Playing Surface Technical Analysis 3

A comparative analysis of Russian Premier League matches played on football turf and natural grass surfaces during 2011

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Contents

1.0 Introduction

In 2004, the use of football turf pitches in competition was approved by both FIFA and UEFA. Since then, many competitive games at all levels have taken place on FIFA RECOMMENDED 2 STAR football turf. A number of studies – including medical, biomechanical, and psychological – have since been conducted to provide a comprehensive assessment of performance on the relative playing surfaces.

Over the last five years, Prozone Sports Ltd have provided FIFA with in-depth technical performance analysis from over 100 competitive football matches across a number of independent studies using the MATCHVIEWER® analysis system. These studies found that no significant differences exist between team and player performance on football turf and natural grass.

Prior to this study, however, information relating to the physical performance of players of varying playing surfaces had not been reported. Subsequently, the Prozone tracking solution (PROZONE3®) was installed at two stadiums in Moscow – the Luzhniki Stadium (football turf surface) and the Khimki Arena (natural grass surface) – and the physical performance of players could be analysed throughout the 2011 Russian Premier League season. This provided a unique opportunity to assess whether the playing surface has an effect on physical performance, whilst also adding to the previous studies on technical performance.

1.1 Aim

The aim of this study was to analyse and compare team and player performance on football turf and natural grass to assess if the playing surface has an impact on physical and technical output. It was hoped that further objective analysis could provide important information to key stakeholders in the game looking to make decisions around the introduction of football turf pitches to enhance participation levels and grow revenue streams.

1.2 Keywords

Football turf, natural grass, artificial turf, FIFA, playing surface, Prozone, physical data, performance analysis, tracking technology, objective feedback.

2.0 Methods

2.1 Sample

Data was collated from 30 Russian Premier League games from the 2011 season. Fifteen of these games were played at Spartak Moscow's home stadium, the Luzhniki Stadium, which uses a FIFA RECOMMENDED 2 STAR football turf playing surface, while the other 15 games were played at Dinamo Moscow's home stadium, the Khimki Arena, which has a top-quality natural grass surface. With both stadiums located in Moscow, limitations relating to climatic differences and weather conditions were reduced, thus providing a good basis for direct comparison.

Only the away team data from each match was included in the study in an attempt to eliminate any perceived home team bias or learned effect. In addition, only players who competed for >90 minutes were included for the individual and positional average data. In total, therefore, 30 team performances and 215 player performances (109 on football turf and 106 on natural grass) were available for analysis.

The study allowed us to compare the same away teams on each playing surface; an additional "constant" helping to further enhance the consistency and fairness of the study.

2.2 Data collection

Matches were captured and analysed at both the Luzhniki Stadium and Khimki Arena using the patented tracking and coding system PROZONE3®, which has been independently validated for reliability of output by Di Salvo et al. (2007). PROZONE3® is a computerised video system that allows the tracking of every player during a game. The capture system incorporates eight digital IP cameras strategically positioned throughout the stadium to capture player movements and actions every tenth of a second. Comprehensive positional and physical information is therefore the main outcome of the tracking system. In addition, the system enables a range of tactical and technical information to be extracted through plotting every on-the-ball action that occurs in a game. Around 2000-2500 Prozone "events" were analysed per game using the PROZONE3® system, providing a comprehensive range of technical match data for comparison.

All data was then imported into Prozone's TREND® database application, which allowed for the multi-game comparative analysis of the dataset. Other matches played in Russia were also added to the overall dataset to produce a Russian League average for benchmarking purposes.

2.3 Data analysis

Mean averages were collated for the physical and technical parameters and compared across two surfaces. Standard deviations and standard error figures for the same variables were also recorded for analysis. The standard deviation figures allow us to assess how much variation from the mean exists within the data, while the standard error indicates the potential variance in the mean and

therefore how much the mean might vary from sample to sample or study to study or indeed league to league. Within the Prozone TREND® database application, match data could also be broken down into team, player and positional datasets, and further broken down into different time segments for deeper analysis: half-by-half, 15-minute periods, and five-minute periods. The mean average data was therefore also compared across these different time segments. Match-by-match information was also analysed in chronological order to assess potential climate change effects during the season from March through to November, and the effect that this may have on the playing surface and consequently the performance data. For this, per-match data was plotted onto a line graph to allow for clear identification of trends and patterns in the performance data.

Within the dataset, there were pairs of observations for each Russian team; i.e. their away performance against Spartak Moscow on football turf and then away at Dinamo Moscow on natural grass. The "paired-tests" method was used to assess whether the mean differences between the two surfaces were large enough to be statistically significant. If a statistical significance was shown, this would mean that one could confidently dismiss the idea that the observed differences occurred by chance and accept that the differences represented real or true differences that exist in the larger population of teams in all leagues.

Using the statistical analysis package, SPSS, paired t-tests were performed on the dataset. Paired t-tests assume that the differences can be understood to come from a normal probability distribution. This assumption was assessed by "eyeballing" histograms of the differences (FT –NG) and using a Shapiro-Wilks test of normality. The paired t-tests therefore only performed on those variables that satisfied the assumption of normal distribution (the Shapiro-Wilks "Sig" value was more than 0.05). As these statistical tests required pairs of data, the data for the two games in which Spartak Moscow and Dinamo Moscow played against each other were discounted at this stage of analysis as only one half of the "pair" was available for these teams owing to the other half being their home performance.

In addition to the significance tests, using the statistical package SPSS, correlation coefficients were produced to measure the strength of the linear relationship between the two sets of data from the two surfaces for each variable.

Results have been presented in a combination of data tables, line and bar graphs and dot plots to allow for a full examination of the trends and findings.

3.0 Results

Table 1: Physical (fitness) data table comparing the average per game player and team outputs on natural grass and football turf.

	Natural grass		Football turf	
	Player	Team	Team	Player
Physical overview				
Total distance	11.124	112.06	113.93	11.128
HI distance	1.169	12.13	11.81	1.082
Number HI activities	171	1756	1738	161
Sprint distance	0.342	3.56	3.35	0.307
Number of sprints	55.9	575	542	49.5
HSR distance	0.827	8.57	8.46	0.775
Number HS runs	179	1841	1830	168
HI distance with poss	0.441	4.92	4.90	0.410
HI distance without poss	0.648	6.39	6.03	0.593
HI distance ball out of play	0.080	8.2	8.15	0.075
Avg. sprint distance (m)	5.80	5.98	5.87	5.90
	Natural grass		Football turf	
	Player	Team	Team	Player
Speed changes				
No. high accelerations	24.2	243	232	21.9
No. medium accelerations	149.6	1517	1488	143.5
No. low accelerations	795.6	7981	8267	811.2
No. high decelerations	13.9	141	135	12.8
No. medium decelerations	123.3	1259	1249	119.4
No. low decelerations	793.2	7949	8238	807.2

Table 2: Technical data table comparing the average per game player and team outputs on natural grass turf and football turf.

	Natural grass		Football turf	
	Player	Team	Team	Player
Tactical overview				
Total headers	5.36	52.73	55.2	5.83
Tackles	3.20	31.4	39.2	3.90
Fouls	1.35	14.67	13.53	1.07
Blocks	1.74	17.73	15.67	1.67
Interceptions	10.66	98.67	100.73	11.09
Clearances	2.28	21.07	22.6	2.59
Possession won	15.59	158.3	164.07	16.66
Possession lost	18.98	205.6	215.2	19.83
Average number touches	2.06	NA	NA	2.01
Dribbles	0.60	7.47	4.13	0.34

	Natural grass		Football turf	
	Player	Team	Team	Player
Passing overview				
Total passes	31.99	315.7	273	27.45
Successful passes	26.00	256.9	214.5	21.27
Unsuccessful passes	5.99	58.8	58.5	5.73
Total pass completion %	79.90%	80.70%	77.50%	76.20%
Balls received	33.17	343.9	304.9	29.11
Passes forwards	15.05	144	129.1	13.64
Passes backwards	5.92	63.2	55.4	4.99
Passes sideways	11.03	108.5	88.5	8.82
Pass attempted own half	17.76	167.5	156.7	17.15
Passes attempted in opp half	14.23	148.2	116.3	10.30
Total no. short passes	7.80	81.4	72.7	6.55
Total no. medium passes	18.26	177.7	142.5	14.68
Total no. long passes	5.92	56.7	57.8	6.22

	Natural grass		Football turf	
	Player	Team	Team	Player
Attacking overview				
Goals	0.05	0.73	0.87	0.10
Goals inside the area	0.04	0.67	0.60	0.07
Goals outside the area	0.01	0.07	0.27	0.04
Total number of shots	0.94	11.73	12.00	1.13
Headers at goal	0.15	2.07	1.00	0.08
Shooting accuracy	49.50%	47.70%	53.90%	54.20%
Final third entries	5.08	53.67	52.07	4.97
Penalty area entries	2.85	28.00	26.07	2.57
Total corners	0.42	4.67	4.33	0.50
Crosses	0.83	8.60	11.00	0.93
Offsides	0.20	2.73	2.67	0.19

