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Original Article

Training load quantification in Italian professional football team third division (serie C 2021-2022); within and between microcycle comparisons.

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Abstract
The aim of this study is analyzed training load quantification in Italian Professional football club (Serie C 2021-2022), during a week with 1 match. Twenty-five (n=25) élite football players participated in this study (age 24.1±1.4; body weight 79.8±1.7; height 182.9±0.6; fat mass 12.1±3.5), without goalkeepers. Every player has been analyzed with a K-AI live device 50Hz (K-Sport Universal STATS, Italy) in 299 training and 39 official matches for regular seasons. The game week analyzed are 26 with 1 match on Saturday or Sunday. Data show that distance covered in sprint (D_S7 > 25km/h) is different respect to MD (match day) and MD-2; but the same in every day (MD+2; MD+3; MD-3) in all training, due probably to the lack of specific physical training during "strong day" of week (MD+2; MD+3; MD-3). In MD-2, gradually decreases training load, because is near to match day. Insted for distance covered at high intensity (D_S5 >20Km/h), is the same in MD+3 and MD-3 and different in other training and MD. This confirm there haven't been change in training load at high intensity during MD+3 and MD-3, as indicated by physiology of soccer. Weekly training load is completely flat, without undulatory trend: every day the same result in sprint distance and acceleration at very high intensity (MD+2; MD+3 ,MD-3). Infact during season, last 6-7 game week, acceleration and sprint are completely decreased: the concurrent decrease in the overall parameters may suggest a periodisation strategy that is able to compensate for the increased load derived from high-speed distances.
Key Words: GPS, training planning, performance, K-AI

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.5 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

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informing training prescriptions (Figure 1). 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. Practitioners are constantly trying to appropriately manipulate training content to optimize training outcomes and competitive performance, as well as mitigating injury risk.

Players must maintain a sufficient training stimulus to keep fit throughout the season, so practitioners must find an optimal balance between loading and freshness before the upcoming match, as well as a risk vs reward towards injury risk. Research on how training load fluctuates within and between microcyles across a full season could be of use for practitioners aiming to further their understanding of the training planning process. Little is known about differences in training load both within and between microcycles throughout a season in professional football. Such information could be beneficial to improve our understanding of weekly and seasonal load distribution in elite football and to understand the periodization strategies employed in professional football. Therefore, this study aimed to investigate the training load within and between microcycles during the competition phase in an elite professional football team. 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 Methods

Twenty-five (n=25) élite football players participated in this study (age 24.1±1.4; body weight 79.8±1.7; height 182.9±0.6; fat mass 12.1±3.5), without goalkeepers. Every player has been analyzed with a K-AI live device 50Hz (K-Sport Universal STATS, Italy) in 299 training and 39 official matches for entire season. The game week analyzed are 26 with 1 match on Saturday or Sunday. . 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.

Differences in load variables within microcycles were analyzed with one-way repeated measures ANOVA (SPSS, Inc., Chicago, IL, USA).An alpha level of $p< 0.05$ was chosen. Data are presented as means ± standard deviation.

The professional football team trained for approximately 1h30 five times per week (always Tuesday, Wednesday, Thursday, and Friday) plus the official match was played on Sunday. All players included in the study had to have a minimum of 75% of observed training session and familiarized with protocol. Before training session and match, players were equiped with a tracking device K-AI.

Results

From this data it is clear that in this parameters, there are no significant differences compared to the match as regards the very high intensity accelerations (> 3m / s²) between MD + 2, MD + 3, (high load days of the week) compared to to the Sunday match MD (145 ± 26 m and 152 ± 25 m vs 159 ± 19m) respectively (Table 1.). From the training carried out during the week, only 0.07% of cases involved very high intensity "all out" lactic acid work without the ball, with the aim of improving the accelerative performance of the team. This dosage was insufficient to improve match performance: the performance level of very high intensity accelerations was low compared to the parameters of the category (220 ± 45 meters), but above all the pace was the same as that of training. Basically, the training parameters had to be increased to develop greater match performance. The desirable data was to have a much higher performance in the match than in training, in which very little was done and often only with the ball. Going forward in the analysis it is clear that the run> 20 Km / h (at very high intensity) in the race (MD) was greater than that covered in the MD + 2, MD + 3, MD-3 and MD-2, but not there there are differences between MD + 3 and MD-3 which should be two completely different days at load level, so there is no statistically significant difference (244 ± 87m vs 242 ± 95m) (Table 1.). All this would have required more physical work on MD + 3 day of the aerobic-anaerobic type without the ball. Regarding the sprint parameter (> 25 Km /h) there is a difference statistically significant between all days of week and match (MD), with a non-significant difference between MD + 3 and MD-3 (44 ± 46 vs 41 ± 28), in practice no sprint, acceleration and explosive strength (0%) work has ever been carried out in the field that improve these parameters. So the game became the training not done during the week. According to the data obtained, the distance covered in sprints was remarkably small in the weekly training sessions compared to the average match requirements (38.5 m vs 118 m). The training / game ratio should be 1.7 between the high intensity produced in training and that in the game, here it stands at 1.3 in absolute values and at 0.30 in the values (see Sassi R. et al. 2022 unpublished data).

