

DOES THE WORKLOAD ACCUMULATED BY FOOTBALL PLAYERS HAVE AN EFFECT ON PERFORMANCE IN COMPETITION?

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Abstract: *The aim of this study was to analyse the correlations between internal and external load accumulated in periods of 4 weeks (current+3-weeks previous) and competitive performance in football. The study was conducted in a Spanish semi-professional football team during the 2020/2021 season (22 football players; age 23.21±4.22 years, weight 74.98±5.78 kilograms and height 1.79±0.06 meters). The study was conducted over a full season where participants were daily monitored. All subjects participated voluntarily and anonymously, providing informed consent. This study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. The devices used were 10Hz Playertek+ GPS/GNSS with inertial system and the 6-20 points version of the Rate of Perceived Exertion (RPE). The variables used to assess the internal and external workload of the players were: total distance (TD m), high-speed running >21km/h (HSR; m), total Player Load (PL; UA) and session-RPE (s-RPE; session minutes*RPE). All external workload variables over the course of the season, TD ($p \leq 0.001$; $r = 0.23$), HSR ($p \leq 0.001$; $r = 0.48$) and PL ($p \leq 0.001$; $r = 0.30$), showed significant correlations between cumulative workload and competitive performance in HSR; however, this was not the case for internal load measured with s-RPE. Cumulative workload over 4-week periods appears to be significantly related to HSR performance in competition. High intensity actions and their magnitude become relevant to performance and competitive success in football and this finding should be further investigated in future research. Monitoring is essential for coaches in order to obtain information and prepare the athlete, in optimal conditions, for competition.*

Key words: soccer; monitoring; training; high-speed running; match.

INTRODUCTION

Training load monitoring allows professionals to assess and understand, adjust and optimally prescribe the volume and intensity of loads for athletes (Gabbett, 2016). Through this process, it is possible to identify the physical stimuli that optimise athletes' performance and reduce the risk of injury (Clemente et al., 2020; Huling et al., 2016).

Currently, there is no universally recognised gold standard for measuring football performance (Akenhead & Nassis, 2016). The integrated approach of internal and external loads provides more meaningful information than interpretations based on isolated data (Bourdon et al., 2017; Impellizzeri et al., 2019).

Despite the considerable volume of literature discussing the acute:chronic workload ratio, the effectiveness of this method in preparing soccer players remains inconsistent (Wang et al., 2020). Consequently, some authors have suggested that coaches should consider the accumulated weekly load during the micro-cycle to ensure players can adequately respond to the demands of high-intensity competition (Chena et al., 2021). To the authors' knowledge, only two studies have examined the correlation between cumulative weekly load and weekly match demand in professional soccer players (Clemente et al., 2019 Springham et al., 2020). However, this relationship remains unknown among semi-professional players.

Analysing the correlation between cumulative loads and the locomotor and mechanical response of players during matches will help to understand and optimise training load management. The aim of this study was to analyse the correlations between internal and external load accumulated in periods of 4 weeks (current+3-weeks previous) and competitive performance in football.

METHOD

Design

Retrospective observational study based on the analysis of correlations between internal and external training load variables and competitive performance over one-full season.

Participants

The research took place within a Spanish semi-professional football team during the 2020/2021 season. This team comprised 22 semi-professional footballers (average age 23.21 ± 04.22 years, weight 74.98 ± 5.78 kilograms, and height 1.79 ± 0.06 meters) competing in the Spanish third division. The study was conducted over a full season where participants were daily monitored. All participants received detailed information regarding the study's protocol and objectives, and their involvement was voluntary, anonymous, and contingent upon signing an informed consent form. It adhered to the ethical principles outlined in the Declaration of Helsinki.

Instruments

The equipment utilized consisted of 10Hz Playertek+ GPS/GNSS devices with an inertial system, boasting a sampling rate of 400Hz (recorded at 100Hz) and an accelerometer measuring $\pm 18g$ at 400Hz on three axes (Catapult Innovations, Melbourne, Australia).

