

Comparison of very high-intensity acceleration and deceleration in two professional elite football clubs (Serie C) across three seasons (2019-22).

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Abstract

This study aims to analyze and compare very high-intensity acceleration and deceleration in official matches in two different professional teams during three competitive seasons (Italian 3rd Division-Series C, 2019-20, 2020-21, 2021-22), to understand how two different training methodologies during the week influenced the performance about these parameters indicated above. Eighty-seven (n=87) elite football players participated in this study (age 23.1±1.4; body weight 77.8±1.7; height 181.9±0.6; fat mass 10.7±1.5), without goalkeepers. Every player has been analyzed with a K-AI live device 50Hz (K-Sport Universal STATS, Italy) in 857 pieces of training and 104 official matches for three regular seasons. These data were collected in groups with similar performance indexes (PI). All data have been analyzed with Dynamix Software, K-Sport Online. Data show that percentage very high intensity acceleration (%D_A8; >3m/s²) and very high intensity deceleration (%D_A1; < -3m/s²) are very large differences from during training session, respectively (ES: -1.63; p<0.05 and ES: -2.38; p<0.05) and during official match, respectively (ES: -2.11; p<0.05 and ES: 2.22 p<0.05). As regards the comparisons between seasons of the official competitions, there is an insignificant difference for all parameters between T1 and T2, which denotes a similar style of play and a similar level of preparation between the two seasons same athletic trainer and work volume physical between 32.9% and 35.4%. With an important all-out lactacid contribution without the ball in training 1 session per week for about 40 weeks. Instead between T1 and T3, the changes are statistically significant on all parameters in favor of T1 and between T2 and T3 in favor of T2. Also, this season the head fitness coach was the same but he worked between 7 and 10% less and the lactic acid work without the ball and with the ball was practically inexistent (0.07%).

Key Words: accelerations, decelerations, K-AI, sprints

Introduction

Modern elite football is getting more and more demanding in terms of the number of matches played during the season which may add extra physical and mental load to the players. A top-level European team used to play around 50 matches in the 2008/2009 season, and this number has increased to around 60 in the 2018/2019 season. In addition, for the most outstanding players, we also have to add the friendly matches as well as the international fixtures to the total. This may result in more than 70 matches played per season.

The UEFA Elite Club injury study with 36 top European clubs reported a 2.5-fold increase in training and match time between the 2001/2002 and 2013/2014 seasons, and this constitutes an elevated workload for the players. Football is likely to be played at higher speeds in the future with more dense periods of high-intensity efforts. An analysis of the FIFA World Cup finals between 1966 and 2010 reported an increase in the number of passes per minute by around 35% (from 11 to 15 passes/min) and an increase in the game speed, using ball tracking, by 15% (from an average of 8.0 m/s to 9.2 m/s). Assuming a similar trend in the future, the game speed will be increased by ~5% between 2010 and 2025 and by ~7% in 2030, reaching a value of around 9.8 m/s.

The number of passes per minute may increase to above 16 by 2030 from 10.7 in 1966 and 14.7 passes/min in 2010. About the match running distance, data from the English Premier League between 2006/2007 and 2012/2013 showed a ~20% elevation (~3% increase per year) in the distance covered at high intensity and a ~50% increase in the number of high-intensity actions.

The total sprint distance increased by 8% in the same period. Assuming a comparable trend for the season 2013/2014 and beyond, one would expect an additional increase of >40% in the distance covered at high-intensity running in 2030 compared with that covered during the 2012/2013 season. We assume that this trend observed in the English Premier League will be presented in other national football leagues too.

We suggest that tactical evolutions of the future game, predicated on models of high-intensity pressing, counter-pressing, and counterattacking, will result in greater exposure to intense, short accelerations and decelerations, interspersed between more high-speed running moments. Accordingly, the creation of high-intensity locomotor profiles may be especially insightful for individualizing load demands and accurately informing training prescriptions (Figure 1).

