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Proposal for a Football Training Design: Integrated Physical Training and Intermittent with Explosive Strength Component.

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Abstract: *The purpose of this study is to propose a tactical and physical training design with a training load control tool adapted to the requirements of modern football. In this scope, our work was constructed in three parts.*
The first study evaluates the effect of integrated physical training on the VO2 max, based on a continuous VAMEVAL running test (Cazorla George, 1990) and the recovery heart frequency (2 minutes after the test).
The second experiment indicate the value of explosive strength combined with intermittent running exercises at the level of the ability to repeat fast and high-intensity efforts in football.
To figure out the type of explosivity we adopted, we try, in a third experiment, the effects of low and medium pliometry on the explosiveness of lower limbs.
After a synthesis of the different elements of this research, we can conclude that with an integrated physical training focused on the collective tactics of the team, we can develop the VO2 max and the quality of recovery, which are essential factors on which, we can graft individual specific training based on explosive strength combined with intermittent race in order to win in sprint rehearsals and delay as much fatigue as possible during a football match.
Key words: *Football, Explosive Force, VO2MAX, Integrated Physique, plyometric, Explosive Endurance, Capacity of sprint repetition.*

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I. Introduction:

1.Physical and physiological analysis of football activity

The aim of the analysis of the activity of the footballer in different competitions (world cup, league of the champions and national championships) by different methods and different equipments was to know what the specific physical and physiological qualities are, the different energetic metabolisms solicited with a view to define the factors of performance and establish an adapted training design to the requirements of modern football (Bangsbo, 1994/1999/2008, Mohr and al, 2003, Dellal, 2008/2010/2011, Carling, 2010, Bradley, 2010) and to offer adapted content in different individual or collective situations required by a football match. The use of scientific equipment has given more information to the technical staff in order to propose training programs adapted to each player according to his qualities / defects specific to his field position: The heart rate monitor (heart rate in gaming situations), GPS (distances traveled with different speeds) and The most commonly used automatic or semi-automatic video analysis systems in the scientific field that capture and measure the position, movement of players and the ball 25 times per second during the match (Rampinini and al, 2007).

(Bangsbo, 1994 and Verheijen, 1998) were the first to analyze a footballer's activity according to level, position, pace, physical, physiological and technical aspects. Their studies have established that a footballer performs between 825 and 1632 race per game, 140 to 160 sprints (80 sprints greater than 24 km / h); 150 to 250 short and intense actions. As a percentage of the total distance, we have : walk 27%; slow run 46%; fast race 13.5%; sprint 6.6%; back stroke 7.8%. With an intensity ranging between 80% and 90% of FCM in the elites France / England / Spain / Italy for Dellal and al, (2010/2011), 75% of VO2 max for (Stolen and al, 2005) and a decrease of 1 to 9% of the total distance between the first and second half for (Mohr and al, 2003, Disalvo and al, 2007). The oxygen consumption during a match is 65 to 70% for 12 minutes, 70 to 80% for 29 minutes, 80 to 85% for 46 minutes, 58 to 95% for 3 minutes and VO2 max is reached 2 to 5 times per game. Training can improve the VO 2 max by 15 to 30%, especially during the pubertal period, until the age of 25 years.

Benjamin Bar, (2013) proved that during a match, each player performs 1000 to 1400 short actions of 2 and 4 seconds, the sprints from 2 to 4 seconds are repeated every 90 seconds, the average recovery time is 18 seconds in 90% of cases. Jones and al. (2013) demonstrated a correlation between oxygen consumption (Vo2 max) and the average time of each sprint and total sprint time in a sprint repetition test. They also showed that training based on sprint repetition significantly increases the results achieved during an aerobic test for high level footballers. For this, players will have to optimize their aerobic abilities regardless of their position and perform work at maximum speed and high intensity because they represent 4 to 5% of the total distance traveled, the ability of players to repeat short sprints in having the lowest possible performance loss. The intermittent efforts with high intensities (16-19 km / h) and very high intensities (19-24 km / h) seem the most repeated during a football match (250 high intensity actions of which 90% are lower than 15 secs) interspersed with recoveries of which 85% less than 15 seconds and 80 sprints higher than 24 km / h (0.5 and 3-4% of the total distance).