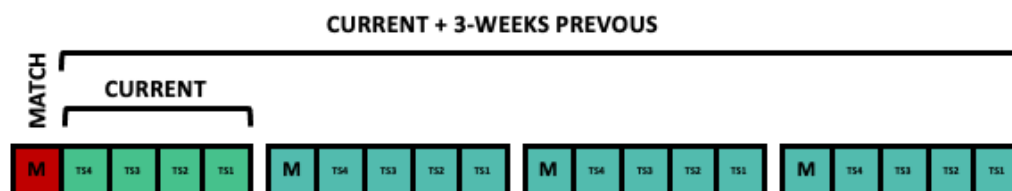
Throughout the season, the subjective Borg scale in its 6–20-point version, known as the Rate of Perceived Exertion (RPE) (Borg G, 1998), was utilized. The RPE value obtained was multiplied by the duration of the training session or match participation time in minutes, yielding the RPE-session (RPEs). Researchers employed record sheets to gather individual or collective football player data throughout the season. Variables used to measure the internal and external workload of players include:

- **RPE:** RPEs.

- **GPS/GNSS variables and inertial system:** total distance (TD; m), high-speed running >21 km/h (HSR; m) and total Player Load (PL; UA).

Total data were accumulated in internal and external loading periods in 4-week periods (current week+3 full previous weeks) and all variables were correlated with competition data (Figure 1). Data from players who participated in matches of less than 75 minutes were not taken into account.

Figure 1 Cumulative load structure



Legend: M = Match; TS: Training Session.

Procedure

The researchers collaborated closely with the team's coaching staff and provided a detailed explanation of the research project after obtaining necessary permissions. Descriptive data of the participants were gathered at the commencement of the season, and data collection spanned all training sessions and competitive matches throughout the season. Pre-season data were excluded.

The typical weekly training regimen at the club's facilities comprised four sessions lasting approximately 90 minutes each, structured similarly on Tuesday, Wednesday, Thursday, and Friday, with one match per week usually scheduled for Saturday or Sunday.

GPS-GNSS data were transferred to the Go Playertek+ tool (Playertek Sync software, version 5.66; Catapult Innovations, Melbourne, Australia) and collated into spreadsheets for subsequent analysis alongside RPE data.

Statistical analysis

All data are reported as mean values $\pm$ SD. The distribution of each variable was verified by the Shapiro-Wilk normality test. The relationships between variables were determined using Pearson's coefficients (r). The correlation coefficients were qualitatively interpreted as follows: < 0.1 (trivial); > 0.1 (small), > 0.3 (moderate), > 0.5 (large), > 0.7 (very large) and < 0.9 (nearly perfect) (Hopkins et al., 2009). Statistical analysis was performed using JASP software (JASP Team 2019, Version 0.18.2.0, University of Amsterdam).

RESULTS

The correlation values between locomotor and mechanical variables analyzed during both training sessions and matches are outlined in Table 1. All external workload variables over the course of the season, TD ($p \leq 0.001$; $r=0.23$), HSR ($p \leq 0.001$; $r=0.48$) and PL ($p \leq 0.001$; $r=0.30$), showed significant correlations between cumulative workload and competitive performance in HSR; however, this was not the case for internal load measured with RPEs.

Table 1 Team correlation coefficients describing the relationship between match outcomes and the accumulated locomotor, mechanical and self-perceived training load

	Total Distance	High-Speed Running	Player Load
Week+3 RPEs	0.01	0.13	-0.11
Week+3 TD	0.06	0.23***	-0.03
Week+3 HS	0.12	0.48***	0.09
Week+3 PL	0.04	0.30***	0.00

Legend: Week: accumulated load during the week of the match, excluding the match data; Week+3: chronic load from 3 weeks prior to the match, incorporating the 'week' variable.

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. RPEs: Rate Perceived Exertion session; TD: Total Distance; HSR: High-Speed Running; PL: Player Load.

DISCUSSION

The aim of this study was to analyse the correlations between internal and external load accumulated in periods of 4 weeks (current+3-weeks previous) and competitive performance in football. Cumulative workload over 4-week periods appears to be significantly related to HSR performance in competition.

Performance and success in football are influenced by a multitude of factors (Ryan et al., 2017; Springham, et al., 2020). The primary objective of training is to provide a stimulus that enhances both player and team performance during competition, aiming to improve player fitness and alleviate fatigue (Gabbett et al., 2016). Therefore, effective management of training load in the lead-up to competition is essential. Understanding the cumulative impact of training load on match locomotor and mechanical performance is crucial for effectively guiding each player's performance (Coutts, 2018). Our study demonstrates significant correlations between the team's accumulated training load and match response.

