MOVEMENT AND ACCELERATION PROFILE OF FORWARD PLAYERS IN ELITE FOOTBALL MATCH

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Contents

DATA

Sample data set contains various variables for speeds and acceleration across a match for the entire season of four players.

Data manipulation

1. Data for all the players was combined together and each player was given a code:

Player_code	Player_name
1	Sane
2	Salah
3	Firmino
4	Origi

2. Following changes were made to clean data:

Original	New
Period : 1 & 2	Half : 1st and 2nd
Salah: Arsenal Home, Leicester City Home, Southampton, Watford and West Ham	Salah: Arsenal FC Home, , Leicester Home, Southampton FC, Watford FC and West Ham United
Origi vs Aston Villa Home Activity no. 165 1.68 Period : 1.68292682926829	Origi vs Aston Villa Home Activity no. 165 1.68 Half : 2nd

3. No data was found or available for the following:

Player_name	Opponent Team and Location (Home/Away)
Origi	Norwich Home and Away, Bournemouth Away, Arsenal Home, Brighton Away, Burnley Home, Chelsea Away, Crystal Palace Home, Manchester City Home, Southampton Home and West Ham United Home
Firmino	Norwich Home
Salah	Everton Home and Away, Crystal Place Away, Manchester United Away and Norwich Home
Sane	Bournemouth Away, Norwich Home, Southampton Home, West Ham United Away

Therefore, from the table above:

- Origi has very less amount of data since he is often a substitute player
- No Norwich Home data for all the players, therefore:

Player_name	No. of matches
Sane	34
Salah	33
Firmino	37
Origi	27

4. New columns duration_min, distance_km, initial_speed_km/h and peak_speed_km/h was created and calculated for every rows based on combined data.
5. New columns movement_category, acceleration_category and deceleration_category was created based on previous studies [1,2] as per following:

	movement_category	**peak_speed_km/h**
Movement profile	Walking	0 to 7.1
	Jogging	7.11 to 14.3
	Running	14.31 to 19.7
	High-speed running	19.71 to 25.2
	Sprint	>25.2

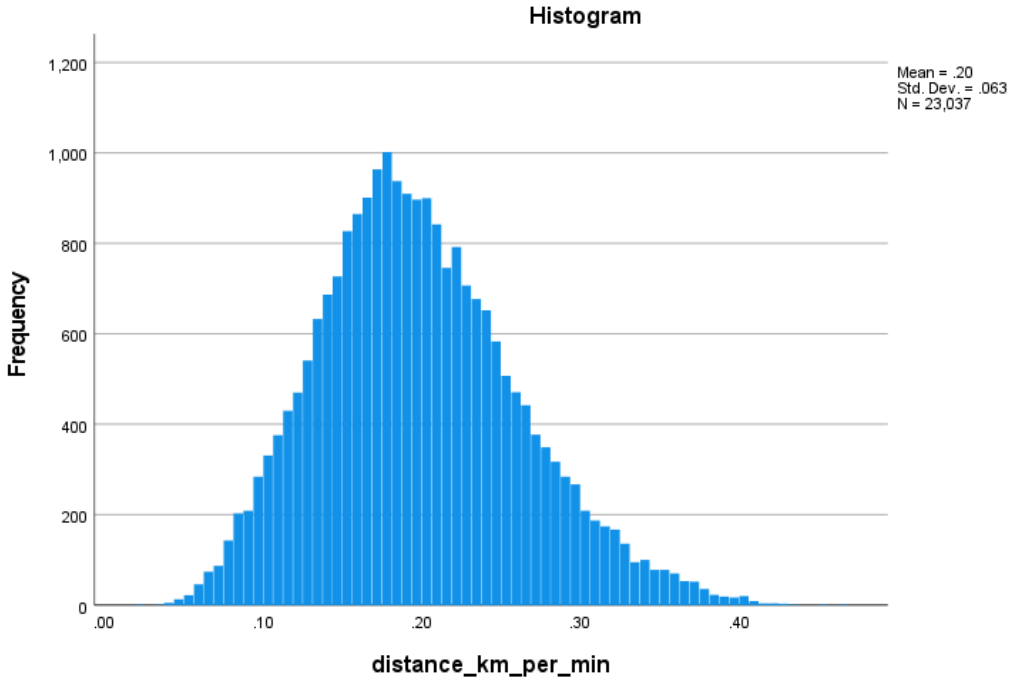
	acceleration_category	**peak_acceleration_m/s2**
Acceleration profile	High-intensity acceleration	≤ 3
	Low-intensity acceleration	>3
	deceleration_category	**peak_deceleration_m/s2**
	High-intensity deceleration	≤ 3
	Low-intensity deceleration	>3

