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The effect of short intermittent training IT (running / running-strength) on the maximum aerobic speed (MAS), maximum oxygen consumption ($\dot{V}O_2max$) and explosive strength of lower limbs in the U17 handball players.

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Abstract

This study aims to comparing the effect of short intermittent training "running" (ITr) and intermittent training "running-strength" (ITr-s) on aerobic-anaerobic performances: the maximum oxygen consumption (VO_2max), maximum aerobic speed (MAS) and explosive strength of lower limbs of handball players. For this purpose, we used the experimental method on an intentional sample of (12) male handball players subdivided into two homogeneous experimental groups from Nadjm Djemila -Setif- for 6 weeks of training, and for data collection, we used the physical tests (Yo-Yo test and Sargent Jump test).

After collecting the results and having treated them statistically, we conclude that the two intermittent training had almost the same effect on MAS and VO_2max, while the effect of short ITr-s on explosive strength of the lower limbs was significant compared to the ITr, the study recommends using the ITr-s in the physical preparation process at the beginning of season in order to develop effectively both aerobic/anaerobic performances.

1. Introduction

Handball is an strenuous Olympic sport that consumes a lot of effort and therefore requires physical preparation, great physiological capabilities and integrates technical, tactical, and physical skills which is a sport that requires physical efforts of high-intensity muscle power and of short duration, with emphasis on sprinting, jumping, and throwing (Moisés et al., 2017; Hermassi et al., 2018; Jorge Viaño et al., 2017; Feghouli et al., 2020).

Bojsen et al (2015) indicates that handball involves activities of well-developed aerobic and anaerobic qualities. During the 60 minutes of match-play, the players work intensely for short intermittent times, for Marquez and Badillo (2006), Buchheit et al (2009) and Rhibi (2019) performance hinges upon to a large extent, on the aerobic and endurance capacities of the athlete, whose values of VO_2max and MAS are a fundamental determinant in order to maintain performance over an entire season.

VO_2max is a crucial performance index, representing for any age or level of training an indicator of good or bad general physical condition. The VO_2max is also decisive for any physical performance, allowing both higher training loads, a better quality of training and a more efficient recovery (Aurélien and Olivier, 2012; Derradji and Ait lounis, 2020), as well as the MAS, is the smallest running speed allowing to apply the VO_2max (Buchheit, 2005), it gives us a valuable indication for training because it determines the work intensities and a limit that we will try to push back (Jean and Lacrampe, 2007), therefore knowledge of the MAS have major interest for the trainer because this speed will allow, in addition to monitoring the athlete's aerobic progress, and the precious determination of the training load (Aurélien and Olivier, 2012).

Also, anaerobic fitness unlike aerobic fitness, related to muscle mass and the ability to perform repeated high intensity and short duration muscle actions. (Khiat, 2014; Rochcongar et al., 2013), the participation of anaerobic metabolism is important in handball, the anaerobic sector is called during shots, jumps, one on one, start for the counter-attack, and defense work between 9m and 6m. In addition, the phases of play are characterized by exercise-rest intermittent mostly less than 10 seconds. It is therefore evident that a handball team must be composed of players with good anaerobic aptitude (Maurelli, 2018).

Hermassi et al. (2014) and Cavar et al. (2018) sited that in handball, players are required to repeat sequences of short explosive efforts, such as sprints (<15 m) with changes in direction, jumping ability, throwing and sprinting, demonstrate the importance of anaerobic fitness which appears on explosive strength and anaerobic power to optimize the performance of elite handball players (Mendez et al., 2010).

To develop these aerobic and anaerobic qualities, physical training today uses several training methods. The most recognized method in team sports called "intermittent training" or "interval training" (Rhibi, 2019), the IT has been proposed as a time-saving strategy to improve both aerobic power (VO_2max, MAS) and anaerobic capacity. Therefore, IT has become a preferred method of endurance training for anaerobically dominant sports like handball (Cavar et al., 2018; Ritchard et al., 2016; Bigard et al., 2020).

