Original Article

Video tracking for the detection of external load to establish proper parameters in elite soccer players during high intensity training

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Abstract:
The video recording and following analysis of games allows sport scientists and coaches to evaluate physical performances of professional soccer players. In particular, can be useful to allows and analyse speed thresholds, accelerations, decelerations and total amount of energy expenditure expressed with metabolic power. It is well known that accelerations are essential to establish sport specific metabolic loads (Di Prampero et al., 2010). Given the obvious importance of a correctly quantifying of metabolic of the various football movements, the aim of this study is to analyse accelerations, decelerations and speed thresholds player by player during matches. Given the obvious importance of a correct metabolic load of the various football movements, the aim of this study wants to analyse accelerations, decelerations and speed thresholds, players by players during matches. The study will also highlight players, into their own field roles, for a better optimization of individual and team project planning.
Key Words: Sprint, video tracking, high intensity, optimization, metabolic load

Introduction
The aim of the study is to evaluate speed, acceleration, deceleration and metabolic power in soccer players through video tracking (K-Sport Universal, Italy). The video analysis is able to automatically analyse events and evaluate all aspects of performance with proven criteria through a tracking system that is able to detect the positions of all the elements that participate (such as players, referees and ball for entire duration of matches), with high precision and accuracy of data obtained (Appleby, 2002). Thanks to the K-Fitness software applications (K-Sport Universal, ITA), it was possible to analyse, in this case, the Sprints parameters (speed, acceleration, deceleration and metabolic power thresholds) of the individual athletes, being able to perform a comparison of the athletic data role by role (Rampinini, 2007).
It is of fundamental importance to consider how the software detects sprints:
- Sprint based on the speed threshold can be detected by software when a subject exceeds the speed of 5,56 m/s (20 km/h) holding the velocity for at least 1 second (fig.1);
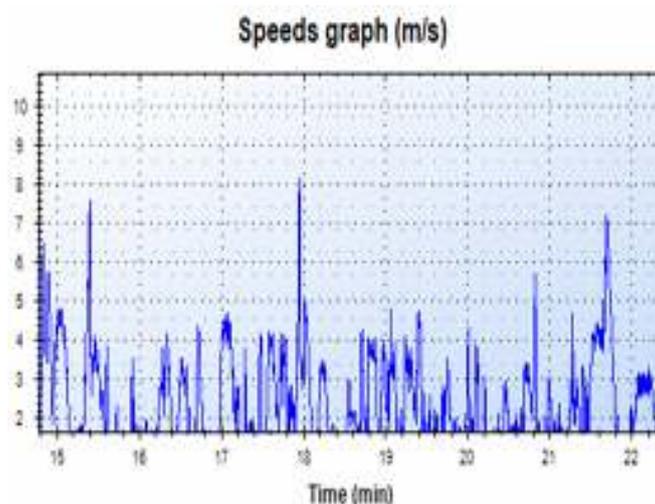

Figure 1: High intensity speed threshold for detection of sprint

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- Sprint based on acceleration threshold can be detected by software when the subject accelerates above 3.00 m/s2 for more than 0.4 seconds (fig. 2);
- Sprint based on deceleration threshold can be detected by software when the subject decelerates below - 3.00 m/s2 for more than 0.4 seconds (fig.2);
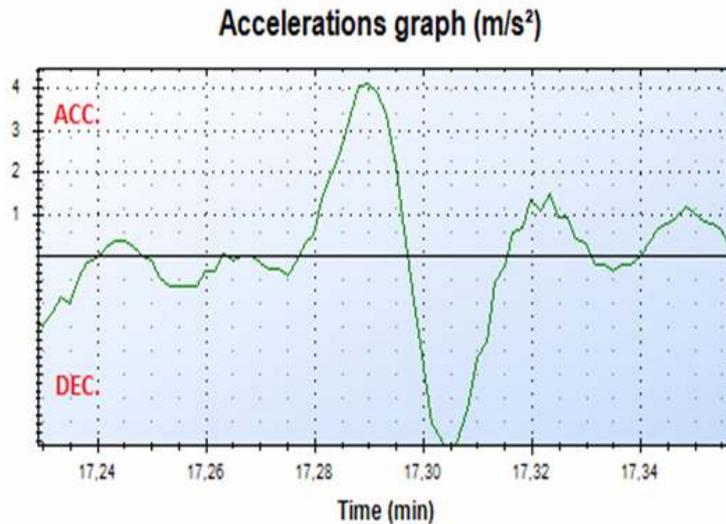

