The Football Movement Profile of Youth National Team Players

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Headline

The Football Movement Profile (FMP) is a new sport specific movement algorithm developed by Catapult Sports (Catapult Sports, Melbourne, Australia), to provide deeper insight into the true demands of football training and match play. The algorithm groups movement characteristics by type and intensity into 6 categories which can be both represented in absolute (total duration) and relative (percentage duration) terms. This could help coaches and practitioners to better understand the load characteristics of players in training and match-play scenarios.

Aim. Recently, it has been common practice in football to monitor locomotor activity based on distance and velocity parameters during training and match, also highlighting positional differences (1,2). However, the use of GPS based parameters has its limitations, such as playing in closed stadiums, only one to mention (3). The use of inertial sensors in training and match load monitoring has gained recent popularity in reporting work profiles (4). In recent years total sprint distance covered during soccer match has been increasing in contrast with the distance per sprint, placing a larger emphasis on the repetitive acceleration and deceleration ability of football players (5,6). Similarly, high match-to-match variance in high intensity running distance and sprinting distance has been reported (7). The increasing significance of acceleration (ACC) and deceleration (DEC) activity in the physical performance of soccer players has resulted in practitioners increasingly referring to it in load monitoring and management strategy (8,9). However, one of the key limitations of GPS technology is its ability to accurately monitor ACC and DEC profiles. A viable alternative to using GPS to monitor ACC/DEC in soccer is to use inertial sensors, which have been shown to display good reliability and validity (10).

The FMP algorithm, recently developed by Catapult Sports, assigns all movements into one of six movement categories, defined by a combination of intensity (very low, low, medium, high) and movement type (running-linear locomotive, dynamic – change of direction or speed). The following categories are specified by the Catapult FMP profile:

- **Very Low Duration** % (Standing like movements)
- **Low Duration** % (Walking like movements)
- **Running Medium Duration** % (Steady state linear and curved jogging and running movements at medium intensity)
- **Running High Duration** % (Steady state linear and curved running movements at high intensity)
- **Dynamic Medium Duration** % (Medium-intensity multi-directional movements, linear acceleration and deceleration movements)
- **Dynamic High Duration** % (High-intensity multi-directional movements, linear acceleration and deceleration movements)

Resultant categories are illustrated in figure 1. Intensity thresholds are based on Player Load^{TM} values, a parameter derived from accelerometer data, and which has been previously shown to be a valid and reliable metric (11).

Differentiation between running and dynamic movements is based on variance in data in the medio-lateral and posterio-anterior planes. The FMP monitoring has potential advantages, such as its simplicity, recorded by inertial sensors, differentiating between linear and multidirectional movement, as well as between low, medium and high intensities.

In our study, we present the FMP profile for elite youth national team football players and highlight the differences between different playing positions.

Methods

Athletes. 27 elite youth national team outfield football players (age: 16.8±0.3 years, weight: 70.9±6.2 kg, height: 179.7±5.5 cm) participated in the study. Players were categorized by position as central defender (CD, $n = 5$), full back (FB, $n = 6$), central midfielder (CM, $n = 6$), wide midfielder (WM, $n = 5$) and striker (ST, $n = 5$). Data were collected and analysed in line with the national team daily practices which all conformed to the Declaration of Helsinki. The study was approved by the ethical board of the University of Physical Education (Budapest, Hungary, TE-KEB/No9/2020), the players and their parents provided their informed consent to participate in the study.

Design. In this study a retrospective longitudinal observational design was employed. FMP data was recorded in 34 international matches, including both official ($n = 14$) and friendly ($n = 20$) fixtures between February 2018 and November 2019. Only data from players who played more than 80 minutes in the game has been included in the study. A total of 418 player observations were included in the final data set.

Methodology. The physical activity profiles of players were monitored using a portable 10 Hz GPS unit with a 100 Hz accelerometer (Catapult Sports, Melbourne, Australia; S5 Optimeye between February 2018 - June 2019, S7 Vector between June 2019 – November 2019). Identical model of inertial sensors is used in both systems, thus ensuring the accuracy of the measurement (9). Data was processed by dedicated software (Catapult OpenField Version 3.1.0), and exported to Excel Sheets (Microsoft Office, Version 2103) for further analysis.

