

# Performance Model Analysis of Armenian Premier League Soccer Players Using Global Positioning System Technology and Comparison between European Championship

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**Abstract:** The aim of this research was to analyze the PPM of Armenian Premier League using 25 GPS 10 Hz (K-Sport, Montelabbate, Italy), in order to compare data from literature from major European championship. In total 25 matches were analyzed from one team militant in Armenian Premier League (10 wins, 10 loses and 5 draws), 33 different players (age  $24.3 \pm 4.2$ , height  $1.76 \pm 4.2$  and weight  $74 \pm 3.5$ ) and in total 270 performances (10.8 for matches). Matches were divided in First Half (T1), Second Half (T2), Second Half Substitution (T2 Sub), Full Match, Full Match Substitution (Full Match Sub) and Total Match (Total) that include all the players detected during a games. Furthermore, all matches were divided even by quarters 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90, only players that played all match were included in this analyses, in order to check the performance decreasing during the time. All data were added in an Excel Spreadsheet in order to build a database, to organize and better analyze data, cataloging events for data, results, and role of players. Average data from Armenian Premier League in comparison with literature data from European and Italian Championship show that in every parameter, the Armenian Premier League is under the average. This is obviously related to the non-high level of the Armenian football that is in fact placed at the 106<sup>o</sup> place of the FIFA ranking (update 7 June 2019). Physical data represent an indicator of performance but also of the qualitative level of the league and of individual players. For this reason, the use of the match analysis can be decisive to verify the PPM, in order to better evaluate the championships, teams, and players, in order to build an easier search and discovery of talents.

**Key words:** Match analysis, performance model, GPS, comparison, European championship.

## 1. Introduction

The sports performance of footballers during games and training has been the subject of research for years. Reilly and Thomas [1] described a football competition counting the number of steps taken for each movement performed by the players (walking, running and shooting) and took one of the pioneering studies. From that starting point, the match analysis has undergone significant changes, through the notational analysis (notational analysis, which can be manual or

computerized), motion analysis (which analyzes the activity and movements of athletes) and video analysis (it is practically realized with the installation of automated systems inside the stadiums) [2]. Thanks to this new technology during years some studies were executed that took into consideration the distances traveled and the movements of the players in the field [3, 4]. All these researches were performed in order to define the Player Performance Model (PPM) of footballers. In 2010 Osgnach et al. [5] proposed a new method to analyze the PPM during matches and training, this was a turning point for the evolution of performance analysis. The new method analysis was

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based on the evaluation of training load using the metabolic power (MP), mediating changes in speed activities and acceleration of the individual athlete. Subsequently numerous studies were performed through GPS technology and semi-automatic video tracking system, trying to evaluate the PPM [6-8]. The Global Position System (GPS) is a system that processes position signals, sent from satellites in orbit, providing position and time to a GPS receiver. The GPS provides a kinematic analysis to measure the movement of the players (volume and intensity) and then quantify the level of physical effort. The accuracy of the detection depends on weather conditions, satellite position, and type of receivers and radio propagation effects of the radio signal [9]. GPS can have different frequencies: 5, 10, 25 and 50 Hz. It has been shown that the latest 10 Hz GPS is quite reliable in calculating accelerations, decelerations, and distance covered during the various stages of games in team sports, while those at 5 Hz are less reliable [10]. In general, GPS is reliable in assessing the external load of training, even if they tend to overestimate the distances during curvilinear changes of direction and underestimate them during the shuttle tests, so their accuracy decreases in high-intensity actions and changes of direction [11]. The video analysis is carried out with the installation of cameras devices that allow filming matches or trainings, data are analyzed thanks to specific tracking software. Video tracking systems are an important tool for identifying players' physical efforts during professional official matches played in stadium with big stands (where GPS could be inefficient) and even to let players free from use GPS jacket, thing that could damage the physical and psychological confidence during games. Video tracking systems with multiple cameras tend to overestimate the distance covered at high intensity (> 18 km/h) compared to GPS [12]; video analysis also slightly overestimates the distances covered at various speeds, overestimates the peak of maximum speed and the average speed, but calculates better the total

distances [13], even if we must consider that often the cameras cannot be installed in optimal locations. GPS is more accurate in measuring accelerations, but tends to underestimate the distances covered (error: 1-3%), is more accurate in calculating linear actions than changes in direction, underestimates the average speed of about 6% and sprints also tend to decrease in precision with increasing distance [14]. Both systems are reliable in measuring the total distance, the peak of maximum speed and the distances greater than 30 meters [15], while they tend to drop precision with short distances, short sprints and changes of direction (the last parameter is more penalized in GPS) [16]. The analysis of the PPM using GPS or video-tracking of a specific championship could provide crucial information to define the level of players and allow the comparisons with other leagues and nations.