IT is work that alternates between intense phases and phases of relaxation effort and counter-effort (Kharoubi et al., 2018; Darsau-Carre, 2010) and is an effective method of improving some of the determinant characteristics of success in handball. For instance, IT enhances aerobic capacity and the ability to perform high-intensity actions with a high solicitation of the anaerobic system, developing $\dot{V}O_2max$, MAS and anaerobic allows the player to improve his physical performance throughout the match by increasing the recovery speed between periods of high intensity effort (Bangsbo et al., 2008; Castagna et al., 2019; Boufaroua and Mimouni, 2020; Dellal, 2008; Didier and Pascal, 2013).

While improving anaerobic performance by developing the explosive power of the leg muscles enhances the strength of the jump and makes the player more efficient in the match (Hermassi et al., 2018; Dellal, 2013).

The importance of IT emerges as it represents the best way to simulate interval effort in handball through the nature of performance, which consists of short periods of effort, high intensity followed by incomplete rests that allow the athlete to properly prepare for an ideal performance during the match.

1.1 Literature Review

Many of the previous studies were based on a new principle, which is to combine high-intensity running exercises with strength exercises (plyometric) in a 6-week training program, as these studies concluded that this twinning significantly affects the aerobic capabilities of the athlete and the explosive strength of the lower limbs together (El ouirghioui et al., 2016; Cometti, 2007; Gacon, 1996; Pui-Lam et al., 2010).

As well as the results of several researchers found that the inclusion of high-intensity exercises (100-120% of MAS) through phases of acceleration and

deceleration has a positive effect on the ability of the lower limbs to release the explosive strength and improve the jumping ability. It also develops the character of maximum aerobic capacity, MAS, and VO_2max, which is a crucial element in some team sports, especially handball (Cregg, 2013; Hermassi et al., 2018).

In our study, we wanted to compare the effect of short ITr and short ITr-s, which is based on the combination of running and plyometric exercises in the aerobic and anaerobic performances for handball players.

In this context, we raised the following question: Did the effect of short intermittent training (10"-20" running – strength) on the MAS, VO_2max and the explosive strength of the lower limbs differs from the short intermittent training (10"-20" running) of handball players?

2. Method and Materials:

For the concretization of our research, we saw it was necessary to use the experimental method in order to answer our initial questions.

2.1. Participants

The study sample consists of twelve (12) male handball players from the Najm Riyadi Djemila (NRBD), they participated in the study for 6 weeks of training with two sessions per week who was selected deliberately, the sample was subdivided into two experimental groups, with the same specifications (age, weight, height, the result of yo-yo test and vertical jump test), participant's characteristics are presented in Table 1.

Table 1. ***Participant characteristics (mean (M)±standard deviation (SD)) / n=12***

Groups	Participants	Age (years)	Weight (kg)	Height (cm)	Vertical jump test (cm)	Yoyo test (Km/h)
1st experimental group	6	16,5±0,5	67,16±9,66	177,33±8,45	40,83±2,92	15,58±0,97
2nd experimental group	6	16,33±0,5	65,5±5,24	175±6,33	41,16±2,92	15,33±1,03

2.2 Materials

The collecting data materials used in the current study is the physical tests (Yo-Yo test and Sargent Jump Test), each test is performed once during the pre-test period and the post-test period. The choice of tests was based on bibliographic sources, local and organizational conditions.

2.3 Design and Procedure

This study is conducted during the competitive phase of the season between February and April 2019 After looking at several references in the field of sports planning and intermittent training, we came up with two training programs, taking into account some basic principles that allow us to reach the achievement of previously established goals through the application of these two training programs while preserving the health and safety of athletes and not to expose them to injuries.

These two programs were built on the basis of 6 weeks Plus two weeks for physical tests (pre-tests and post-tests) at a rate of 2 sessions per week (Saturday and Tuesday), and the sessions were performed at 16:30 in the Djemila multi-sports hall, in the wilaya of Setif. The implementation of this program was performed on the same days and at the time where the team used to train.

The study begins with series of one-week pre-tests that will be used to assess the athlete's MAS, VO_2max, and vertical jump ability and will serve as benchmarks for comparison with post-tests, for the first experimental group to which the first training program will be applied (short IT 10"-20" running) the intermittent sessions designed with a shuttle exercises at 110% of MAS intensity in the form of 10" seconds of running with 20" seconds of passive recovery for 8 minutes and 30 (8'30) of work and 8' minutes of active recovery between blocks (technical exercises) for 3 sets, and the second experimental group to which the second training program will be applied (short IT 10"-20" running-strength) the load of training sessions was all the same but have added plyometric exercises which is about vertical and horizontal leaps and we kept the same size, intensity, and recovery periods. After the six-week training period comes the one-week post-test period, which will be done according to the same protocol and conditions as the pre-tests.

