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Speed, acceleration, deceleration and metabolic power in the work to roles for a workout more targeted in elite football

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Abstract

The paper aims to determine with greater scientific rigor, the differences in the amount of work in the high intensity of their positions in the field by athletes in soccer, and then determine the most correct training parameters, especially through the use of a teaching job optimized and addressed to the parameters obtained.

In fact, our study showed that Midfielders are working more above the speed (2.196 m/s) acceleration (719.14 m/s) deceleration (711.91 m/s) and metabolic power (3305.7 watts/kg) high-intensity thresholds compared the other roles, consequently followed by Outside, Strikers and Defenders for every mentioned parameter but for Metabolic Power, as it appears to be greater in Outsiders (3153 watts/kg): latters result to be working less above the high-intensity thresholds.

Whit this study of velocities, accelerations, decelerations and metabolic power in the work of high intensity above threshold in elite football (VADPM in the work of high intensity above threshold in football elite) it was possible to estimate not only the total distance traveled, which is simply a partial index of the total energy expenditure, but also to quantify the work done performance above the threshold of high-intensity acceleration and deceleration during the various stages of the game, the thresholds calculated by the research universities of Urbino and by the K-Sport from the threshold of high-intensity metabolic power (Pm) of 20W/Kg (corresponding to 16Km/ha constant speed or 4.4 m / s). To qualify the marketability of the parameters derived from the analysis of 6 football teams of the top division of the Italian league season 2012-2013 with semi-automatic tracking system, K-Sport, (from which are derived the physio-specific metabolic profiles depending on the roles), and to emphasize the relative effectiveness of the training offered some optimized, have been obtained percentages of the parameters of competition in the various items investigated and compared with the percentages extracted through the use of GPS K-10 Hz (K-Sport, Italy) for specific training such as:

- **Half field drill:** (eg. 20x40 meters or the like). In this drill the dimensions of the fields are considerably smaller than the official match size, although they may change.
- **Two-touch small-sided pitch drill:** a training match played in a smaller field where players just can touch the ball twice at a time, that is to say that after the second touch he must pass the ball to another player.
- **Small-sided pitch drill:** the same as for "*Half-field drill*" but in this case the field is exactly an half of the official one: a door remains in the same position it has in the real field game while the other is shifted in the halfway line.
- The GPS or Global Ground Positioning are satellite tracking systems that allow an accurate detection of all the moves of moving objects (in this case the ball and the players), thanks to appropriate sampling frequencies. In particular, the K-GPS 10Hz (K-Sport, Italy) has become famous as the evolution of 5Hz systems. In fact, its sampling frequency at 10Hz gives the possibility to catch the position up to ten times per second in order to properly record all the sprints, accelerations and decelerations.
- From the comparison performed to determine the workout congruence with the data obtained in the matches we deduce that:
- Training in Half field drill and Two-touch small-sided pitch drill reduced field, they found that essentially all of the roles analyzed are trained to just above the threshold of high-intensity acceleration and deceleration and become null and void with respect to speed and metabolic power;
- The Small-sided pitch drill reduced, on the contrary, it was found a job above the threshold of high-intensity acceleration and deceleration while they are not even trained with this methodology workout speed and metabolic power.

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Introduction

Football is a sport of situation, it is a team game played collectively, but like any collective activity is the result of the work of individuals.

From the work cited studies that will not only speed, but also in particular the acceleration, deceleration and metabolic power in the work of high intensity above threshold in football, and the results shown in the sports literature (Azzon V., A. Bouillon, Colli R., Lucarini L, 2010; Bernardini R., C. Osgnach, Poser S., R. Rinaldo, Prampero, 2010; Carling C., Bloomfield, J., Nelsen Lee, Reilly T, 2008. Prampero PE, Fusi S, Sepulcri L, Morin JB, Belli, G. Antonutto, 2005; Di Salvo, V, Baron, R., Tschan, H., Calderon Montero, FJ, Bachl, N. and Pigozzi, F, 2007; D'Urban G., 2010; Figueroa, PJ, Leite, NJ and Barros, RML, 2006; M. Ricardo Barros L. 2007; Osgnach Cristian. Prampero and *et al.*, 2010; T. Reilly, Thomas V 2008; Thatcher, R. and Batterham, AM, 2004) [2, 2, 4], it can be said that soccer players play during the competition athletically different activities.

