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Does the Weekly Distribution of Games and Competition Density Affect Training Load in Elite Male Basketball Players Based on their Playing Role?

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ABSTRACT

Purpose: The aim of this study was to compare the external workload encountered by Euroleague basketball players based on the weekly game density (ranging from 0 to 3-games per week) and player roles (bench, rotation, and starter). **Method:** A longitudinal observational study was conducted across two full seasons. The weekly workload was determined by recording PlayerLoad™ using microsensors during basketball practices and estimations for games. A linear mixed model with Bonferroni post-hoc tests was used to compare the workload among weeks and player roles. Additionally, Cohen's d effect sizes were applied to determine the magnitude of the differences. **Results:** Starting players consistently experienced higher external workload compared to rotation players and bench players across all weekly configurations. In weeks with more games, especially from Friday to Sunday, starters faced the highest workload, followed by rotation players. Significant differences (p<0.05) were observed both in the total number of games per week and in the specific distribution of games within the week. **Conclusion:** These findings highlight the substantial impact of game density and player roles on the workload experienced throughout a professional men's basketball season. Therefore, coaches should take this into account when planning appropriate weekly workloads based on players' roles within the team roster.

Keywords: basketball, accelerometry, team sport, workload, week, player role

INTRODUCTION

Basketball is a team sport in which the head coach and their assistants can utilize 12 players on a team to participate in a 5v5 format during live gameplay on the court. Rules allow for an unlimited number of substitutions throughout the game, as is common in other team sports (e.g., ice hockey, handball, lacrosse) (FIBA, 2024). However, even though coaches might aim to evenly distribute minutes among all players, the most common scenario is that certain players accumulate more minutes while others accumulate fewer than the average (Caparros et al., 2018). This leads to three typical categories of players: Starters, Rotation players, and Bench players. Starters are the players who begin the game and accrue the most minutes. Rotation players tend to accumulate fewer minutes, and Bench players accumulate the least out of all three categories. According to previous research, thresholds were set at <12 min for Bench players, 12-22 min for Rotation players, and >22 min for Starters (McLean et al., 2019).

In 2016, Euroleague basketball changed its format, expanding from 16 teams to 18 teams, with a regular season of 34 games (17 home and 17 away). The top eight teams advance to the Playoffs, which are played in a best-of-five series, vying for a spot in the Final Four tournament. Throughout the regular season, there are typically 6-8 'double round,' weeks where each team plays two games, usually scheduled on Tuesday-Thursday, Tuesday-Friday, or Wednesday-Friday. Spanish teams in the Euroleague also compete in their National League, the ACB Liga Endesa, where they play one game per week, usually on Saturday or Sunday, with Playoffs following a best-of-three or best-of-five format. Consequently, Spanish Euroleague teams average 2-3 games weekly, with occasional variations such as weeks with 0-1 games (e.g., FIBA windows) or up to 4 games (e.g., Playoff phase) (ACB, 2014; Euroleague, 2024).

The analysis of the physical and physiological demands of basketball games has been of great interest to researchers for many decades, particularly given the frequency of games (Abdelkrim et al., 2007; Berkelmans et al., 2018; Stojanovic et al., 2018). In recent years, the widespread adoption of microtechnology, including accelerometers, gyroscopes, and magnetometers has become standard in basketball (Svilar et al., 2018; García et al., 2022; Fox et al., 2018; Vázquez-Guerrero et al., 2018). These sensors offer precise external load data, enabling strength and conditioning coaches, as well as sports and data scientists, to efficiently explore player variations (Vázquez-Guerrero et al., 2019; Scanlan et al., 2011) and playing positions (García et al., 2020; Salazar et al., 2020a) during both training sessions and actual gameplay. Basketball is a sport characterized by frequent changes of direction and inertial actions, making the use of microsensors highly beneficial for quantifying variables such as player load, accelerations, decelerations, and changes of direction (Taylor et al., 2017). These variables are crucial as they reflect the dynamic and high-intensity nature of the game. Consequently, they are often utilized in basketball research and practice (Svilar et al., 2019).