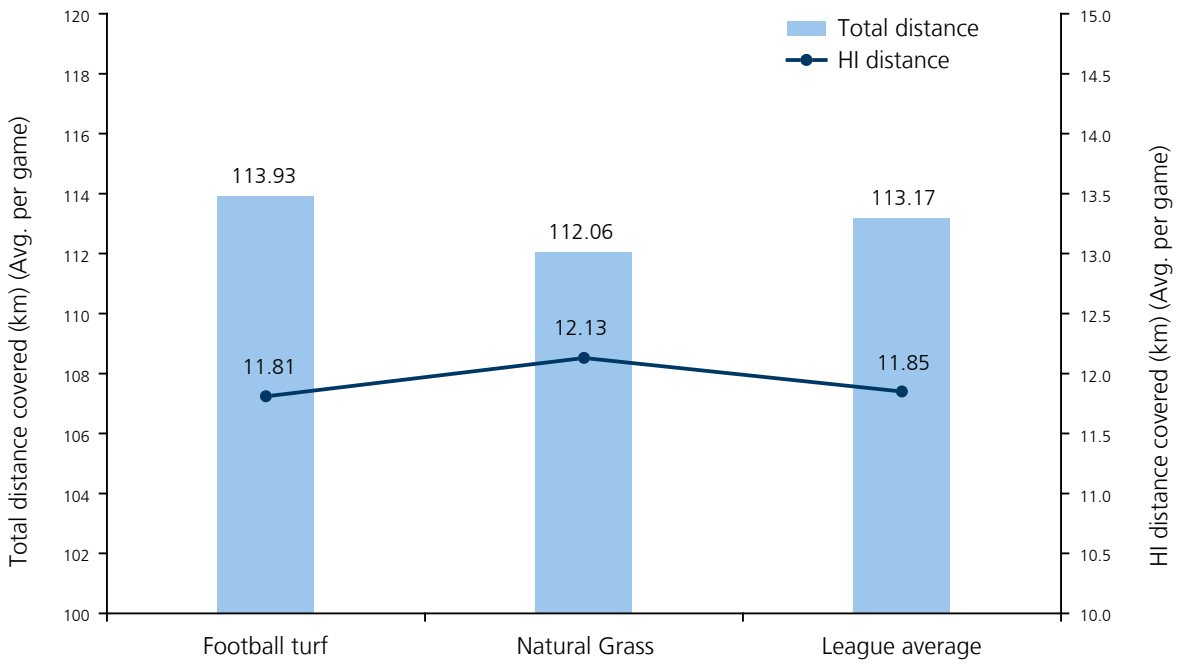

Fig. 1: Total distance and high intensity distance comparison; football turf, natural grass and Russian league average.

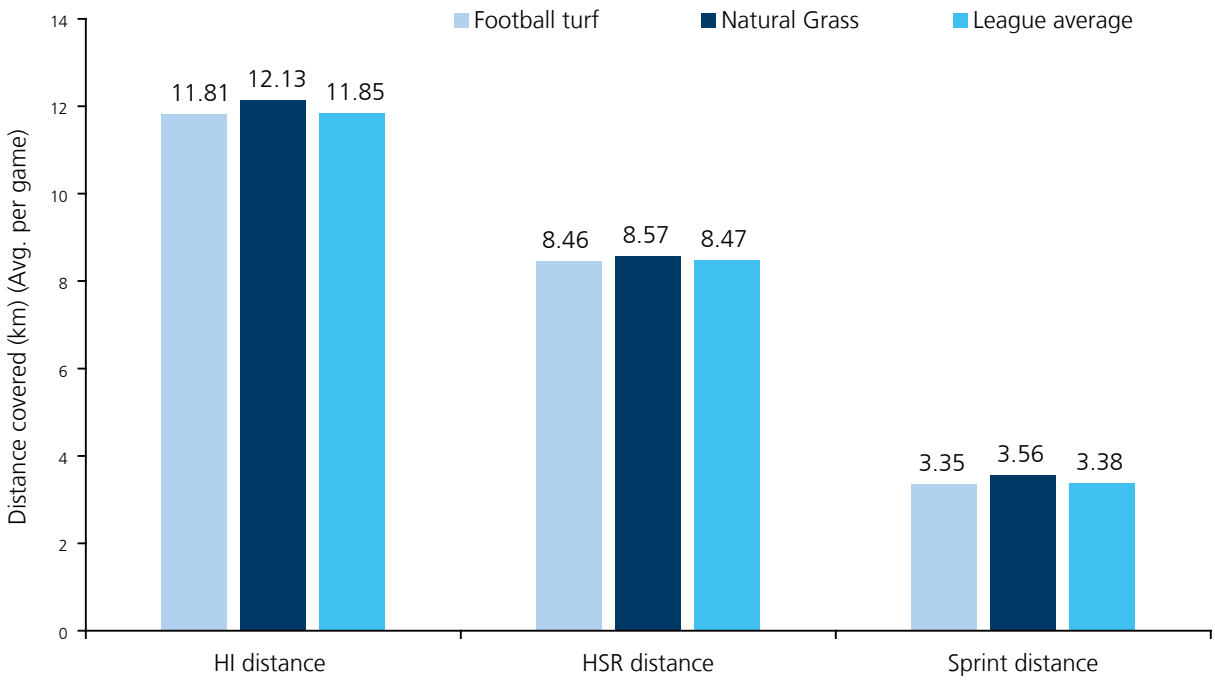

Fig. 2: High-intensity activity broken down into high-speed runs (HSR) and sprints. A comparison between average figures on football turf, natural grass and Russian league.

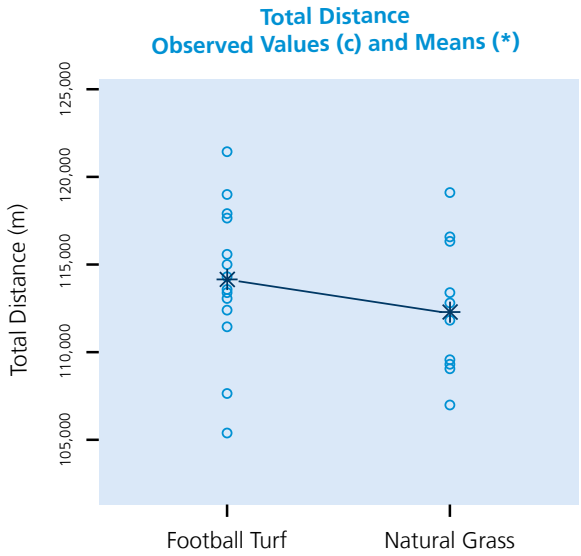

Fig. 3: Dot plot showing the variance in results for total distance from games played on football turf and natural grass.

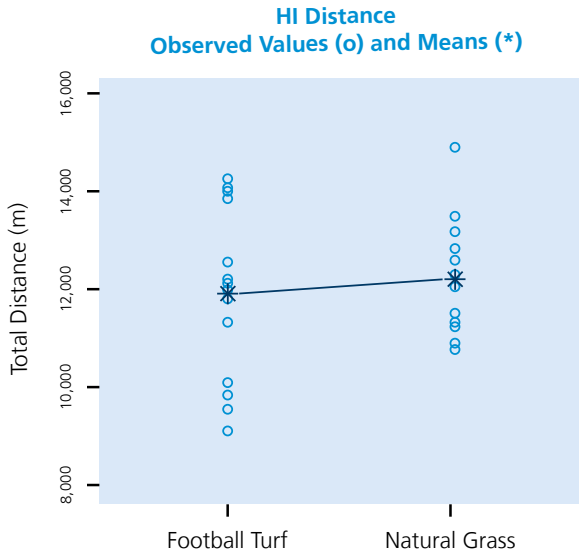

Fig. 4: Dot plot showing the variance in results for high intensity distance from games played on football turf and natural grass.

Dot plots allow you to assess the variance in the data as they plot data for each individual game. Figure 3 shows that the mean average for total distance is higher on football turf than natural grass; however the range of figures shown on football turf is greater than on natural grass. The lowest figure in a single game was also recorded on football turf. Figure 3 shows that although high-intensity distance figures are generally higher on natural grass, the range of figures from games played on football turf is again greater than on natural grass. With less variance in the data, this finding could suggest a greater level of consistency in physical performance on the more traditional surface, possibly owing to greater familiarity. See Appendix 1 for more dot plots on other variables, both technical and physical.

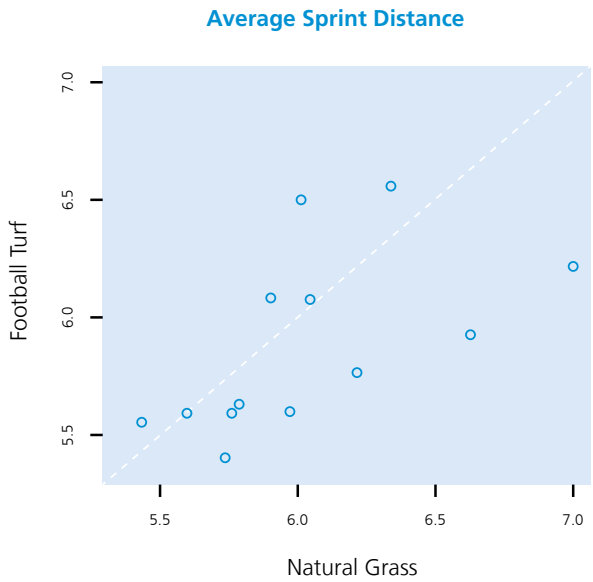

Fig. 5: Plot showing the correlation between figures for average sprint distance recorded on the two surfaces

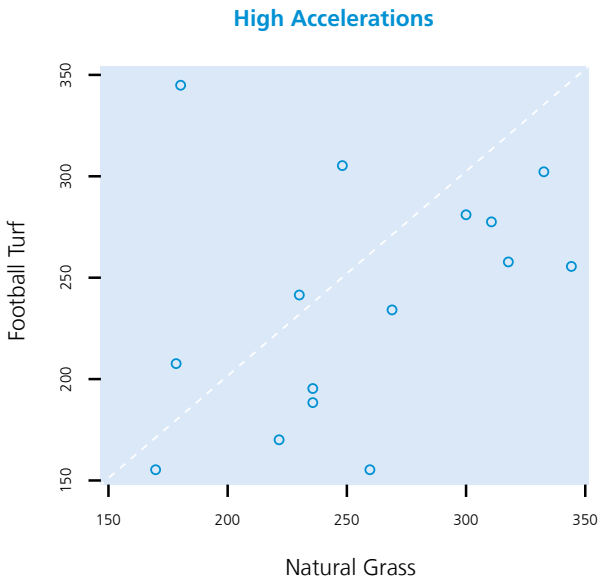

Fig. 6: Plot showing the correlation between figures for number of high accelerations recorded on the two surfaces

Figures 5 and 6 show the potential correlation between the two surfaces across the different performance variables captured. The closer the dots are to the 45-degree line, the stronger the relationship is between the two surfaces. A perfect positive correlation (significance of 1.0) would mean than all dots sit on the line, meaning that there were identical data on both surfaces. We can see a strong relationship that was close to significance (correlation coefficient of 0.06) for average sprint distance. This suggests that teams performed relatively similarly on both surfaces for this variable. See Appendix 2 for a full breakdown of correlation coefficients for the tested variables.