The study begins with the importance of these properties highlighted by Prampero et Coll. (2005) [1], for the estimation of Metabolic power expressed by different components of performance during competition (A, V). The study estimated the average values of the energy cost for the various categories of metabolic power used during acceleration and the relative percentage of the total energy cost. The results showed an energy cost relative to the constant speed of 16 Km / h, which corresponds to a metabolic power of about 20 W / kg, a value beyond which one can speak of "high intensity" [2]. This index allowed us to develop a more accurate assessment of soccer performance compared to previous studies. Above a threshold of high intensity V and PM, have been obtained by the research group of the School of Sport Sciences in Urbino and company K -Sport thresholds of high intensity, not yet present in the literature, A and D:

- AHI (threshold of high intensity of acceleration) > 2.0 m / s, high-intensity threshold for the acceleration;
- Dechi (threshold of high intensity of deceleration) < -2.0 m / s, high-intensity threshold for the deceleration;
- Mphi (threshold of high intensity of metabolic power) > 20,000 watts / kg, lata threshold intensity of Metabolic Power;
- VHI > (threshold of high intensity speed) 4.4 m / s, the threshold intensity for the high speed (threshold of 16km / h reported in m / s).

What this paper will try to show is more or less apparent adequacy of the training work of three specific methods of training, Half field drill, Two-touch small-sided pitch drill, Small-sided pitch drill, allowing you to try if you really athletes in training perform work in excess of the thresholds of high intensity equal to the competition.

Thanks to scientific surveys of Match Analysis was then

¹ Di Prampero P.E, Fusi S, Sepulcri L, Morin J.B, Belli A, Antonutto G. Sprint running: a new energetic approach. *J.Exp.Biol* 2005;

Bernardini R., Osgnach C., Poser S., Rinaldo R., Di Prampero P.E., "Energy cost and metabolic power in elite soccer: a new match analysis approach"; *Med. Sci. Sports Exerc.* 2010; Vol. 42, No. 1, pag. 173.

² Bernardini R., Osgnach C., Poser S., Rinaldo R., Di Prampero P.E., "Energy cost and metabolic power in elite soccer: a new match analysis approach"; *Med. Sci. Sports Exerc.* 2010; Vol. 42, No. 1, pag. 173.

possible to evaluate the actual performance of the player that allows you to define parameters for more individualized training based on the actual working capacity of each athlete, highlighted by a subdivision of the same roles (defender, midfielder and attacker), also according to the specific characteristics of the location of each role (for example, by distinguishing midfielders outside the central midfielders).³ Specifically, through the use of computerized systems for automatic tracking (K-Sport Tracking, K-Sport, Italy), software (K-Fitness, K-Sport Italy), which go to create custom profiles concerning the modification of the parameters studied during the performance and through the application of K-10 Hz GPS (K-Sport, Italy) on players specific during workouts, it was possible to compare the recorded parameters, highlighting both methods of detection, (first used during the competition and the second in training), the same sampling frequency. This comparison is crucial since it allows to evaluate both the efficiency of the training according to the actual parameters required in the competition based on the potential of the individual player and also on the demands prestative which provides real role in the field.

Means end Methods

As mentioned previously, the data collection took place with two different methods, one used during the competition and the other only in training:

- The video system used during competitions, provides for the installation of 3 cameras with sampling frequency of 25 Hz (25 frames per second), carefully placed in the stadium (the installation of the cameras has been previously cleared by the Football League Italian, the latter having decision-making authority on all videos that are made during official races of the championship).

The information collected were stored and analyzed by a program called K-Sport-tracking system, which performs the tracking of the players automatically. The collected data were downloaded and converted to a format compatible with the software K-Fitness which processes them by creating reports in which there are both the recording of the match played, the parameters, both medium and specific to each individual player.

- KGPS 10 Hz systems (K-Sport, Italy) during specific workouts (forbidden during the competitions): able to detect the position up to 10 times per second, a speed rate that allowed an accurate detection of the sprints and accelerations and decelerations. The numbers were downloaded to personal computers via USB cable, and then analyzed by the K- Fitness software (K-Sport, Italy).

Analysis

- This study took into consideration:
- 6 matched of the top level Italian football championship of 2012/2013;
- 6 different teams;
- 60 players;
- 3 different training methods;
- 5 weekly drills, 2 per each method considered;
- 20 players for each drill.

³ Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F.J., Bachl, N. and Pigozzi, F. (2007) "Performance Characteristics According to Playing Position in Elite Soccer." *International Journal of Sports Medicine (serial online)* 28(3), (06 screens/inclusive page), March. Available from URL: <http://www.thieme-connect.com/ejournals/toc/sportsmed>.