2.4. Statistical Analysis

All statistical analyses were performed using SPSS version 21.0 for windows. The results are expressed as the mean ± standard deviation. Correlation coefficients were calculated between the two tests using a Pearson test, a Student's t-test for paired samples was used, this statistical tool aims to define significant differences between the two compared tests. the level of significance was established at $p < 0.05$.

3.Results

3.1. Analysis of the results of the pre-test and post-test of YO-YO on maximal aerobic speed MAS for the 1st and 2nd experimental group:

Table 2. ***shows the results of the maximal aerobic speed for the two experimental samples in Yo-Yo test***

MAS	Pre test		Post test		T Tabular	T Calculated
	SMA	Standard deviation	SMA	Standard deviation		
Experimental group 1	15.58	0.97	16,66	0.87	2,571	3.606
Experimental group 2	15,33	1,08	16,16	1,03	2,571	3,371

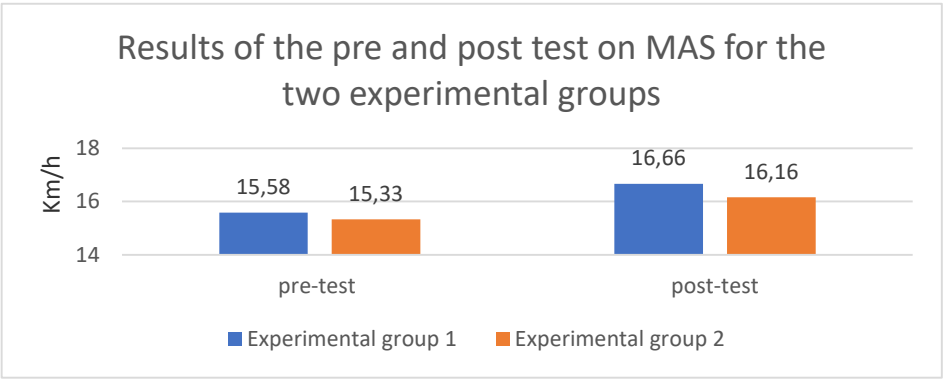

Figure 1. Shows the difference between the Arithmetic average of the results of the pre and post-test of the two experimental groups on maximal aerobic speed (MAS).

From the results in Table (2), the MAS was increased in the two experimental groups, from 15.58 to 16.66 km / h for the 1st group and for the 2nd group from 15.33 to 16.16 km / h. After statistical treatment of these data, we say there is a small numeric difference but there is no statistical significance in the effect of both the short ITr program running and the short ITr-s program on the MAS at the level of significance (0.05) and the degree of freedom (10).

3.2. Analysis of the results of the pre-test and post-test of YO-YO on maximum oxygen consumption VO_2max for the 1st and 2nd experimental group:

Table 3. ***shows the results of the pre and post-test on VO2max for the two experimental samples in Yo-Yo test***

VO2max	Pre test		Post test		T Tabular	T Calculated
	SMA	Standard deviation	SMA	Standard deviation		
Experimental group 1	54.54	4,71	58.29	5,83	2,571	3,529
Experimental group 2	53.66	4.98	56.58	4.86	2,571	3.548