Statistical Analysis. Descriptive data (mean±standard deviation (SD)) for all observations, as well as data variance (reported as coefficient of variation (CV%)) is presented in Table 1. Statistical analyses were conducted using SPSS for Win-

Table 1. Proportion of playing time spent in FMP Profiles for all outfield positions

Positions	Observations	Very Low Duration %	Low Duration %	Running Medium Duration %	Running High Duration %	Dynamic Medium Duration %	Dynamic High Duration %
Central Defender	n=60	20.15 ± 1.05	36.89 ± 1.93	15.38 ± 1.32	1.97 ± 0.61	18.04 ± 1.21	7.56 ± 0.72
Full Back	n=93	14.87 ± 1.98	37.66 ± 4.84	17.06 ± 3.81	3.02 ± 2.51	16.44 ± 3.07	10.96 ± 2.09
Central midfielder	n=133	14.64 ± 3.44	32.08 ± 0.88	19.52 ± 1.45	4.14 ± 1.11	17.93 ± 1.51	11.68 ± 2.19
Wide midfielder	n=69	14.14 ± 2.41	36.80 ± 3.63	18.14 ± 2.69	3.43 ± 0.70	16.17 ± 1.08	11.33 ± 0.97
Striker	n=63	14.23 ± 2.26	35.61 ± 4.01	18.09 ± 2.38	3.25 ± 0.86	16.97 ± 2.45	11.84 ± 1.76
MEAN ± SD		**15.61 ± 2.56**	**35.81 ± 2.21**	**17.64 ± 1.54**	**3.16 ± 0.79**	**17.11 ± 0.85**	**10.67 ± 1.77**
CV		**16.39 %**	**6.17 %**	**8.72 %**	**24.92 %**	**4.97 %**	**16.60 %**

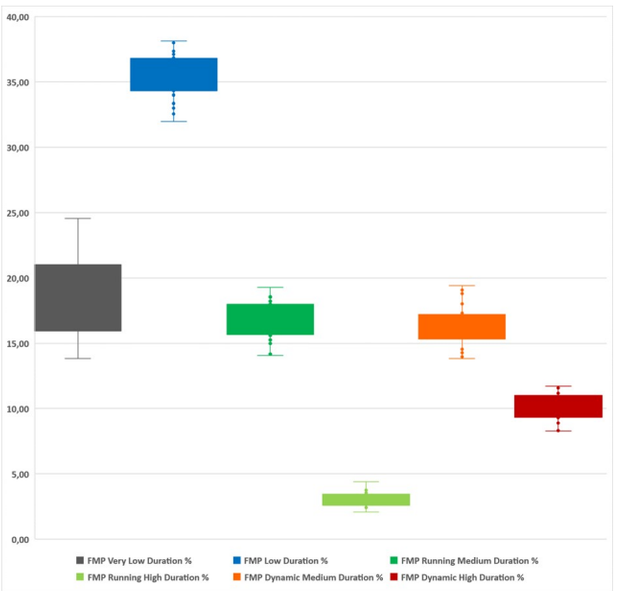

Fig. 1. Distribution of the Football Movement Profile Categories for all observations

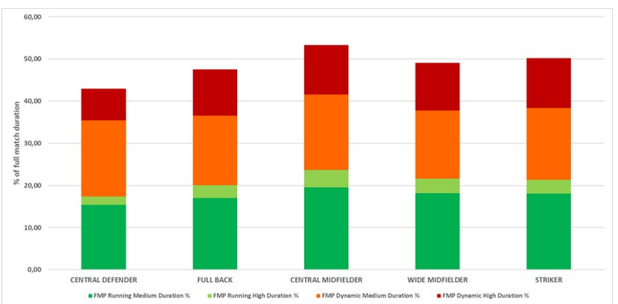

Fig. 2. Distribution of the medium and high intensity Football Movement Profile Categories in different playing positions

dows 16.0 (SPSS, Inc., Chicago, USA). Magnitude of differences between positions for FMP were calculated using effect size (ES). Cohen's d values were used to represent the power of the results. Cohen's d values were classified as trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0) and very large (2.0-4.0) (12).

Results

Players typically spent a large proportion of the time performing very low (15.6±2.6%) and low intensity (35.8±2.2%) work. 20.8% of the time (17.6 ± 1.5% medium intensity; 3.2 ± 0.8% high intensity) was spent performing running activities, with 27.8% of time (17.1±0.9% medium intensity; 10.7±1.8% high intensity) spent performing dynamic activity (Figure 1.)

Results of the statistical analysis revealed very large and large differences when central defenders were compared to the other positions regarding all FMP categories. Large differences were detected between CM and FB, WM and ST positions in the very low intensity category, as well as in the dynamic medium running between CM and WM positions. All other comparisons regarding the FMP categories between playing positions resulted in trivial, small or moderate differences presented as effect sizes. Table 2 presents the effect size differences between each position.

Discussion

The Football Movement Profile (FMP) provides a viable alternative for traditional metrics to monitor activity patterns during football match play and training. The differentiation of medium- and high-intensity work into 'running' and 'dynamic' activity provides additional insight, particularly into the multidirectional / mechanical component of the game, which is difficult to measure.