Understanding the variation in training loads among players of different roles and in relation to the frequency of games is crucial for basketball practitioners to tailor workload management strategies effectively (Manzi et al., 2010). The aim of this study was to compare microtechnology-based external training loads accumulated per week according to players' roles on the team (starters, rotation, and bench players) and in relation to weekly game density (1 to 3-game weeks) in elite-level European basketball teams.

METHODS

Participants

A total of 19 elite male basketball players (age: 26.3 ± 2.5 years; height: 201.1 ± 9.0 cm; body mass: 100.3 ± 8.3 kg) from the same basketball team were recruited to participate in this study. The sample size was determined based on the availability of players meeting the inclusion criteria, which required participants to be currently active members of an elite basketball team, with a minimum of three years of professional playing experience. These criteria ensured a homogeneous sample of highly trained athletes, which was necessary for the purposes of the study. The team competed in two major competitions during the observed seasons: internationally in the Euroleague and domestically in the ACB (Liga Endesa) league. Each player was assigned a specific team role based on their average game minutes: bench role for players with <12:00 min, rotation role for players with 12:01-22:00 min, and starter for those who played >22:01 min (McLean et al., 2019). As the study's time unit is one week, a player was included in the analysis only if they completed a full week of basketball practices and games without missing any activities. If a player completed the week, but data collection was impeded due to an error (such as the device's battery running out during an activity), that week was excluded from the study. Players and the club provided written consent to participate after being informed about the investigation's purpose, the research protocol, and requirements, as well as the associated benefits and risks. Furthermore, no ethics committee approval was required because the data were collected as part of routine monitoring of players during training and matches throughout the competitive seasons, as requested by the performance staff (Winter & Maughan, 2009).

Experimental approach to the problem

A longitudinal observational study was conducted to compare the external workload across different weeks during two competitive seasons. A total of 34 in-season weeks were recorded per season. The external workload experienced by all basketball players during practices and games was monitored with input from the coaching and performance staff. As an elite European basketball team concurrently participates in two competitions, the players' total weekly workload was assessed during four types of weeks: a) weeks with only one game (1-game week), b) weeks with two games (2-game week), c) weeks with three games (3-game week), and d) weeks without any competition (0-game week). A week was defined as Monday to Sunday to ensure capturing games played within the same 7-day period.

Strength workouts typically occur with a frequency of four to five sessions per week, with varying intensities based on individual player needs and training objectives. These sessions are integral to the athletes' external load and overall training regimen, contributing significantly to their physical conditioning and performance. However, it is important to note that these sessions were excluded from our study's workload calculations to focus specifically on the demands of games, team practices, individual skills practices, and morning shoot-around sessions. Games were played between Tuesday and Sunday, with Euroleague games scheduled during the week and ACB games weekend days. Considering the distribution of games, for 2-game weeks, there were a total of eight possibilities: Friday-Sunday, Monday-Thursday, Thursday-Saturday, Thursday-Sunday, Tuesday-Saturday, Tuesday-Thursday, Wednesday-Saturday, and Wednesday-Sunday; and for 3-game weeks, there were three options: Tuesday-Friday-Sunday, Tuesday-Thursday-Sunday, and Wednesday-Friday-Sunday.

Procedures

Each player wore a device (Vector S7; Catapult Sports, Melbourne, Australia) placed in a custom pocket within a vest positioned on the upper thoracic spine between the scapulae. The devices comprised an accelerometer (~16 g, 100 Hz), magnetometer (±4,900 μT, 100 Hz), and gyroscope (up to 2,000 deg/sec, 100 Hz). All players were familiarized with the monitoring technology, as they had previously used microtechnology devices either in the previous season or with former teams.

The selected variable for analysis was PlayerLoad™ (PL), calculated by the manufacturer as the square root of the sum of the instantaneous rate of change in acceleration in the three movement planes (x, y, and z axes). This variable has been previously used and accepted in basketball load monitoring research (Barrett et al., 2014; Fox et al., 2018; Svilar et al., 2019). All players wore the devices during basketball activities and domestic games played by the team. Each device was activated approximately 20-40 min before the team warm-up preceding each basketball practice or game. Players used the same device throughout the study period to mitigate inter-device variation in external load data outputs (Castellano et al., 2011).