Table 3: Paired samples t-test results for the physical (fitness) variables. There were no significant differences.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Total Distance_FT – Total Distance_NG	1817.571	5977.397	1597.527	-1633.675	5268.818	1.138	13	.276
Pair 2	HS Run Distance_FT – HS Run Distance_NG	-117.000	1200.011	320.716	-809.866	575.866	-.365	13	.721
Pair 3	Num HS Runs_FT – Num HS Runs_NG	-12.714	260.176	69.535	-162.935	137.507	-.183	13	.858
Pair 4	Sprint Distance_FT – Sprint Distance_NG	-184.071	657.771	175.797	-563.857	195.714	-1.047	13	.314
Pair 5	Num Sprints_FT – Num Sprints_NG	-31.214	112.643	30.105	-96.252	33.824	-1.037	13	.319
Pair 6	HI Distance_FT – HI Distance_NG	-301.143	1806.054	482.688	-1343.927	741.642	-.624	13	.543
Pair 7	HI Number_FT – HI Number_NG	-17.214	270.493	72.292	-173.392	138.964	-.238	13	.815
Pair 8	Recovery Time_FT - Recovery Time_NG	.000	5.738	1.534	-3.313	3.313	.000	13	1.000
Pair 9	Avg Sprint Dist_FT – Avg Sprint Dist_NG	-.098786	.405860	.108471	-.333122	.135551	-.911	13	.379
Pair 10	HighAccelerations_FT - HighAccelerations_NG	-.06117	.27228	.07277	-.21838	.09604	-.841	13	.416
Pair 11	High Decelerations_FT - High Decelerations_NG	-8.071	42.059	11.241	-32.356	16.213	-.718	13	.485
Pair 12	Medium Accelerations_FT - Medium Accelerations_NG	-31.786	223.082	59.621	-160.589	97.018	-.533	13	.603
Pair 13	Medium Decelerations_FT - Medium Decelerations_NG	-13.571	194.006	51.850	-125.587	98.444	-.262	13	.798
Pair 14	Low Accelerations_FT – Low Accelerations_NG	258.571	704.957	188.408	-148.459	665.601	1.372	13	.193
Pair 15	Low Decelerations_FT – Low Decelerations_NG	262.143	754.342	201.606	-173.401	697.687	1.300	13	.216

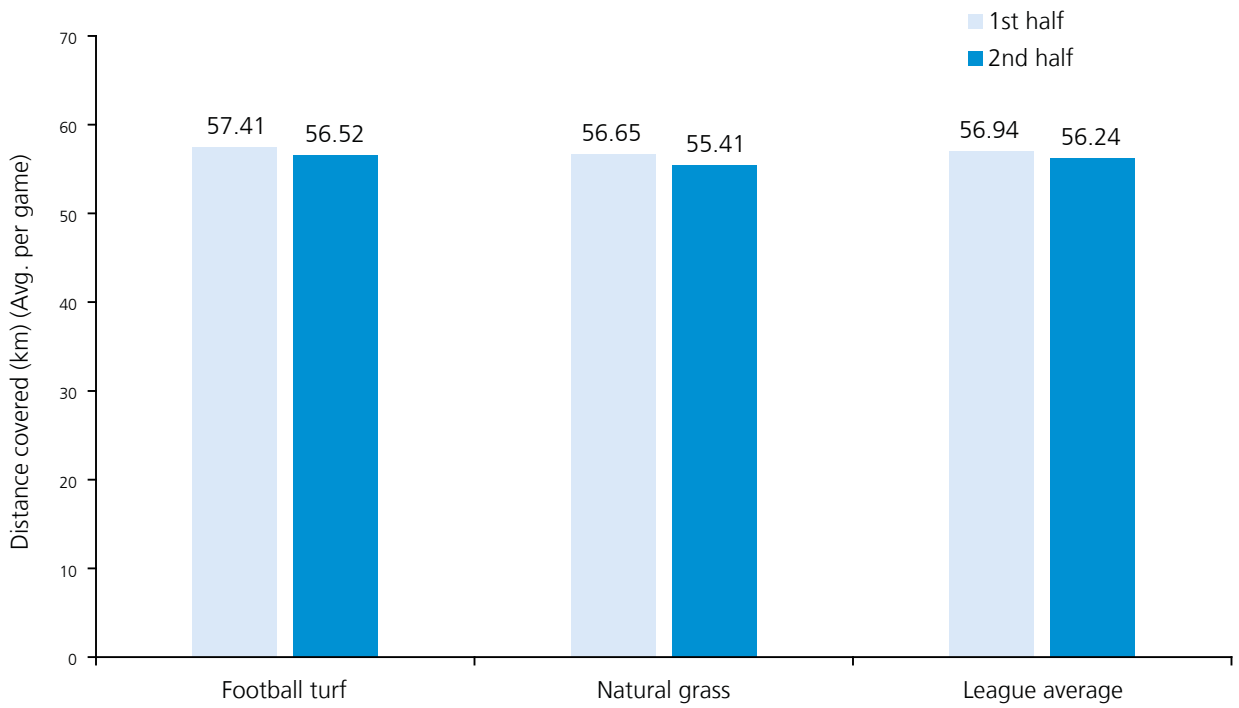

Fig. 7: Half-by-half breakdown showing the average total distances covered by teams on the two surfaces and across the league as a whole.

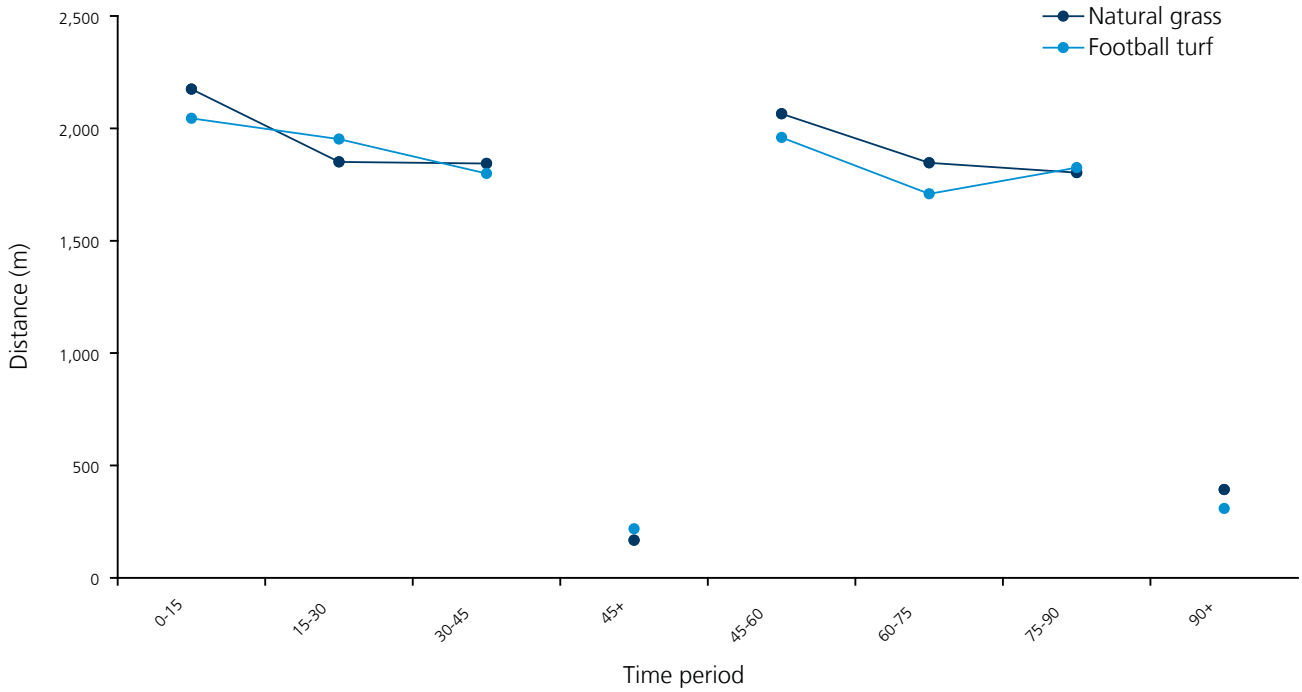

Fig. 8: 15-minute breakdown; average high intensity distances covered on the two surfaces and across the league as a whole.

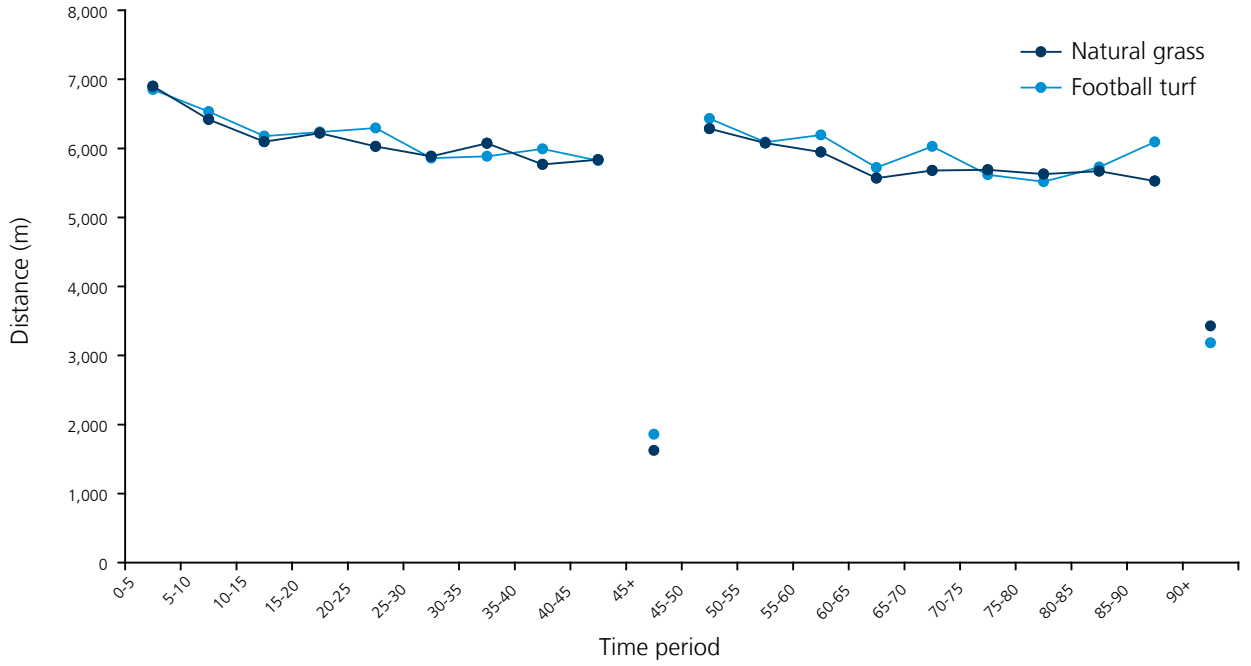

Fig. 9: 5-minute breakdown; average total distances covered on the two surfaces and across the league as a whole.