The FMP profile for central defenders is markedly different when compared to other outfield positions. Proportion of high intensity running and dynamic activity are lower than for all other positions, indicating lower linear and multidirectional intensity. Previous studies found similar results, showing that CD players performed significantly less high intensity and sprint running distance during matches than other positions (13). Assuming that high-speed running distance is inappropriate to fully describe the central players' physical load, other metrics have been created and used to solve this problem, such as metabolic power, high metabolic load distance, accelerations and decelerations (14). However, the total match load of central players is still not fully understood, FMP profiling might help to objectively quantify the locomotive and mechanical work distribution and the inter-player load comparison. It is interesting to note the relatively similar profiles for full-backs, wide midfield players and strikers, with only trivial and small differences observed in all categories. The similarities between full back and wide-midfield players have already been described in previous studies, with both positions being largely linear in nature, and tactically demanding similar movement characteristics (1). However, the dynamic profile based on traditional GPS metrics showed correspondingly minor differences between the aforementioned two positions and strikers (15).

The CM players display consistently higher proportions of high intensity work (both running and dynamic) than full backs, wide midfield players and strikers. The higher proportion of dynamic work is possibly due to the previously described fact, that CM players cover the central area of the field during play, therefore complete a significant number of accelerations, decelerations and changes of directions whenever the match situations dictate so. (15) According to previous studies, CM players cover less distance in high intensity and sprint velocities than FB, WM and ST (1). The higher FMP proportion of high intensity work completed by CM players might be a unique charateristic of our dataset or could be due to the CM players possessing innately higher levels of fitness than their peers, or to the tactical strategy employed by the coach. Based on our results we suggest using FMP profiling in addi-

Table 2. Differences between all outfield playing positions regarding all FMP categories presented as effect sizes. The colours of the Cohen's d values also represent the magnitude of difference for the better transparency of the results (trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0) and very large (2.0-4.0)). The positive/negative sign of the values simply shows the direction of the difference between positions, and it can change if the direction of the comparison is altered (e.g. CD – FB or FB – CD comparison). As an example, when central defenders and full backs are compared regarding the dynamic high parameter, the effect size (-2.17) shows, that full backs perform significantly larger proportion of their activity in that zone, opposed to the central defender players.

POSITIONS	COMPARED POSITIONS	VERY LOW INTENSITY	LOW INTENSITY	RUNNING		DYNAMIC	
				Medium	High	Medium	High
Central Defenders	Full Backs	3.33	-0.21	-0.59	-0.58	0.69	-2.17
	Central Midfielders	2.17	3.21	-2.99	-2.42	0.08	-2.53
	Wide Midfielders	3.23	0.03	-1.30	-2.22	1.63	-4.41
	Strikers	3.36	0.41	-1.41	-1.72	0.56	-3.18
Full Backs	Central Midfielders	0.08	1.60	-0.86	-0.58	-0.61	-0.34
	Wide Midfielders	0.33	0.20	-0.33	-0.22	0.12	-0.23
	Strikers	0.30	0.46	-0.33	-0.13	-0.19	-0.46
Central Midfielders	Wide Midfielders	0.17	-1.79	0.64	0.77	1.34	0.21
	Strikers	0.14	-1.22	0.73	0.89	0.47	-0.08
Wide Midfielders	Strikers	-0.04	0.31	0.02	0.22	-0.42	-0.36

tion to previous methods and not by replacing the traditional approach based on well-studied and described metrics.

Higher levels of variance in data for very low intensity, high intensity running and dynamic work are observed. This can predominantly be attributed to the magnitude of difference between central defenders and other positions.

In conclusion, the Football Movement Profile analysis is a highly valuable tool in load monitoring of soccer training and matches. Moreover, the practical use of the FMP distribution is simple, due to the low number of metrics (categories), it is easily understandable for coaches and can be used for inter-player and inter position differentiation of training load. High intensity categories show the greatest variability, therefore they should be used for evaluation of physical performance. Hopefully, the results of this study can be used as a reference for further application of FMP analysis.

Practical applications

- FMP is a useful and easily applicable tool in order to objectively monitor the players' intensity distribution in football specific activities.
- Our results provide football and position specific references for practitioners, so they can better evaluate their results.
- FMP can provide intensity targets for certain types of football drills and is utterly useful to create individual references for players based on their match values, which can be applied for planning of the pre-match preparation period.
- FMP could help in creating easier communication of information to coaches and players.

Limitations

- The FMP profile-based load monitoring appears a highly valuable asset, although it only represents the distribution of the intensity and duration of football specific activity. It is therefore suggested to apply it as a supplementary method beside traditional metrics.
- Even though, the FMP was developed for Catapult Vector S7 units, data from both S5 and S7 units were used in the sampling period in order to have a larger data set, as the FMP algorythm and analysis is the same.
- Data of only a certain age group (U-17 players) has been used, therefore our results can not be generalised to other age groups.

Conflict of Interest

A co-author of this study is an independent consultant for Catapult Sports. The other authors declare no conflict of interest and received no funding for executing the study.

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