Since the Euroleague competition did not allow the use of microtechnology at that time, values from these games were estimated using individual PL per minute during live time from ACB games and multiplied by the player's game minutes derived from official box score (Salazar et al., 2020b). In this way, live time consider playing time derived from devices including all stoppages in play such as free-throws, fouls, and out-of-bounds, but excluded break periods between quarters, time-outs, or time when players were substituted out of the game. Box score time excludes any passages of play where the game clock is stopped (e.g., inter-quarter breaks, time-outs, fouls, out-of-bounds). For instance, if a player had a PlayerLoad™ per minute of 9.5 during ACB games, and their playing time derived from the official box score was 15 min, the estimated PlayerLoad™ for that Euroleague game would be 9.5 (PlayerLoad™ per minute) × 15 (minutes of playing time) = 142.5.

All data from the devices were downloaded using Catapult Openfield software (Catapult Sports, Melbourne, Australia) and exported into a customized data spreadsheet (Microsoft Excel version 15, Microsoft Corporation, Redmond, USA) for collection and further analysis.

Statistical Analysis

Data is presented as mean with 90% confidence interval (CI) for figures and mean with standard deviation (SD) for tables. Prior to further analysis, the normality of the data and sphericity were tested using the Shapiro-Wilk statistic and Levene's Test for equality of variances, respectively. A linear mixed model with Bonferroni post hoc test was conducted to compare the external workload based on player role (e.g., bench, rotation, and starter), number of games per week (e.g., 0 to 3-game weeks), and distribution of the games during 2-game and 3-game weeks. In all models, player role, games per week, and distribution were selected as fixed factors, while player name was entered as a random effect. The level of statistical significance for the model was set at $p < 0.05$. Cohen's effect sizes (ES) with 90% confidence intervals were calculated to quantify the magnitude of differences in the integrated load between weeks for each playing role. The ES comparisons were interpreted using the Hopkins scale: <0.2 (trivial), 0.2-0.59 (small), 0.6-1.19 (moderate), 1.2-1.99 (large), and >2.0 (very large) (Hopkins et al., 2009). Statistical analyses were performed using Microsoft Excel v15 (Microsoft Corporation, Redmond, USA) and JASP v0.17.1 (JASP Team, 2023).

RESULTS

Weekly PL data for all types of weeks and each player role are presented in Figure 1. Bench demarcation showed differences in PL when comparing 2-game versus 3-game weeks (p=0.006; ES: 0.61). For rotation players, a significant difference with moderate effect size was found between 1-game and 2-game weeks (p<0.001; ES: -0.76) and between 1-game and 3-game weeks (p=0.007; ES: -0.71). Starters followed the same pattern as rotation players, with differences found in 1-game weeks compared with 2-game weeks (p<0.001; ES: -0.98) and 3-game weeks (p<0.001; ES: -1.06). Using the number of games as a factor, results did not show any differences across player roles for 0 and 1-game weeks. However, in 2-game weeks, bench players showed significantly lower external load compared with starters (p<0.001; ES=-1.27). Additionally, when the number of games per week was the highest (3-game weeks), bench players also showed differences compared to rotation players (p=0.001; ES=-0.83) and starters (p<0.001; ES=-2.00).

Table 1 presents PL values from different game distributions during 2-game weeks. Regardless of the player role, the higher workload was observed in weeks where games were scheduled on Friday and Sunday. According to each player role, none of the different game distributions showed any significant differences for bench players. However, for rotation players, the Fri-Sun distribution was significantly more demanding than Thu-Sat (p=0.027; ES: 0.95) and Tue-Thu (p<0.001; ES: 1.95) weeks. Similar results were obtained for starters, where Fri-Sun weeks were significantly higher with moderate to large effects than Thu-Sat (p<0.001; ES: 1.10), Tue-Thu (p<0.001; ES: 1.76), and Tue-Sat (p=0.029; ES: 1.67). When comparisons were made across playing roles within the week, only 2 types of weeks presented significant differences. On one hand, Fri-Sun weeks showed large effect differences between bench and rotation players compared with starters (p<0.001; ES: -1.37 and p<0.001; ES: -1.04, respectively). Additionally, Thu-Sun weeks were also different for bench players compared to starters (p=0.005; ES: -0.33).