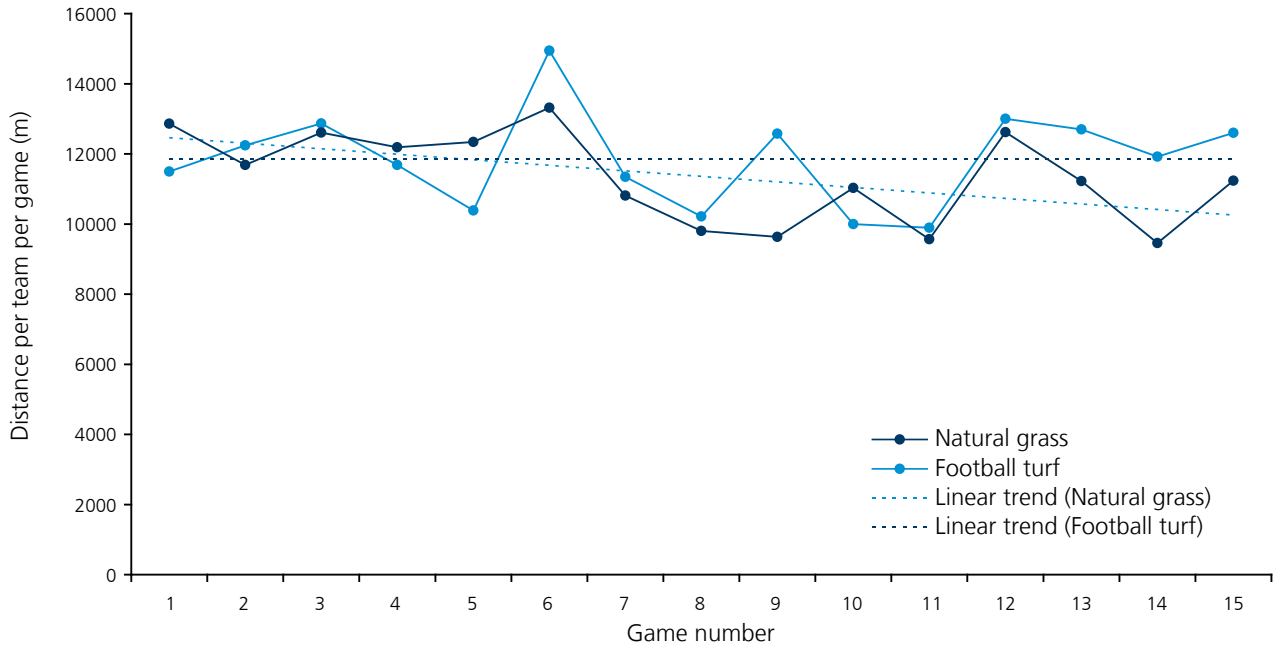

Fig. 10: Chronological game by game figures for high intensity (HI) distance covered by the home team on the two different surfaces.

4.0 Discussion

4.1 Effective playing time

The average effective playing time [duration of ball in play] during all matches was 54 minutes 17 seconds [60.3%], which is similar to figures reported in the previous studies (Wooster, 2006-8). Overall analysis of the data shows that effective playing time was not affected by the playing surface [53 minutes 29 seconds – 59.4% – on football turf versus 55 minutes 05 seconds – 61.2% – on natural grass]. This data, coupled with the findings from the previous studies demonstrates that the effective playing time is not affected by playing surface and that the ball is in play, on average, for the same duration on football turf and natural grass.

4.2 Physical analysis

4.2.1 Overview

When assessing the physical variables collectively, it can be concluded that no significant differences were observed in the data collected on natural grass and football turf, thus suggesting that playing surface does not affect physical performance during a football match. There are, however, some subtle differences in the data between the two surfaces that will be discussed in more detail.

4.2.2 Total distance covered

The average total distance covered on natural grass and football turf was 112.1km versus 113.9km, respectively. The difference observed was not significant [p= .276]. One main finding, however, was that there was more variance in the data from game to game on football turf than on natural grass

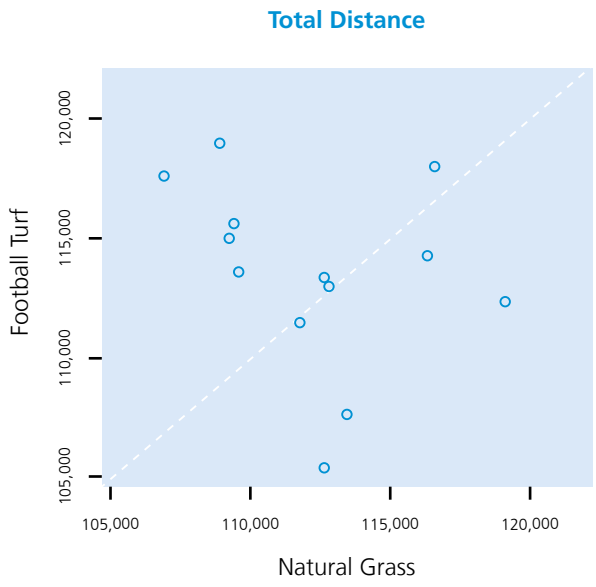

Fig. 11: Plot showing the correlation between figures for total distance covered recorded on the two surfaces.

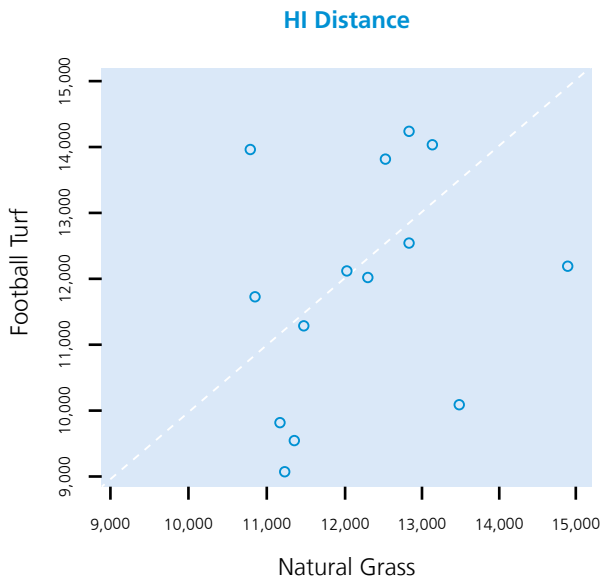

Fig. 12: Plot showing the correlation between figures for high intensity distance covered recorded on the two surfaces.

[see Fig. 3]. Although the mean average for total distance is higher on football turf, the lowest figure for this variable was also observed during a game on this surface. The range of figures is nearly 28% higher on football turf than on natural grass [a range of 16,062m on football turf from highest to lowest versus 12,122m on natural grass – a difference of 3940m on both surfaces]. It could be suggested that this finding may be linked to an increased consistency in performance on the more traditional grass surface and perhaps indicates unfamiliarity for away teams on football turf. It may also be owing to the varying nature of playing style from game to game by the home team (Spartak Moscow) on football turf and the effect of this on the opposing team. The correlation plot graph for total distance (see Fig. 11) further demonstrates the variance or "noise" within the data for this variable. The plots are very sporadic, indicating a high level of variance is inherent within the dataset.

4.2.3 High-intensity activity

Although the mean average total distance was reported to be higher on football turf, distance covered at high intensity (HI) was higher on natural grass than football turf [12.13km versus 11.81km]. This finding is further supported when the number of HI activities is considered, with 1,841 observed on natural grass and the slightly lower figure of 1,830 on football turf. These differences, however, were again not highlighted as significant [p= .543 for HI distance covered, p= .815 for total number of HI activities]. Regardless of these differences, data for high-intensity distance covered showed less variance in the data than was observed for total distance, and a stronger correlation between figures on the two surfaces can be identified (see Fig. 10).

When high-intensity activity is broken down further into sprints and high-speed runs (HSR), a similar trend is observed with both sprint distance and HSR distance being slightly higher on natural grass than on football turf (see Fig. 2 for breakdown). Of particular interest within this study was the players' ability to perform the HI activity in the same manner without being influenced by the playing surface. It is useful at this point, therefore, to consider the finding for average sprint distance – that is the average length of each sprint. Interestingly, the average length of sprint showed a strong correlation between each surface (see Fig. 5) and it was this variable that was in fact closest to significance [correlation coefficient of 0.06]. This suggests that teams are likely to show similar results for sprinting patterns on natural grass and football turf, thus suggesting with high confidence that the surface had very little effect on this important area of elite physical performance.

4.2.4 Accelerations

The ability of a player to accelerate and decelerate at the same rate on both playing surfaces is of great importance. Due to the unpredictable nature of the game, a player is required to make many changes of direction and changes to travelling speed through the game, and actually an entire football performance is made up of this type of explosive intermittent activity at different intensities. Information regarding the number of accelerations and decelerations at low, medium and high intensities on both surfaces is available for comparison. In line with the findings relating the high-intensity activity, greater numbers of high accelerations on average were performed on natural grass than on football turf [243 versus 232 per team per game]. The finding is again not significant [p= .416] and as so it would be unreasonable to suggest that this finding is due to a reduced ability to perform these activities on football turf, but rather that there was perhaps just a reduced demand for high accelerations during the games played on that surface.