Accumulated TD, HSR and PL showed significant relationships with match response in HSR. A recent study by Clemente et al. (2019) demonstrated a significant correlation between match performance and cumulative load for the same week and variables. Previous research has also highlighted increases in response during matches when the cumulative load surpasses the team's mean value (Lazarus et al., 2017). Additionally, Springham et al. (2020) identified a linear relationship between chronic high metabolic load and performance in matches with high metabolic load, suggesting that prolonged exposure to high-intensity activity may result in increased high-intensity actions during matches. Moreover, other studies have suggested that maintaining chronically high workloads enhances readiness among professional soccer players (Bowen et al., 2020; Ehrmann et al., 2016), consequently reducing the risk of injury. Our study contributes by indicating that the high load accumulated in preceding weeks may serve as a reliable indicator of high-speed running (HSR) performance in upcoming matches, owing to the positive correlation observed. The significance of high-intensity actions and their magnitude in football is well recognized and warrants focused training (Gualtieri et al., 2023). It's important to acknowledge that excessive acute loads may detrimentally impact the performance of football players (Soligard et al., 2016). Thus, maintaining average to somewhat above-average values in acute accumulated load seems to correlate with a heightened conditioning response in competition. However, this needs to be carefully monitored considering physical performance in light of both fitness and fatigue (Gabbett, 2016). The utilization of uncoupled acute and chronic loading variables appears to yield valuable insights into football performance (Springham et al., 2020).

The study has several limitations, notably the small sample size, the exclusion of certain matches or players who did not meet the criteria, which could affect the results, and the exclusive reliance on RPE for the analysis of internal load.

CONCLUSION

Cumulative workload over 4-week periods appears to be significantly related to HSR performance in competition. High intensity actions and their magnitude become relevant to performance and competitive success in football and this finding should be further investigated in future research. Monitoring is essential for coaches in order to obtain information and prepare the athlete, in optimal conditions, for competition.

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DA LI OPTEREĆENJE KOJE AKUMULIRAJU FUDBALERI UTIČE NA UČINAK U TAKMIČENJU?

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Sažetak: Cilj ovog istraživanja bio je da se analiziraju korelacije između unutrašnjeg i spoljašnjeg opterećenja akumuliranog u periodima od 4 nedelje (trenutne + 3 nedelje ranije) i takmičarskih performansi u fudbalu.

Istraživanje je sprovedeno u španskom poluprofesionalnom fudbalskom timu tokom sezone 2020/2021 (22 fudbalera; uzrast $23,21 \pm 4,22$ godine, težina $74,98 \pm 5,78$ kilograma i visina $1,79 \pm 0,06$ metara). Studija je sprovedena tokom cele sezone gde su učesnici svakodnevno praćeni. Svi subjekti su učestvovali dobrovoljno i anonimno, dajući informisani pristanak. Ova studija je sprovedena u skladu sa etičkim standardima navedenim u Helsinškoj deklaraciji. Korišćeni su uređaji od 10Hz Plaiertek+ GPS/GNSS sa inercijalnim sistemom i verzija od 6-20 poena Rate of Perceived Ekertion (RPE). Varijable korišćene za procenu unutrašnjeg i spoljašnjeg opterećenja igrača su: ukupna udaljenost (TD m), trčanje velikom brzinom $>21\text{km/h}$ (HSR; m), ukupno opterećenje igrača (PL; UA) i sesija-RPE (s -RPE; minuti sesije*RPE). Sve varijable eksternog opterećenja tokom sezone, TD ($p \leq 0,001$; $r=0,23$), HSR ($p \leq 0,001$; $r=0,48$) i PL ($p \leq 0,001$; $r=0,30$), pokazale su značajnu korelaciju između kumulativnog opterećenja i konkurentske učinke u HSR; međutim, to nije bio slučaj za unutrašnje opterećenje mereno sa s-RPE. Čini se da je kumulativno opterećenje tokom perioda od 4 nedelje značajno povezano sa performansama HSR-a na takmičenju. Akcije visokog intenziteta i njihova veličina postaju relevantni za performanse i takmičarski uspeh u fudbalu i ovaj nalaz treba dalje istražiti u budućim istraživanjima. Praćenje je neophodno za trenere kako bi dobili informacije i pripremili sportistu, u optimalnim uslovima, za takmičenje.

Ključne reči: fudbal, praćenje, obuka, trčanje velikom brzinom, meč