PL for 3-game weeks distribution according to each playing role are shown in Figure 2. Within each player role, the three-week distribution assumed a similar workload. Conversely, bench and rotation

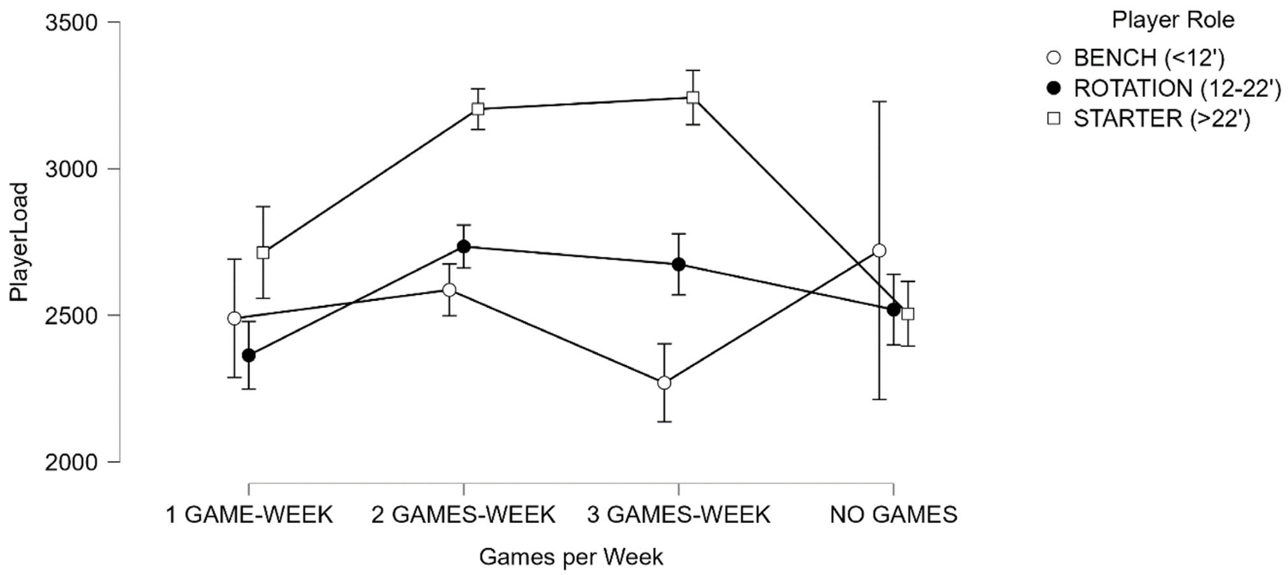

Figure 1. Total PlayerLoad™ accumulated in a week (arbitrary units) for games played per week across different player roles

Table 1. Mean ± SD values of PlayerLoad™ accumulated in a week for the players regarding different distribution of the games during 2-game weeks.

	Role		
Week type	**Bench**	**Rotation**	**Starters**
Fri-Sun	2870.0±446.2	3017.6±316.4	3484.9±449.9
Mon-Thu	2561.6±6.9	2444.4±539.4	3027.4±278.8
Thu-Sat	2536.0± 38.8	2642.7± 75.9	2977.1±363.2
Thu-Sun	2414.9±530.3	2563.1±359.3	3111.3±87.3
Tue-Sat	2051.6±236.7	2210.2±265.4	2715.2±281.6
Tue-Thu	2290.2±441.1	2253.0±362.6	2674.2±386.0
Wed-Sat	2012.1±8.8	2225.9±298.4	2753.2±226.5
Wed-Sun	2252.3±146.4	2449.9±274.2	2997.6±187.2

Note: Mon= Monday; Tue= Tuesday; Wed= Wednesday; Thu= Thursday; Fri= Friday; Sat= Saturday; Sun= Sunday.