In conclusion, these analyzes allow us to orient the training according to the position knowing that Rampinini and al. (2007) estimate that forward performs more sprints (27) compared to a central defender (18) or a midfielder (24) which performs more distance at high intensity. The games conception or technical-tactical requirements of the technical staff. The opponent can also influence the distance traveled and the type of energy provided during the match. The number of matches played and the playing time for each player directs the training towards sessions of development, maintenance or recovery of physical qualities.

2.analysis based on tactics and design

Bradley and al, (2011) reported that defenders travel more distances in a 4-4-2 (10452 m) system than in a 4-3-3 (10073 m) or 4-5-1 system (10123). In 4-4-2, defenders travel 11% more distance at high intensity than in 4-5-1 (2454 vs 2207), while the forwards have 28% and 32% more distance in addition to higher intensity in 4-3-3 (2988 m) than in 4-4-2 (2250 m) or 4-5-1 (2333). At very high intensity, the forwards travel more distance in 4-3-3 than in 4-5-1 (1155 m vs 870 m). Dellal, (2010) reveals that at high intensity (21 to 24 km / h) and in sprints (> 24 km / h), the defenders make a greater distance during the defensive phase than during the phases of offensive game . Only eccentric midfielders and offensive midfielders participate in both the defensive and offensive phases.

3.energy substrates and football efforts

The energy provided during a match comes from two main sources, the catabolism of phosphagens (ATP-PC), aerobic glycolysis and a secondary source which is lactic glycolysis. Glycogen is the energy substrate essentially used during a match. Its muscle depletion depends on the quality of the muscles involved, the level and intensity of the game, the level of training of the player and the importance of the initial energy reserves. (Karlson, 1969, Jacobs et al, 1981, Curie et al, 1981) believe that glycogen is the essential energy substrate during the game. Compared to its initial muscle reserves, at the end of the match, its depletion is between: 21% (Currie et al, 1981); 50% (Smaros 1980, Leatt 1986). Cazorla George, (2006) showed, that during a match, we find 14.9% sprint, more intense and short actions and as substrate (ATP: PCr + oxidative power), 4.3% intense race , mixed metabolism: aerobic (glycogen), VO2 max, glycogenolysis (lactic), 70.8% of walking, plus slow race: aerobic metabolism (AGL-glycolysis).

(Hultman and Sjoholm, 1983) show that the earliest activation of lactic glycolysis can contribute between 20 and 30% to the total energy supply while the oxidative supply already accounts for about 3%, the rest would result from hydrolysis of PCr. Siércovich, (2005) reports that 80% of the energy consumed during a match is associated to the oxidative system, while 8-18% contributes to the glycolytic system. (Ross and Leveritt, (2001), Spencer et al, 2005/2006 Aziz et al, 2007, Castagna et al, 2007, Impellizzeri et al, 2008) demonstrated during a repetition of 12 sprints of 3 to 5 seconds separated by 30 to 40 seconds of passive recovery, increases the relative share of the oxidative pathway to more than 50% of the total energy supply while that of the hydrolysis of the PCr represents only 15 to 20%. The rest is ensured by lactic glycolysis. Gaitanos et al. (1993) suggested, in a series of 10 sprints of 6 seconds on an ergo cycle with a 6 seconds recovery, concentration of PCr in the lateral vast falls from 76 to 32.9 mmol / kg after the first working time at maximum intensity, but the PCr participates in the supply of energy until the end of the 10^{th} repetition. Thus, the power output of the last sprint would be supported by the degradation of PCr and an increase in aerobic metabolism. Glaister, (2005) notes the physiological impact of using PCr during this type of exercise and explains that during intermittent exercises with short 45 seconds recoveries, PCr is never fully synthesized and the body accumulates inorganic phosphates (Pi).