Despite the differences observed, the correlation plot for high accelerations (see Fig. 6) shows a strong correlation for this variable, with the plots relatively close to the 45-degree line. This suggests that the same teams performed a similar number of high accelerations on both surfaces (home and away performances). It is, however, useful to further interpret this plot graph slightly differently. If more data points are located above the 45-degree line, this would suggest a greater tendency of the variable in question to occur on football turf. In this case, more data plots were located below the 45-degree line, indicating a greater tendency for high accelerations to occur on natural grass as the mean average suggests, but we can begin to observe this finding in more detail.

Conversely, there were a greater number of low accelerations on football turf than on natural grass [7,981 versus 8,267], which is in line with the finding that greater total distance was covered on this surface on average. This again could suggest how the physical demands and movement profiles varied against the different home teams on the two surfaces. The games on football turf demanded fewer quick, short bursts of movement at high intensities than the games on natural grass. Further work would need to be done to establish what proportion of the differences can be attributed to the effect of the playing surface.

4.2.5 High-intensity movement profiles

Figures 13 and 14 show the movement profiles of one particular player (player X) on the two different playing surfaces. It can be seen that, although the player played in the same position in both games (central midfield) and the team played with the same formation in both games, the physical demands and the type of runs required in the two game are somewhat different.

The general positioning of the player in question is reactively similar on both surfaces, however the make-up of the type of runs is not quite as consistent. The "hotter" the colour of the arrow on the movement profiles, the greater the velocity of that particular movement. The movement profile on natural grass (see Fig. 14) shows a greater number of runs hitting the sprint threshold (red) and, in addition, and possibly more insightful, more recovery-type runs against the direction of play can be viewed on the illustration for this surface. See Appendix 4 for a detailed positional breakdown of the physical data.

4.2.6 Physical endurance: breaking the game down

When breaking the game down into smaller segments (for example, half-by-half or by 15- and 5-minute periods), it is possible to begin to assess whether playing surface affects the physical endurance of players – i.e. their ability to sustain their physical output throughout the game. This data can also be used as an indicator of fatigue during matches.

Half-by-half

As expected, on average there is a slight decline in physical output from figures in the first to the second half on both surfaces. When looking at total distance in particular (see Fig. 7), the decrease from first to second half is consistent across both surfaces. The percentage decrease is also comparable [1.72% versus 2.19% on football turf and natural grass, respectively].

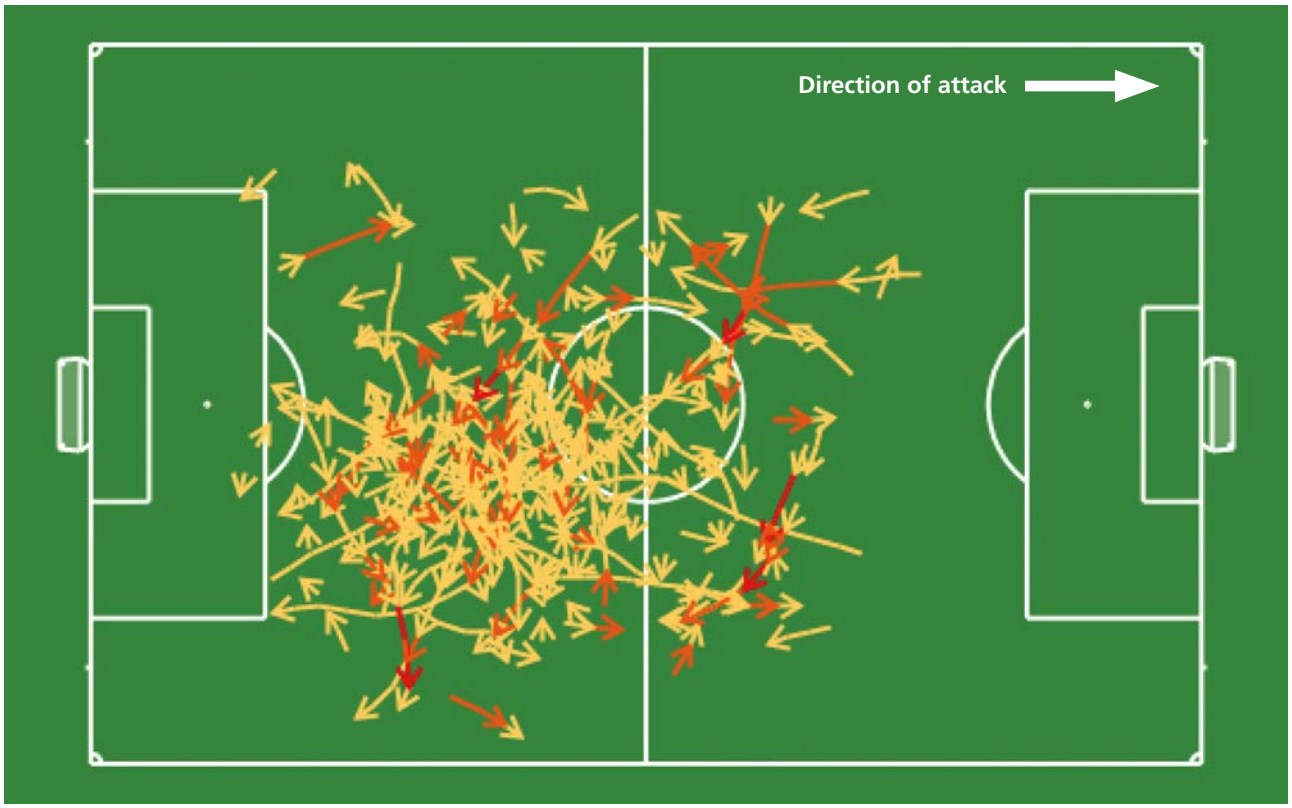

Fig. 13: Player X 1st half high intensity movement profile on football turf versus Spartak Moscow.

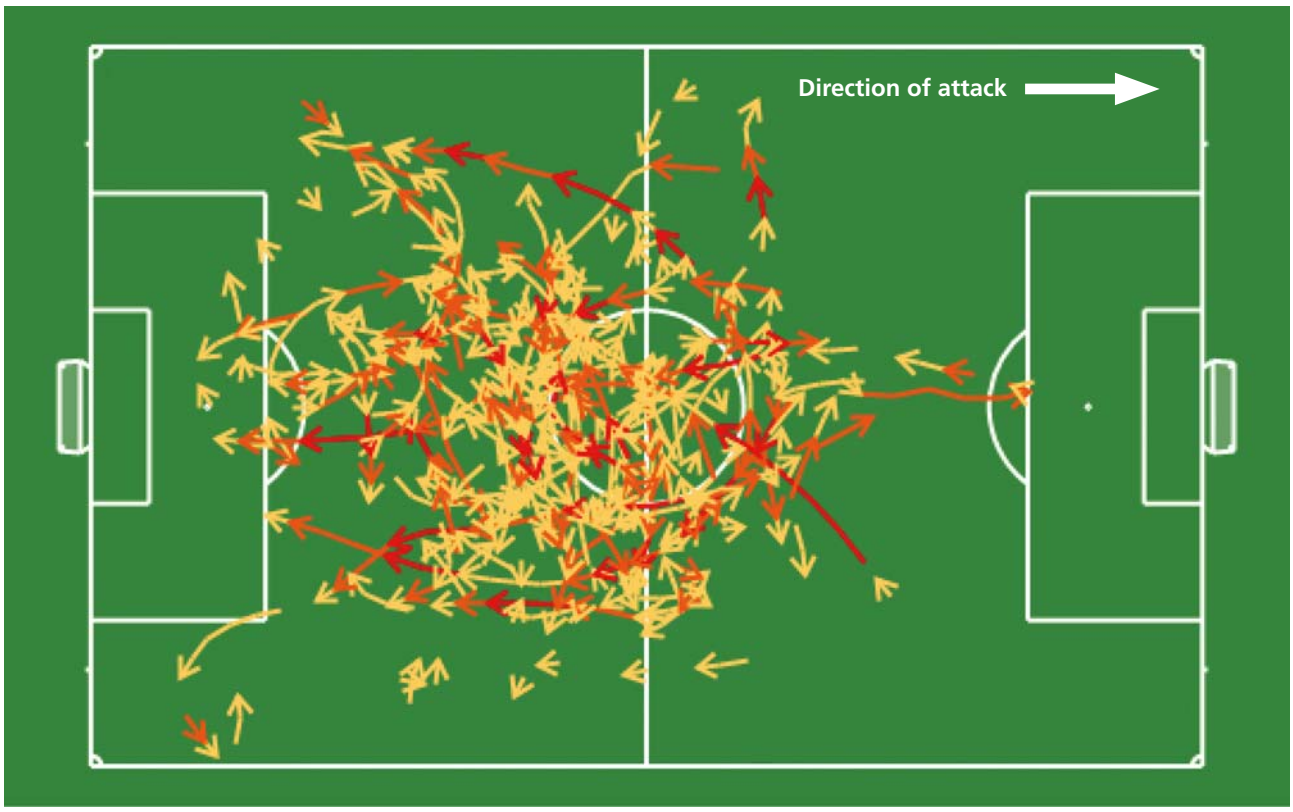

Fig. 14: Player X 1st half high intensity movement profile on natural grass versus Dinamo Moscow.

By 15-minute segments

When the game is broken down into the even smaller segments of 15-minute periods, a similar trend can be observed for total distance covered – i.e. there is a gradual decline throughout the game from the first 15 minutes to the last on both surfaces. This finding supports the notion that playing surface does not affect the physical endurance trends and therefore the capabilities of the players. When considering average HI distance across the 15-minute segments, some interesting findings arise. On average, the figures suggest that teams began the games at a higher intensity on natural grass with greater HI distance covered during the first 15 minutes of the game on this surface. During the time between 15 and 30 minutes, however, a relatively steep decline of this HI distance covered is observed on natural grass in comparison to the more conservative decline on football turf over the same time period (see Fig. 6). This graph also highlights that, although HI distance is generally greater on natural grass than on football turf during the second half, there is actually a slight incline in this statistic on average in the final 15-minute segment of the game on football turf. This finding can help dispel the potential preconception that football turf has a limiting effect on the physical endurance capabilities of players who are unfamiliar with this playing surface.

