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Internal training load and its longitudinal relationship with seasonal player wellness in elite professional soccer

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ABSTRACT

Monitoring internal training load has been extensively used and described within team sport environments, however when compared to internal physiological measures such as heart rate (HR) and rating of perceived exertion (RPE), the literature is sparse. The primary aim of this investigation study was to assess differences of playing position on ITL, session-RPE and wellness across two different training microcycles (1 vs. 2 competitive games), in addition with examining the relationship between ITL and Hooper's Index across an entire season. Thirty-five professional soccer players from the Portuguese premier league participated in the study (25.7 ± 5.0 years; 182.3 ± 6.4 cm; 79.1 ± 7.0 kg). Analysis of variance revealed higher values of DOMS (Means(M): 3.33 vs. 3.10; $p = 0.001$; effect Size (ES) = 0.087), fatigue (M: 3.18 vs. 2.99; $p = 0.001$; ES = 0.060) and HI (M: 11.85 vs. 11.56; $p = 0.045$; ES = 0.034) in 2-game weeks compared with 1-game weeks. Correlation between ITL and HI levels found significant negative correlations between ITL and DOMS ($\rho = -0.156$), ITL and sleep ($\rho = -0.109$), ITL and fatigue ($\rho = -0.225$), ITL and stress ($\rho = -0.188$), and ITL and HI ($\rho = -0.238$) in 2-game weeks. Results from 1-game microcycle only highlighted negative correlations between ITL and stress ($\rho = -0.080$). It was concluded from the study that greater fatigue potential, muscle soreness, stress and ITL was significantly more apparent within a 2-game microcycle. As a result, care should be taken when planning the lead into and out of a 2-game fixture microcycle highlighting key specific recovery strategies to damped the increased stress effect. Additionally, the potential utilization of squad rotation strategies may be a positive approach with aim of managing the fatigue effect.

1. Introduction

Monitoring internal training load has been used extensively and well discussed in sports, especially in team sports [1]. Additionally, compared to internal physiological measures, such as heart rate (HR) and rate of perceived exertion (RPE), other measures of physiological status are less known. Recent literature has reported the use of the Hooper index [2] as a reliable method for the monitoring of athlete wellness providing further information concerning the detail of player fatigue, stress, muscle soreness and sleep perception. The Hooper index has recently been utilized to monitor player wellness during a 4-day FIFA international futsal tournament [2] in addition with a 2-month study on cycling performance [3]. However, apart from the aforementioned studies, the relationship between use of the Hooper index and session-RPE is limited amongst the research. One investigation observed no association between the Hooper index and RPE [4], however, further research is needed in this subject to validate the findings further.

Recent literature using team sport players competing in one game microcycle have shown that internal training load might be more intense towards the beginning of the microcycle as a way to ensure fatigue is minimal close to competitive match play [5–7] and a one-month mesocycle [8]. However, competing in 2-game microcycles occurs often in team sports such as soccer, when teams are more successful based on their need for domestic and European competition [6,9]. A recent study also suggests that there are evidences of a negative impact of a longitudinal fixture congestions cross the season [10]. Only a few studies have so far investigated the quantification of training of

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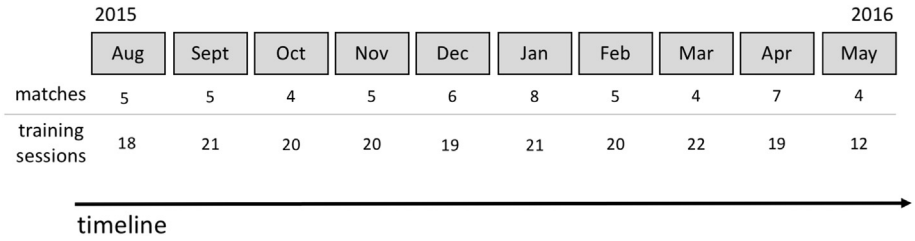

Fig. 1. Timeline of the study.

microcycles varying for scheduled matches focusing on the external load, i.e. distance covered per training unit [6,11,12].

The effect of game and training load on fatigue have been also analyzed in the context of soccer [13,14]. The immediate effect of a game is to reduce the maximal voluntary contraction and increase the muscle soreness [15]. Decreases in repeated sprint ability after the game is also commonly observed [16,17]. However, the extension of the fatigue effect after game or training seems to be influenced by the competitive level in which elite recover faster than amateur players [15].