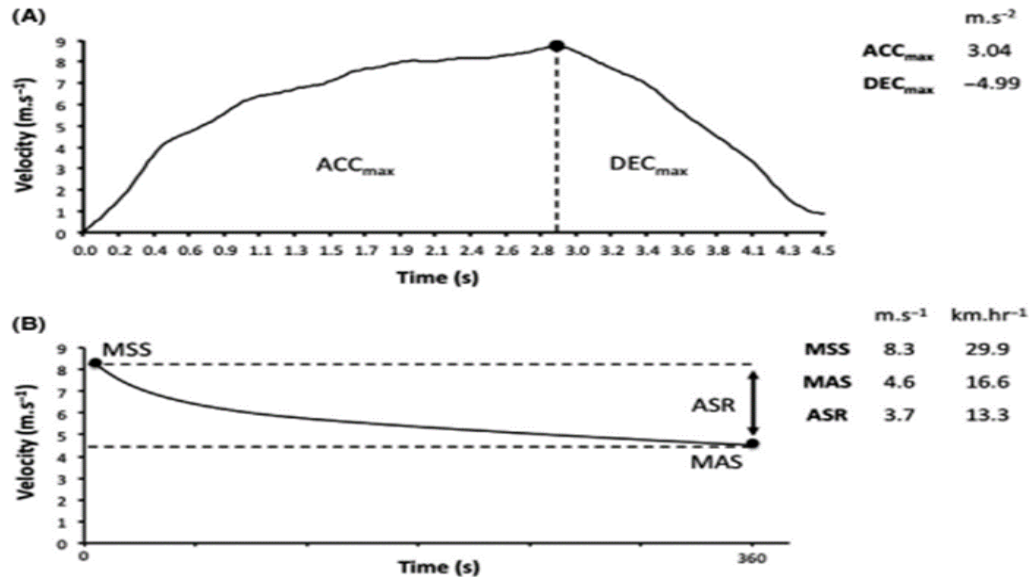


Fig.1. Example of individual high-intensity locomotor player profile (A), maximal acceleration (ACC_{max}) and deceleration (DEC_{max}), and (B) anaerobic speed reserve (ASR) calculated as the speed range between a player's maximal sprinting speed (MSS) and maximal aerobic speed (MAS)

Such a profile could include maximal: (1) acceleration, (2) deceleration, (3) maximal aerobic speed (MAS), and (4) maximal sprinting speed (MSS) metrics — with the latter two components enabling evaluation of ASR. Future players will also require concurrent improvements in high-speed decision-making. The future game will demand an increasing priority on “individualization.” We offer the locomotor profile as a key tool that may help us navigate the complexity of future game demands.

In this study, the goalkeeper profile isn't necessary, because our previous study has demonstrated that training load and movement must be analyzed with inertial sensors K-Track (K-TRACK/IMU K-Sport Universal STATS, Italy). However, the physical demands imposed by the respective positional role may result in different capacities to perform intermittent exercise

Material and Method

Eighty-seven (n=87) elite football players participated in this study (age 23.1±1.4; body weight 77.8±1.7; height 181.9±0.6; fat mass 10.7±1.5), without goalkeepers. Every player has been analyzed with a K-50 AI live device 50Hz (K-Sport Universal STATS, Italy) in 857 training weeks seasons and 104 official matches for three regular seasons. All data have been analyzed with Dynamix Software K-Sport Online.

To be included in the study, subjects had to 1) ensure regular participation in all the training sessions, 2) have competed regularly during the previous competitive season, and 3) possess medical clearance. Before entering the study, participants were fully informed about the study aims and procedures, and they provided written informed consent before the testing procedure.

The study protocol was conformed to the code of Ethics of the World Medical Association. The professional football team trained for approximately 1h30 five times per week (always on Monday, Tuesday, Wednesday, Thursday, and Friday) plus the official match was played on Saturday or Sunday. The acceleration and deceleration profile was analyzed to understand how and how the match affected the weekly load (Fig.2 and 3).

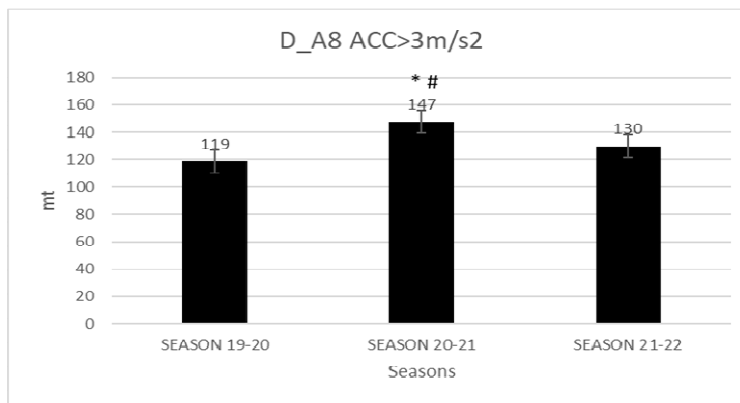


Fig.2. Average Distance Covered at Very High-intensity acceleration during weekly training (mean $\pm$ SD) (*ES:0.46; #ES: -0.29 p <0.05) Large, Moderate statistical meaningfulness.