By 5-minute segments

Breaking the physical parameters down into 5-minute segments provides a greater level of granularity and allows for a more thorough assessment of the physical output throughout the game. Figure 7 shows how, for total distance covered, the trends are in many ways mirrored from one surface to the other. This provides further evidence to suggest that the effect of playing surface on physical output is limited. This graph also, however, shows in more detail the increase in physical output and therefore perhaps "work rate" on football turf towards the end of the game. A marked increase in total distance covered can be observed from 80 minutes onwards on football turf, while figures for the final five minutes actually show a decline on natural grass.

4.2.7 Cross-season trend

In order to assess whether playing conditions and therefore performance statistics were affected throughout the season by changing weather conditions, it was useful to consider the home team data in isolation and in chronological order across the season (from March to November 2011). By using only the home team data for this particular trend analysis, the personnel, playing styles and team capabilities were relatively consistent from game to game. The data should be assessed with some caution as the home team's approach to the game may have varied slightly from game to game depending on the opposition, although the analysis is still interesting. As the data was being assessed across the season on the same surface rather than a comparison of the two, familiarisation or the potential habituation process regarding the playing surface was not a factor.

Figure 8 shows the two sets of home data from the start to the end of the season for HI distance covered. The linear trend lines show that HI distance covered is maintained throughout the season on football turf, while a slight decline is observed in the data from games played on natural grass. Of course, this could be owing to squad rotation and relative squad fitness of these two teams, but it also highlights an important message that player perform similarly on both playing surfaces. In this specific case, it could be contended that football turf actually enhances a player's ability to perform consistently throughout the season as the playing surface is not affected by changing or adverse weather conditions.

5.0 Technical overview

Technical data was collected alongside the physical data in order to add to previous research and provide further depth to the overall analysis. As with the previous studies, only a few differences were reported for the frequency of player and team events from games played on natural grass and football turf (See Table 2).

5.1 Tactical analysis

Objective match data regarding the relative frequency of tackles in games played on football turf and natural grass surfaces is vital given the perceived relationship with the incidence of injury in games played on the newer surface. Consistent with the findings from the previous study (U-20 World Cup), more tackles per game were performed by teams on football turf than natural grass [39 versus 31] suggesting that players are required to make more tackles on football turf. However, across all 130 games analysed in each study, the tackle data is very similar (28 natural grass per team per match on average versus 30 on football turf), suggesting that this was a specific competition-related finding as opposed to being related to playing surface.

As in previous studies, the frequency of interceptions [99 versus 101 per team per match] and incidence of blocks [1.74 versus 1.67 on average per player per game] reported on natural grass and football turf were very similar. Regardless of this finding, a greater number of possession transitions per game (possession won and lost) were observed on football turf than on natural grass, although this was not statistically significant. The number of possession losses per team per game equated to 215.2 on football turf and just 205.6 on natural grass. This finding will, of course, be linked to the reduced pass success rate on football turf and may therefore be related in large part to playing style rather than the actual effect of playing surface.

One of the key performance indicators analysed across all the previous technical research studies has been the players' average number of touches per possession per game. It has been contended that this data will provide crucial information on player-ball interaction (for example, a player's ability to control the ball) on natural grass and football turf playing surfaces. The average number of touches per possession per player was almost identical on grass and football turf [2.06 versus 2.01]. Coupled with the findings from the previous studies that are consistent with this, we can conclude that players are equally comfortable with the ball at their feet on both playing surfaces.

5.2 Passing analysis

This study saw a greater frequency of passes attempted on natural grass than football turf [316 versus 273]. This finding is inconsistent with previous studies of this type. It had previously been suggested that due to the consistently higher average number of total passes per game on football turf, this surface encourages teams to attempt more passes. Findings from this study would oppose that notion and thus suggest that this statistic is more related to the playing style of the home team.

Arguably more important is the fact that the quality of passing and success rates was similar on both surfaces [80.7% on natural grass versus 77.5% on football turf]. It could be suggested that the playing surface may have an effect on accuracy, although when looking closer at the breakdown of passes and assessing in more depth the length and direction of passes, this pass success rate can be better understood. A greater percentage of total passes on football turf were long (>25m) [21.2% versus 17.9%]. The reduced accuracy associated with the increased number of long passes on football turf will inevitably lower the overall total pass success rate on this surface. Furthermore, there were more forwards (144 versus 129), backwards (63 versus 55) and sideways (109 versus 89) passes on natural grass, which is a reflection of the greater frequency of passes reported generally on this surface. However, when these figures are viewed as a percentage of the total number of passes on football turf and natural grass, a greater proportion of passes are directed forwards on football turf. This finding, alongside the greater proportion of long passes on football turf, may indicate a more direct style of play on this surface and hence another reason why the overall pass success rate is slightly lower on this surface.

One significant result that is again contradictory to previous study findings was the figure for the number of passes attempted in the opposition's half. In the current study, a larger proportion of total passes were performed in the opposition's half on natural grass as opposed to football turf [46.9% versus 42.6%]. This result was found to be significant [p= .032]. This could suggest that football turf encourages teams to defend deeper in their own half, although it is also necessary to consider the effect of playing styles.

5.3 Attacking analysis

Attacking statistics were generally higher on football turf than natural grass, with more shots [12.0 versus 11.7], crosses [11.0 versus 8.6] and goals [0.87 versus 0.73] reported. The difference for the average number of crosses per game was found to be significant [p= .016]. Studies 1, 2 and 4 found the inverse to be true with more crosses on average being performed on natural grass (see Appendix 3 for a technical overview from past studies). This had led to the contention that football turf may lead to a narrower style of play. The technical research conducted on Dutch football games (Study 3), however, also reported a higher number of crosses on football turf [12 versus 11]. Given that no continuity seems to have emerged across each of the five studies, we can therefore assume that the type of competition (rather than playing surface) is more likely to be the cause of the difference observed.

Considering the above finding, it was surprising that the frequency of attacking entries was higher on natural grass than on football turf [final third entries: 53.7 versus 52.1; penalty area entries: 28.0 versus 26.1]. This may suggest that when playing on natural grass, teams are less efficient with their attacking play once the ball has been delivered into the attacking area. In addition, the higher figures for attacking entries on natural grass may also just be a reflection of the increased possession by the teams on this surface.

6.0 Possible study limitations

Throughout the study, only the away team data was included within the data comparison analysis. Eliminating the home team's data removed any perceived bias or learned effect resulting from regular experience of playing on football turf or natural grass, and therefore, a habituation process. The home teams' playing styles, standards and general approach to games, however, will have had an inevitable consequential effect on the away team performance data. It can be noted, however, that the two home teams were not dissimilar in terms of standard of play, with both teams occupying 3rd and 4th position at the end of the 2011 season.

The same away teams played on both surfaces owing to the Russian League format – i.e. all teams that played on natural grass also played on football turf. Despite this fact, differences in team line-ups due to squad rotation, injuries, or adapted approach to the games may have reduced the consistency in the sample from one surface to the other.

Other possible limitations include the different officials used in the games and potential incidents in the game (e.g. dismissals, injuries, etc.), the standard and adopted approach of the opposition (including formation utilised) and the timing of the matches (kick-off time and rest in between matches). In addition, it was impossible to control the players' footwear, game preparation and psychological mindset to ensure consistency on both surfaces.

With both stadiums located in the same city (Moscow), it is possible to suggest that climate change was consistent on both surfaces. Weather conditions, on the other hand, could not be controlled; therefore, this was a possible limitation of the study.

7.0 Conclusions

This study aimed to assess the impact of different playing surfaces, natural grass and football turf, on the physical (fitness) performance of the teams and players, while adding to the existing body of technical data research. Thirty games from the 2011 Russian Premier League were analysed using Prozone Sports' PROZONE3® tracking technology, (15 games on natural grass and 15 games on football turf). Direct comparison and advanced statistical analysis of the objective information from both surfaces was conducted to ascertain whether the game changes on football turf.

In conclusion, the current findings reveal that:

- Football turf does not affect the physical performance trends and capabilities of teams and players during a football match. There were some subtle differences in the data when comparing physical performances on football turf to natural grass, yet none of these were statistically significant.
- Greater total distance and physical outputs at lower intensities were reported on football turf, while a higher mean average for HI distance covered per team per game was reported on natural grass [Total distance: 113.9km versus 112.1km; HI distance: 11.8km versus 12.1km on football turf and natural grass, respectively]. Following the assessment of the home team technical data, it was concluded that this slight difference could most likely be attributed to the different demands within the games on the two surfaces as a direct effect of the home teams' contrasting playing styles rather than a direct effect of the differing playing surfaces.
- Greater variability in the physical data (range of results) was observed in the information captured on football turf than on natural grass. It could be suggested that this variability in the data indicates a potential inconsistency of physical output on this newer, perhaps less familiar surface.
- No difference was found for effective (ball in play) playing time on football turf and grass [on average, 54-55mins, approximately 60%, on both surfaces].
- Although subtle differences were observed with certain variables within the "tactical analysis" (for example, frequency of tackles and possession transitions), the majority of variables (including the players' average number of touches per possession) reported comparable findings.
- Contrary to previous study results, a higher frequency of passes was attempted on natural grass than on football turf, although this finding is more likely linked to playing styles rather than surface owing to the lack of continuity in this finding with other studies.
- Attacking statistics were generally higher on football turf than on natural grass, with more shots, crosses, and goals reported on this surface. Attacking entries, however, that is final third entries and penalty area entries, were higher on natural grass than on football turf.

Overall, from this study, we can conclude that, in terms of the physical (fitness) performance, the game does not change when played on football turf.