Our conception is based on cycles of dominant race, explosive force, speed and recovery, in which we give more importance to physical work using technical situations (posts qualities) and tactics (offensive and defensive conception) adapted to the qualities / defects of our players., intermittent exercises with an explosive strength component with a number of bounds adapted to develop the V02 max and gain repetition of high intensity efforts and explosive of lower limbs.

II. Material And Methods:

The experimentation of this study deals with a training conception that will allow players to adapt to the physical and tactical requirements of modern football. It is made in three parts:

- In a first step, we proposed integrated physical training to develop the cardiovascular qualities (VO2 max and the frequency of heart recovery) (**group I**).

- knowing that there is a correlation between the VO2 max and the ability to repeat the sprints, we have adopted, in a second step, the intermittent race combined with an explosive force component as a training method to develop VMA, the ability to repeat efforts of high intensities and sprints (RHSA) as well as the quality of recovery, physical qualities required by a football match (**group II**).

- In order to further improving our proposal and to figure out the type of plyometric work with minimum bounce and explosive efficiency of the lower limbs, we performed the third experiment that allowed us to conclude that the vertical bounce develop the explosivity and explosive endurance qualities of the lower limbs (**group** III).

1. sampling:

1st group: The study took place as part of a 3-month training cycle in a Belgium provincial football club (Etoile Brussels) with a squad of 14 players whose age varies between 18 and 23 ± 3 years old.

The aim of the experiment is to evaluate the effect of the integrated physical training on the VO2 max, from a field test, a continuous race, VAMEVAL (Cazorla George, 1990) and the heart rate 2 minutes after the test.

2nd Group: The study was conducted in a professional club D2, Moroccan championship. 19 players senior sampled in this study. Their average age is 25 ± 3 years, average 1.80 m ± 3 cm and weigh on average 75.43kg ± 4kg.

The purpose of this experiment is to evaluate the effect of the intermittent race with an explosive strength component on the VMA, from a field test, intermittent race 45 " / 15 " (George Gacon) and heart rate recovery 30 seconds after the test, as well as the ability to repeat high intensity efforts and sprints (RHSA), 5 " / 25 " as long as possible.

3rd Group: Our sample is made up of 48 subjects aged 15 to 18 ± 3 playing football as a leisure sport at school or on Sunday in neighborhood amateur organizations.

The aim of this experiment is to study the effect of low and medium pliometry (30, 50 cm) on the explosive strength and the explosive force endurance of the lower limbs from a test of vertical jump and succession of vertical jumps (50 cm) as long as possible.

2.Tests and realization conditions:

the players carried out the tests (VAEVAL for the 1st group, 45 " / 15 " of George Gacon and 5 " / 25 " for the 2nd group and vertical jump, endurance of explosive force for the 3rd group) in the Standardized conditions: time, field, climatic conditions and measured variables.

The 1st group trained 3 times a week for 12 weeks with tactical sessions in small groups integrating a physical component with frequency cardio-meter to control the load in the actual conditions of the match (players, field, goal and instructions).

The 2nd group adopted a design based on an intermittent race with an explosive force component and charge contrast exercises integrating the low and medium pliometry, 5 times a week for 1h 15 minutes per session over a period of eight weeks, according to the working conditions.

The 3rd group (13 subjects) was subjected to an low and medium pliometry training (30 to 50 cm), twice a week, 45 minutes per session for a period of six weeks with a maximum of 200 jumps per week, depending on the specificity of the work.

3.Conception of training:

1st group: Training of the intelligent player who masters the football of zone by means of a planning well thought out and a good coaching. The zone is a game conception and has nothing to do with the game system. In the first instance, it aims at a rational use of space. A player's offensive and defensive actions are based on an intelligent positional game in the full context of the entire team.

The content of the sequences is decided on the basis of two principles:

- The game is the starting point and point of return for any transformation effort.
- This is the analysis of the last match, given still the forecast for the upcoming match.