Tab.1. Mean ± SD values within microcycles

	MD+2	MD+3	MD-3	MD-2	MD
TD(m)	8944±992 a,c,d,e	8641±826 a,b,d,e	7947±1295 a,b,c,e	6816±1279 a,b,c,d	10071±958 b,c,d,e
D_S5 >20 Km/h (m)	346±253 a,c,d,e	**244±87 a,b,e**	**242±95 a,b,e**	182±55 a,b,c,d	398±80 b,c,d,e
D_S7 >25 Km/h(m)	41±25 a	**44±46 a**	**41±28 a**	28±18 a,b,c,d	118±35 b,c,d,e
D_A8 >3 m/s² (m)	**145±26 e**	**152±25 e**	138±29 a,e	116±21 a,b,c,d	159±19 e

Abbreviations: MD = match day, MD+2 = match day + 2, MD+3 = match day + 3, MD-3 = match day -3, MD-2= match day -2, MD= match day. TD= Total distance covered; D_S5: distance covered at high intensity >20 Km/h; D_S7: distance covered in sprint >25Km/h; D_A8: distance covered at very high intensity acceleration >3m/s². a = different from MD; b= different from MD+2; c= different from MD+3; d= different from MD-3; e= different from MD-2.

Another methodological aspect that can be showed from this data are the percentage differences of external load during week compared to Match Day (Fig.1.). The distance covered above 20 Km /h it can be seen that in the MD+2 is 87% of the game average is reached 48 hours after the previous game, on a day in which the players have not fully recovered from the point of view of muscle glycogen and cumulative fatigue. The same can be seen for very high intensity accelerations greater than 3m/s² (91% of match distance). This indicates a considerable load on the MD+2 compared to the MD+3 where, the players have completely recovered from the previous match and could work more: instead, 61% of very high intensity above 20 Km/ h and 95% accelerations are made above 3 m/s².

The ideal was to reverse the training days (MD + 2 to MD + 3 and vice versa), with a more balanced schedule that respects post-match physiological recovery. In all this, the sprint distance (>25Km/h) is practically flat: there are not volumes capable of generating significant improvements in match performance (32.7% of the average match). With regard to very high intensity accelerations >3m/s² the percentage distribution should be revised and reversed on the day MD + 2 with MD + 3. We can see how they are present, but not well distributed (Fig. 1).

The analysis of the percentage distribution (Fig. 2) in the training weeks, highlights a constant increase in the% of distances covered above 20 Km/h with a statistically significant decrease in the last 4 weeks of the season (P <0.05). The distances covered in sprints (> 25 Km/h) remained constant throughout the season, without undergoing significant changes, essentially a few percentages from the beginning to the end of the season, confirming what we have analyzed above. The data that has undergone the greatest change are the accelerations above 3m/s² which have undergone a statistically significant reduction in the last 6 weeks of the season: confirming the total absence of additional work without the ball in favor of work with the ball that did not bring the desired adaptations (p <0.05).

