

Insurgence of fatigue and its implications in the selection and accuracy of passes in football. A case study

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Abstract

Football is a situational team sport, the measurement of individual and group performance is therefore complex, especially if the intent is to investigate the individual components that influence the result. Performance depends on multiple factors, which can be summarized in four specific areas physiological, psychological, technical and tactical, all of these together build the player performance model. The execution of the pass, in all its modalities, is a substantial technical and tactical ability during a football game and is it influenced by several factors that may be intrinsic or extrinsic. The aim of this study is to evaluate the role of fatigue in the distribution of type of passes and their accuracy, analysing two complete season 2017/2018 and 2018/2019 from a team belonging to the Lega Pro (third level of the Italian Football) for a total of 74 matches. Data were collected from thereports provided by WyScout database (Chiavari, Italy).

Key words: football, fatigue, pass accuracy, match analysis

Introduction

Football is a situational team sport, the measurement of individual and group performance is therefore complex, especially if the goal is to investigate the individual components that influence the result. Performance depends on multiple factors, which can be summarized in four specific areas physiological, psychological, technical and tactical, all of these together build the player performance model (PPM) [1]. The competitive moment therefore takes on different shades, not only in function of the environmental conditioning or that linked to the presence of the opponent, but also in relation to the collaboration and cooperation between teammates, all connected and depending from team tactical and technical indications. The video Match Analysis (MA) plays a very important role for the evaluation and in-depth study of the performance, taking into account the individual player as a specific and unique subject and each team as the sum of subjects [2]. Franks and Miller (1986) have shown that the best international coaches have the ability to remember at most 30% of the key factors that determine success during a game, therefore the MA, of both single match or an entire championship, allows coaches to obtain more information, in addition to more precise details, compared to subjective observation [3].

The evolution of the MA has gone from the use of notational evaluation forms up to the modern computer systems of today. The automatic computerized analysis systems have brought significant advantages to the sports world by providing detailed information regarding physical, technical and tactical performance. These evaluation systems are essentially linked to the recognition of the subject's position and movement in the field (speed, distances travelled, trajectories) and the detection of his relationship with his teammates, opponents and the ball [4]. All these data are obtained thanks to a complex system of cameras placed around the stadium, interfaced with software. The aim of the study is to investigate the trend of passes accuracy (%) during the match, trying to evaluate the influence of fatigue.

The pass can be defined as the act of directing the ball towards one's teammate, to place him in an advantage situation respect to his opponent. It is the technical gesture of kick applied to game development; it can therefore be considered the element that connects individual potential to collective play [5]. The pass also requires less energy consumption than dribbling and guiding the ball, and is dictated by the movement without the ball of the possible receiver. The transition can be direct or indirect; Direct, if carried out on the figure of the teammate and Indirect when is carried out in the free space, on the running direction of the teammate. In relation to the perimeter lines of the field there are various types of passes [6].

- Long Pass (LP); these are passes on the air, doesn't matter the distance, can be 20-25 meters, can be 60-70 meters, long passes have to have a specific target or idea;
- Key Pass (KP); It's really important pass or cross, which creates clear situation and opportunity to score, but the player misses it. It's important to underline that the player, who made the pass, created clear goal situation.
- Through Pass (TP); Direct pass in the empty spaces behind the defensive line, 2 or more defender, leading the attacking player alone against the goalkeeper. With this pass you will show the ideas and creativity of the player, his vision to create opportunities for his teammates. It can be added to Smart Pass (if the pass is on the ground or it's over the heads of the opposite players, but it's on short distance – 5-10 meters) and Long-Range Kick (when it's high, long pass in the air, behind the defensive line);
- Final Third Pass (3/4 P); A pass to an area within 35 meters of the opponent's baseline;
- Progressive Pass (PP); A pass that moves the ball considerably forward. The minimum requirement for a progressive pass towards the opponent's goal area is 30 meters, if the starting and finishing points are in the middle of the pitch; 15 meters, if the starting and finishing points are in the opposing half of the pitch;
- Smart Pass (SP); It is for significative pass or smart pass in general. Something with special characteristics, more than a simple pass, not so easy to be done. There has to be some ideas in the pass, something creative, when the player is breaking the defensive line and obtaining some advantage for his teammates with this pass, leading them in good position to attack. The pass should be between 2-3 opposite players.

