Proceeding

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Intermittent training and improvement of anthropometric parameters and aerobic capacity in youth football

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ABSTRACT

Optimal football training, among many targets, should allow both the improvement of the maximum oxygen intake (VO_{2max}), as well as the body mass index or BMI. The aim of this study is to demonstrate the effectiveness of the methodology of intermittent training, in terms of a significant improvement in the performance of the players involved in the study. The study is useful for trainers to reorganize training planning and adapt it to individual players. The method is experimental and involves the usual parameters for performance monitoring. There were 17 young amateur footballers, aged between 16 and 17, who participated in the regional under-17 championship this year. Data were collected over the course of twelve weeks. They were expressed as average ± SD for: height (176.1 ± 8.45), weight (63.3 ± 12.7) and body mass index (20.2 ± 2.5). Gacon intermittent field test was used to determine the VO_{2max}. Statistical data analysis was performed with the t-test to check the differences between pre-test and post-test (at the beginning and end of three months of specific training). Significant differences were fixed at $p < .05$. Results show that there is a significant difference in performance between pre and post-workout for tests conducted.

Keywords: Intermittent training; Gacon test; BMI; VO_{2max}.

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INTRODUCTION

Each type of physical activity always brings about changes in the body. Through systematic and continuous repetition, training determines physiological effects with consequent functional responses that promote an improvement in performance (Izzo et al., 2020ab) and in several cases could be dangerous for the health and performance for the damage (Sannicandro et al, 2017, 2016, 2015ab, 2014, 2012ab, 2011ab, 20210, 2008). Relevant to improve the performance is the definition of Verkhoshansky about training as "process by which it is possible to bring out the maximum, or in any case, the highest percentage of an athlete's genetic potential". In fact, depending on whether they are amateur, competitive, or high-level athletes, training always brings changes and adaptations to the body (Izzo et al., 2019abc). These changes can be of various types: anatomical (such as the increase in muscle volume or heart size); ultrastructural (such as increasing the number of mitochondria, or transforming muscle fibres from one type to another); biochemicals (linked to enzymatic changes); and exclusively functional changes (where what changes is the function). In the specific case of intermittent work, it is a method that allows to train different motor qualities simultaneously such as endurance and strength and, it is characterized by an alternation of maximum effort and recovery carried out actively (Gaetano & Rago, 2014). It is carried out with the aim of achieving and reconciling two different objectives: stimulating the aerobic system (raising the level of maximum aerobic power) and improving the propulsive force ,in particular that of support (Rago et al., 2017). In this way, every study on related study could have the basis to deep the issue (Sgrò et al, 2018, 2017ab, 2016, 2015, 2009) as well as the interdisciplinary investigations on the other sport or physical activity, because it is relevant for this specific aspects of training methods (Invernizzi et al, 2020, 2014ab, 2008) . The origins of intermittent football work go back to research by the Swedish physiologist Per-Olof Åstrand. The ability to perform intermittent and high intensity exercises for prolonged periods today plays a key role in competitive football (Federici et al., 2019). As a result, training and testing strategies have been proposed to monitor and improve players' ability to perform high-intensity activities during the match (Raiola & Altavilla, 2020). Although talent selection is an uncertain procedure because there are many different factors that are involved in the development of a potential player, knowledge of player profiles has been shown as a valuable resource to guide talent selection and subsequent coaching (Esposito et al., 2020). In addition, the evaluation of changes induced by different training strategies on physical components relevant to football's performance is important in the control of the training process (Raiola & D'Isanto, 2016; Coppola & Raiola, 2019).) Therefore, the identification of valid field tests that allow the assessment of the specific resistance of football in young players is of fundamental importance (Ceruso et al., 2019).

Aim of the study

The aim of this study is to demonstrate the effectiveness of the intermittent training methodology, carried out over a period of 12 weeks, in relation to an improvement in the VO_{2max} value and the BMI of the athletes involved.

MATERIAL AND METHODS

Subject

Seventeen young amateur footballers from the club Grippo DRS, aged between 16 and 17, who took part in the regional under-17 championship were observed. To be included in the study, athletes had to be injury-free and not have sustained any training suspension during the previous six months. All players were familiar with the use of intermittent training methodology. The research design and procedures comply with the standards set out in the Helsinki declaration.

