INTERNATIONAL JOURNAL OF BASKETBALL STUDIES
Department of Physical Education, Universitas Majalengka, Indonesia

A Comparison of Training and Competition Physical Demands in Professional Male Basketball Players

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ABSTRACT

The main aim of this study was identifying differences in physical load between training and match-play. Twelve professional basketball players were monitored during 5 games. The following workload variables were recorded: Movement load (ML), Training Impulse (TRIMP), average Heart Rate (HR). Non-significant differences were found between activities (game vs practice). Regarding to practical meaningfulness, greater match values were reached for EL and IL variables compared to practices. In this regard, large differences for ML (F = 0.71, ES = 1.69) and TRIMP (F = 0.02, ES = 1.71, large) were found. In conclusion, greater values of physical load but non-significant differences were achieved during games compared to practice for ML, TRIMP and HR. In this regard, physical demands remain consistent (large effects) regardless of activity (game vs practice) in professional basketball players.

Keywords : Heart rate; movement load; game demands; load monitoring; technology

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Article History:
Submitted: April 4, 2023
Revised: June 6, 2023
Accepted: June 6, 2023
Published: June 29, 2023

Authors' contribution:
A) Conception and design of the study;
B) Acquisition of data;
C) Analysis and interpretation of data;
D) Manuscript preparation;
E) Obtaining funding

Cite this article : Portes, R., Ribas, c., García, A. L., & Pérez-Chao, E. A. (2023). A Comparison of Training and Competition Physical Demands in Professional Male Basketball Players. *International Journal of Basketball Studies,* 2(1), 25-33. https://doi.org/10.31949/ijobs.v2i1.4983

INTRODUCTION

The use of an electronic performance tracking system (EPTS) is gaining huge popularity in the basketball industry. Due to the emergence of EPTS, it is easier to understand external physical demands during match-play and practice sessions. Then, monitoring devices allow practitioners to precisely quantify physical demands during basketball games (Fox et al., 2017). In this regard, one of the main objectives during load monitoring is to ensure that an adequate external load (EL) is undertaken to stimulate specific physical adaptations (Aoki et al., 2017; Harriss & Atkinson, 2015). Further, load monitoring can also document the psycho-physiological responses during exercise (e.g., heart rate) or internal load (IL) (Harriss & Atkinson, 2014) to support training practices.

One of the main objectives during practice is to prescribe the adequate external training load (Aoki et al., 2017), which is defined as the physical work prescribed in the training plan (Harriss & Atkinson, 2014), to stimulate specific adaptations (Aoki et al., 2017) to elicit the desired response (Harriss & Atkinson, 2014). Besides, one of the most common practice cues utilized by staff during practice sessions is to train at “game intensities” (Alonso et al., 2020; Pérez-Chao et al., 2022). Competition is the most specific skill-based conditioning tool, involving the most realistic cognitive, physical, and physiological requirements (Schelling & Torres-Ronda, 2013). Among the complexities involved in the development of elite athletes, the need to employ training strategies that replicate competition performance demands is well established (Alonso et al., 2020). Then, identifying basketball physical game demands will allow coaches to design training programs, and especially sport-specific practices drills, that optimize performance in competition (Torres-Ronda et al., 2016). Thus, the need to employ training strategies that replicate competition performance demands is well established (Brandão et al., 2019; Fox et al., 2018; Reina et al., 2019).

Recently, a number of descriptive studies analyzed the differences between match-play and training sessions from an external load perspective (Brandão et al., 2019; Fox et al., 2018; Reina et al., 2019). However, most of them are under simulated/unreal situations (Brandão et al., 2019; Fox et al., 2018) or with a small sample group (Brandão et al., 2019; Reina et al., 2019). Findings showed training drill (5v5) had greater intensity than match-play in which it was concluded that the 5v5 non-stop drill elicits greater relative values (PL/min, ACC/min, DEC/min, JUMP/min) than the match-play (Svilar et al., 2019). In the same way, a novel study carried out in semiprofessional players (Fox et al., 2018) found that the external physical training demands exceeded those of competition. Then, absolute values (PL, different heart rate zones and DIST) and relative values (DIST/min) were statistically significant higher during practices than match-play. The only variable in which match-play was greater to training sessions was the sRPE/PL ratio, which showed higher values during competition than training drills. Therefore, a novel study carried out with female basketball players showed external and internal physical load (Peak HR, mean HR, PL, DIST, JUMPS and impacts) (Reina et al., 2019) were greater during match-play when comparing with practice sessions. Additionally, similar findings were achieved in male professional basketball players being internal (peak HR, mean HR) and external physical demands (number of movement/min) higher during friendly match-play than different training drills excepting for 1v1.

