Managing high-speed running load in professional soccer players: The benefit of high-intensity interval training supplementation

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HIIT | Soccer | Top-up | Monitoring

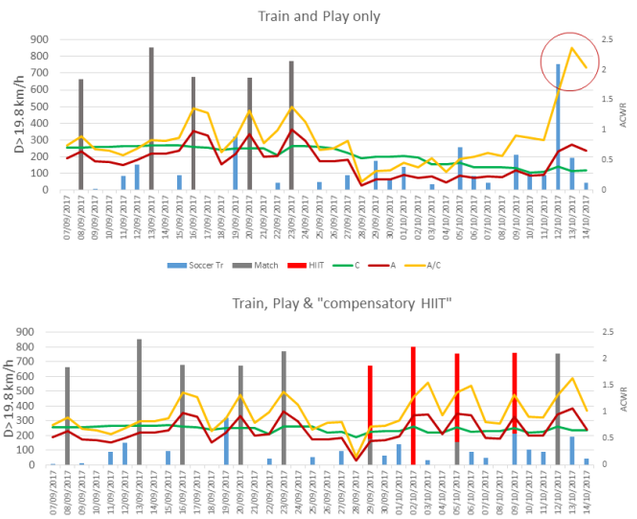


Fig. 1. High-speed running distance (>19.8 km/h, HSR) covered during training and matches (upper panel), and training, matches and supplementary high-intensity interval training (HIIT) (lower panel) in a midfielder (22 y-old, playing in a 1st division club) during a 5-week in-season period. The acute (A) and chronic (C) loads are calculated over 5 and 20-d periods, respectively. ACWR: A/C workload ratio. A spike (A/C >2) in HSR is shown with the red circle. GPS (training) and semi-automatic (matches) locomotor data were integrated with calibration equations (6). *Note that while the match sequence is real, the actual dates have been changed to ensure anonymity.*

Headline

Despite the current debate surrounding the feasibility (1), calculation (2) and overall value of the acute/chronic workload ratio (ACWR) for predicting injury incidence (3), it's well appreciated that we should maintain a stable and constant training stimuli to keep players fit and healthy. Conversely of course, large spikes in load, and especially in high-speed running (HSR) load, which may share an association with hamstring injuries (4), should be avoided. Additionally, results from a recent systematic review and expert-led Delphi survey of key football performance practitioners operating in teams from the Big 5 Leagues (Bundesliga, English Premier League, La Liga, Ligue 1, Serie A) have shown HSR management to be the most valued strategy for preventing lower-limb injuries (5).

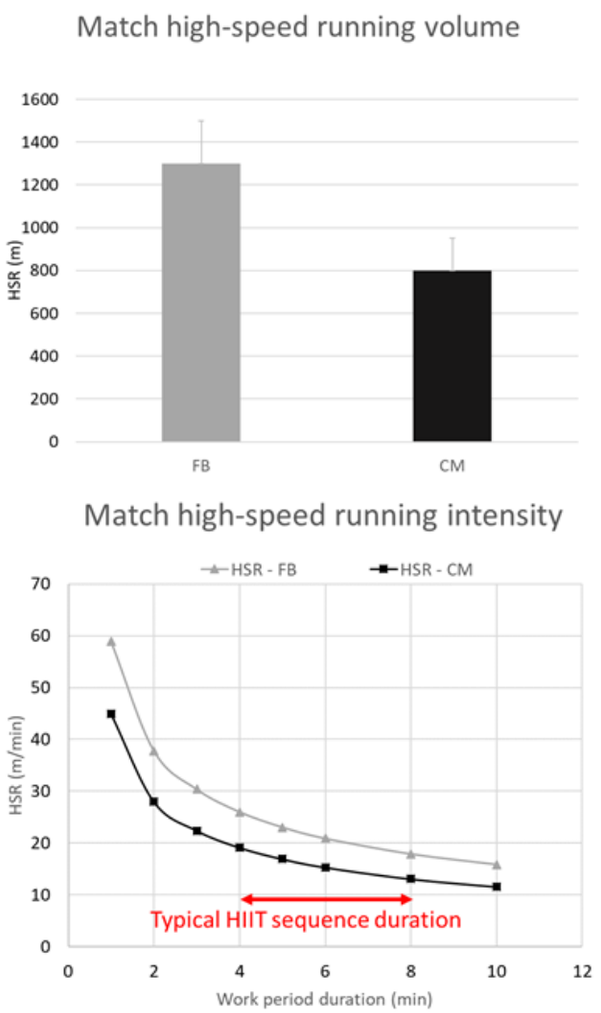
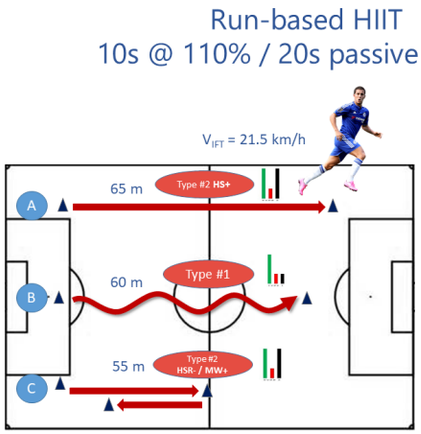