The passes can also be divided into short within 15-20 meters, using the inside foot kick or the outside neck, in case the player makes a pass during a fast run or long over 20 meters, using mainly the inside of the foot and in some cases, where maximum distances are desired, even the full neck kick. During the action of the pass, the characteristics of the possible receiver must be considered and possibly enhanced. Figure 1 shows, the average numbers of passes and their percentage of accuracy (%Acc) for match, from the season 2018/2019 divided from different levels of the Italian League data taken from Wyscout database (Chiavari, Italy). It is possible to observe how the number of passes and %Acc decrease linearly to the lowering of the category.



Figure 1; Match Average Passes and %Acc distributing in different Italian Pro Leagues

League	LP		KP		TP		3/4 P		PP		SP	
	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc
SERIE A	44.7	57.6	2.5	----	7.1	28.5	54.4	70.9	74.6	76.1	6.2	39.2
SERIE B	49.0	55.5	2.1	----	6.9	26.5	55.4	67.4	74.5	75.5	5.4	36.8
Lega Pro	57.9	52.2	1.9	----	7.1	24.5	59.1	61.8	40.6	54.3	5.2	35.6
Avg.	50.6	55.1	2.1	----	7.0	26.5	56.3	66.7	63.2	68.6	5.6	37.2

Table 1; Passes Types distribution and %Acc in different Italian Leagues

Table 1; shows the average distribution of types of passes during matches and the %Acc from the season 2018/2019 divided from different leagues of the Italian Championships. Long Pass show a different distribution between leagues, the higher league Serie A have the lower number and the Lega Pro shows the higher, this can be connected with the quality of players and the typology of match play. No particular differences are showed in the others types of passes, in general the higher league the Serie A shows the best

value in %Acc in all the category. Figure 2 shows, the average numbers of passes and the %Acc for a match, from the season 2018/2019 divided by European leagues (Wyscout). The data are from the major European Leagues: SerieA (Italy), Premier League (England), La Liga (Spain), Ligue 1 (France), Bundesliga (Germany), Eredivisie (Netherlands) and Primeira Liga (Portugal). It is possible to observe, that the Serie A is the league with the higher number of passes and the better %Acc, instead the Primeira Liga shows the lower number of passes and %Acc.

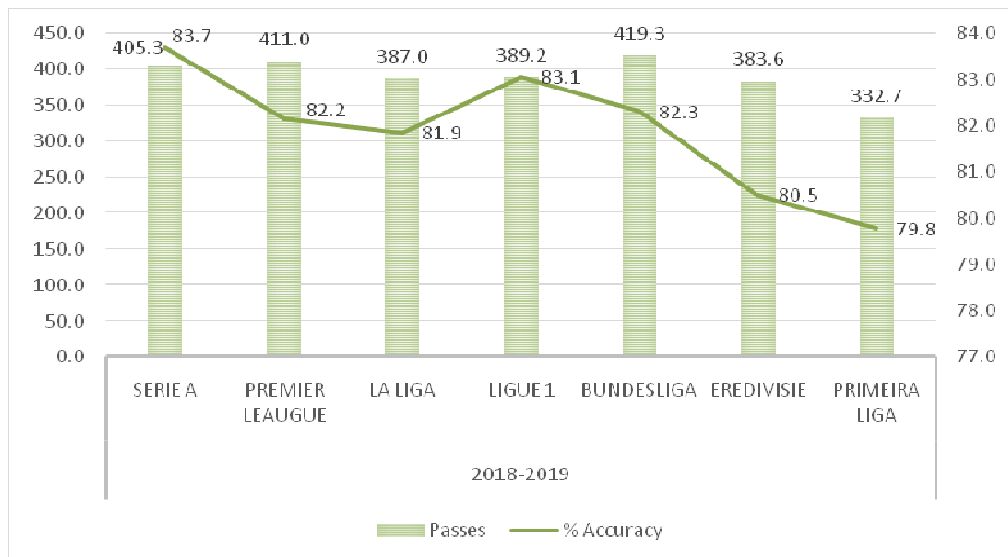


Figure 2; Match Average Passes and %Acc distributing in different European Leagues