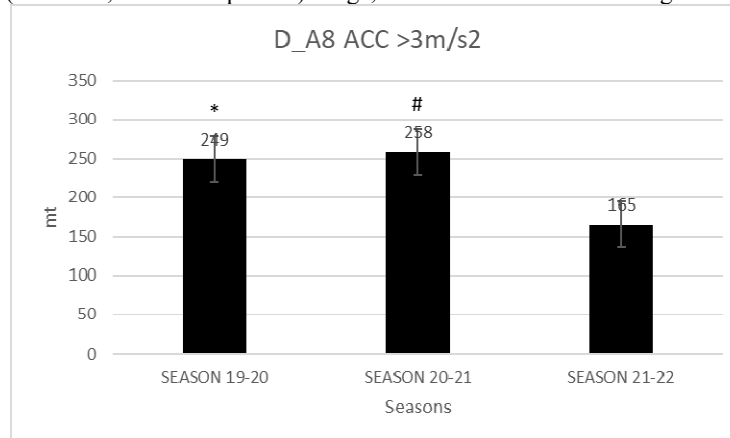


Fig.3. Average Distance Covered at Very High-intensity acceleration during officials matches (mean $\pm$ SD) (*ES:-2.46; #ES: -1.83 p <0.05) Very Large; Statistical meaningfulness.

Statistical Analysis

We analyzed variables with d-Cohen (effect size; ES), to compare two different parts of the season and Pearson's correlation coefficient (r). An alpha level of $p < 0.05$ was chosen. The statistical analyses were performed with SPSS (SPSS, Inc., Chicago, IL, USA). Data are presented as means $\pm$ standard deviation. The effect size dimension is low from 0 to 0.4, moderate from 0.5 to 0.6, and large from 0.7 to 1.0.

Results

The data obtained allow us to better understand what were the differences in the three seasons considered both in terms of training and in terms of official competitions. It is clear that between 2019-20 (T1) and 2020-21 (T2) seasons carried out within the same team, as regards the external load events related to the training, there were statistically significant differences between the % D_A8 and % D_A1, respectively (ES: 0.74 T1 vs T2 and ES: 0.58 T1 vs T2), with a large increase in T2 for both parameters.

This could indicate an increase in physical work without the ball with a lactic acid goal and accelerations in the second season for the same team (from 0.71 to 0.80%), but also a better adaptation of the players to the work proposed in the second season. Another hypothesis could be an increase in overall physical work (without the ball) from 32.9 to 35.4%. Same head fitness coach two different results with the same training method and with the same interpreters (Table 1.). Similarly, the comparison made between the 2019-20 (T1) and 2021-22 (T3) seasons shows a statistically significant difference from medium to large as regards the number of NU_A8 accelerations at very high intensity and respect. of very high-intensity ND_A1 decelerations (ES: 0.51 T3 vs T1 and ES: 0.71 T3 vs T1), in favor of the T3 season.

The training shows only this increase in the external load events examined and where the physical training without the ball is little compared to the other seasons 26.4% vs 32.9% and 35.4%.

We hypothesize that the use of very large playing surfaces (210-220m² per player) and the game model based on non-possession led to an increase in the braking and acceleration phases at the expense of the distance traveled in acceleration and deceleration and especially of the duration of the accelerations and decelerations. Also, this season the head fitness coach was the same but he worked between 7 and 10% less and the lactic acid work without the ball and with the ball was practically inexistent (0.07%) (Table 1).