Taking under consideration the current literature, results regarding to external physical demands comparison between gameplay and practices are unclear. In this sense, there are several factors such as playing time, the fitness status of the athletes, the motivation, the tactical approach of the teams or modulation of different variables during training practices (e.g., court restriction, presence/absence of coach, number of players) that can influence the external workload outcomes (Abdelkrim et al., 2010). Additionally, different data-filtering methods can substantially modify the results (Malone et al., 2017), then, the exclusion of rest periods from analysis may overestimate the external physical load during match-play (Narazaki et al., 2009). In this regard, while some studies described more workload during training than games (Brandão et al., 2019; Reina et al., 2019), others reported similar physical load (Narazaki et al., 2009).

These discrepancies are probably due to previous factors mentioned (e.g., gender, age, category, tactical aspects, methodological factors, technology applied or the duration that each player is on the court). Consequently, based on the limited understanding of the physical demands experienced by basketball players further research is needed to compare external physical load between match-play and training sessions, which will provide useful evidence for coaches to optimize game/training management strategies. For this reason, the aim of this study was to compare physical load during match-play and training sessions. It was hypothesized that match may elicit greater demands for all physical variables.

METHODS

Participants

Professional basketball players (n = 9, mean age 25.4 ± 4.59 years, height 195.5 ± 8.8 cm, body mass 97.88 ± 13.4 kg) one team of the Spanish professional basketball League (ACB) volunteered and were monitored during 5 pre-season games and 20 practices, where progressive overload was the selected strategy for the team´s preparation. Data from each player was collated from all games with players and their data retained in the final analysis if they completed a minimum of 5 minutes of box-score time, in at least three games. The box-score time was based on the playing time (minutes) derived from the official game records and excluded any passages where the game clock was stopped (e.g., inter-quarter breaks, time-outs, fouls, out-of-bounds). Subsequently, data from one player originally recruited (i.e., n = 10) was excluded from the final analysis, resulting in 9 players being retained in the study. Overall, 39 game records and 162 practices samples for the 9 players were included in the final analyses. The study was in accordance with the Declaration of Helsinki (Harriss & Atkinson, 2014).

Procedures

This descriptive study was carried out during the 2020-2021 and 2021-2022 ACB pre-seasons where gameplay was conducted in line with official FIBA rules (i.e., 4 x 10-minute quarters) and officiated by experienced and qualified referees. During games, each player wore a Firstbeat SPORTS TeamBelt (Firstbeat Technologies Ltd., Jyväskylä, Finland). This 9-axis motion sensor (10g including battery) collected data at 50 Hz with all players familiar with the monitoring technology during training and games. The Firstbeat system was reported to be valid and reliable for the assessment of heart rate, respiratory rate, heart rate variability and oxygen consumption (VO2) (Bogdány et al., 2014). Devices were turned on immediately prior to each game and players wore the same device throughout the study to avoid inter-unit variation in outputs (Castellano et al., 2011; Johnston et al., 2014; Nicolella et al., 2018). After each game, the average value for each variable were extracted from the Firstbeat Sports software (version 1.23.0) and exported into a Microsoft Excel (version 16.0, Microsoft Corporation, Redmond, WA) spreadsheet for further analysis.

Variables

The following physical variables were recorded as averages (i.e., value per minute considering the entire game): average Movement load (ML), average Training Impulse (TRIMP) and average Heart Rate (HR). The physical parameters recorded were classified in (I) one EL variables, (II) two internal load variables.

External physical Load variables:

- **Movement Load (ML):** This parameter considers all of an athlete's accelerations in three-dimensional planes using the following formula (Portes etal., 2022):

$$ML = \sqrt{\frac{\left(a_{y1} - a_{y-1}\right)^2 + (a_{x1} - a_{x-1})^2 + (a_{z1} - a_{z-1})^2}{300}}$$

Internal physical Load variables:

- Heart Rate (HR): The average of heart rate measured in beats per minute (bpm).
  - TRIMP: The TRIMP formula in Firstbeat Sports is based on Banister's original TRIMP calculation with some modifications. Instead of using the mean heart rate across a session, Firstbeat uses beat-to-beat heart rate data, which has been proved as a more reliable method to determine it (Berkelmans et al., 2018). Firstbeat has also set a lower intensity limit for the TRIMP accumulation to ensure that TRIMP number is derived only from activity. The formula is (Scanlan etal., 2014):

$$TRIMP = T \times \left[\frac{(HR_{ex} - HR_{rest})}{(HR_{max} - HR_{rest})}\right] \times 0.64e^{1.92\left[\frac{(HR_{ex} - HR_{rest})}{(HR_{max} - HR_{rest})}\right]}$$

Notes: T = Duration; HRex = Hear rate during workout; HRrest = resting heart rate; HRmax = maximal heart rate; e = ~2,718.