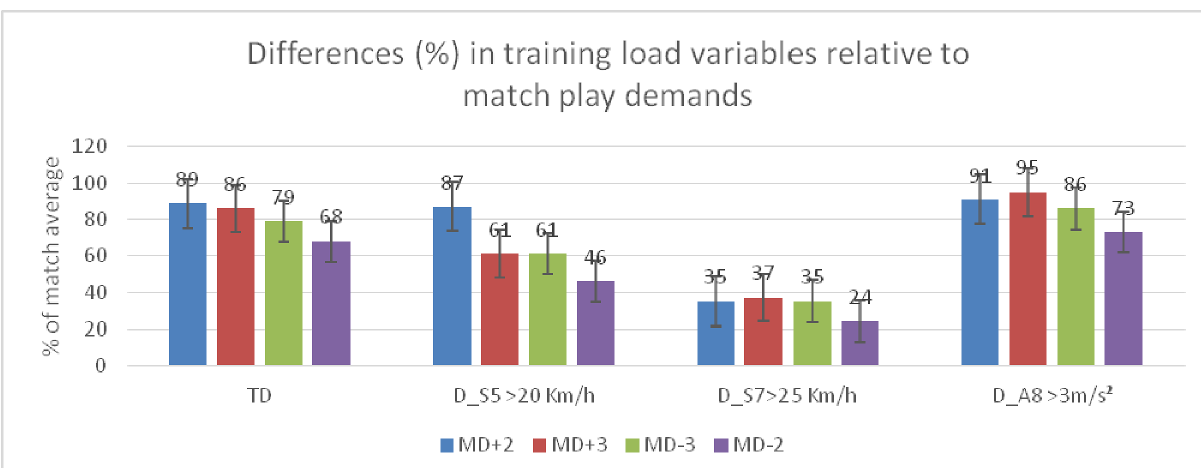

Fig.1. In-week differences in training load variables relative to match play demands. Data are presented as mean ± SD. Abbreviations: MD+2 = match day + 2, MD+3= match day + 3; MD-3= match day -3, MD-2 = match day -2. TD= Total distance covered; D_S5: distance covered at high intensity >20 Km/h; D_S7: distance covered in sprint >25Km/h; D_A8: distance covered at very high intensity acceleration >3m/s²