Table 2 shows the averaged distributions of different types of passing and the %Acc during matches from the major European leagues

League	LP		KP		TP		3/4 P		PP		SP	
	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc	Avg.	% Acc
SERIE A	42.6	55.5	2.6	----	6.6	27.8	52.5	67.6	73.3	74.9	5.4	37.1
PREMIER LEAGUE	44.0	55.8	2.2	----	7.5	31.4	55.6	70.1	75.3	74.9	6.6	40.8
LA LIGA	45.1	57.8	2.4	----	7.4	30.3	53.0	69.9	6.6	39.2	72.2	75.6
LIGUE 1	40.9	57.1	2.1	----	6.7	29.1	51.5	69.5	6.1	38.2	69.6	76.6
BUNDESLIGA	47.2	58.5	2.5	----	7.4	32.3	54.8	69.2	6.7	42.3	78.7	76.0
EREDIVISIE	49.0	54.9	2.5	----	7.0	33.7	55.0	67.6	6.3	42.7	77.7	75.4
PRIMEIRA LIGA	42.0	54.0	1.9	----	6.7	28.7	48.2	68.9	5.4	38.6	66.1	74.0
Avg.	44.4	56.2	2.3	----	7.0	30.5	52.9	68.9	25.7	50.1	53.8	65.1

Table 2; Passes Types distribution and %Acc in different European Leagues

The technical gesture of the pass is first taken into consideration globally and then each typology is analysed. The execution of the pass, in all its modalities, is a substantial technical and tactical ability during a football match and is set in crisis by several factors that may be intrinsic (for example physical and / or cognitive fatigue, appearance emotional) and extrinsic (for example the weather, the ability in turn of the companions and opponents). Computerized analysis of the performance movement identified the player's activity profiles and the physical needs of the competition^[7,8].

The movement analyses also provide information on the extent of the fatigue experienced by the players at the highest level of competition, in fact it is widely recognized that there is a drop in physical efforts in the middle of the game and in particular towards the end of the games^[9,10]. In a comparison between 0-15 and 75-90 quarters : -21.2% Total Distance, -6.7% Walking, -25.7% Jogging, -25.6% Running, -20.8% High Speed Running and -27.6% in Sprinting^[11,12]. The distance travelled at high speeds in professional players decreases substantially in the third final of the game^[13]. Similarly, players also experience temporary fatigue during the game, as research has shown that the amount of high intensity running performed by FA Premier League players has decreased by 50% after the most intense 5 minutes of the activity period^[14].

This is due to the high aerobic demands during a game but also to the anaerobic ones in certain intense periods. Exercise leads to important metabolic changes and contributes to the development of fatigue towards the end of matches^[15]. There is also the possibility for players to experience residual fatigue after intense competitive program during the season. Research has shown that physical performance in professional footballers has been adversely affected in an intense period of three official matches in 5 days^[16]. In fact, elite players need 96-120

hours to reach optimal pre-game values to face new sprints and to normalize the blood markers of muscle damage (creatinase kinase) and inflammation (uric acid)^[17]. The research also investigated the relationship between changes in physical performance and those related to football skills, as many game skills are performed in a fatigued state^[18]. In young footballers, a decline in passing accuracy was observed immediately after completing a 90-minute game and after an isolated period of 5 minutes of high-intensity exercise that simulated the most demanding phase of a game^[19].

Similar results have been reported in semi-professional adult soccer players^[20]. The speed and accuracy with which players completed their specific skills in football were significantly affected after a 45-minute intermittent shuttle period that replicated half of a football game. Finally, the performance of football skills measured by the time taken to complete a test, including the penalty time accumulated for inaccurate passing or poor control, decreased during the last 15 minutes of exercise within an uninterrupted 90-minute test^[21]. Decrease in excitement affect the neuromuscular and cognitive functions, depletion of glycogen and dehydration are possible candidates for the insurance of the reduction of the performance ability^[22].