The training content must include during the session game sequences corresponding to the collective plan of the game. Therefore; the situations are based on a basic structure constituting a common core that the player likes to find, and where he must never be disoriented with a well-defined structure and parameters: Number of partners; number of opponents; game rule; dialectic of the balance of power: attack / defense; Ball; Space and Goals.

2nd group: Our program is based on the intermittent race with a component of explosive force and composed by cycles and each cycles has a dominant that are race, strength, speed and recovery.

Our Intermittent with an explosive force component:

- explosive force followed by the race.
- the race at the beginning then the explosive force at the end of the repetition.
- shuttle race: the race, then the strength and the return is made in the race.

In the race-dominated cycle, we offer three intermittent; two intermittent race and the last intermittent with a component explosive force variable according to the repetition:
1 ° repetition (force at the beginning), 2º repetition (force in the middle), 3º repetition (the force at the end of the race) and so on until the end of the series.
In the speed-dominated cycle, we offer intermittent (5 " / 25 ") with two series with an explosive force component and the 3rd series with an intermittent two-speed race.
In the cycle with dominant force we proposed three intermittent, the 1first with a component force at the beginning of the repetition, the 2nd intermittent shuttle with a component of force in the middle of the repetition, the 3rd intermittent with a force component at the end of repetition.
3rd group: There is a correlation between the vertical jump and the flexibility of the quadriceps requiring elasticity (flexibility) and neuromotive coordination (acceleration):
We believe that a plyometric training based on jumps of the feet joined at height can exert an influence on the reactivity as well as maximum force and subsequently increase the explosivity of the lower limbs, favoring the development of fast fibers and increasing the stiffness of the component elastic, thus a better explosiveness of the lower limbs and subsequently sustained explosive endurance.

III. Analysis And Interpretation Of The Result

Group 1: Based on the following results and through the evaluation of the dispersion, we observe a low dispersion at the level of the different variables, which means that our group is homogeneous.

Variable	VMA	FCR 2min
Sx/X:1er test	3.37%	1.17%
Sx/X:2e test	3.07%	1.23%
Evaluation Dispersion	Faible	Faible

Evaluation of dispersion (VMA, FCR 2mn)

Analysis using T-student

VMA	
VMA	VMA(T1)/VMA(T2)
Probability: P	**0.0167: X^X**

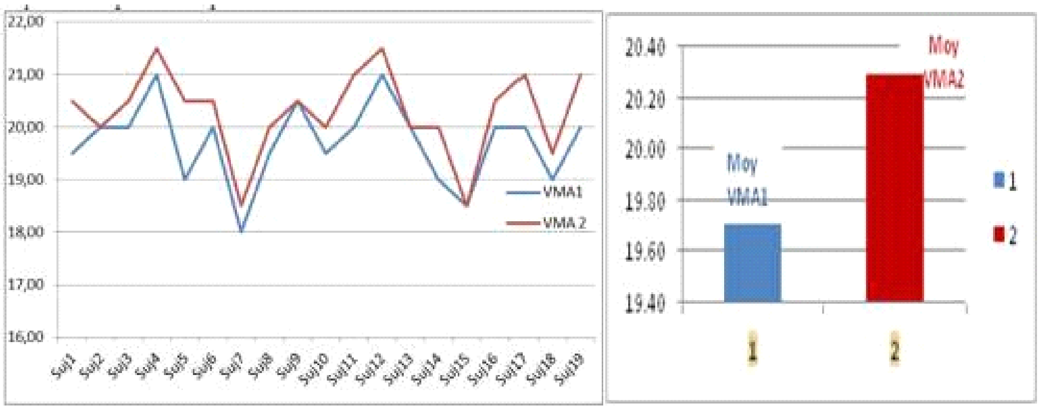
Probability (VMA1 et VMA2)

We find that there is a different meaning between the VMA (T1) and VMA (T2):
P = 0.167. The pre-test average is 15.12 ± 0.53 km / h against 15.62 ± 0.50 km / h, an increase of 0.50 km / h.