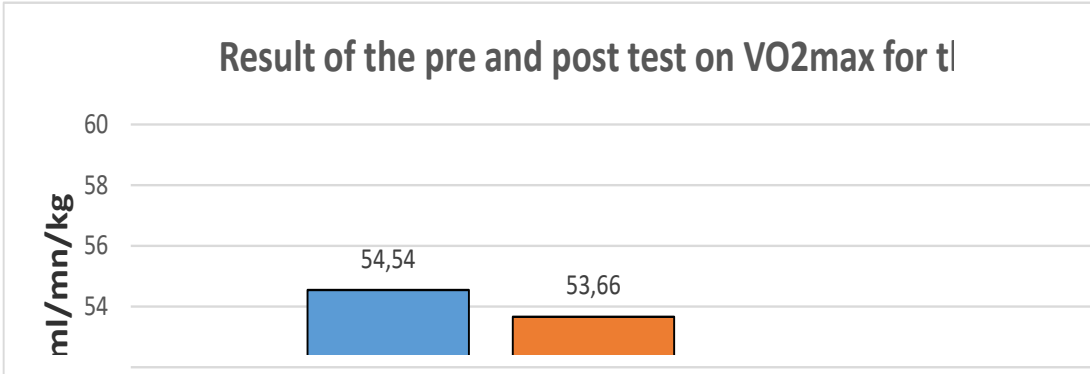

Figure 2. Shows the difference between the Arithmetic average of the results of the pre and post-test of the two experimental groups on maximum oxygen consumption VO2max.

From the results in Table (3), the VO2max was increased in the two experimental groups, from 54.54 to 58.29 ml/Mn/kg for the 1st group and for the 2nd group from 53.66 to 56.58 ml/Mn/kg.
After statistical treatment of these data, we say there is a small numeric difference but there is no statistical significance in the effect of both the short ITr program running and the short ITr-s program on the $\dot{V}O_2$max at the level of significance (0.05) and the degree of freedom (10).

3.3. Presentation and analysis of the explosive strength results of the lower limbs inferred from the pre-test and post-test of vertical jump test for the 1st and 2nd experimental group:

Table 4. ***show the results of the pre and post-test on explosive strength of the lower limbs for the two experimental samples in the vertical jump test.***

Vertical jump	Pre test		Post test		T Tabular	T Calculated
	SMA	Standard deviation	SMA	Standard deviation		
Experimental group 1	40,83	2.93	41,16	3,06	2,571	3.606
Experimental group 2	41,83	2.92	45,66	1,63	2,571	3,371

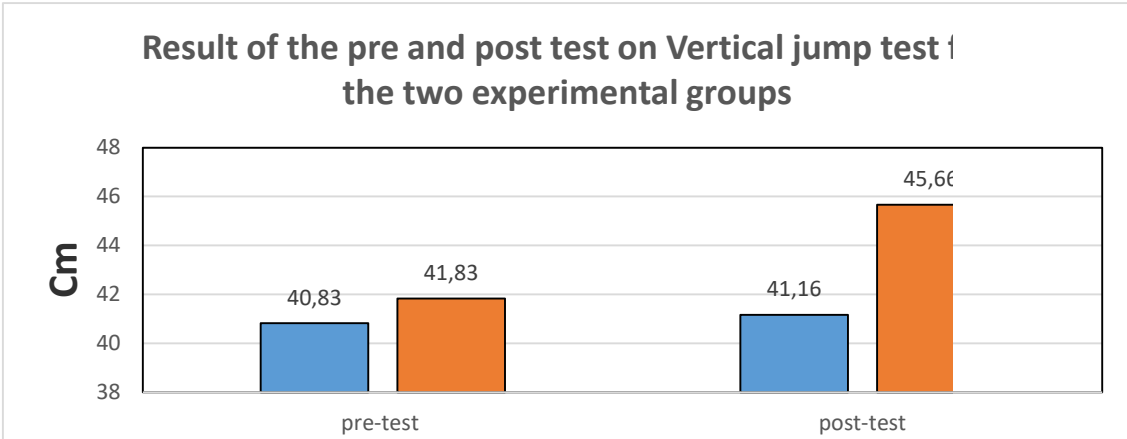

Figure 3: Shows the difference between the Arithmetic average of the results of the pre and post-test of the two experimental groups on vertical jump test.

Through Table (4), we found that the first experimental group achieved an arithmetic average in the post-test, an arithmetic average of (41.16), and a standard deviation of (3.06), while the second experimental group achieved an arithmetic mean (45.66) and a standard deviation (1.63) in the post-test.
After statistical treatment of these data, we say there is a statistical significance in the effect of both the short ITr program and the short ITr-s program on explosive strength of lower limbs at the level of significance (0.05) and the degree of freedom (10).

4. Discussion

From the analysis and interpretation of the results obtained after the completion of the proposed programs, the results show that IT combined with strength has a bigger impact than classic running IT on explosive strength and aerobic performance of handball players, we found that there is a significant difference between the two-arithmetic average of the two experimental groups in the post-test on MAS and VO_2max. Players who followed the short ITr-s program and players who followed the short ITr exercise program influenced the MAS and VO_2max but without major differences (15.58 passed to 16.66 and 15.33 to 16.16), (54.54 passed to 58.29 and 53.66 to 56.58).