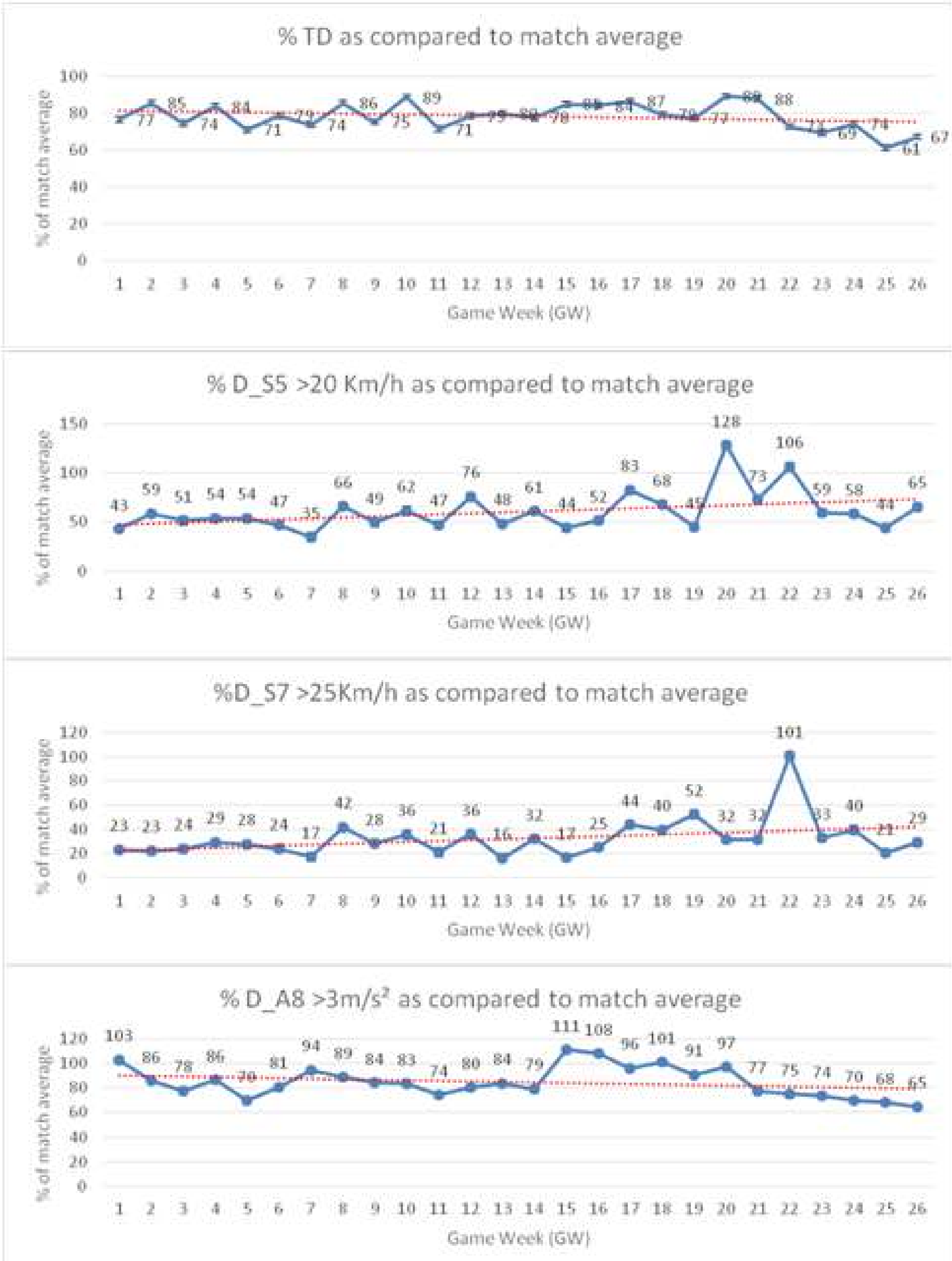

Fig. 2. Distribution and alterations in A) Total distance covered; B) D_S5: distance covered at high intensity >20 Km/h; C) D_S7: distance covered in sprint >25Km/h; D) D_A8: distance covered at very high intensity acceleration >3m/s² throughout the competition phase, expressed as relative to match play demands. Data are presented as mean ± SD. Abbreviations: GW= game week. **Physical Event Legend:** TD(m): total distance covered, D_S5(m): distance covered at very high intensity >20 Km/h, D_S7(m): distance covered in sprint >25Km/h, D_A8(m): distance covered in very high intensity acceleration > 3m/s²

Discussion

This study aimed to investigate the differences within and between microcycles throughout a season in a professional football club (Italian 3rd division). The main findings were decreased in all parameters leading up match play (D_S5, D_S7,D_A8), statistically meaningfullness ($p<0.05$) (Fig.1.). According to previous articles and research weekly training load it should be floating with differences on every training day. In our case there have not fluctuaction in all parameters, day by day until match day (MD) there are only decreases percentage of match average, (e.g. sprint distance >25 Km/h is flat!). Our analysis shows how it's necessary to have more training load in MD+3 respect to MD+2 (very high intensity distance >20 Km/h, acceleration > $3m/s^2$ and sprint > 25 Km/h). It's impossible to create adaptations without correct distribution of training. In practice we trained on average without reaching peaks!

In fact during season, last 6-7 game week, acceleration and sprint are completely decreased: the concurrent decrease in the overall parameters may suggest a periodisation strategy that is able to compensate for the increased load derived from high-speed distances.

Conclusions

These findings can be used as a reference load for practioners planning micro and macrocycles in professional football. When evaluating microcycle and macrocycle load, a combination of internal and external training load is needed. 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. 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. In conclusion to avoid a drastic decrease in physical performance in the final part of season, it is necessary to create the specific bases from the aerobic-anaerobic system during in-season week and increase the all-out sprint training at least once a week (about 20-25 training session to improve and to maintain performance). Furthermore Ratio T/M (distance covered in sprint (>25km/h) during training / distance covered in sprint during match it must be a least (x1.7-2.1), to have positive adaptations and reduce injury risk.

Author Contributions:

Conceptualization: Izzo R., Giovannelli M.
Methodology: Giovannelli M., Izzo R.,
Validation: Giovannelli M., Cejudo A.
Formal analysis: Giovannelli M.
Investigations: Izzo R., Giovannelli M., Cejudo A.
Data curation: Giovannelli M., Cejudo A.
Statistical analysis: Izzo R., Giovannelli M.
Writing, original draft preparation: Giovannelli M., Izzo R.
Writing, review, and editing: Izzo R., Giovannelli M.

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