Figure 2: High intensity acceleration and deceleration threshold for detection of sprint

- Sprint based on metabolic power threshold, can be detected by software when the subject exceeds power of 55.00 W/Kg for more than 0.4 seconds (fig.3).
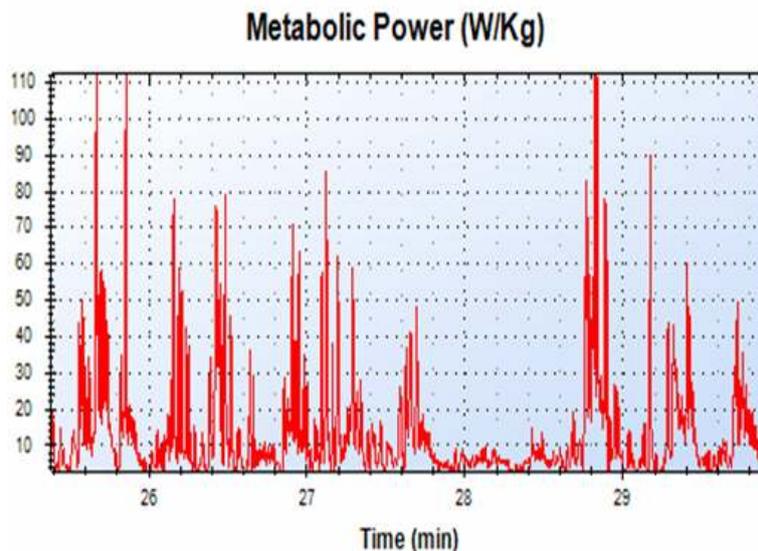

Figure 3: High intensity metabolic power threshold for detection of sprint

Material & methods

The aim of this study is a statistical analysis concerning football physical performances of matches detected from Professional First Italian League, during 2012-2013 football season. During our study were monitored 5 matches and 60 players, belonging to six different teams. Basic parameters taken into consideration were number of high intensity action performed by the players over: speed threshold (S-HI), accelerations (A-HI), decelerations (D-HI) and metabolic power (MP-HI). Data collection were carried out by video recording system of 3 cameras with a sampling frequency of 25 Hz (moderately low), carefully arranged in stadium of matches. The information's collected were stored and analysed by the K-Sport tracking program (K-Sport Universal, Italy). The Report created represents the registration of every movement made by players inside the filed; data were collected for each player and create a team average for every teams. The reports concern only data from players who had played the full match, subjects were divided according to their role on field: Forwards; External Midfielders; Central Midfielders; Defenders; and Playmaker. Obviously to quantify the number of sprints, always intended as performed at very high intensity and to calculate the total workload performed above the thresholds taken into consideration, the parameters of matches were added together in order to obtain total average.

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Results
The following table shows average data for every parameter role by role (table 1, figure 4).

Role	S-HI	A-HI	D-HI	MP-HI
Forwards	43	82	84	108
Playmakers	29	63	60	74
E. Midfielders	52	90	97	127
C. Midfielders	50	86	98	124
Defenders	28	72	74	83
Average	40	79	83	104

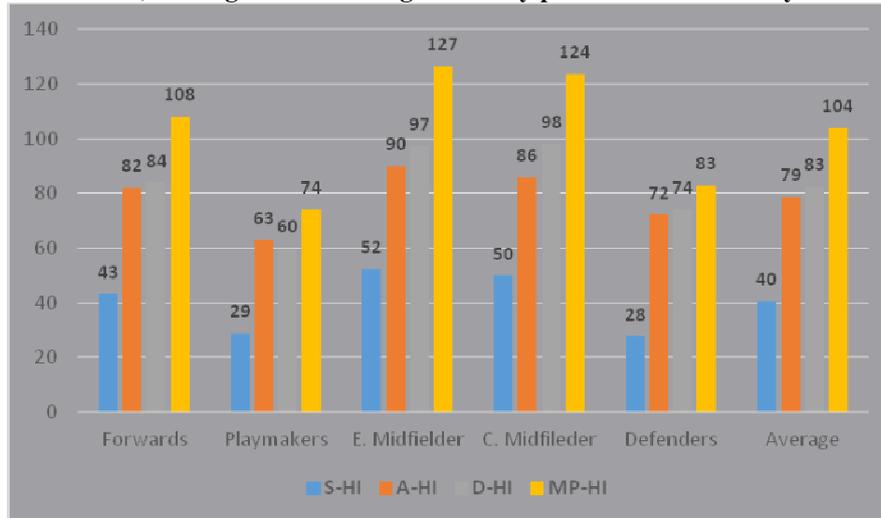**Table 1; Average data from high intensity parameters divided by role**

Figure 4; Histograms that show average data from high intensity parameters divided by role
After performing a specific analysis by role, the overall total averages of each individual match were also evaluated, team-by-team. In this way, it was possible to correlate the data obtained in the physical performance with the result of matches (table 2).

