kwon et al., 2022; Mahesvi et al., 2023; Mulyadi et al., 2020). Increased muscle strength in wrestlers can be achieved through different forms of training, such as weight training, isokinetic training and isometric training.

Isokinetic training optimises muscle strength through dynamic contraction at a constant rate, which is very effective in improving overall strength. Isokinetic exercises allow the athlete to work the muscles with a full range of motion and at a certain speed, corresponding to the explosive movements required in wrestling (Olmez, 2022). Both types of exercise have their own advantages, but the choice between them should be tailored to the specific purpose of the exercise.

Both types of exercise have their own advantages, but the choice between them should be tailored to the specific purpose of the exercise. Increasing speed is also very important in wrestling. Speed, which includes the ability to move quickly

and make decisions in a short period of time, is a key factor in determining the outcome of a match. Speed is not only related to the movement of the whole body, but also to reacting quickly to the actions of the opponent. Athletes who can react quickly have a great advantage when it comes to capitalising on their opponent's mistakes or taking the initiative in a match (Danko et al., 2023; Qakhkhorovich, 2023; viaScience, 2023).

Exercises to increase speed in wrestling can include different types of plyometrics and agility exercises that focus on muscle explosiveness and coordination. (Shedge et al., 2024; Vala et al., 2022). Plyometrics train the body to produce explosive power quickly, which is essential for executing attacking movements or avoiding attacks. Agility training enables athletes to move quickly and efficiently over short distances and prepares them to change position quickly during the game. Isokinetic exercises play a role in increasing speed as they teach body movements with better control. However, isometric exercises do not focus on speed, but rather on strengthening muscles in specific positions, which makes them less effective in directly improving speed.

In addition to strength and speed, endurance is an important element that supports the performance of wrestlers, especially in long and intense matches. Endurance allows the athlete to maintain his performance even in conditions of fatigue. (Jeon, 2024; Sobko et al., 2021). Endurance in wrestling is not only about surviving the duration of the match, but also about continuing to perform movements with good quality without sacrificing technique.

Muscular endurance training focuses on increasing the ability of muscles to work for longer periods of time without decreasing performance, while cardiorespiratory training improves the efficiency of the cardiovascular system in delivering oxygen to working muscles. Interval training, high repetition light weight training and aerobic exercise are effective ways to improve endurance. (Kurnaz et al., 2024). Wrestlers with good stamina will not only be able to stay in the match longer, but will also be able to reduce the risk of injury due to fatigue and speed up recovery after the match. (Permana et al., 2022).

Based on existing theories, isokinetic training is known to increase muscle strength through dynamic contraction at a constant speed, whereas isometric training focuses on static contraction without joint movement. Muscle strength, as the main outcome of these two types of exercise, can be explained by the basic principle of physiological adaptation mechanisms in which training loads increase muscle protein synthesis and improve muscle contractile capacity. (Belamjahad et al., 2024; Kaple et al., 2023; Kwon et al., 2022).

The increase in running speed with greater isometric training results than the isometric group proved that both exercises were effective in improving the speed aspect. This can be caused by an increase in muscle mass that affects the efficiency of the movement, or a change in the technique used during the test. A greater increase in endurance in the Isokinetic group may corroborate the findings of previous research suggesting that higher endurance exercise may help improve overall muscular endurance, including the ability to endure intense physical activity. Lower endurance in the isometric group was associated with a lack of movement variability or decreased metabolic activity in the atihan, which generally focused more on static tension than dynamic.

The effectiveness of isokinetic and isometric training in increasing the strength, speed, and endurance of wrestling athletes is an important factor that every athlete must have. One important finding was that although the Isokinetic group showed greater increases in strength and endurance, the detected decrease in speed in both groups was a concern for the design of further exercise programs. The impact of this study is the importance of a more in-depth evaluation of the exercises applied, as well as the need to regulate the intensity and frequency of exercises to ensure a balance between the development of strength, speed and endurance.

The limitations of this study did not include a control group that did not undergo training, so it is not certain whether the improvement found is due only to exercise or to other factors, such as the natural adaptation of the athlete's body. Secondly, the duration and frequency of training used in the study are not fully representative of the daily training conditions of a wrestling athlete, which may affect the generalization of the results of these findings. Further studies with larger samples, longer training durations, and more detailed speed measurements are needed to confirm these findings and provide a clearer picture of their impact on wrestling performance.

Conclusions

Overall, strength, speed and endurance are three very important and intertwined components of wrestling. Strength provides the basis for performing more effective movements, speed allows athletes to react quickly and take advantage of the moment, and endurance ensures that athletes can maintain their performance despite challenging physical conditions. Therefore, comprehensive training involving these three aspects is essential to optimise the overall performance of wrestlers. Good training must balance the development of strength, speed and endurance and be adapted to the specific needs of the athlete and the demands of the competition. Further research could deepen the understanding of the effects of training on the performance of wrestlers, as well as develop more targeted and effective training programmes to optimise the strength, speed and endurance of wrestlers.

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Conflict of interest

The author declares no conflict of interest.

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