## **2. Means and Methods**

The aim of this research was to analyze the PPM of Armenian Premier League using 25 GPS 10 Hz (K-Sport, Montelabbate, Italy), in order to compare data obtained with literature from major European championship. In total 25 matches were analyzed (10 wins, 10 loses and 5 draws), 33 different players (age  $24.3 \pm 4.2$ , height  $1.76 \pm 4.2$  and weight  $74 \pm 3.5$ ) and in total 270 performances (10.8 for matches). We analyzed 37 central defenders (CD), 45 full-backs (FB), 66 central midfielders, 44 external midfielders, 28 forwards and 50 substitutions (average for matches 2,0). The substituted players played in 36 cases less than 45 minutes and in 14 cases the entire second half. Matches were divided in First Half (T1), Second Half (T2), Full Match, Full Match Substitution (Full Match Sub) and Total Match (Total) that include all the players detected during a games. Furthermore, all matches were divided even by quarters 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90, only players that played all matches were included in this analyses, in order to check the performance decreasing during the time. All data were added in an Excel Spreadsheet in

order to build a database, to organize and better analyze data, catalog events for data, results if the match was played home or away. The following parameters were taken into consideration:

- Total distance (meters, D);
- Distance per minutes (meters/minutes, Drel);
- Distance covered at high-intensity (speed  $\geq$  than 16 km/h, HI);
- Distance covered at high-metabolic intensity (MP  $\geq$  20 watt  $\text{kg}^{-1}$ , MPHI);
- Distance at medium acceleration  $> 2 \text{ m/s}^2$  (meters, Acc);
- Distance at medium deceleration  $< -2 \text{ m/s}^2$  (meters, Dec);
- Sum of medium acceleration and deceleration (meters, Acc-Dec)
- Average metabolic power (W/kg, AMP).

To easier define PPM it is possible to divide the total distance covered in each event with the total minutes played in order to find the Relative (Rel) parameter, in this way obtaining an easier number to remember and compare and also have a better idea of the performance performed on average per minute.

### 2.1 Data Analysis

Table 1 shows data from T1 and T2, showing even the decrement percentage (%Dec) from T2 compared with T1. The lower decrement was recorded in D parameter, 2.86%, HI and MPHI showing the same %Dec (7.24% and 7.29%), a greater decrease can be noted in Dec then Acc and the higher %Dec is shown by MP.

Table 2 shows data from:

- Full Match: players that played all 90' minutes and extra time;
- Full Match Sub: players that were replaced (in and out);
- Total: data from all players that took part of the match.

Tables 3 and 4 show data divided by quarters and the percentage of decrease or increase during quarters. Quarters that show higher values of %Dec are the 0-15/15-30 and 45-60/60-75, this means that during the first and second quarters of T1 and T2 it is possible to detect the higher decrease. Between last quarter of T1 (30-45) and the first quarter of T2 (45-60) it is possible to detect and increase all parameters.

**Table 1 Average data from all detected matches for T1 and T2.**

Type	D	HI	MPHI	Acc	Dec	Acc-Dec	MP
T1	4,717	694	1,214	252	233	485	9.5
T2	4,582	644	1,125	238	218	456	8.8
% Dec	2.86%	7.24%	7.29%	5.51%	6.53%	6.00%	7.66%

**Table 2 Average data from all detected matches.**

Type	D	HI	MPHI	Acc	Dec	Acc-Dec	MP
Full Match	9,254	1,304	2,304	488	447	935	9.1
Full Match Sub	5,364	877	1,447	286	273	559	9.8
Total	7,607	1,120	1,938	402	372	774	9.4

**Table 3 Average data from quarters.**

Type	D	HI	MPHI	Acc	Dec	Acc-Dec	MP
0-15	1,647	256	450	93	85	178	10.3
15-30	1,529	223	387	79	74	153	9.4
30-45	1,456	203	355	75	69	145	9.0
45-60	1,512	233	393	81	75	156	9.3
60-75	1,402	194	338	73	67	140	8.6
75-90	1,389	178	324	70	63	133	8.5

Table 5 shows data from all players divided by roles:

- CD, showing the lowest values in HI, MPHI, Dec and Acc-Dec, and an average value in Acc;
- FB, showing average values in D, HI, MPHI, and MP and the highest values in Acc and Acc-Dec;
- CM, showing the lowest value in Acc, average values in Dec and Acc-Dec and the highest values in D and MP;
- EM, showing the highest values in HI, MPHI, and Dec;
- FO, showing the lowest values in D and MP.