Matches		S-HI	A-HI	D-HI	MP-HI
M-1	**Team A**	**47**	**92**	**106**	**126**
	Team B	34	78	75	95
M-1 Average		40	85	91	110
M-2	**Team A**	**44**	**97**	**98**	**119**
	Team C	38	78	81	101
M-2 Average		41	88	90	110
M-3	**Team A**	**41**	**85**	**92**	**105**
	Team D	34	60	82	99
M-3 Average		37	72	87	102
M-4	Team A	45	60	56	90
	Team E	**40**	**79**	**71**	**103**
M-4 Average		43	70	64	97
M-5	**Team A**	**40**	**80**	**80**	**105**
	Team F	39	77	85	98
M-4 Average		40	79	83	102
Total Average		40	79	83	104

Table 2; Data team by team for every matches analysed, for every matches team in bold suggest the winner of the match.

Discussion

Table 1, shows detected data in order to evaluate the difference work performed between the five roles in the execution of high intensity events, carried out according to the high intensity threshold: S-HI when speed reach value $> = 5.56$ m/s for at least one second, A-HI when acceleration reach value > 3.00 m/s2 for at least 0.4 seconds; D-HI when deceleration reach value of $< - 3.00$ m/s2 for at least 0.4 seconds and MP-HI when metabolic power reach value of > 55.00 W/Kg for an interval time of 0.4 seconds. From data analysis is easy to see that there are many differences role by role. Playmakers are the players that show lowest value in every high intensity parameter in the other hand both type of midfielders external and central show highest values detected. In order to add another key analysis to the study, teams and matches were analysed, in correlation with won and lost matches. In all the analysed games, the team that showed higher values in high intensity events won the game. This can help to understand how important is in the modern football, to have a high fitness condition. It is also interesting to evaluate, from the data analysis, that on average, in all the roles:
• The greater number of event carried out according to the speed threshold, mainly concern distances between 5 and 10 meters;
• No Sprint on the speed threshold over 35-40 meters;
• The greater number of events made on the Acceleration and Deceleration threshold is highlighted on average distances of 1-2 meters;
• No events are performed on the Acceleration and Deceleration thresholds greater than 4-5 meters;
• The greater number of events made according to the Metabolic Power threshold are for distances of 2-3 meters, no events above 7-8 meters were performed.

Conclusions

The aim of this study was discover and underline the high intensity performance of professional football player, using the video tracking system. Data collection were carried out by video recording system of three cameras with a sampling frequency of 25 Hz (moderately low), carefully arranged in stadium of matches. From parameters taken into consideration, has emerged that:
• The External Midfielders, are the players who play during the match, the largest number of high intensity actions according to the thresholds of Speed, Acceleration, Deceleration and Metabolic Power, compared to the other roles covered in the field followed by Central Midfielders and Attackers;
• Playmakers shows more high intensity actions on the threshold of Speed, compared to the Defenders;
• The higher number of high intensity actions, in all roles, are greater on the Metabolic Power threshold, followed respectively by Deceleration, Acceleration and Speed.
It was also possible to evaluate that on average, in all the roles:
• The greater number of high intensity actions made according to the speed, mainly concern distances between 5 and 10 meters (followed by distances of 10-15 meters).
• No actions on the speed threshold over 35-40 meters;
• The greater number of high intensity actions made on the Acceleration and Deceleration threshold is highlighted on average distances of 1-2 meters (so the maximum acceleration and maximum deceleration of a Sprint is 1-2 meters).
• High intensity actions are not carried out on Acceleration and Deceleration thresholds greater than 4-5 meters;
• Average distance Metabolic Power threshold are 2-3 meters, no actions above 7-8 meters are made.
Moreover, from the analysis of matches, it has been possible to deduce that players belonging to the winning teams have played a greater number of high intensity event, compared with losing teams. In the same way, the winning teams have covered more distance than the losing teams. These data cannot be defined as decisive in the sporting success. Only by identifying the needs and physical characteristics of athletes during matches, coaches and trainer will be able to select the most useful and productive way to achieve growth of the fitness condition for individual whole team (Stolen, 2005).
Conflicts of interest - If the authors have any conflicts of interest to declare.

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