Statistical analysis

The mean, standard deviation (SD) and coefficient of variation (CV) were calculated for each variable. The Kolmogorov-Smirnov test confirmed the normality of all variables. T-test was performed in each variable to identify the differences between groups. Statistical significance was set at an alpha level of <0.05.

To determine the practical meaningfulness of any differences, mean differences and Cohen's effect sizes (ES) with 95% confidence intervals were determined for all pairwise comparisons. ES were interpreted as: trivial: ≤ 0.20; small: 0.21–0.60; moderate: 0.61–1.20; large: 1.21–2.00; very large: 2.01–4.00; and extremely large: > 4.00. All analyses were conducted using IBM SPSS for Windows (version 23, IBM Corporation, Armonk, New York) except for ES, which were calculated using a customized Microsoft Excel spreadsheet (version 16.0, Microsoft Corporation, Redmond, WA).

RESULT

Descriptive analysis for each variable is presented in Table 1. Non-significant differences were found between activities (game vs practice). Regarding to practical meaningfulness, greater match values were reached for EL and IL variables compared to practices (Figure 1). In this regard, large differences for ML (F = 0.71, ES = 1.69) and TRIMP (F = 0.02, ES = 1.71, large) were found.

Table 1. Descriptive analysis of differences in physical demands between game and practice

Variables		Activity	Mean	SD	CV %	N	F	Sig.	Mean Difference	Effect Size	Effect Size Magnitude
External Load	Movement Load	Game	265.5	67.7	25.5	39	0.7	0.3	103.5	1.69	Large
		Practice	162.0	59.4	36.7	162			103.5		
Internal Load	TRIMP	Game	143.8	41.6	28.9	39	0.0	0.8	66.4	1.71	Large
		Practice	77.3	38.1	49.2	162			66.4		
	Average HR	Game	124.5	11.6	9.3	39	3.7	0.05	1.3	0.10	Trivial
		Practice	123.1	14.4	11.7	162			1.3		