Fig. 2. HSR volume (left panel) and peak intensity (right panel) as a function of different durations during matches for two positions (full back, FB; center midfielder, CM). Not surprisingly, the shorter the time period, the greater the peak HSR intensity. Also apparent is that in addition to a greater volume of HSR, FB show also a greater peak intensity of HSR compared with CM, irrespective of the period of interest. Adapted from (7).

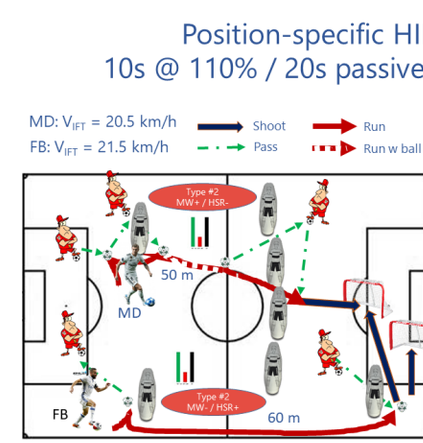
Aim

It is with this particular view of HSR management that this short white paper was written. Here, I will place special emphasis on the importance of high-intensity interval training (HIIT) supplementation. Guidelines for HIIT programming in terms of physiological targets, format, volume and intensity will also be provided.



TD (m)	MW (A.U.)	HSR (m)	HSR (m/min)
780	3	600	100
720	3	0	0
540	6	420	70

Fig. 3. Example of three HIIT sequences with short intervals (10-s run/20-s passive recovery periods), performed either with or without turns at different angles to modulate both the amount and nature of the neuromuscular load (i.e., HSR and mechanical work, MW), which leads to variation between Type #1 vs. Type #2 – this later being oriented either toward HSR or MW. The associated locomotor responses analysed by GPS are provided for each 6-min sequence, as if the same running pattern was to be repeated 12 times (e.g., 12 x pattern A). TD: total distance, HSR: high-speed running >19.8 km/h, MW: > 2ms^2 accelerations, decelerations and changes of directions. V_{IFT}, Velocity achieved during the 30-15 Intermittent Fitness Test (10). Degree of contribution from oxidative (O2), anaerobic (Ana) and neuromuscular (Neuro) systems are shown by the degree of green, red and black bars, respectively. Adapted from (8).



TD (m)	MW (A.U.)	HSR (m)	HSR (m/min)
600	9	200	33
720	6	460	77

Fig. 4. Example of two position (midfielder, MD and full back, FB) -specific HIIT with short intervals (10 s/20 s format, Type #2), based on V_{IFT}. The associated locomotor responses analysed by GPS are provided for each 6-min sequence, as if the same running pattern was to be repeated 12 times. The FB can't progress because of an opponent (dummy), so he passes the ball to a coach/partner playing as a central defender, then runs along the sideline to receive from a 2^{nd} coach/partner another ball close to the box where he shoots into one of two mini goals (as if he was crossing). The MD comes close to the central defender to receive the ball, then to eliminate a defender passes and receives to/from a coach/partner situated on the side line as a FB, before running forward with the ball where he passes to a 2^{nd} coach/partner and finishes his run toward the box, shooting into a mini goal. Note the large differences in terms of HSR and MW between the two position-specific efforts, which likely matches their match-specific loading targets (9). TD: total distance, HSR: high-speed running >19.8 km/h, MW: mechanical work > 2ms^2 accelerations, decelerations and changes of directions). V_{IFT}, Velocity achieved during the 30-15 intermittent fitness test (10). Degree of contribution from oxidative (O2), anaerobic (Ana) and neuromuscular (Neuro) systems are shown by the degree of green, red and black bars, respectively. Adapted from (8).

Problem

The upper panel of Figure 1 shows the in-season HSR distribution measured in a midfielder during both training and matches over a 5-week congested match period. While he repeatedly performed 600-800m of HSR during the 5 first consecutive matches of that period, the coach decided to rest him for the 6^{th} match (26^{th} of September, bench). He then played 30 min as a sub on the 29^{th}, was not selected in the squad on the 2^{nd} of October (cup match for which he wasn't qualified), played again as a substitute on the 5^{th} of October, remained benched on the 8^{th} (away game), before finally playing another full match on the 12^{th}. If we were to only consider the loading pattern of HSR consecutive to his exclusive participation to training and matches, a spike would have been inevitable from the load associated with the full match on the 12^{th} of October (i.e., ACWR >2).