8.0 References

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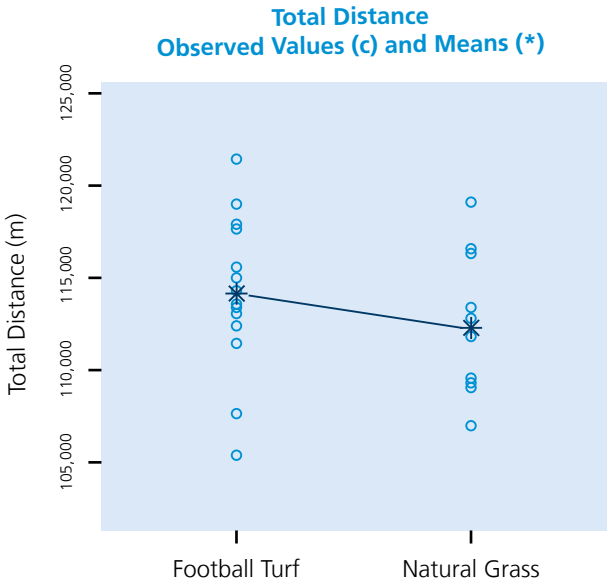
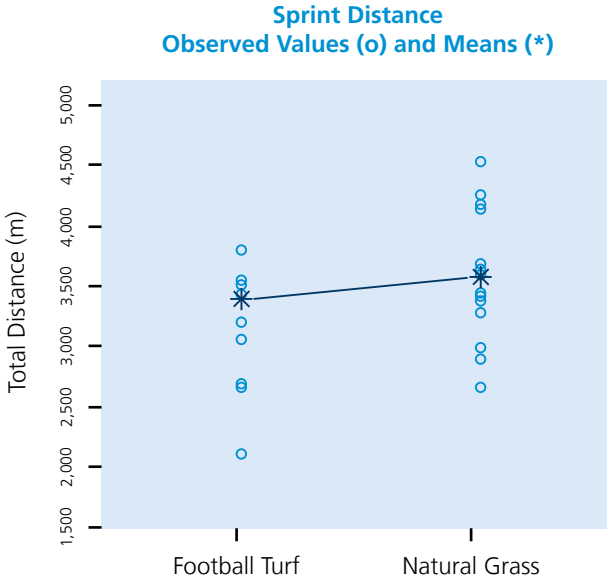
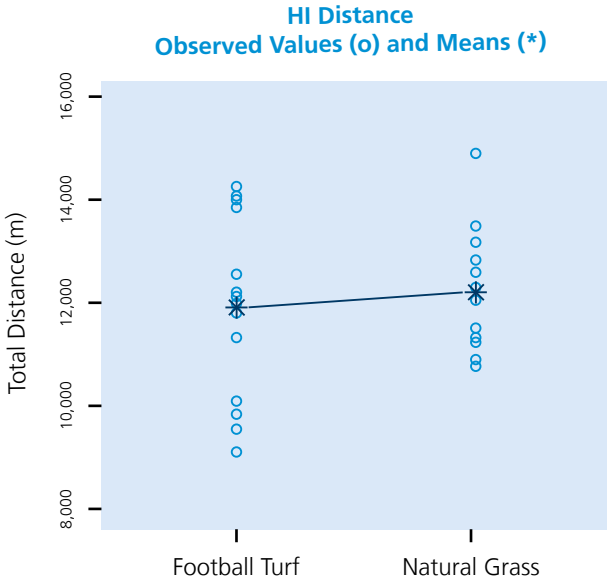
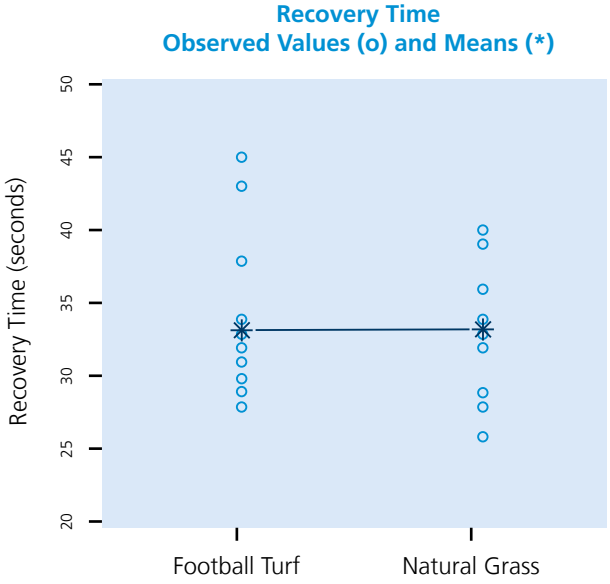
Appendix 1

Technical and physical dot plots

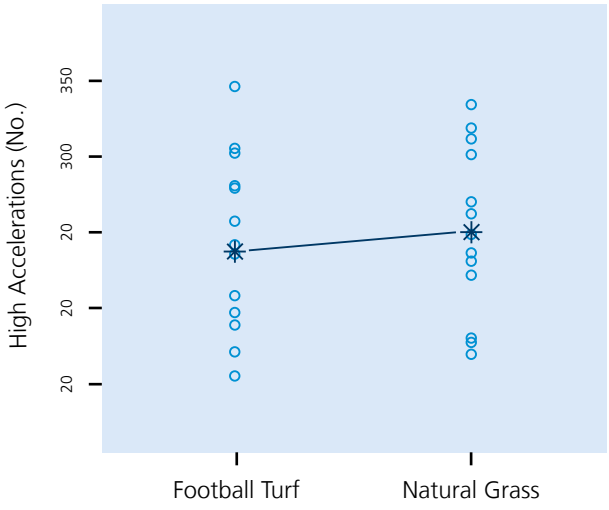




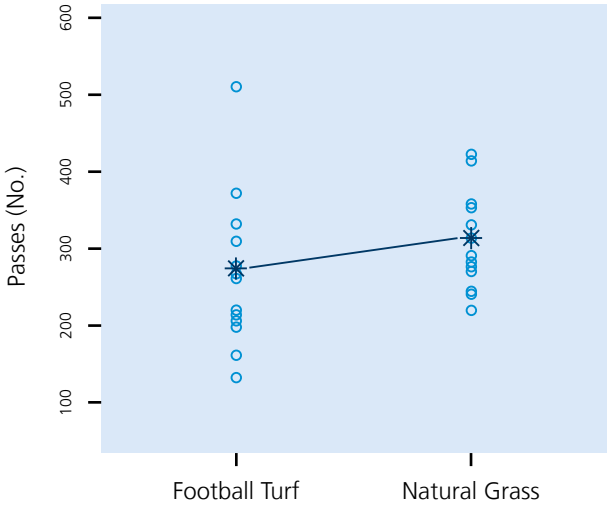




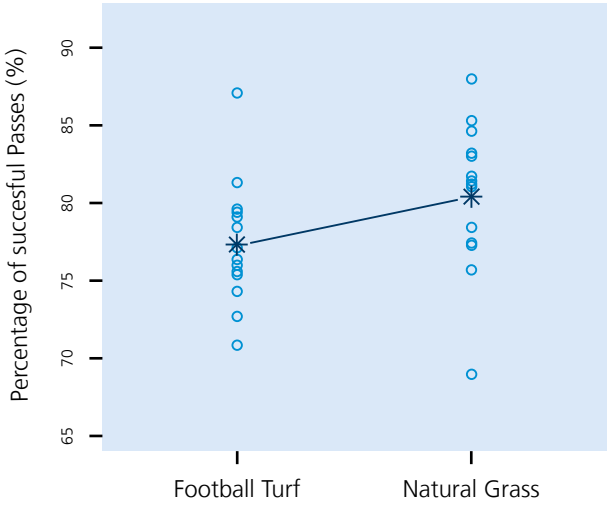
High Accelerations
Observed Values (o) and Means (*)



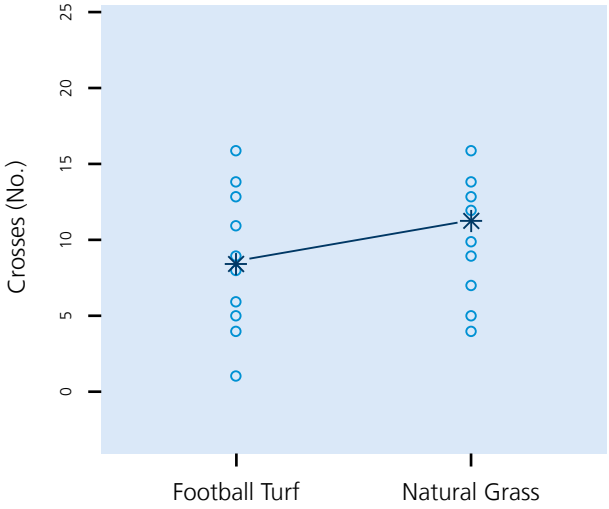
Passes
Observed Values (o) and Means (*)



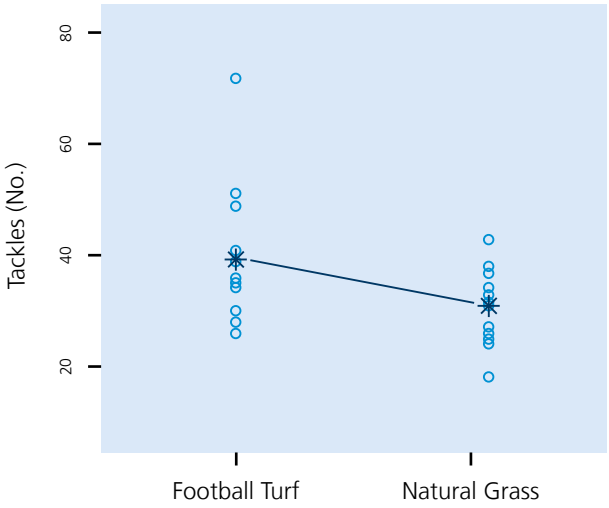
Percentage of Succesful Passes
Observed Values (o) and Means (*)



Crosses
Observed Values (o) and Means (*)



Tackles
Observed Values (o) and Means (*)