The analysis phase

To assess the marketability of the parameters measured by scientific study "VADPM in the work of high intensity above threshold in football," and to be able to create new individualized plans and effective workout, was accomplished primarily a division of the average values obtained for each role to above the threshold of high intensity taken into account, with the average total distance traveled by the athletes during

the match analyzed.

Was necessary to follow such mathematical procedure for obtaining, from the results obtained by the division, the percentage of work performed by each role above the threshold of high intensity.

The graphs below (picture 1, 2, 3, 4, 5) show the values for the, Striker, Midfielders, Defenders and Directors.

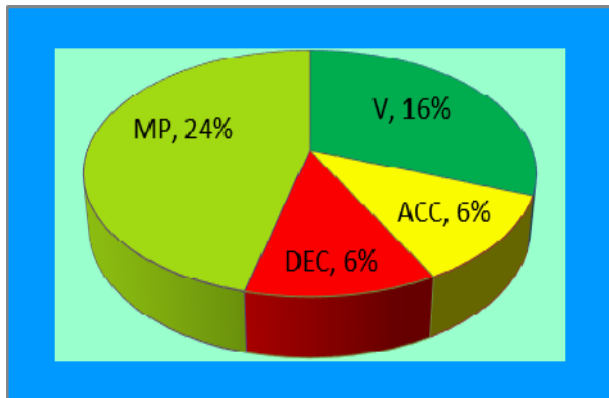


Fig 1: of labor above the high threshold high threshold Strikers.

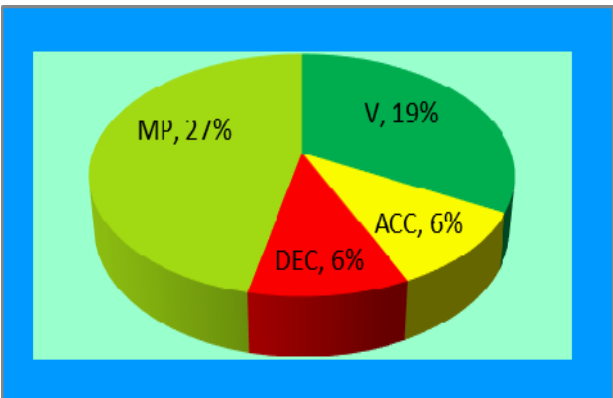


Fig 2: of work performed above the Midfielder's intensity of Outside Midfielders.

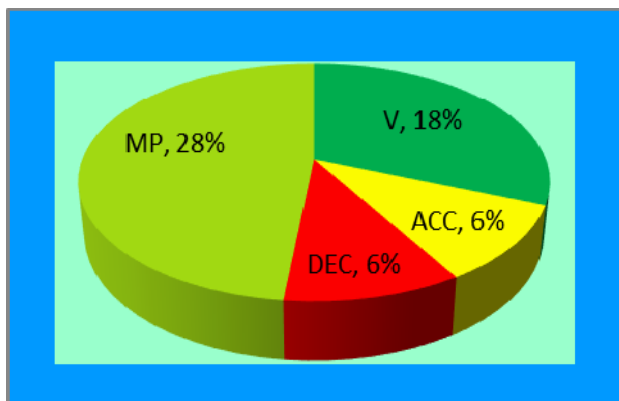


Fig 3: of work performed above the high intensity by C. Midfielders.

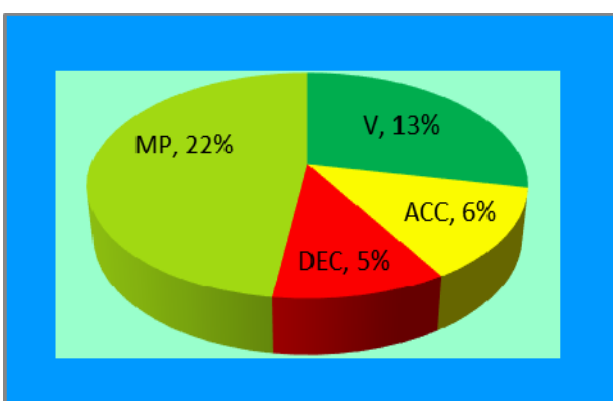


Fig 4: of work performed above the threshold of high-intensity Defenders.