Procedures

In a first phase of the study, before the intermittent training period, the anthropometric values of each boy were obtained. Specifically: weight and height from which the BMI or body mass index was then obtained. The collected data were reported in a table, calculating the average and the standard deviation, to establish normality criteria within the group. The BMI data is considered as a generic index of the player's physical form and is very useful because it allows to classify players into categories. In young people the BMI shows a considerable variability mainly linked to age and gender, so for this parameter in Italy are used the percentiles proposed by Cacciari et al. in 2006. At international level there are the reference parameters proposed by Cole et al., (2005) which indicate as underweight a BMI lower than the 5th percentile, normal between the 5th and the 85th percentile, at an overweight risk between the 85th and the 95th percentile and obese beyond the 95th percentile.

Table 1. BMI Reference Parameters (Cole et al., 2000).

Classification	Percentiles
Underweight	< 5
Normal weight	5 and < 85
Overweight	85 and < 95
Obese	95

This parameter allows to intervene by educating players on the concepts of health and fitness, with important preventive effects. Higher values seem to negatively affect technical-tactical performance since the masses to be accelerated and decelerate in the changes of direction seem to be excessive. After the detection of the anthropometric characteristics, the players were subjected to the Gacon test in order to obtain the V02max. The test involves an alternation of stroke sections lasting 45 s, with recovery moments of 15 s. The initial speed is 10 km / h which corresponds to a stretch of 125 m (covered in 45 s). After a pause of 15 s, 6.25 m more is covered (total 131.25 m, equal to 10.5 km / h) and so on until the athlete can no longer cover the expected distance in 45 s. This test is a maximal test which foresees accelerations and decelerations and short breaks between the different loads (Roi, 2014). It does not foresee changes of the running direction. It needs a perfectly calibrated sound system. Provides an underestimation of the VAM compared to non-shuttle tests. The figure shows the original scheme for the Gacon test.

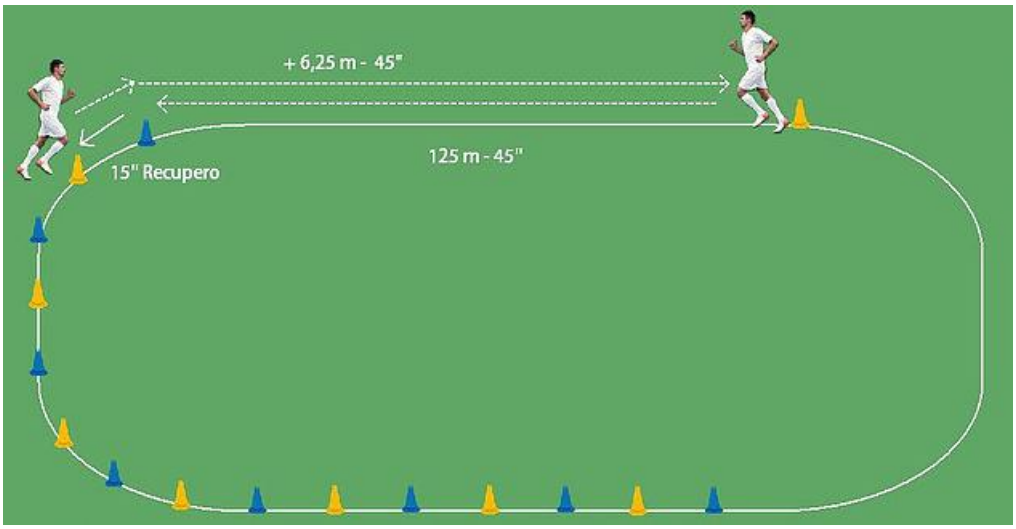

Figure 1. Gacon Test Scheme.

The test was repeated after three months. In the period between the two tests, the workouts were structured by repeating intermittent training twice a week in the preparation phase, and once a week during competition phase. After an initial phase of activation, intermittent training was carried out, following this pattern:

Table 2. Intermittent training scheme used in the study.