FCR : 2MIN APRES L'EFFORT :	
FCR : 2min	FCR2(T1)/FCR2(2)
Probability : P	**0.000 : S^{xxx}**

Probability (FCR1 et FCR2)

With respect to this variable, we notice that there is a highly significant difference P = 0.000.
Group 2: We statistically analyzed the normality of distributions using the Kolmogorov test and found that our group is homogeneous.
VMA: All players improved their average VMA by 0.58 km / h; (Average VMA1: 19.7 ± 0.71 km / h) (Average VMA 2: 20.28 ± 0.79 km / h): relationship between VO2 Max and ability to repeat sprints.

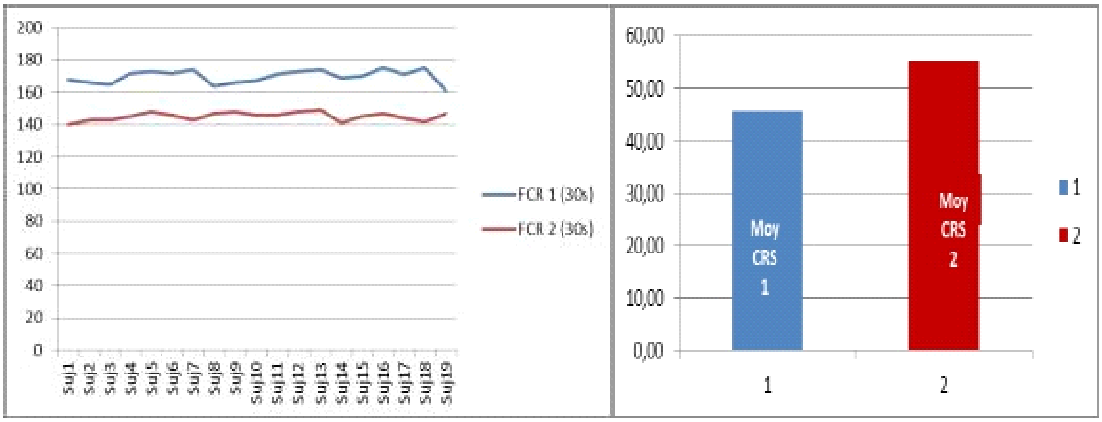


<u>VMA improvement</u>

RHSA: All players have improved their abilities to maintain an effort with high intensity and sprint race (5 " / 25 ") for as long as possible from 3 minutes to 12 minutes with an average of 9.78 ± 1.45 (average 1: 45.5 ± 9.15); Mean 1: 55.26 ± 10.60).

FCR 30 secs: All players improved their recovery abilities by (24 ± 1.35) beating per minute; (Average CR1: 169 ± 3.86) (average CR 2: 145 ± 2.51).

All players improved their ability to recover from intermittent race and play sequences from 20 to 30 beats per minute with an average of 24 ± 1.3.



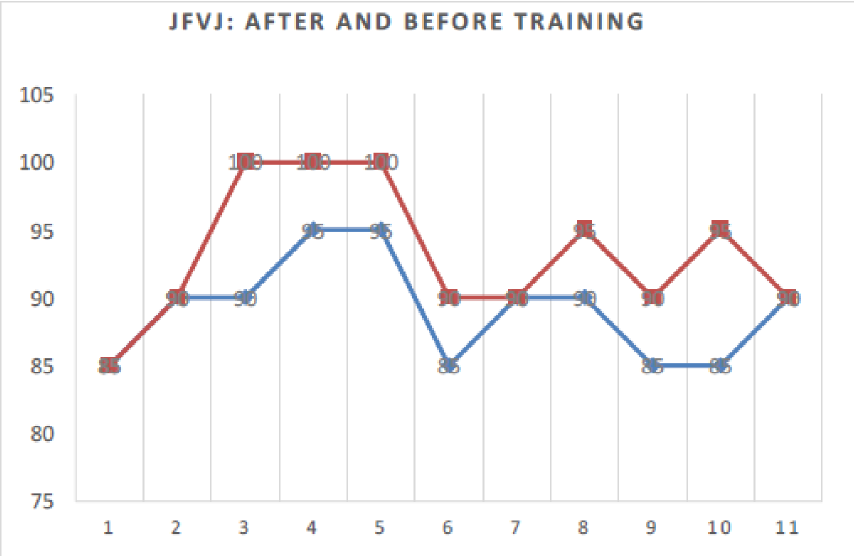
<u>quality of recovery Improvement</u>

3rd Group:

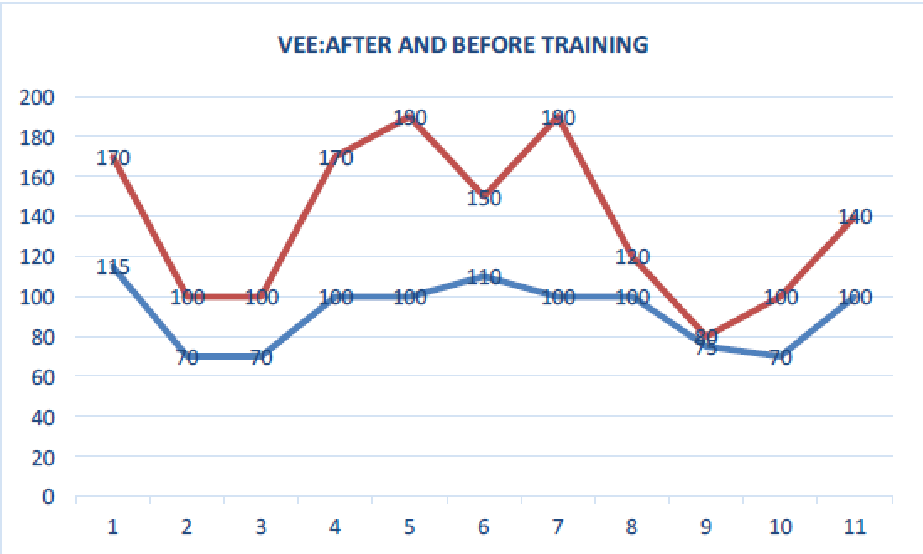
<u>Test before and after training and vertical jumps</u>

VERTICAL JUMPS JFVJ : jumping feet vertical joint VEE : Vertical Explosive Endurance					
TEST 1			TEST 2		
	JFVJ	VEE		JFVJ	VEE
1	85	115	1	85	170
2	90	70	2	90	100
3	90	70	3	100	100
4	95	100	4	100	170
5	95	100	5	100	190
6	85	110	6	90	150
7	90	100	7	90	190
8	90	100	8	95	120
9	85	75	9	90	80
10	85	70	10	95	100
11	90	100	11	90	140
Mean	89,090909	93,1818181		91,8181818	137,2727273
Standard-Deviation	3,7537859	5,13455318		17,0693771	39,51984542

<u>Mean comparison before and after training:</u>
The Wilcoxon test, which is not very sensitive to sample size, is often used to compare two small sample sizes before and after a certain event.
When reading graphical representations, we can suspect the existence of difference between the reduction before and after the training.
The significance of our nonparametric test of the order of 0.001, allows us to confirm the existence of this difference and reject the null hypothesis of equality of means.



SFVJ 1 SFVJ 2 .



VEE 1 VEE 2

We conclude that low and medium plyometric training allows subjects to gain vertical jump and vertical explosive endurance.

IV. Discussion:

The purpose of this study is to propose a conception, a tactical and physical training program to meet the requirements of modern football. In a first study, we proposed an integrated physical training to evaluate its effect on the cardiovascular capacity namely the VO2 max and the quality of recovery. In the second study, we presented an intermittent race with an explosive strength component to facilitate the repetition of fast, explosive and high intensity efforts. In the third study, we tried to choose the type of low and medium plyometric as well as the number of jumps per week to gain explosive strength of the lower limbs required by a football match.