The daily training load may also constrain the perception of fatigue and the risk of illness and injury [18]. In a study conducted in elite soccer players it was found that ratings of fatigue were sensitive to fluctuations in acute total high-speed running distance accumulation [19]. Moreover, the high perception of leg muscular effort after high training volume can impair the improve of physical fitness variables [20]. The quality of sleep and the stress are also sensitive to the training volume [21].

Although the abovementioned research has enhanced our understanding of the variation of fatigue in different periods, namely identifying some decreases in performance variables [9] and the association of training load with quality of life variables, we believe that is still necessary to cross in a single study the variables of training load, perception of fatigue, stress, muscle soreness and stress and analyze such variance in different types of week. Such information would be of practical and theoretical value for coaches and researchers, respectively, as it may help coaches tailor training sessions with the aim of minimizing fatigue and lead to the player's perceptions. Therefore, as a result of the limited investigations in this area, the aim of this study was to i) to analyze the microcycle variance using the Hooper index scales amongst positional roles (1 vs 2 games per week), and ii) study the association between internal training load (ITL) and Hooper index scales.

2. Methods

2.1. Participants

Thirty-five professional soccer players from the Portuguese premier league participated in this study (25.7 ± 5.0 years; 182.3 ± 6.4 cm; 79.1 ± 7.0 kg). Two inclusion criterions were selected to analyze the variance of HI and ITL between microcycles: i) ensure regular participation in the majority of training sessions (80% of weekly training sessions); ii) possesses medical clearance at the beginning of the microcycle to participate in full training. The study of HI levels between weeks with one or two matches met the following criteria: i) completing at least 75 min in three consecutive games to be included in the analysis of the week(s). The study was approved by the local institute's research ethics committee and written informed consent was obtained from each player before participation. The study followed the ethical recommendations for the study in humans as suggested by the Declaration of Helsinki. All the players were accustomed to the daily procedures used in this research as part of their habitual training routines.

2.2. Design

A correlational research design was used to test the relationships between internal load and the variables of sleep quality, perception of fatigue, stress and muscle soreness (DOMS). Analysis of variance design was used to test differences in dependent variables of internal load and Hooper index between the factors (independent variables): i) microcycle (1 vs. 2 game weeks); and ii) playing positions (GK: goalkeeper; WD: wide defender; CD: central defender; MF: midfielder; WMF: wide midfielder; FW: forward).

2.3. Experimental procedures

Training data were collected during the entire season (Fig. 1) which commenced August 2015 and ended at May 2016 (European schedule).

All training programs were planned by the coach and staff and the researchers only standardized the first 30 min and the final 30 min before and after session. The wellness questionnaire and session-RPE questionnaire were applied in the beginning and in the end of the session, respectively. The familiarization of the subjective scales (Hooper's Index and session-RPE) was held during the pre-season period. Two types of training microcycle (TM) were analyzed in this study: i) week with one official match; and ii) week with two official matches. Playing positions were codified in: i) goalkeeper (GK); ii) external defender (ED); iii) central defender (CD); iv) midfielder (CMF); v) external midfielder (EMF); and vi) forward (FW).

2.4. Hooper index (HI)

Approximately 30 min before each training session, each player was asked to rate the perception of the quantity of fatigue, stress and DOMS and quality of sleep of the night that have preceded the evaluation. The hooper index scale of 1–7 [22] was used in which 1 is very, very low and 7 is very, very high (for stress, fatigue and DOMS levels) and 1 is very, very bad and 7 is very, very good (for sleep quality). The Hooper Index is the summation of the four subjective ratings.

2.5. Session-RPE and internal training load (ITL)

The session-RPE was collected approximately 30 min after each training session. The Borg's CR-10 scale was applied (1 is very light activity and 10 is the maximal exertion) in order to determine the perception of effort made during the training. The value rated by the player was multiplied by the time of session in minutes (from warm-up until the last moment of cool-down) as suggested by previous studies [23,24]. Match data was not considered for use within the investigation.

$$\textit{Internal Training Load}\ (ITL) = \textit{session} - \textit{RPE}\ (AU) \times \textit{training duration}\ (\textit{mins})$$

Each player rated the session-RPE in an individual portable computer tablet (Microsoft Surface Pro 3, USA) with a custom-designed application, where the subjects were able to answer the scales. This application was specifically developed for HI and session-RPE. Each