SEASON 19-20 T1	Avg ± sd	ES T1vsT2	ES	ES T1vsT3	ES
Team Average-D_A1 (m)	101±33	-0,21	Small	0,08	Very Small
Team Average-D_A8 (m)	119±38	-0,46	Medium	0,27	Small
Team Average-NU_A8	21±9	-0,37	Medium	0,51*	Medium
Team Average-ND_A1	21±9	-0,27	Small	0,71*	Large
Team Average-T_A1 (s)	45±22	-0,08	Very Small	0,05	Very Small
Team Average-T_A8 (s)	51±25	-0,17	Very Small	0,14	Small
Team Average-%D_A8 (%)	2,5±0,6	-0,74	Large	-1,54	Very Large
Team Average-%D_A1 (%)	2,1±0,6	-0,58	Large	-1,51	Very Large
SEASON 20-21 T2	Avg ± sd	ES T2vsT1	ES	ES T2vsT3	ES
Team Average-D_A1 (m)	109±33	0,21	Small	0,17	Small
Team Average-D_A8 (m)	147±67	0,46	Medium	-0,29	Small
Team Average-NU_A8	27±19	0,37	Medium	-0,06	Very Small
Team Average-ND_A1	24±10	0,27	Small	0,38	Very Small
Team Average-T_A1 (s)	47±23	0,08	Very Small	-0,05	Very Small
Team Average-T_A8 (s)	57±35	0,17	Very Small	-0,07	Very Small
Team Average-%D_A8 (%)	3,4±1,5	0,74*	Large	-1,63	VeryLarge
Team Average-%D_A1 (%)	2,5±0,6	0,58*	Large	-2,38	Huge
SEASON 21-22 T3	Avg ± sd	ES T3vsT1	ES	ES T3vsT2	ES
Team Average-D_A1 (m)	104±28	0,08	Very Small	0,17	Small
Team Average-D_A8 (m)	130±33	0,27	Small	-0,29	Small
Team Average-NU_A8	26±8	0,51*	Medium	-0,06	Very Small
Team Average-ND_A1	28±8	0,71*	Large	0,38	Very Small
Team Average-T_A1 (s)	46±13	0,05	Very Small	-0,05	Very Small
Team Average-T_A8 (s)	55±14	0,14	Small	-0,07	Very Small
Team Average-%D_A8 (%)	1,7±0,3	-1,54	Very Large	-1,63	VeryLarge
Team Average-%D_A1 (%)	1,4±0,2	-1,51	Very Large	-2,38	Huge

Tab.1. Season Comparison: Weekly Training and Effect Size

As regards the other parameters, if we compare the T3 vs T1, a statistically significant difference can be deduced as regards the % D_A8 and % D_A1 respectively (ES: -1.54 and ES: -1.51) in favor of T1; this difference is even more marked between T3 vs T2, % D_A8 and % D_A1 respectively (ES: -1.63 and ES: -2.63), in favor of T2. (Tab.1). Our hypothesis confirms the fact that the percentage of acceleration and deceleration phases produced during training, which was moderately changed between T1 and T2, is completely reduced at T3. This confirms the literature data (Bangsbo J., Mohr M., 2014) for which role training and SEP and SEM lactation training are important for the improvement of the ability to repeat sprints and the ability to recover after a period of work done at high intensity.

Accelerations and braking were performed with ball work in T3, but few percentages and were not maintained over time, it is no coincidence that the all-out SEP and SEM work took up 0.07% of the training in T3, in practice the effect it was insignificant.

As regards the comparisons between seasons of the official competitions, there is an insignificant difference for all parameters between T1 and T2, which denotes a similar style of play and a similar level of preparation between the two seasons same athletic trainer and work volume physical between 32.9% and 35.4%. With an important all-out lactacid contribution without the ball in training 1 session per week for about 40 weeks. Instead between T1 and T3, the changes are statistically significant on all parameters in favor of T1 and between T2 and T3 in favor of T2 (Table 2).

Here too it confirms in the game that between T3 and T2 there is a statistically significant difference as regards the percentage of very high-intensity accelerations (% D_A8) (ES: -1.44) and between T3 and T1 (ES: -2.11). This confirms our previous hypothesis: the lack of general physical work to improve these qualities in T3 in favor of only ball work, which did not occur in seasons T1 and T2 (Table 2).

SEASON 19-20 T1	Avg $\pm$ sd	T1vsT2	ES	T1vsT3	ES
Team Average-D_A1 (m)	251 $\pm$ 50	0,24	Small	2,58	Huge
Team Average-D_A8 (m)	249 $\pm$ 45	0,13	Very Small	2,46	Huge
Team Average-NU_A8	37 $\pm$ 7	0,24	Small	0,94	Large
Team Average-ND_A1	55 $\pm$ 10	-0,10	Very Small	1,36	Very Large
Team Average-T_A1 (s)	109 $\pm$ 19	-0,08	Very Small	5,85	Huge
Team Average-T_A8 (s)	103 $\pm$ 16	0,18	Very Small	3,21	Huge
Team Average-%D_A8 (%)	2,7 $\pm$ 0,7	0,0	n.s.	2,11	Huge
Team Average-%D_A1 (%)	2,6 $\pm$ 0,7	-0,13	Very Small	2,16	Huge
SEASON 20-21 T2	Avg $\pm$ sd	T2vsT1	ES	T2vsT3	ES
Team Average-D_A1 (m)	238 $\pm$ 45	0,24	Small	2,41	Huge
Team Average-D_A8 (m)	258 $\pm$ 74	0,13	Very Small	1,83	Huge
Team Average-NU_A8	40 $\pm$ 15	0,24	Small	0,82	Large
Team Average-ND_A1	56 $\pm$ 8	-0,10	Very Small	1,73	Huge
Team Average-T_A1 (s)	111 $\pm$ 25	-0,08	Very Small	2,74	Huge
Team Average-T_A8 (s)	108 $\pm$ 32	0,18	Very Small	2,05	Huge
Team Average-%D_A8 (%)	2,7 $\pm$ 1,0	0,0	n.s.	1,44	Large
Team Average-%D_A1 (%)	2,5 $\pm$ 0,6	-0,13	Very Small	2,22	Huge
SEASON 21-22 T3	Avg $\pm$ sd	T3vsT1	ES	T3vsT2	ES
Team Average-D_A1 (m)	160 $\pm$ 11	-2,58	Huge	-2,41	Huge
Team Average-D_A8 (m)	165 $\pm$ 14	-2,46	Huge	-1,83	Huge
Team Average-NU_A8	31 $\pm$ 4	-0,94	Large	-0,82	Large
Team Average-ND_A1	44 $\pm$ 4	-1,36	Very Large	-1,73	Huge
Team Average-T_A1 (s)	65 $\pm$ 4	-5,85	Huge	-2,74	Huge
Team Average-T_A8 (s)	64 $\pm$ 5	-3,21	Huge	-2,05	Huge
Team Average-%D_A8 (%)	1,6 $\pm$ 0,2	-2,11	Huge	-1,44	Large
Team Average-%D_A1 (%)	1,6 $\pm$ 0,1	-2,16	Huge	-2,22	Huge