1ST Group: With a zone football design, we tried to present an integrated physical training based on game situations consistent with the internal logic of the football activity to facilitate the transfer to games. The use of VMA Tests therefore allows a better use of the aerobic profile of each player allowing an individualization of the work. Thus, studying the data collected during the training session makes it possible to modify the consequences of a game session, namely to transform a maximum aerobic power effect (PMA) into a less intense effect of aerobic capacity type, or to transform an anaerobic lactic situation into aerobic. While working a tactical-technical sequence, the physiological component will always be present with a permanent control of the heart rate. Thus, the integration of the physical component in a technical-tactical combination gives us the opportunity to achieve two objectives at the same time. Increasing the VO2 max of a football player is one of the physical objectives in alliance with the mastery of the game. To achieve this synthesis of work, we rely on the game sequences. The training content must include races. In the session of the game sequences corresponding to the collective plan of the game: this consists of setting up the dynamics of the game of the team. This offensive and defensive matrix makes it possible to order the collective game, to give it benchmarks. The player will be able to flourish in a structured collective game with reduced numbers and restricted spaces, in order to have close perception to the game. In this study we noticed a remarkable increase in VMA in post-tests compared to pre-tests. This increase in VMA implied an increase in VO2 max (24% improvement in VO2 max in 3 months), the same finding is made by Rowland, (1990) in youngsters trained for 4 months: 10 to 20% improvement of VO2 max. An improvement in heart rate recovery from certainly to a decrease in rest time during game sequences**.**

2nd Group: Using a set of tests: VMA (45 " / 15 ") by George Gacon, ability to repeat sprints (5 " / 25 ") giving a first reference on aerobic qualities, explosive strength and speed, we tried to conceive a design, a training program based on a dominant of explosive force associated with an intermittent race to facilitate repetitions of explosive actions, fast and high intensities at the end of the game. Many similar studies have been identified, (Disalvo and al, 2007; Dellal, 2010/2011; Carling, 2010; Bradley and al, 2010) who tried to analyze the physical activity of a footballer and propose content adapted to the factors of physical performance.

We have proposed an intermittent race with a strength component (at the beginning, middle or end of the race) to accustom players to different situations of strength (race plus shooting, race plus acceleration and center, long pass plus sustained run. ...). Our results are supported by those of Gille Cometti, (2002) who suggested an intermittent strength to preserve the explosive qualities at the end of the match. We have also presented a work by contrast of charge to facilitate the transfer of the force max in explosive force which is the major quality required by a football match. This result is confirmed by Duffour, (1990) who claimed that players travel 7 km of which 14% at high intensity: 18 to 24 km / h and put the action on bodybuilding exercises to solicit the fast fibers and become explosive. Cometti, (2007) proposed a max strength work to develop the ability to repeat sprints. Our third quality, which is speed, is the capital of football. For this, we presented a program on different forms of speed namely, speed amplitude, speed frequency and starting speed to ensure that our players with the work of the other two qualities already worked can repeat more fast and explosive actions during any the duration of the match. This result is in line with that of Cazorla, (1998) who showed that there are 140 to 160 sprints per match and advised to develop the ability to repeat sprints that are essential in games. Dellal, (2008) shows that 4 to 5% of the total distance of which 247 to 400 m are performed in maximum or supra maximum strokes. LeMeur, (2014) distinguishes four types of workouts to develop the ability to repeat sprints that are focused on the work of speed technique, strength and maximum sprint speed.

Thus, this study confirms the hypothesis that a training program based on the explosive strength associated with an intermittent race with its different forms (ability to resynthesize phosphocreatine), development of VO2 max which can be a factor limiting the ability to repeat sprints (Jones and al, 2013; McGawley and Bishop, 2014) and effectiveness in preserving the ability to repeat high intensity efforts and player sprints during training sessions, thereafter transfer to matches will be easy and players will be able to produce more explosive actions without a significant reduction in physical performance (repeat short, high-intensity efforts along the two halves of a football match), in line with (Bradley and al, 2010; Disalvo and al, 2010) who claim that explosive efforts are a critical factor in team performance, 10% sprint the total distance (878 m). (Bloomfield and al, 2007; Little and Williams, 2005; Ratames and al, 2007) have combined plyometric work to improve speed quality. Strength and VO2 Max are directly related to sprint and sprint rehearsal performance (Aziz and al, 2007; Ronnestad and al, 2008). The ability to repeat sprints is an essential quality for modern footballers (Mendez Villanueva and al, 2007/2008).