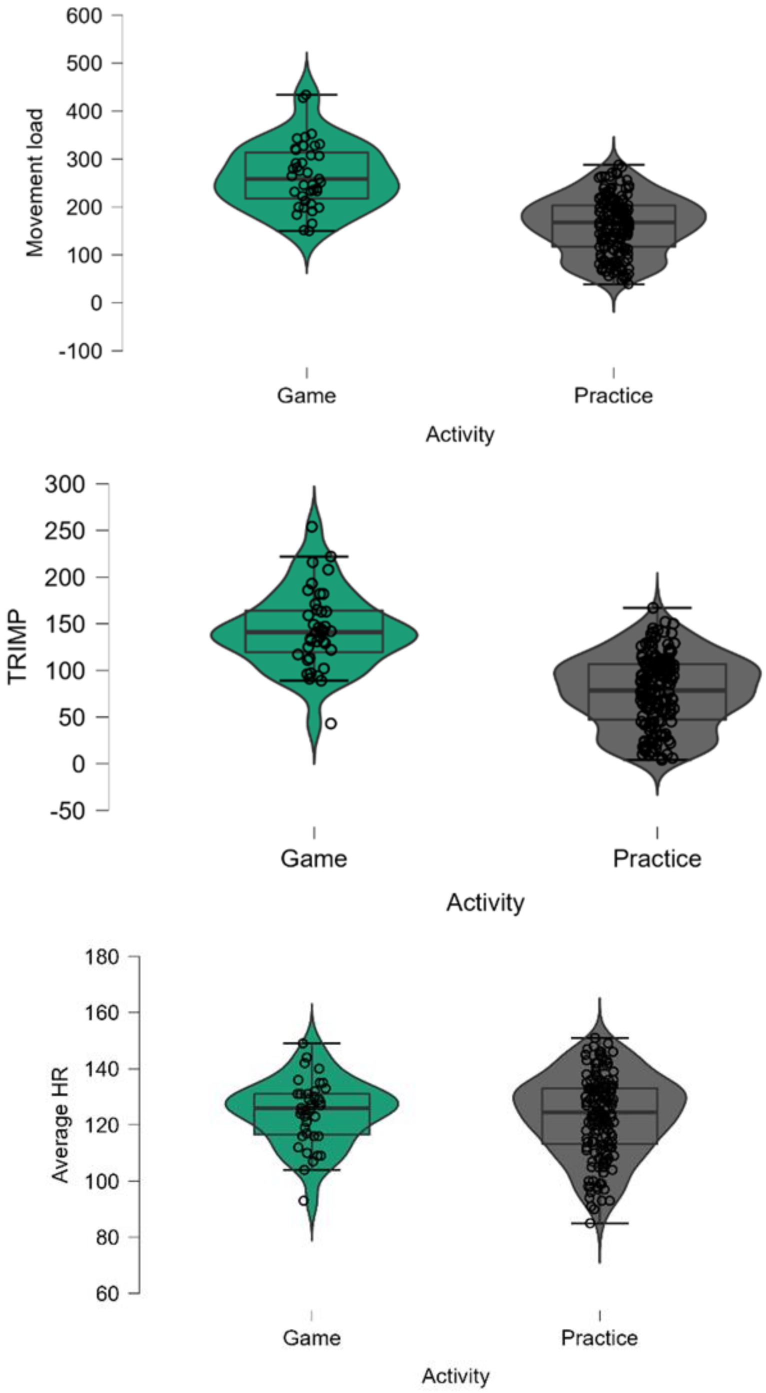

Figure 1. Differences in physical demands between activities (Game vs Practice)

DISCUSSION

The aim of this study was to compare competition and training demands in professional basketball players during a specific preparatory period. The results show large differences in the EL and IL between the competition and training scenarios, being competition load the one that elicited higher values and highlighting the need to keep improving and adjusting preparatory periods to the competition demands in these populations.

Findings of this study differ from the ones obtained in male populations where training demands exceeded match ones in professional and semiprofessional players (Fox et al., 2018; Svilar et al., 2019), these differences could be due to monitoring periods or training strategies involved in the preparation period, in this regard, playing level also seems to play a key role on the differences between groups. Elite level players seem to be more efficient on the court, but they also seem to be able to develop higher speed based probably on a higher sense of awareness of game tactics and schematics (Petway et al., 2020), these differences could also elicit different demands between groups. Also, distribution of playing time in different teams could play a key role on game demands between groups, as starters seem to elicit higher loads than in-rotation players (Palmer et al., 2021), therefore distribution of playing time could also play a role on differentiating loads between teams of the same level of play (Perez-Chao et al., 2021). Results of different studies could also be influenced by the monitoring periods where the data is obtained, as these relate to also different fitness levels, results will be influenced by those levels and this fact must be taken in consideration when interpreting them.

Keeping into account all the factors that have to be taken into consideration when interpreting data from training and competition of different groups, there are matching results through literature to the ones obtained on this study, as previous evidence of basketball competition in elite female young players confirmed that competition might be a more intense scenario while training seems to be higher in volume (Espasa & Caparrós, 2017), these findings concur with the ones of female amateur basketball players, competition scenario for this group showed also higher demands than the ones registered during training sessions (Román et al., 2019). There are also results that point to the similarity between training and game loads in a group of young players, even though the heart HR max value showed higher results during the game than during training sessions, showing matching evidence with our study and previous evidence of elite basketball players that game scenarios could elicit higher cardiac demands than training sessions (Torres-Ronda et al., 2016), in this regard and when comparing training to competition, specific drill constraints, number of players on drills, coaching feedback and work-to-rest ratios could influence the intensity of training sessions, thus consequently affecting match preparation.

Nevertheless, is important to keep into account that competition could elicit higher loads due to team and individual fitness levels in relation to the season stage, raised player sympathetic activity, player rotation and tactical distribution on the court from the subjects measured and the opposite team (Abdelkrim et al., 2010). Matches of this specific study were monitored during the preparatory period, and the preseason loading strategy might have played a key role in the results obtained, as progressive overload with a tapering before competition was the preparation strategy chosen by the coaching staff, this could have affected players fitness status in the beginning of the competitive friendly matches, as fitness levels were not the desired ones for the official competition. Other strategies might elicit faster adaptations and therefore, better preparation for early matches, but also could elicit higher stress on the cardiovascular system suppressing optimal recovery on the subjects exposed to it (Lukonaitienė et al., 2020). Therefore, although some responses from the data analyzed would not be desirable under an overall adaptation point of view, context is crucial when analyzing training and competition load results. The current study employed a considerable sample of professional basketball players at a time of high player preparation for competition (i.e., pre-season). However, these findings may not be applicable to non-professional basketball teams or other phases of the competition season with future studies recommended to extend these results to other contexts.

CONCLUSION

The results of this study show higher demands in basketball players during professional pre-season friendly matches than during training sessions. These could be desirable for the coaching staff in this particular stage of the season, as progressive overload during preseason should elicit its best result towards the end of the preseason period where official competition starts and inducing lower fitness levels during this period´s early stage. Coaching strategies should be oriented keeping into account all characteristics of the teams, in particular, style of play, projected rotations, player characteristics, playing schedule or what percentage of team members have been playing together for the same coaching staff. Specificity should be a priority in preseason to meet team and player demands derived from the stablished coaching philosophy and the overall and immediate season periodization.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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