Table 6 contains data from Armenian Full Match including SD, and Max and Min values detected. Tables 7 and 8 show data respectively from the European Championship [17], and from Italian

Championship [18].

Table 9 shows a comparison between different championships using data from our study and from literature, in this case, Italian Championship shows higher value in all parameters except for Acc and Dec that are higher in Euro Championship. Armenian League shows the lowest values in all parameters in comparison with these leagues. One last comparison is shown in Table 10 and is between the average data from Euro and Armenian Premier League, the higher percentage differences are in HI and lower ones are recorded in D.

One last interesting comparison was made (Table 11) correlating the results of games with fitness data, in order to find a correlation between parameters and

**Table 4 Percentage of decrease or increase between quarters.**

Type	D	HI	MPHI	Acc	Dec	Acc-Dec	MP
0-15/15-30	-8%	-15%	-16%	-18%	-15%	-16%	-10%
15-30/30-45	-5%	-10%	-9%	-5%	-7%	-6%	-4%
30-45/45-60	4%	13%	10%	7%	8%	7%	3%
45-60/60-75	-8%	-20%	-16%	-11%	-12%	-11%	-8%
60-75/75-90	-1%	-9%	-4%	-4%	-6%	-5%	-1%

**Table 5 Average data from Full Match divided by role.**

Role	D	HI	MPHI	Acc	Dec	Acc-Dec	MP
CD	8,575	863	1,881	483	405	888	8.4
FB	9,174	1,362	2,285	518	467	985	9.1
CM	9,894	1,409	2,565	466	448	913	9.6
EM	9,611	1,638	2,576	493	475	968	9.5
FO	8,174	1,191	1,948	471	418	889	8.1

**Table 6 Average data, SD, min and max from Armenian Premier League.**

Armenian Premier League							
Type	D	HI	MPHI	Acc	Dec	MP	
Average	9,254	1,304	2,304	488	447	9.1	
SD	376	134	172	41	39	0.4	
Min	8,502	1,088	1,955	414	377	8.4	
Max	9,896	1,567	2,600	545	512	10.0	

**Table 7 Average data, SD, Min and Max from European Championships.**

European Championships							
Type	D	HI	MPHI	Acc	Dec	MP	
Average	10,672	1,778	2,759	636	612	10.6	
SD	347	208	241	118	97	0.4	
Min	9,417	1,156	2,028	397	437	9.1	
Max	11,595	2,310	3,344	911	890	12.0	

**Table 8 Average data, SD, Min and Max from Italian Championship.**

Italian Championship						
Type	D	HI	MPHI	Acc	Dec	MP
Average	10,950	1,996	2,839	591	599	10.7
SD	1,044	220	601	128	130	0.8

**Table 9 Comparison between Championships.**

Total Comparison						
Type	D	HI	MPHI	Acc	Dec	MP
Euro	10,672	1,778	2,759	636	612	10.6
Italian	10,950	1,996	2,839	591	599	10.7
Armenian	9,254	1,304	2,304	488	447	9.1

**Table 10 Comparison and percentage comparison.**

Type	D	HI	MPHI	Acc	Dec	MP
Euro Average	10,811	1,887	2,799	614	606	10.7
Armenian	9,254	1,304	2,304	488	447	9.1
% Dec	14.40%	30.88%	17.68%	20.38%	26.21%	14.48%

**Table 11 Comparison of data between results from Armenian Premier League.**

Result	D	HI	MPHI	Acc	Dec	MP
Win	9,281	1,283	2,308	500	452	9.2
Lose	9,333	1,365	2,354	477	441	9.1
Draw	9,204	1,280	2,250	496	455	9.1

sports results. No crucial differences were found between results, it is interesting how during lost matches it is possible to detect higher values in D, HI, and MPHI, parameters of movement, but when talking about high-intensity actions the values are the lowest (Acc, Dec and MP).

### 3. Discussion

The aim of this research was to analyze the PPM of Armenian Premier League using GPS 10 Hz (K-Sport, Montelabbate, Italy), and to compare data obtained with literature from major European championship. Matches were divided in First Half (T1), Second Half (T2), Full Match, Full Match Substitution (Full Match Sub) and Total Match (Total) that include all the players detected during a games. Comparing T2 with T1 it is possible to observe the usual decrease that is described in the literature, the lower decrease value is in D with a 2.86%, HI and MPHI showed same value (7.24% and 7.29%) and the higher decrease is shown in MP 7.66%. The decreasing of Acc (5.51%) is lower of

Dec (6.53%), this can be correlated with the deceleration movements that are correlated with an eccentric contraction that is more difficult to execute when muscle soreness rises up. It evaluated even the decreasing during quarters, of course, the higher values were recorded during the first quarter (0-15), the higher %Dec were recorded in the second and fifth quarter (15-30, 60-75). Between the third and fourth quarter (30-45, 45-60) it detected an increase of every parameter, this is correlated with the break preset between the T1 and T2. Furthermore, the lower %Dec is recorded between the fifth and sixth quarter (60-75, 75-90). The higher values of %Dec during quarters are recorded in HI parameter (-8%) and the lower is equal to D (-4%) and MP (-4%), other parameters show an average %Dec of MPHI (-7%), Acc (-6%), Dec (-6%) and Acc-Dec (-6%).