Appendix 2

Paired statistics and correlation coefficients

Paired statistics

Paired Samples Statistics		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total Distance_FT	114116.86	14	4266.941	1140.388
	Total Distance_NG	112299.29	14	3363.455	898.921
Pair 2	HS Run Distance_FT	8509.57	14	1161.053	310.304
	HS Run Distance_NG	8626.57	14	684.858	183.036
Pair 3	Num HS Runs_FT	1843.64	14	249.591	66.706
	Num HS Runs_NG	1856.36	14	187.917	50.223
Pair 4	Sprint Distance_FT	3397.79	14	635.720	169.903
	Sprint Distance_NG	3581.86	14	550.245	147.059
Pair 5	Num Sprints_FT	548.64	14	104.787	28.005
	Num Sprints_NG	579.86	14	89.529	23.928
Pair 6	HI Distance_FT	11907.86	14	1753.527	468.650
	HI Distance_NG	12209.00	14	1170.504	312.830
Pair 7	HI Number_FT	1756.86	14	254.314	67.968
	HI Number_NG	1774.07	14	209.767	56.063
Pair 8	Recovery Time_FT	33.21	14	5.807	1.552
	Recovery Time_NG	33.21	14	3.906	1.044
Pair 9	Avg Sprint Dist_FT	5.88600	14	.359178	.095994
	Avg Sprint Dist_NG	5.98479	14	.449187	.120050
Pair 10	High Accelerations_FT	236.86	14	60.365	16.133
	High Accelerations_NG	249.43	14	52.824	14.118
Pair 11	ln_HighAccelerations_FT	5.4364	14	.26125	.06982
	ln_HighAccelerations_NG	5.4975	14	.21838	.05837
Pair 12	High Decelerations_FT	136.71	14	37.745	10.088
	High Decelerations_NG	144.79	14	39.029	10.431
Pair 13	Medium Accelerations_FT	1503.57	14	204.001	54.521
	Medium Accelerations_NG	1535.36	14	173.687	46.420
Pair 14	Medium Decelerations_FT	1260.93	14	197.019	52.655
	Medium Decelerations_NG	1274.50	14	173.964	46.494
Pair 15	Low Accelerations_FT	8278.93	14	565.026	151.010
	Low Accelerations_NG	8020.36	14	484.512	129.491
Pair 16	Low Decelerations_FT	8260.36	14	605.219	161.751
	Low Decelerations_NG	7998.21	14	546.153	145.965

Correlation coefficients

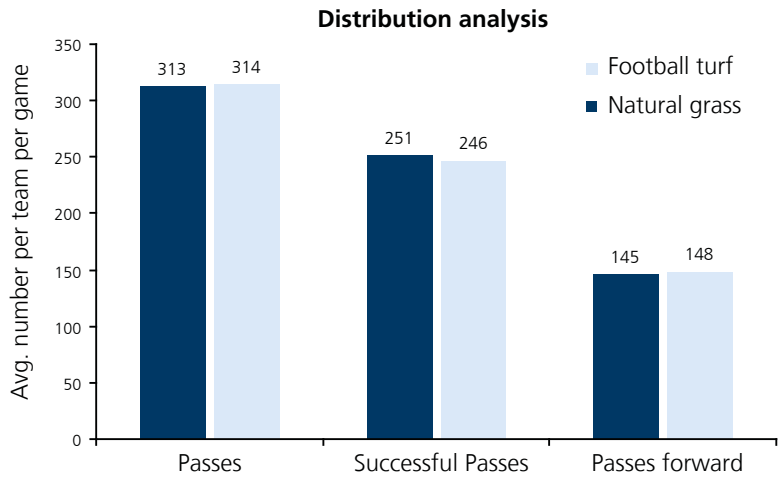
Paired Samples Correlations		N	Correlation	Sig.
Pair 1	Total Distance_FT & Total Distance_NG	14	-.216	.458
Pair 2	HS Run Distance_FT & HS Run Distance_NG	14	.237	.414
Pair 3	Num HS Runs_FT & Num HS Runs_NG	14	.319	.266
Pair 4	Sprint Distance_FT & Sprint Distance_NG	14	.392	.166
Pair 5	Num Sprints_FT & Num Sprints_NG	14	.336	.240
Pair 6	HI Distance_FT & HI Distance_NG	14	.288	.318
Pair 7	HI Number_FT & HI Number_NG	14	.333	.245
Pair 8	Recovery Time_FT & Recovery Time_NG	14	.354	.214
Pair 9	Avg Sprint Dist_FT & Avg Sprint Dist_NG	14	.515	.060
Pair 10	High Accelerations_FT & High Accelerations_NG	14	.352	.217
Pair 11	ln_HighAccelerations_FT & ln_HighAccelerations_NG	14	.366	.198
Pair 12	High Decelerations_FT & High Decelerations_NG	14	.400	.156
Pair 13	Medium Accelerations_FT & Medium Accelerations_NG	14	.311	.280
Pair 14	Medium Decelerations_FT & Medium Decelerations_NG	14	.459	.099
Pair 15	Low Accelerations_FT & Low Accelerations_NG	14	.104	.723
Pair 16	Low Decelerations_FT & Low Decelerations_NG	14	.145	.622

Appendix 3

5-Study Technical Overview

	Study 1 - UEFA Cup			Study 2 - Champions League & UEFA Cup			Study 3 - Dutch Football			Study 4 - U'20s World Cup			Study 5 - Russian League		
	Natural grass	Football Turf	UEFA Average	Natural grass	Football Turf	CL & UEFA Average	Natural grass	Football Turf	Dutch Eredivise Average	Natural grass	Football Turf	U'20s Tournament Average	Natural grass	Football Turf	Russian League Average
No. of Performances	**2**	**2**	**28**	**20**	**8**	**80**	**17**	**17**	**68**	**46**	**58**	**104**	**15**	**15**	**62**
Passes	360	352	339	336	341	353	270	308	274	282	296	291	315	273	319
Successful Passes	301	280	267	275	268	290	204	237	208	220	231	227	257	215	258
Success Pass %	84%	80%	79%	82%	79%	82%	76%	77%	76%	78%	78%	78%	81%	76%	80%
Passes forward	162	164	155	152	159	154	135	147	136	134	140	137	144	129	146
Balls received	417	396	368	373	374	388	310	349	316	319	330	327	344	305	350
Headers	72	59	67	56	68	57	76	76	76	64	60	62	53	55	52
Tackles	22	22	28	28	28	30	34	30	33	27	32	30	31	39	31
Interceptions	117	120	136	110	130	115	138	141	139	128	131	130	99	101	101
Crosses	19	16	15	13	12	13	11	12	13	13	10	12	9	11	12
Shots	12	15	13	13	14	13	12	13	13	14	15	15	12	12	12

Overall average		
	Natural grass	Football turf
Passes	313	314
Successful Passes	251	246
Passes forward	145	148
Success Pass %	80	78
Balls received	353	351
Headers	64	64
Interceptions	118	125
Tackles	28	30
Crosses	13	12
Shots	13	14



Appendix 4

Performance Benchmark

Natural grass vs. Football Turf Physical Benchmarking

Attacker	Grass	Turf
Dist. Covered	11184	11006
H.I. Dist Coverd	1280	1223
H.I. Dist Coverd WP	767	729
H.I. Dist Coverd WOP	437	400
H.I. Dist Coverd BOP	75	94
No. H.I. Activities	177	169
Sprint Dist.	389	367
HSR Dist.	891	856
No. of Sprints	60	56
Recovery Time	32	35

Left Midfield	Grass	Turf
Dist. Covered	11742	11942
H.I. Dist Coverd	1375	1448
H.I. Dist Coverd WP	639	701
H.I. Dist Coverd WOP	664	638
H.I. Dist Coverd BOP	71	107
No. H.I. Activities	199	216
Sprint Dist.	394	411
HSR Dist.	981	1036
No. of Sprints	67	67
Recovery Time	29	26

Centre Midfield	Grass	Turf
Dist. Covered	11766	11740
H.I. Dist Coverd	1257	1205
H.I. Dist Coverd WP	460	412
H.I. Dist Coverd WOP	723	724
H.I. Dist Coverd BOP	73	68
No. H.I. Activities	197	194
Sprint Dist.	335	318
HSR Dist.	922	886
No. of Sprints	59	55
Recovery Time	29	30

Right Midfield	Grass	Turf
Dist. Covered	12386	11933
H.I. Dist Coverd	1629	1418
H.I. Dist Coverd WP	740	691
H.I. Dist Coverd WOP	771	627
H.I. Dist Coverd BOP	117	98
No. H.I. Activities	235	195
Sprint Dist.	496	431
HSR Dist.	1133	986
No. of Sprints	83	64
Recovery Time	23	28

Left Back	Grass	Turf
Dist. Covered	10952	11330
H.I. Dist Coverd	1208	1163
H.I. Dist Coverd WP	386	382
H.I. Dist Coverd WOP	745	705
H.I. Dist Coverd BOP	76	75
No. H.I. Activities	164	165
Sprint Dist.	396	353
HSR Dist.	812	810
No. of Sprints	59	54
Recovery Time	34	35

Centre Back	Grass	Turf
Dist. Covered	10038	10240
H.I. Dist Coverd	772	714
H.I. Dist Coverd WP	137	160
H.I. Dist Coverd WOP	558	482
H.I. Dist Coverd BOP	75	59
No. H.I. Activities	117	112
Sprint Dist.	209	188
HSR Dist.	562	526
No. of Sprints	35	32
Recovery Time	49	54

Right Back	Grass	Turf
Dist. Covered	11321	11104
H.I. Dist Coverd	1342	1113
H.I. Dist Coverd WP	456	415
H.I. Dist Coverd WOP	783	617
H.I. Dist Coverd BOP	101	80
No. H.I. Activities	187	156
Sprint Dist.	432	324
HSR Dist.	910	788
No. of Sprints	68	52
Recovery Time	30	38

Team Total Analysis (excluding GK)					
	Grass	Turf		Grass	Turf
Total Distance (km)	112.1	113.9	**No. of H.I. Activities**	1756	1738
H.I. Distance	12127	11813	**Sprint Distance**	3561	3355
H.I. Dist Coverd WP	4917	4897	**HSR distance**	8565	8458
H.I. Dist Coverd WOP	6390	6032	**No. of Sprints**	575	542
H.I. Dist Coverd BOP	820	815	**Recovery Time (secs)**	34	34

Key

H.I. = High Intensity - > 5.5 m/s
WP = With Possession
WOP = Without Possession
BOP = Ball out of Play
HSR = High Speed Run - 5.5 - 7 m/s

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