	Workouts/week	Sprints/week	Sprint duration	Rest duration	Rest intensity
Week 1	2	4	10 s	10 s	1
Week 2	2	6	10 s	10 s	1
Week 3	2	8	10 s	10 s	1
Week 4	2	4	20 s	20 s	1
Week 5	2	6	20 s	20 s	1
Week 6	2	8	20 s	20 s	1
Week 7	2	4	30 s	30 s	1
Week 8	2	4	30 s	30 s	1
Week 9	2	4	30 s	30 s	0-1
Week 10	3	4	30 s	30 s	0-1
Week 11	3	4	30 s	30 s	0-1
Week 12	3	4	30 s	30 s	0-1

The alternation of 30 seconds of effort followed by 30 seconds of recovery was performed without interruption, with a circuit technique, for a total training time that could vary from 9 to 15 minutes overall. In this way, the cardiovascular system and the aerobic system of the athlete are stimulated. In fact, throughout the exercise time the heart rate remains at fairly high levels in a narrow range that goes from 160 to 180 beats per minute.

Statistical analysis

The results are presented as mean ± standard deviation (M ± SD). The statistical model used is the paired sample t-test: tests to assess the significance of the differences between the averages of two samples that are related to each other, as well as when some subjects are evaluated on two different occasions. The results were presented as a number expressed as a percentage. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS 15.0 for Windows) software and the significance level was set at $p < .05$.

RESULTS

Table 3. Anthropometric characteristics of the subjects before training.

Players	Age	Weight	Height	BMI	Percentiles
Player 1	17	67.2	183	20.1	38.6
Player 2	17	82	190	22.7	69.5
Player 3	16	50.2	170	17.4	9.5
Player 4	17	63.5	171	21.7	59.9
Player 5	16	57.3	177	18.3	19.8
Player 6	16	55.9	172	18.9	28.1
Player 7	16	46.8	160	18.3	19.8
Player 8	16	86	185	25.1	86.9
Player 9	16	48.6	160	19	29.5
Player 10	16	63.3	181	19.3	34.1
Player 11	16	68.5	177	21.9	66.3

Player 12	16	69.2	177	22	67.7
Player 13	17	59.5	169	20.08	49.2
Player 14	17	82	186	23.7	77
Player 15	17	60	180	18.5	17.4
Player 16	17	66.5	182	20.1	38.6
Player 17	17	68.5	175	22.4	66.3
Mean	16.4	64.4	176.1	20.5	45.7
SD	0.51	11.4	8.4	2.1	23.7

Table 4. Gacon test results before the training period.

Players	Fraction Speed	Fraction Distance (m)	VO_{2max}
Player 1	16	200	48
Player 2	16	200	48
Player 3	16	200	48
Player 4	17.5	218	53
Player 5	17.5	218	53
Player 6	16	200	48
Player 7	18.5	231	56
Player 8	17.5	218	53
Player 9	17.5	218	53
Player 10	17	212	51
Player 11	17	212	51
Player 12	17.5	218	53
Player 13	16	200	48
Player 14	16	200	48
Player 15	17	212	51
Player 16	17.5	218	53
Player 17	17	212	51
Mean	16.9	211	50.9
SD	0.77	9.43	2.53

Table 5. Anthropometric characteristics of subjects after training period.

Players	Age	Weight	Height	BMI	Percentiles
Player 1	17	67.3	183	20.1	33
Player 2	17	86	190	23.8	78
Player 3	16	47.8	170	16.5	2
Player 4	17	61.5	171	21	47
Player 5	16	56.3	177	18	12
Player 6	16	52.9	172	17.9	11
Player 7	16	44.8	160	17.5	8
Player 8	16	88	185	25.7	91
Player 9	16	45.6	160	17.8	11
Player 10	16	62.3	181	19	26
Player 11	16	66.5	177	21.2	59
Player 12	16	68.2	177	21.8	66
Player 13	17	57.5	169	20.1	34
Player 14	17	80	186	23.1	72

Player 15	17	59	180	18.2	9
Player 16	17	66.5	182	20.1	33
Player 17	17	66.5	175	21.7	56
Mean	16.4	63.3	176.1	20.2	38.11
SD	0.51	12.7	8.45	2.5	28.03

Table 6. Gacon test results after the training period.