Comparing PPM with roles it is possible to discover that:

- CD, showing the lowest values in HI, MPHI, Dec and Acc-Dec, and an average value in Acc;

- FB, showing average values in D, HI, MPHI, and MP and the highest values in Acc and Acc-Dec;
- CM, showing the lowest value in Acc, average values in Dec and Acc-Dec and the highest values in D and MP;
- EM, showing the highest values in HI, MPHI, and Dec;
- FO, showing the lowest values in D and MP.

In Armenian Premier League FO runs less in D and Acc-Dec then CD and this goes against literature [16], but they coincide with literature in HI, MPHI, and MP that are higher in CM and EM. Average data from Armenian Premier League in comparison with literature data from European and Italian Championship show that in every parameter, the Armenian Premier League is under the average. This is obviously related to the non-high level of the Armenian football that is in fact placed at the 100<sup>o</sup> place of the FIFA ranking (update 20 September 2018). Physical data represent an indicator of performance but also of the qualitative level of the league and of individual players. For this reason, the use of the match analysis can be decisive to verify the PPM, in order to better evaluate the championships, teams, and players, in order to make the search and the discovery of the sporting talent easier. The use of objective values simplifies and makes a scientific analysis of the performance and consequently also the evaluation of the players. The higher differences between Armenian and European Leagues are in HI, MPHI, Acc and Dec parameters, respectively with a %Dec of 30.88%, 17.68%, 20.38%, and 26.21%. As the literature shows, the high-intensity events are the performance indicators of efficiency and of sport results, more correlated with the possibility of obtaining an advantage in the sport of football. Comparing GPS data with the result of matches it shows that in Armenian Premier League, there were no significant differences between physical data and type of result (wins, loses and draws).

#### **4. Conclusion**

The aim of this study was to analyze the physical

performance of soccer players and to relate and compare the external load through the use of detection hardware, analyzing the physical performance during the competitions of the Armenian Premier League, then comparing the data with the major European championships. Analyzing the PPM of the Armenian Premier League allows defining another aspect of match and training analysis, that is the performance of external effort and the comparison of players and leagues. Comparing T2 with T1 it is possible to observe the usual decrease that is described in the literature, the lower decrease value is in D with a 2.86%, HI and MPHI showed same value (7.24% and 7.29%) and the higher decrease is shown in MP 7.66%. The decreasing of Acc (5.51%) is lower than Dec (6.53%), this can be correlated with the deceleration movements correlated with an eccentric contraction that is more difficult to execute when muscle soreness rises up. It evaluated even the decreasing during quarters, of course, the higher values were recorded during the first quarter (0-15), the higher %Dec was recorded in the second and fifth quarter (15-30, 60-75). Between the third and fourth quarter (30-45, 45-60) it detected an increase of every parameter, this is correlated with the break preset between the T1 and T2. Talking about roles, FO runs less in D and Acc-Dec then CD and this goes against literature [19], but they coincide with literature in HI, MPHI, and MP that are higher in CM and EM. Average data from Armenian Premier League in comparison with literature data from European and Italian Championship show that in every parameter, the Armenian Premier League is under the average. Physical data represent an indicator of performance but also of the qualitative level of the league and of individual players. For this reason, the use of the match analysis can be decisive to verify the PPM, in order to discover talents. Using objective values simplifies the scientific analysis of the performance and consequently also the evaluation of the players. The higher differences between Armenian and European Leagues are in HI, MPHI, Acc and Dec

parameters, respectively with a %Dec of 30.88%, 17.68%, 20.38%, and 26.21%. As the literature shows the high-intensity events are the performance indicators of efficiency and of sport results, more correlated with the possibility of obtaining an advantage during matches, the PPM analysis during training and matches turns to be crucial to determinate the performance of teams and individual players, in order to create specific training divided by roles and characteristics. Using PPM could be easier to define talent and to divide players into levels. Of course, using GPS or performance video analysis is possible to detect only physical data that have to be correlated with technical and tactical, to better define the real abilities of footballers.

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