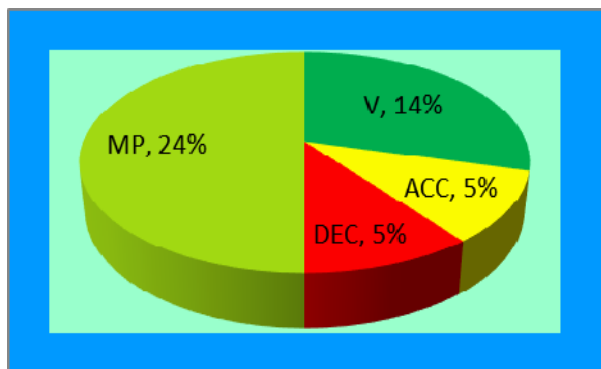


Fig 5: of work above high-intensity threshold performed by Directors.

In order to be athletically valid as training methods, these percentages were compared with the statistics from the GPS of the K -Sport 10Hz system considering the above mentioned training methods. This was possible because the video monitoring tracking method and the GPS system had the same sampling rate.

The 3 training methods suggested to train speed, acceleration and metabolic power, were:

Half field drill

Two-touches small-sided pitch drill

Small-sided pitch drill.

Charts primarily show that (chart 1.) the training methods (data obtained from K-GPS 10Hz, K-Sport ITaly) exceed in the percentage of the threshold of high intensity; secondly (chart 2.) whether these parameters can really train the player in comparison with those obtained from the analyzed matches (K-Sport Tracking system and K-Fitness, K-Sport, Italy softwares).

Table 1

Metodiche Di Allenamento	V	ACC	DEC	PM
Partita A Meta Campo	9%	8%	7%	22%
Partita Due Tocchi Campo Ridotto	3%	7%	6%	15%
Campo Ridotto	5%	6%	6%	16%

Table 2

Partite Analizzate	V	ACC	DEC	PM
Attaccanti	16%	6%	6%	24%
Centrocampisti C.	18%	6%	6%	28%
Centrocampisti E.	19%	6%	6%	27%
Difensori	13%	6%	5%	22%
Registi	14%	5%	5%	24%

Observations by Comparison

- In the half field drill: All roles analyzed showed a workout just above the threshold of high-intensity acceleration and deceleration and do not train in speed and metabolic power.
- In the two-touches small-sided pitch drill: it was found a workout over the threshold of high-intensity acceleration and deceleration, speed is not training and Metabolic Power.
- On the contrary, in the small-sided pitch drill, was detected above the training threshold intensive acceleration and deceleration as the percentages match and still not practicing speed and metabolic power.

In essence we can argue scientifically that these methods of training, however, used by many elite football clubs, they are not responding to the real needs of performance in acceleration and deceleration and not at all for the speed and metabolic power.

However, it should be noted that all the values collected via GPS at 10 Hz during the drills, can sometimes not be considered as valid because of game interruptions for technical corrections (requested by the coach), that created “dead times” for the surveys.

Conclusions

We believe that this study will be an element of scientific substance and reflection as well as the original, which should significantly revalue the physiological model of the player, according to the analysis of additional parameters not analyzed in the literature so far. The study made use mainly of the fact that in the course of a game the player is not obviously only runs at a uniform rate, but it takes a significant number of accelerations and decelerations (expressed in m/s^2) which clearly have a different metabolic cost, especially if carried out with efficiency, ie, with abrupt changes of speed in both growth that decrease, then in a non-progressive.

The increased specificity analysis of the performance of the study undertaken, it allows us to assess more responsive to the realities of competition and the movement of the constituent elements specific sport of football, claiming in this case that the most solicited on average during competition in all roles Metabolic is the Power for approximately 26%, followed by the speed to 17% and the percentage of acceleration and deceleration, which are respectively 6% and 5.6% and opening the field to a scientific qualification optimized as well as performing the proper choice of exercises for training.

For what concerns the 3 methods of training, Half field drill, Two-touch small-sided pitch drill, Small-sided pitch drill,, it was estimated that they have fully satisfied the development of the ability to work above the threshold of high-intensity especially above the threshold speed and metabolic power, except for the midfielders in which case these methods were training for the Acceleration and Deceleration.

In this case, the parameter of speed, the results have not shown made and added additional concepts, since, in training a reduced field is unthinkable to reach and exceed the threshold

of high intensity. But what about the power metabolic results of trainability not have said that, many researchers and sport-specific coaches, who claimed to train with the Power Metabolic these methods actually wandered as it became apparent to the contrary.

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