3rd Group: Using a 6-week training program based on low and medium pliometry, we showed how many jumps per week we can gain in vertical explosiveness as well as in vertical explosive endurance.

The plyometric training allows to develop the explosive strength by acting on one of the muscular components. For Schmidbleicher, (1988), it is the use of the elastic components of the muscle (storage-restitution of the energy stored by the musculotendinous system during the stretching phase). For Bosco, (1985), it is to raise the sensitivity threshold of the Golgi receptors. For Poussin, (1988), it is the improvement in the sensitivity of the neuromuscular spindle that makes it possible to recruit a large number of motor units by using the myotatic reflex demanding a large number of muscle fibers.

In our study, after 6 weeks of training, all subjects improved their physical explosive performance of the lower limbs. In our training, that focuses on low and medium pliometry with a progressive number of jumps, we have focused on the development, recruitment and synchronization of motor units. In agreement with (Peres-Gomez J and Calbet J, 2013) who showed that a plyometric training of at least four weeks and Arnaud Lesserteur, (2009) suggests that an medium pliometry work of 180 to 220 bonds for beginners, improves the vertical jump, acted on the synchronization of the motor units, subsequently develop the fast fibers. and increase the explosiveness of the lower limbs. This result is confirmed by those of Cousilman, (1976) who suggested that there is a relationship between vertical jump and muscle composition in ST and FT fibers. Malisous, (2008) who concluded after 8 weeks of plyometric training, an increase in the diameter of the muscle fiber, an improvement in speed and maximum strength.

Our results show that we can gain explosivity with a minimum of vertical jump and know the number of jumps in low and medium pliometry combined with an intermittent race to repeat more fast efforts and explosives along with the duration of the match.

V. Conclusion:

The objective of our work is to propose a training design with reference to the requirements of modern football and to facilitate their transfer to matches. An integrated physical training to develop the VO2 max as seating for an intermittent with an explosive strength component (at the beginning, in the middle or at the end of the race) in order to preserve the ability to repeat short, fast and high intensity race with fast recovery in the duration of the football match. Our results have also showed that training in vertical jumps allows to gain explosive strength of the lower limbs.

Intermittent running sessions are very important for developing VMA and the ability to repeat sprints. The combination of explosive force exercises with intermittent race promotes the resynthesize capacity of creatine-phosphate in order to produce more fast actions and high intensities without loss of performance. The work of the speed exercises with its different forms (speed technique, shuttle, change of direction) improves the ability to repeat the sprint.

This study also allowed us to present sequences of technico-tactical play with physical markers and as a control tool, heart rate to allow to modulate and quantify the training load and give players the opportunity to invest in a collective plan with complementary roles.

Specific exercises of low and medium pliometry with a number of jumps from 80 in the first week to 200 in the sixth week, showing a considerable gain of explosiveness of the lower limbs.

We also proved that the vertical jumps give more explosive strength to the studied qualities of vertical explosiveness, vertical explosive endurance.

However, further studies seem to show a correlation between lactate production and the ability to repeat sprints; Dardouri and al, (2014) who showed that the higher the capacity to produce lactate, the greater the ability to repeat sprints by maintaining their high speed.

At the end of our study, we can conclude that this design has provided specific tools to guide the physical training of the footballer and confirm that with an integrated physical training we can develop cardiovascular capacity, VO2 max and recovery qualities. The study gave an important support on the plyometric work to know that with a training in low and medium pliometry, a number of jumps per week well defined in advance, which are combined with intermittent race according to the dominant (months, weeks), we can develop the ability to repeat sprints without loss of performance during a football match.

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