Means and Method

In this study the gesture of the passes with its multiple variations during a football match was analysed, specifically highlighting the changes in its accuracy during two complete season 2017/2018 and 2018/2019 from one team belonging to the Lega Pro, third level of the Italian Football for a total of 74 matches (30 Win, 23 Draw and 21 Lose). Data were collected from the match reports provided by WyScoutdatabase (Chiavari, Italy) every single match report was involved in an excel spreadsheets database, in order to proceed to the analysis. The parameters that have been examined are: Total Number of Passes (TotP), Long Pass (LP), Key Pass (KP), Through Pass (TP), Pass made in the ¾ of the opponent field (3/4 P), Progressive Pass (PP), Smart Pass (SP), Number of ball possession (NP), Number of ball possession in opponent filed (NP-OF), Number of ball possession in opponent penalty area (NP-OPA), Ball Possession Percentage (%BP), Total Pass %Acc (%TotP) and Long Pass Percentage Distribution in total passes (%LPD). For all type of pass was taken into consideration the total number and %Acc. In addition, was possible to extrapolated the distribution of %BP, %TotP and %LPD during quarters, in order to evaluate the effect of fatigue in passing distribution. P value (p) and Cohen's effect size (d) were calculated for results of %BP, %TotP and %LPD between first half (T1) and second half (T2) and 0-15 and 75-90. Cohen's effect size (d) was interpreted as small (>0.2 – 0.6), moderate (>0.6 – 1.2), large (>1.2 – 2.0), very large (>2.0 – 4.0)^[23]

Data Analysis

Distribution of all type of passes detected are showed in Table 3, divided by match results. In Win matches, were showed only two higher values respectively for %TP and %SP. In Draw matches, LP, %LP, %KP and %PP were higher. In the end in Lose matches higher value were recorded in TP, %TP, KP, TP, 3/4 P, % 3/4 P and PP. Same number of SP were detected between Lose and Win matches.

Result	LP	%LP	KP	%KP	TP	%TP	3/4 P	% 3/4 P	PP	%PP	SP	%SP
Lose	49 ± 14.7	53 ± 8.8	3 ± 2.5	---	8 ± 4.1	21 ± 19.2	60 ± 12.9	66 ± 12.0	83 ± 14.0	71 ± 8.6	6 ± 3.6	34 ± 23.0
Draw	54 ± 15.0	54 ± 8.7	2 ± 1.5	---	7 ± 3.4	13 ± 13.6	52 ± 13.7	63 ± 9.5	75 ± 13.7	72 ± 9.7	5 ± 2.9	38 ± 26.7
Victory	51 ± 11.9	54 ± 8.5	2 ± 1.2	---	6 ± 4.3	29 ± 28.2	48 ± 11.9	65 ± 11.1	73 ± 15.7	70 ± 9.7	6 ± 5.3	40 ± 27.2
Avg.	51 ± 12.9	54 ± 8.6	2 ± 1.8	---	7 ± 4.0	22 ± 22.0	52 ± 13.4	65 ± 10.3	76 ± 15.0	71 ± 8.8	6 ± 3.5	38 ± 23.8

Table 3; Passes types distribution and %Acc in the team analysed divided by results.

Table 4 shows that in Lose matches were recorded the higher value in TotP, %BP, NP, NP-OF and NP-OFA. No higher values were detected in Draw and Win matches. %TotP shows similar value between results.

Result	TotP	%TotP	%BP	NP	NP-OF	NP-OFA
Lose	460 ± 78.1	81 ± 5.5	56 ± 7.0	105 ± 18.7	67 ± 13.8	12 ± 9.1
Draw	408 ± 84.4	80 ± 6.3	52 ± 8.7	100 ± 22.1	57 ± 11.2	8 ± 3.0
Victory	390 ± 67.3	81 ± 4.7	48 ± 6.6	102 ± 12.9	59 ± 11.8	10 ± 4.4
Avg.	414 ± 80.4	81 ± 5.2	51 ± 7.9	103 ± 17.3	59 ± 13	10 ± 5.9

Table 4; Total Passes, Ball possession and number of actions divided by results.