Our results confirm those of Cometti who sought quality work by offering "intermittent-strength". He replaced the repetitions of runs by a work of strength with or without load or by leaps, where he found that short ITr-s improves MAS and the respiratory efficiency as well as the muscles of breathing and helps to utilize the largest amount of inspiratory capacity, cardiac efficiency and circulation by increasing the stroke volume and the blood expelled from the heart and reducing the rate of the pulse at rest and exercise, as well as nerve harmony and increased coenzyme efficiency. All of these factors raise the maximum level of VO2max, provided the intensity is close to the (MAS) (Cometti, 2007; Amari et al., 2020).

Through the experimental work of Karlson et Coll which compared the load intermittent training work which he showed that the short IT develops a great deal the MAS and VO_2max (Assadi, 2012).

El Ouirghioui and al (2016) and Gacon (1966) compared the effects between two training protocols (IT combined with explosive strength and IT running, the results showed an increase in aerobic parameters such as VO_2max, MAS and the quality of MAS test recovery.

This is what was indicated by Assadi (2012), Gacon (1996), and other researchers that all types of IT induce and develop the MAS and thus result in an improvement in the volume level of the VO_2max.

Regarding the effect of the two training programs on the explosive strength of the lower limbs, the effect of ITr is almost non-existent, while the ITr-s programs had a significant effect on the explosive strength.

Indeed, some authors demonstrate that the use of intermittent short-duration exercises combined with plyometric exercises develops significantly the explosive strength of the lower limbs because the plyometric exercises include a cycle of stretching and contraction of the working muscle, which caused its flexibility and worked on the muscle's use of the reflexive

mechanical energy resulting from the lengthening effect, which leads to greater strength and speed of performance and improvement of the lactic anaerobic capacity in terms of the intensity of IT, practicing plyometric exercises in the intermittent method increases the amount of energy production during a unit of time, so the volume and intensity of the exercises are the decisive factors for this increase (Lantri and al., 2020; Halouz and Hannat, 2019).

El ouirghioui (2016) and Pui-Lam and al (2010) examined the effects of high-intensity IT with plyometric exercises on cardiovascular function, VO_2max, and muscle strength after completing the program, the results showed significant improvements in VO_2max, O2 pulse, and muscle strength. muscle power analyzed by the Wingate test which IT is a basic characteristic that depends on the phosphogene system for energy production, as well as other systems, as it affects the aerobic power, which helps to develop the speed of recruitment of the motor units of the muscle, increase the frequency of nerve stimulation and improve the synchronization of the motor units, which in turn contributes to improving the explosive strength factor (Lantri and al., 2020; El ouirghioui and al., 2016; Assadi, 2012).

5. Conclusion

In conclusion, to answer the problem posed, the comparison of these two programs proposed (IT short running / running-strength) for 6 weeks confirms that the two programs have the same impact on maximum aerobic speed (MAS) and maximum oxygen consumption (VO_2max) for both experimental groups, this is due to the fact that all types of IT develop aerobic capacity through improves MAS and the respiratory efficiency as well as the muscles of breathing and helps to utilize the largest amount of inspiratory capacity, cardiac efficiency and circulation by increasing the stroke volume and the blood expelled from the heart and reducing the rate of the pulse at rest and exercise, as well as nerve harmony and increased coenzyme efficiency (Cometti, 2007; Assadi, 2012).

As for the explosive strength of the lower limbs, the use of IT strength allowed a significant increase in the strength of the lower limbs compared to the classic ITr, this development is due to the IT combined with plyometrics causes an improvement in the nervous and elastic factors of muscle strength. The plyometric action, for the nervous factors, acts on the recruitment of numerous motor fibers and on the synchronization of these motor fibers, and

for the factors linked to stretching, we work on the myotatic reflex and elasticity (Pui-Lam and al., 2010; El ouirghioui and al., 2016).

We can recommend using the results of this study by focusing on ITr-s in the physical preparation process at the beginning of the season in order to develop both aerobic and anaerobic capabilities simultaneously, which allows the trainer to shorten time and effort in the physical preparation process.

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