Statistical analysis

Each data entry in the data set corresponds to different duration of activity. Therefore, to utlise as much of the data as possible **distance_km** was normalised by the **duration_min** [3] to analyse distance covered in movement_category, acceleration_category and deceleration_category, distance_km.

distance_km_per_min = distance_km / duration_min

Normality of distance_km_per_min combined for all the players was confirmed by Kolmogorov-Smirnov test, Normal Q-Q Plot and following Histogram:



Extreme values of distance_km_per_min were removed to do increase the statistically power.

Differences in distance covered between the first and second halves

The **paired samples t-test** was used to determine the significance of differences in distance covered by all the variables between the first and second halves for all players combined is shown below:

Variable	First Half		Second Half		p-Values	Effect Size (CI)
	Mean	SD	Mean	SD		
Running	24.57	4.89	22.18	4.07	0.002	0.558 (0.207-0.901)
Low-intensity acceleration	34.63	7.30	31.64	5.53	0.010	0.449 (0.107-0.784)
High-intensity deceleration	8.43	2.42	7.46	1.61	0.013	0.429 (0.089-0.763)
Total distance covered	63.81	12.25	59.38	8.69	0.019	0.404 (0.066-0.737)
Low-intensity deceleration	55.38	10.73	51.92	7.81	0.040	0.351 (0.017-0.681)
High-speed running	16.07	3.82	14.78	2.66	0.070	0.308 (-0.024-0.635)
High-intensity acceleration	29.18	5.52	27.74	4.52	0.113	0.267 (-0.062-0.594)
Jogging	15.58	3.49	15.08	2.90	0.365	0.151 (-0.174-0.474)
Sprint	7.18	2.27	6.93	2.25	0.598	0.087 (-0.236-0.41)
Walking	0.40	0.19	0.41	0.21	0.927	-0.015 (-0.337-0.307)

(Significant difference ($p \leq 0.05$) is marked in bold)

The analysis in the above table shows that there was a **significant decrease** between the first and second half for distance covered by **Running with 10%**, **Low-intensity acceleration with 9%**, **High-intensity deceleration with 12%**, **Total distance covered with 7%** and **Low-intensity deceleration with 6%**

There was no significant difference for distance covered by **High-speed running, High-intensity acceleration**, Jogging, Sprint and Walking between the first and second half.

Differences in distance covered between the four players

The **Levene's test** was used to confirm the **homogeneity of variances** of distance covered for all the variables. On the one hand, when comparing the distance covered for all the variables relative to each player, **One-way analysis of variance (ANOVA)** with **Bonferroni post-hoc** was used as shown below:

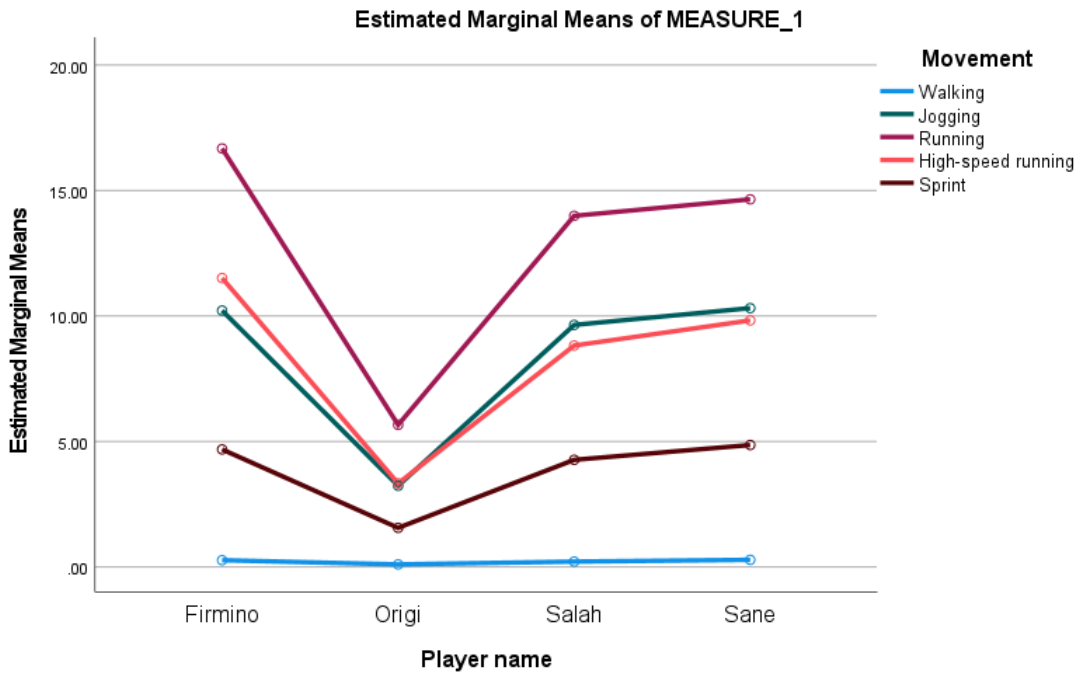
Variable	Player name								p-Values (<0.05)
	Sane		Salah		Firmino		Origi		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
High-speed running	9.83	2.84	8.83	2.17	11.52	3.06	3.33	2.78	**Salah Vs Firmino**
Jogging	10.32	2.92	9.65	2.32	10.22	2.95	3.24	2.71	N/A
Running	14.65	3.9	13.99	2.55	16.68	4.54	5.66	4.96	**Salah Vs Firmino**
Sprint	4.86	1.79	4.27	1.61	4.69	1.48	1.56	1.06	N/A
Walking	0.29	0.15	0.22	0.14	0.27	0.15	0.11	0.13	N/A
High-intensity acceleration	19.76	4.97	16.86	3.28	18.85	4.41	6.67	5.23	N/A
Low-intensity acceleration	20.18	5.37	20.1	3.89	24.52	6.67	7.23	6.16	**Firmino Vs Sane, Salah**
High-intensity deceleration	5.16	1.49	4.88	1.57	5.18	1.75	2.2	1.6	N/A
Low-intensity deceleration	34.78	8.68	32.07	5.55	38.19	9.32	11.71	9.87	**Salah Vs Firmino**
Total distance covered	39.95	9.8	36.96	6.47	43.37	10.27	13.9	11.25	Salah Vs Firmino

Note: Origi Vs other players p-value is always <0.05 for all the variable

The above table shows that **Firmino** has covered significantly more distance in **High-speed running, Running and Low-intensity deceleration Vs Salah**, and in **Low-intensity acceleration Vs Salah and Sane**.

Movement profile

Repeated measure ANOVA was used to obtain the following **Movement profile** of each player:



The above graph shows most distance is covered by Running and least by Walking for each player.

Acceleration profile

The number of High-intensity acceleration (HIA), Low-intensity acceleration (LIA), High-intensity deceleration (HID) and Low-intensity deceleration (LID) was calculated for every match, which were normalised by duration of minutes as per previous study [3].