Table 5 shows distribution of %BP, %TotP and %LBD between quarters and half, same data are showed in the histogram in fig. 1 for easier data reading.

Session	%TotP	%BP	%LBD	Type	Session	%Dec	P-value	Cohen's d
0-15	81.2 ± 5.9	53.1 ± 10.6	11.6 ± 4.9	%TotP	T1-T2	-4%	0.001	-0.38
15-30	80.6 ± 6.7	52.2 ± 11.6	12.2 ± 5.7		0-15-75-90	-6%	0.014	-0.57
30-45	81.3 ± 6.8	52.2 ± 10.8	12.0 ± 6.6	%BP	T1-T2	-3%	0.006	-0.12
45-60	79.0 ± 7.8	50.5 ± 11.8	13.1 ± 6.6		0-15-75-90	-2%	0.074	-0.08
60-75	78.4 ± 8.6	49.0 ± 13.3	13.7 ± 7.8	%LBD	T1-T2	14%	0.001	0.25
75-90	76.4 ± 9.4	52.0 ± 13.2	14.3 ± 7.1		0-15-75-90	19%	0.0006	0.40
T1	81.2 ± 6.5	52.4 ± 10.9	11.8 ± 5.8					
T2	77.8 ± 8.7	50.6 ± 12.8	13.7 ± 7.2					

Table 5;Distribution of parameters during quarters, P-value and Cohen's effect size

Distribution of %TotP decrease of -4% (0.001 p, -0.38 d) between T1 and T2; and of -6% (0.014 p, -0.57 d) between 0-15/75-90 quarts, both decreases were significant relevant for $p < 0.05$ and show a small effect size. Distribution of %BP decrease of -3% (0.006 p, -0.12 d) between T1 and T2; and of -2% (0.074 p, -0.08 d) between 0-15/75-90 quarts, T1-T2 decreasing was significant relevant for $p < 0.05$ and show a very small effect size, 0-15/75-90 decreasing was not significant relevant for $p < 0.05$ and show a very small effect size. In the end %LBD increase of 14% between T1 and T2 (0.001 p, 0.25 d) and 19% (0.0006 p, 0.40 d) between 0-15/75-90 quarts, T1-T2 and 0-15/75-90 increasing was significant relevant for $p < 0.05$ and show a small effect size.