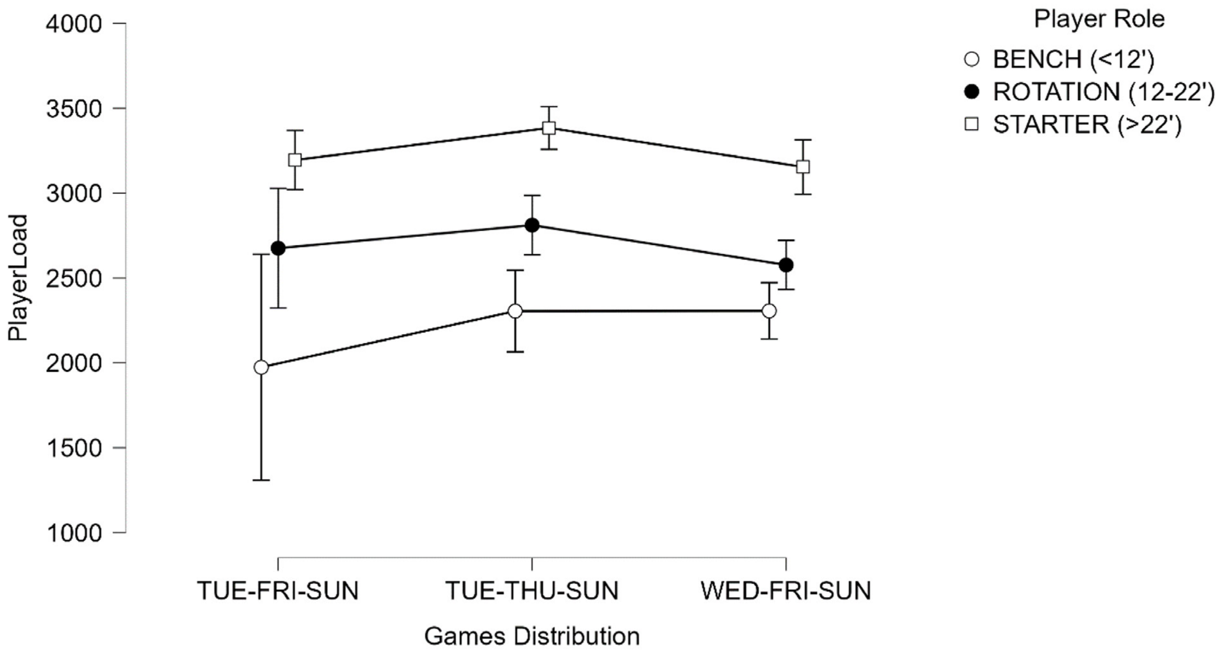

Figure 2. Total PlayerLoad™ accumulated (arbitrary units) in a week for different distribution of the games during 3-game weeks and players roles.

players showed significantly lower accumulated workload than starters during the three types of weeks.

DISCUSSION

The aim of this study was to compare the accumulated PL throughout the week based on players' roles in relation to the density of weekly games in an elite-level European male basketball team. The results of this study revealed distinct weekly training load profiles among elite male basketball players based on their playing roles. These differences were influenced by the number of games per week. Specifically, bench players experienced a different workload only when jumping to play three versus two games per week, while rotation and starters demonstrated significant differences in workload when playing one versus two or three games per week. The distribution of games throughout the week indicated that players faced higher weekly workloads when playing Friday-Sunday games, even when only two games were scheduled. As the number of games increases, such as in 3-game weeks, there is no difference in the distribution of the games, but there is a greater difference in the accumulated workload among the three roles. This novel finding emphasizes the importance of appropriately periodizing training loads across weeks during a Euroleague season, considering the players' roles within the team.

The frequency of games played per week significantly influenced the weekly training and competition load encountered by Euroleague players, depending on their respective roles. Rotation and starting players faced higher workloads during weeks featuring two or three games, a common occurrence in Euroleague competition. Conversely, the workload for bench players remained relatively stable regardless of the number of games. This indicated a notable disparity in workload between rotation/starters and bench players when competing at the Euroleague level and engaging in two or three games per week. Previous research has underscored differences in internal workload among professional and collegiate players across varying game frequencies, such as one and two games per week, as well as between one, two, and three games per week (Manzi et al., 2010; Conte et al., 2018). Our findings align with these studies (Fox et al., 2020; Salazar et al., 2020b), revealing higher workloads for rotation and starters during weeks with two or three games compared to weeks with only one game or no games. Additionally, the present study, conducted with an elite team, reported workloads nearly twice as high as those reported by semi-professional Australian basketball players during weeks with two or three games (Fox et al., 2020). In summary, these findings emphasize the importance of considering the frequency of games per week when managing the workload of players in elite basketball teams, as it can significantly impact their performance and susceptibility of injury.