The Levene's test for homogeneity of variances failed so the **Welch test** instead of the ANOVA

and **Games-Howell Post hoc test** instead of Bonferroni was conducted as shown below:

Variables	Player name								p-Values (<0.05)
	Sane		Salah		Firmino		Origi		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Number of HIA per min	3.54	0.36	3.28	0.35	3.05	0.52	3.48	0.72	Sane vs Salah, Firmino
Number of LIA per min	4.75	0.44	5.12	0.35	4.80	0.57	4.55	0.84	Salah vs Sane, Firmino, Origi
Number of HID per min	0.95	0.20	0.94	0.21	0.86	0.26	1.17	0.43	Firmino vs Origi
Number of LID per min	7.34	0.49	7.46	0.43	6.99	0.37	6.85	1.08	Salah vs Firmino, Origi; Firmino vs Sane
Average of peak_acceleration_m/s2	2.97	0.08	2.90	0.06	2.87	0.10	2.96	0.11	Sane, Origi vs Salah, Firmino
Average of peak_deceleration_m/s2	1.78	0.10	1.71	0.10	1.70	0.10	1.89	0.22	Origi vs Salah, Firmino; Firmino vs Sane

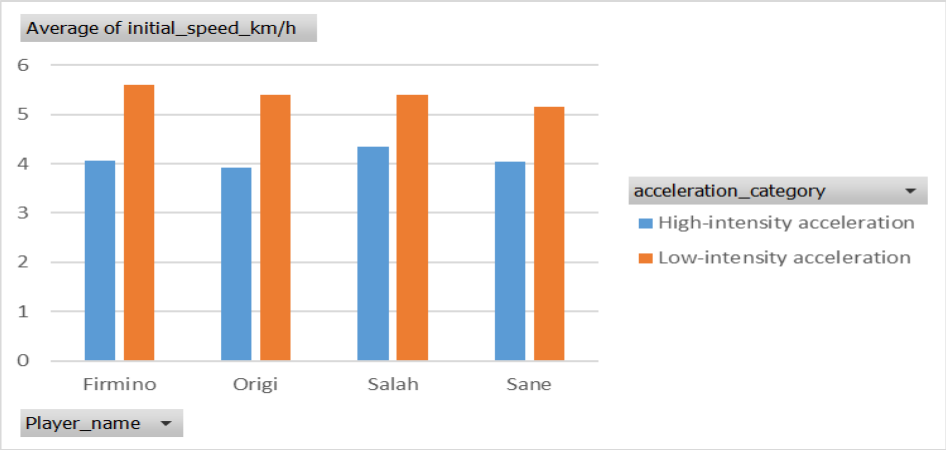
The above table shows **Sane** has significantly more number of **High-intensity acceleration** per min per match than Salah and firmino. **Sane and Origi** has significantly more **average peak acceleration** per match than Salah and Firmino.

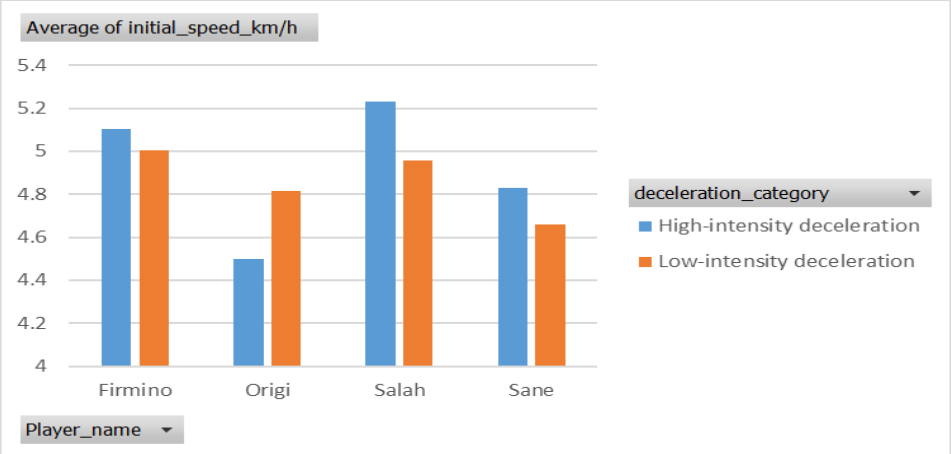
Visualisations

Initial velocity vs Acceleration/Deceleration

Below graphs shows that:

- Higher initial velocity is required to perform a Low-intensity acceleration than High-intensity acceleration for all the player.
- Higher initial velocity is required to perform a High-intensity deceleration than Low-intensity deceleration for all the players except for Origi.

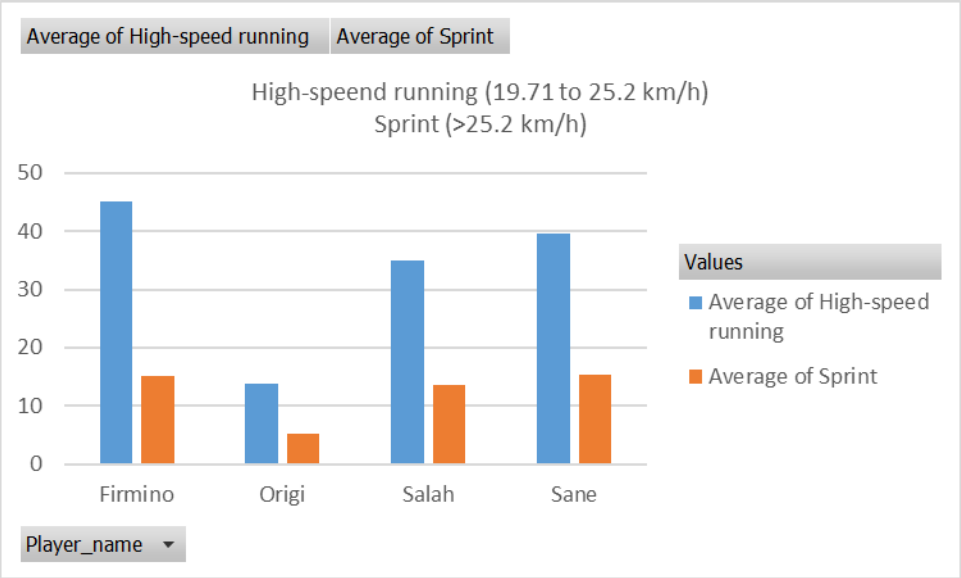




Above results matches with previous study [2].

Number of High-speed running and Sprints

The graph below shows average number of High-speed running and Sprints in a match.