Players	**Fraction Speed**	**Fraction Distance (m)**	**VO_{2max}**
Player 1	16.5	206	50
Player 2	17	212	51
Player 3	19	237	57
Player 4	19.5	243	59
Player 5	18.5	231	56
Player 6	18	225	54
Player 7	19.5	243	59
Player 8	18	225	54
Player 9	19.5	243	59
Player 10	19.5	243	59
Player 11	19.5	243	59
Player 12	19.5	243	59
Player 13	17.5	218	53
Player 14	16	200	48
Player 15	17.5	218	53
Player 16	19	237	57
Player 17	19.5	243	59
Mean	18.44	230	55.64
SD	1.18	14.6	3.65

Table 7. Application of the paired sample t-test.

	VO_{2MAX}	***VO_{2MAX} (2)***
Mean	50.94117647	55.64705882
Variance	6.433823529	13.36764706
Observations	17	17
Overall Variance	9.900735294	
df	32	
t stat	-4.360304346	
p(T<=t) one-tail	6.3014E-05	
t Critical one-tail	1.693888748	
p(T<=t) two-tail	0.000126028	
t Critical due code	2.036933343	

DISCUSSION

By using the t-test it is possible to accept the null hypothesis as the significant improvement margin due to the applied methodology has been confirmed, consequently rejecting the alternative hypothesis. As can be seen from the results, in the comparison of pre and post training VO_{2Max}, a statistically significant result emerges, consequently interval training has allowed to improve the results in terms of VO_{2Max}. It is also

possible to observe a significant improvement in the body mass index following the three months of training as shown in table 3. In the detection of the anthropometric characteristics both pre and post training, only one player is overweight while all the others fall within the normal weight range. The results of this study regarding the effectiveness of interval training in youth football are consistent with those of other studies including those by Faude et al., (2014) and Cvetković, N., et al., (2018). In the first study cited, the authors showed that four weeks of in-season endurance training can lead to significant improvements in stamina. Significant effects were observed in the individual anaerobic threshold (+ 1.3%, ηp2 = .31), in the peak heart rate (–1.8%, ηp2 = .45) and CMJ (–2.3%, ηp2 = .27), without any interaction significant among the groups ($p > .30$). In the second study, however, the authors concluded that intermittent training allowed significant improvements in multiple muscle and cardiorespiratory measures after 12 weeks of training in overweight and obese male children. In contrast, the control group, which only performed physical education lessons, showed small changes over the 12-week course with a significant increase in body mass, BMI, and fat mass values. Finally, in the study by Rago et al., (2017) the collected data submitted to a statistical study showed improvements in the physical performance of the different athletes thanks to the use of the periodization method integrated in the intermittent high intensity training. According to the periodization method, the gradual increase in the applied load that allows the central nervous system (CNS) to adapt and obtain improvements is significant. In conclusion, the advantage and originality of intermittent training is to allow muscles to function in a lasting, high aerobic regime by limiting the formation of lactic acid to a minimum and thus avoiding muscle pain or soreness (Izzo et al., 2019). Another important advantage of this training method is from a physiological point of view: there is an increase in the functionality of myoglobin, which is a muscle protein used for the transport of oxygen at the intramuscular level (Helgerud et al., 2001). In the joint Resistance-Strength training there is an alternation at the muscular level of involvement of the fast, easily fatigued fibres, and of the resistant fibres during the recovery period.

CONCLUSION

The results and discussion show that athletes' performance has significantly improved thanks to a specific twelve-week workout. Intermittent training for the sample taken into consideration was useful and brought about an improvement in BMI as well as in VO_{2max}. The initial hypothesis was therefore confirmed through the statistical study. Intermittent work is therefore a training method that can be applied without problems even on young athletes since it minimizes the formation of lactic acid and the onset of injuries. This study also demonstrated the importance of paying attention to the recovery phase, which in this method is of equal if not greater importance than the effort. It must never be higher than 30s in order not to allow the heart rate to drop too low.

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