Regarding the distribution of games throughout the week, the present study found that Fri-Sun weeks were the most demanding for all player roles, followed by Mon-Thu for Bench players, Thu-Sat for Rotation players, and Thu-Sun for Starting players. The explanation for this observation lies in the total duration of the training week. In weeks with games from Friday to Sunday, teams typically face three days of high-intensity training, namely Tuesday, Wednesday, and Thursday. Meanwhile, in the remaining weeks, starting competition on Thursday allows for high-intensity training only on Tuesday and Wednesday, as the days between matches are often allocated for recovery sessions or lower-intensity training as planned by the coaches. During both the Euroleague and domestic league seasons, effective periodization strategies implemented by coaching and performance staff are crucial for optimizing players' physical performance, well-being, and minimizing the risk of injury. In weeks where games are scheduled from Friday to Sunday, it is recommended to follow two possible scenarios: a) schedule a rest or recovery day on Monday (MD+1), or b) promote an active recovery for starters and compensatory workout for rotation and bench players on MD+1, followed by a full rest on MD+2. This strategic recovery cycle may allow players to recover both mentally and physically from the stresses and fatigue accumulated during the previous week. Research suggests that strategic rest days can aid in reducing injury risk and improving performance (Clemente et al., 2019; Svilar et al., 2019). Furthermore, on Tuesday, Wednesday, and Thursday (match Day [MD]-3, MD-2, and MD-1, respectively), coaches should design micro-periodization models that incorporate variations in training volume, intensity, or both. For instance, implementing a three-day cycle with progressively decreasing training volume from MD-3 to MD-1 has been shown to enhance recovery while maintaining performance readiness (Clemente et al., 2019; Svilar et al., 2019).

The rationale behind the differences in workload among player roles during Fri-Sun weeks can be explained by two factors. Firstly, during practice days, all players accumulate similar training loads, but starters and rotation players accumulate more game minutes, resulting in higher game-related workload and ultimately leading to a greater overall weekly workload compared to bench players. Secondly, it appears that the compensatory workouts for bench and rotation players may not be sufficient to achieve a similar weekly workload as starting players, possibly due to their lower game minutes. Considering the rationale of insufficient compensatory work, it is important for performance and assistant coaches to be cautious with high volumes of compensatory work. Research recommends avoiding spikes in workload and keeping players within their optimal zones of acute-chronic load ratio to maintain optimal physical performance and minimize the risk of injury (Hulin et al., 2016; Weiss et al., 2017).

It is important to acknowledge some limitations when interpreting the results of the study. Firstly, the sample consisted of players from a single elite team with specific characteristics, limiting the generalizability to other competitive levels and teams. Secondly, wearable devices were not allowed during Euroleague games, which may have affected the accuracy of workload estimation during those games. Lastly, the study focused on a single external load metric. Furthermore, it is important to note that the load during Euroleague matches was estimated due to restrictions prohibiting device use, which should be considered when interpreting the findings. Future studies incorporating additional external load variables and internal load metrics with their relationships to player role and competition density could provide further insights to improve load management decisions. Furthermore, it's essential to acknowledge that this study solely focused on workload derived from training sessions and games, while non-sporting loads such as travel were not considered. Integrating non-sporting load factors in future studies could provide a more comprehensive understanding of the overall workload experienced by players.

CONCLUSIONS

The current study reveals significant variations in weekly workload (PL) based on the number of games and player roles. Bench players consistently demonstrated lower external loads compared to rotation players and starters, particularly in weeks with a higher number of games. The scheduling of games also plays a crucial role, with Friday-Sunday game distributions posing the highest workload for rotation players and starters. These findings provide reference values for understanding the total weekly workload experienced by an elite European basketball team across different weeks and player roles. It is important to note that the match load was estimated due to constraints prohibiting device use during Euroleague games, which should be considered a limitation of this work. Consequently, crafting an effective periodized training plan should involve tailoring to individual player roles, considering the fluctuating weekly distributions throughout a basketball season.

CONFLICTS OF INTEREST

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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ETHICAL APPROVAL

Ethics for this study were granted in line with University of Basque Country's ethics procedure.

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