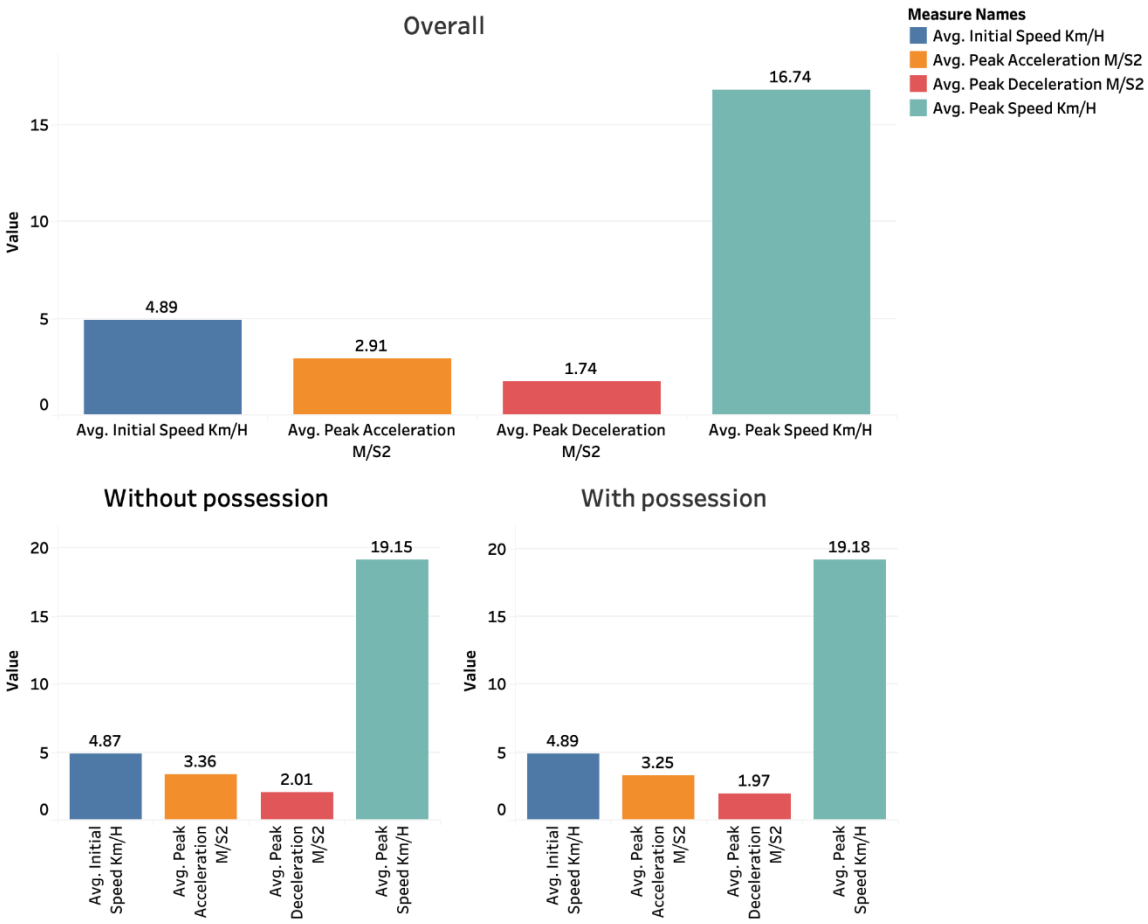
Avg. movement and acceleration with and without team possession

The graph below shows how there is change in movement and acceleration of players when their team have and do not have ball possession **considering the player involved**.

Overall graph shows the average of all the movement and acceleration variable for **all the players combined across the entire season**. Similarly, Without possession and With possession graph shows the average of all the movement and acceleration variable when the players team do not have and have possession respectively considering the players are involved for all the players combined across the entire season.

It can be observed that generally there is a increase in all the movement and acceleration variable of Without possession and With possession graph as compared to the Overall graph.

Graph	Average of peak_speed_km/h
Overall vs Without possession	16.74 to 19.15 **(14% ↑)**
Overall vs With possession	16.74 to 19.18 **(15% ↑)**



Conclusion

- No significant change in distance covered in **High-speed running and High-intensity acceleration in both the half** from paired samples t-test for all the players combined.
- ANOVA analysis shows that there is no significant difference in distance covered in **Sprint and High-intensity acceleration among all four players.**
- **Increase in average peak speed of 14% when team does not have possession** indicates how players are willing to get back possession quickly.
- **Increase in average peak speed of 15% when team have possession** indicates how players are likely to run for an activity for eg. How player react to an long ball pass.
- The above points indicates how all the four forward players of the elite club play a **pressing and an attacking style of football.**

Recommendations

- Differences in movement and acceleration profile of players can be compred between Lower Rank team and Higher Rank team to analyse how the players performed against big and small teams. Also, Home Vs Away performance can be analysed.
- Evenly distributed sample data of all players could result in better understanding of the players with statistically significant power.

References

1. https://www.tandfonline.com/doi/pdf/10.1080/17461391.2014.933879?needAccess=true
2. https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0236959&type=printable
3. https://www.mdpi.com/2075-4663/6/4/130/htm#B24-sports-06-00130