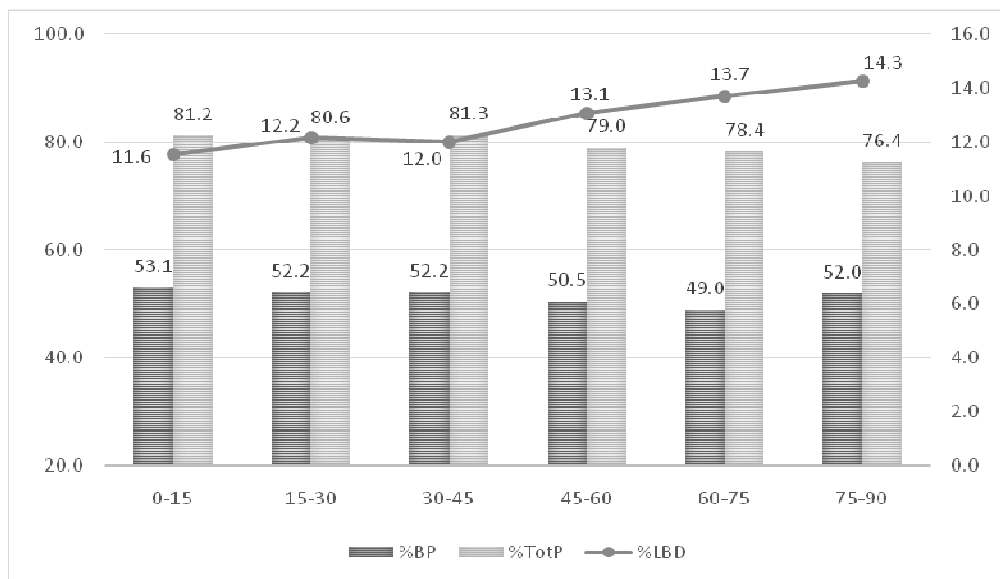


Fig. 1; Distribution of parameters during quarters

Discussion

The aim of this study was to determine how the fatigue can influence the passes distribution during a football match, two seasons of one team belonging to the Italian Lega Pro (Italian Third League Championship) 2017-2018 and 2018-2019 were taken into consideration. A total of 74 matches (30 Win, 23 Draw and 21 Lose) were analysed, using the technical-tactical match report from Wyscout database. The main purpose of this study is to demonstrate how skills vary, specifically the technical gesture of the pass, in an open skill context in which it is conditioned by various factors including specifically physical and cognitive fatigue. Comparing the results between the analysed team and the average from other European Leagues result that:

- PP and %PP were higher in the team analysed then in European mean;
- %TP, SP and %SP, where lower in the team analysed then in European mean;
- Other data were in average with European mean.

No particular correlation was found between distribution of types of passes and match result. Lose matches recorded the higher value in TotP, %BP, NP, NP-OF and NP-OFA. No higher values were detected in Draw and Win matches. %TotP shows similar value between results. Discussing about the distribution of passes during time and connection with fatigue was possible to detect that:

%TotP decrease of -4% (0.001 p, -0.38 d) between T1 and T2; and of -6% (0.014 p, -0.57 d) between 0-15/75-90 quarts;
 %BP decrease of -3% (0.006 p, -0.12 d) between T1 and T2; and of -2% (0.074 p, -0.08 d) between 0-15/75-90 quarts;
 %LBD increase of 14% between T1 and T2 (0.001 p, 0.25 d) and 19% (0.0006 p, 0.40 d) between 0-15/75-90 quarts.

The contemporary decreasing of %TotP and increasing of %LBD, follows the initial thesis, in which the technical gesture is obviously influenced by the onset of fatigue. Athletes accuracy tends to decrease during the match and the following growth of %LBD, shows a change in the tactical and technical approach of the match. The %BP seems to be less effect from fatigue, it shown a significant decreasing (0.006 p) between T1 and T2, while in the other hand the decreasing was not sufficient between 0-15/75-90 (0.074 p).

Conclusion

The aim of this work, it was to assess the changing in the technique of passing, and the correlation with fatigue during the match. Analyse two entire seasons and 74 matches allows the study to have a more accurate result. No particular correlation was found between distribution of different types of pass and their %Acc and result of matches. Significant decreasing during match time were found for %TotP and for the increasing of %LPD, in the other hand %BP don't seem to be strongly influenced by the upcoming of fatigue. The increase in physical and cognitive fatigue leads to a decrease in the precision of specific technical gestures as in the pass, that suffer a reduction in accuracy especially in the last quarter. The work carried out, can provide methodology and useful information to the coaching staff, in order to better read and reach to the data analysis process. Their goal, will therefore be, to perform a specific athletic works during training, in order to prevent as maximum is possible the decreasing of performance during a football match. Having previously analysed that physical and cognitive fatigue does not only negatively affect high intensity running but also the tactical technical abilities reducing the performance of a team during a match. New studies by increasing the number of matches, teams involved and by analysing different leagues and category could provide an adequate performance model linked to the decline of technical performance during the course of a match, in order to provide staff with useful data to be able to present adequate training plans.

Declaration of interest statement

For this study there is no conflict interest. The study protocol and data collection were conformed to the Ethic code of the World Medical Association (Declaration of Helsinki). All subjects were informed on the benefits and risks of the investigation.

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 Writing, review and editing: Izzo R., Hosseini Varde'i C.

All authors have read and agreed to the final version of the manuscript.

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