Remediation strategy

The lower panel of Figure 1 offers a viable strategy as to how HIIT supplementation (i.e., so-called compensatory training) permits the maintenance of HSR loading throughout the pe-

riod where the player did not play much. While no HIIT was programmed on the 26^{th} to enable recovery, compensatory HIIT sessions were implemented subsequently in various contexts during the period of reduced match participation. The detail of the HIIT sequences, in terms of both the HIIT Type and format is provided in Figure 5 and 6. The simple addition of four short HIIT sequences allowed the maintenance of a stable HSR load, which logically prevented the occurrence of a spike in load on the 12^{th} of October, when the player completed a full match after a period of reduced match participation. This simple but likely efficient compensation strategy was either implemented on the fly, immediately after the match when the time and location allowed for it, or the following day at the training ground when the substitutes trained.

HSR volume to be "compensated"

The appropriate volume target of HSR needs to be defined at the individual level, based on typical match demands (Figure 2). Then, the volume can be subsequently adjusted based on the day's context, i.e., whether the player had already performed some HSR as a substitute or not at all if he remained on the bench (Figure 6). In practice, the actual HSR volume of a given HIIT sequence can be easily manipulated and is related to the HIIT Types and formats chosen. I recall for the reader that HIIT Types refer to the physiological targets of the HIIT sequences, representing the degree of aerobic, anaerobic (lactic) and neuromuscular responses (8), while the formats refer simply to the work actually performed in terms of the distance, time and number of repetitions (8). While Type #2 (high aerobic and neuromuscular demands, low anaerobic contribution) or #4 (high aerobic, neuromuscular and anaerobic contribution) are required to incorporate HSR, they can be run-based without the ball (Figure 3 and 5, especially when performed soon after the match on the pitch), or with ball integration (Figure 4, likely individual and substitute training). These Type #2 and #4 sequences are often supplemented with technical/tactical drills, or even Type #1 HIIT sequences (high aerobic but low neuromuscular and anaerobic contribution) when necessary to increase the degree of metabolic conditioning without the neuromuscular load.

HSR intensity – worth considering?

An important point that has received very little attention in the literature so far is that for most of the HIIT options presented here, the actual HSR intensity (33 to 100 m/min of HSR over 6 min, Figure 3 and 4) tends to be far superior to that of peak match demands during similar durations (20-25 and 15-20 m/min over 4 and 6 min, respectively, Figure 2). In other words, when compensating HRS volume with HIIT (Figure 1), what is generally covered in a 90 min match is achieved in less than 15 min with HIIT. This means that match-specific HSR intensity is easily overloaded using HIIT – the question now being – "how much does this really matter in terms of fitness development, match preparation and injury management?" While evidence is still lacking, it may be logical to assume that extreme overload of HSR intensity (e.g., 100 vs. 15 m/min) may not be needed (or should even be avoided). Breaking such HIIT sequences into smaller effort sequences (e.g., 1-2 min of HIIT, then a rest period, then another short HIIT bout again) may lower HSR intensity near that of actual game intensity. However, the cardio-respiratory response may, in contrast, not be sufficient to enable desired adaptations (8). Practitioners may therefore need to decide on what needs prioritizing in the individual i.e., metabolic conditioning (longer HIIT sets $\geq$4-6 min) versus match-specific HSR intensity (multiple shorter HIIT sets $\leq$2-3min). Alternatively, mixing different running patterns within the same HIIT block represents a viable option, such as alternating runs with large amounts of HSR (pattern A, Figure 3 and 5) and runs where HSR is limited or even absent (Pattern B, Figure 3 and 5). For example, if straight-line and zig-zag runs with various levels of changes of directions are alternated over 6 min, the volume and intensity of HSR can be dropped from approx. 600m and 100m/min (straight-line only) to 300m and 50m/min, respectively. Similarly, if position-specific runs are alternated with different patterns/types of efforts (with or without the ball, including various turns, dribbles, passing) that prevent the attainment of high speeds, HSR running intensity can be dramatically reduced and made near equal to match intensity demands. In addition to be closer to match HSR intensity, this approach can allow players to exercise for longer periods of time without accumulating excessively large HSR volumes, which in itself could create a spike in load. For example, if a MD was to repeat 2 set of 6-min HIIT (2 min recovery) including only straight-line runs, which in effect is only a moderate HIIT dose (8), he would likely cover >1.2 times his usual match running distance in no more than 14 min!