Tab.2. Season Comparison: Official Match and Effect Size

Physical Event Legend:

D_A1: distance covered at very high intensity deceleration $< - 3\text{m/s}^2$

D_A8: distance covered at very high intensity acceleration $> 3\text{m/s}^2$

NU_A8: number up at very high intensity acceleration $> 3\text{m/s}^2$

ND_A1: number down very high intensity deceleration $< - 3\text{m/s}^2$

T_A1: average time at very high intensity deceleration $< - 3\text{m/s}^2$

T_A8: average time at very high intensity acceleration $> 3\text{m/s}^2$

%D_A8: percentage distance covered at very high intensity acceleration $> 3\text{m/s}^2$

%D_A1: percentage distance covered very high intensity deceleration $< - 3\text{m/s}^2$

Discussion

Physical training in football cannot ignore its general component (Bangsbo J et al. 2020), in favor only of training with the ball and following the trends of the moment. Evidence-based training (EBT) is the key to improving the performance of professional and amateur football players and guarantees health and physical efficiency even in everyday life. Training is also carried out in the 24 hours of the day, not just in the hours spent on the pitch: the difference that makes the difference. Analyzing the three seasons considered (T1, T2, T3), poor physical efficiency in the acceleration parameters, fundamental in the game dynamics in T3, was heavily noted: football in 2030 (Nassis et al 2020), should have an increase of about 50% of very high-intensity actions: where can I go if I don't have athletes with the adequate physical condition? According to our hypothesis, there is a myth to dispel: if I work with the ball it is enough to condition the players and they have fun. We say that if we worked with the ball and supported this work with general training (without the ball), we would have better performing athletes who will hurt themselves less and above all, they will sustain greater workloads (e.g. increase in the number of games played in a year). Football is not a science, we know that it is a game, but at present, we believe that without adequate support and a correct interpretation of the data we move away from the goal, from what is scientifically demonstrated.

Conclusion

Player recruitment. Using analytics, emphasis should be to recruit the best and most robust players for position-specific team needs. To overcome the growing demands, players with mental resilience will have an advantage. Prepare the players for the future game. Players should perform sufficient high-intensity bouts in training with emphasis not only on the number of bouts but also on the density too (ie, number of high-intensity efforts within 1-2 minutes). Multicomponent training programs that include computational algorithms to individualize the risk of injury might be useful in protecting players from injuries especially of the hamstrings and groin region. Monitor and assess injury risk in real time. This may assist in decision-making with regard to playing formation and the usage of substitutes during match play. The integration of data collected with tracking systems with microsensor inputs in real time using artificial intelligence algorithms is likely to be essential. Focus on the most effective recovery methods. Positional and individual variability in fatigue and recovery patterns should be established. Maintenance of mental health will become a concern, and evidence-based strategies should be implemented to protect the player's health.

Correct communication between the coach and the technical staff, correct use and interpretation of external load data, raise awareness and educate coaches and players about the importance of general physical training and the importance of overcoming "fatigue", educate technicians and players in the culture of work, educate managers and sports directors on data analysis and the importance of training to improve. Enhance the figure of the physical trainer, who, being a collaborator, needs to be supported by the head coach.

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