Summary

In substitute or bench players, HIIT supplementation immediately after matches or the following day is a practical and likely efficient strategy for the maintenance of a stable HSR load over the weekly cycle. Both the volume and intensity of HSR should be tailored for the individual (position and style of play) using typical locomotor match profiles (Figure 2). In practice, HSR volume can be tailored via both the absolute number of run repetitions and the pattern of these efforts (either with or without changes in direction that directly modulate HSR, Figure 3 and 5). While there is little evidence concerning the most appropriate HSR intensity for fitness maintenance, match preparation and injury prevention, it makes intuitive sense to avoid a too high match intensity overload; this can be achieved while adapting running patterns within each HIIT block (Figure 5). It is however worth noting that a volume of HSR accumulated across a 90 min match likely represents a different physiological and biological load than that accumulated in less than 15 min (HIIT) – whether both have the same effect on injury rate is unknown. I believe therefore it may be time for researchers to consider further the importance of the HSR intensity, and not simply its volume (12), when it comes to examining the relationship between load management and injury incidence. Finally, it could be argued that if the compensatory strategy presented in this case study is implemented successfully, computing the ACWR may might not actually be required. Nevertheless, the ACWR might still be a useful guide for deciding on the most appropriate volume of HSR running needed for the compensatory prescription (e.g., 400 vs 800m).

Position	*Pattern (Figure 3)*	*# Repetitions*	*Distance/run (m)*	*HSR/run (m)*	*HSR volume (m)*	*HSR intensity (m/min)*
MD	A	4	65	50	200	100
	B	2	60	0	0	0
Match volume: ~800m	C	6	55	35	210	70
Peak 1-min Intensity: 45 m/min	HIIT block	6 min	710		410	68
	Full compensatory session	6min + 4min (2xB & 6xC) (r=2min)	1160		**650**	**52 (over 12 min)**
FB	A	8	65	50	400	100
	B	0	60	0	0	0
Match volume: ~1300m	C	4	55	35	140	70
Peak 1-min Intensity: 60 m/min	HIIT block	6 min	740		540	88
	Full compensatory session	6min + 4min (6xA & 4xC) + 2min (4xA) (r=2min)	1500		**1110**	**69 (over 16 min)**

Fig. 5. Examples of two position-specific run-based Type #2 HIIT sequences and consecutively, the associated overall daily session. *HSR: high-speed running. Letters refer to the running patterns shown in Figure 3. All runs are performed at 110% of player's V_{IFT} (speed reached at the end of the 30-15 Intermittent Fitness Test (10)) that is 21 km/h in this exemple – with running distance reduced as a function of the nature and number of changes of direction (11). r=2min: 2 min of recovery between sets.*

Date	*Training HSR (m)*	*Match Status*	*Match HSR (m)*	*HIIT HSR (m)*	*HIIT Type and Format*
26/09/2018	0	Bench	0	0	
27/09/2018	91				
28/09/2018	0				
29/09/2018	0	Sub (30 min)	175	500	Directly on the pitch after the home game, run-based without the ball ✓ Type #1: 8 x (20s run 45°-COD slalom @90% V_{IFT}/ 10s passive recovery) = no HSR ✓ Type #4: 10 x (15s @95% V_{IFT} / 15s active-jog recovery) = 500 m HSR
30/09/2018	65				
01/10/2018	138				
02/10/2018	1	Not selected	0	800	Individual session at the training ground ✓ Type #2: position-specific HIIT with the ball (5s run / 10s passive rest). Depends on set-up, likely 2 x 10 reps = 300 m HSR ✓ Type #4: run-based without the ball, 10 x (15s @95% V_{IFT} / 15s active-jog recovery) = 500 m HSR
03/10/2018	34				
04/10/2018	0				
05/10/2018	0	Sub (30 min)	153	650	Directly on the pitch after the home game, run-based without the ball ✓ Type #2: as per Table 1 for MD = 650 m HSR
06/10/2018	86				
07/10/2018	46				
08/10/2018	0	Bench	0		Away match and since the next game was in 4 days, no HIIT was performed that day
09/10/2018	209			550	After technical session of the subs at the training ground ✓ Type #2: position-specific HIIT with the ball (10s @110% V_{IFT} / 20s passive rest). Depends on set-up, likely 2 x 12 reps = 550 m HSR
10/10/2018	106				
11/10/2018	90				
12/10/2018	0	Starter (Full match)	756		
13/10/2018	192				
14/10/2018	44				

Fig. 6. HIIT programming during the period of reduced match participation. *HIIT: high-intensity interval training. HSR: high-speed running. V_{IFT}: speed reached at the end of the 30-15 Intermittent Fitness Test (10). HIIT Types refer to the physiological targets of the sequences, indicating the degree of aerobic, anaerobic (lactic) and neuromuscular responses (8). Formats refer to the work actually performed, in terms of the distance, time and repetition number (8). Note that while the match sequence is real, the actual dates have been changed to ensure anonymity.*

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