Revista de Psicología del Deporte/Journal of Sport Psychology Vol. 28. 2019, Suppl 1, pp. 93–99
Universidad de Almería / Universitat Autónoma de Barcelona. ISSN 1132–239X ISSNe 1988–5636

Load Variability of Training Sessions and Competition in Female Basketball

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Abstract

To know how the efforts are distributed throughout the training week and competition it is necessary a planning of the training loads. Therefore, the objective of this study was to determine the load profile of the training session based on its weekly order and competition. A competitive period of a sub 13 women's basketball team was registered. Each player was monitored with a GARMIN™ heart rate band and a WIMU™ inertial system duritng training and competition. The objective was to determine the load profile of the session based on its weekly order and compare it with competition. The main results identified a constant pattern in the modulation of the load during the week. In this profile, the first session gets lower values than the rest of the week. The intermediate sessions obtain higher values and decreasing in the last pre-match session. These results can be used to design fitness programs that optimize the performance of basketball players.

Keywords: load, iTL, eTL, variability, training

Introduction

Quantifying and monitoring the training and competition load is a commonly used tool by trainers and coaches to optimise sports performance, as it makes it possible to determine a base line, define objectives and monitor the players' evolution (Hernández, Casamichana, and Sánchez-Sánchez, 2017). The identification of the physiological determinants of performance in a sport makes it possible to prescribe and supervise training and also predict sports performance, which is crucial for the development of the athletes' profiles (Reilly, Morris, and Whyte, 2009). Although monitoring training is increasingly common (Halson, 2014), there is little information available about the effect produced by the technical-tactical tasks programmed during the training week (Vargas Fuentes, Urkiza Ibaibarriaga, and Gil Orozko, 2015). This information is vitally important for designing training plans with greater knowledge about the total load imposed on the player in real game situations. Thus it is necessary to make a daily assessment of technical-tactical training sessions and the sports competition.

Load quantification takes two main indicators into account: internal load (the player's physiological response) and external load (the work done by the player) (Halson, 2014). Previous research has reported on analyses of the load in training and competition, mainly using internal load in team sports mostly by monitoring heart rate (Matthew and Delextrat, 2009). However, the use of heart rates has been questioned because of fluctuations due to circadian rhythms and the delayed effect of measurements in intermittent efforts, which limit the immediate monitoring of the load (Schneider et al., 2018). This is why the quantification of velocity using accelerometers and GPS devices is currently attracting interest in team sports, as furthermore it is a measurement which has more practical applications that are easily transferable to training (McLaren et al., 2018).

The development of these portable devices with intelligent sensors has opened up new paths for research in sports sciences, including the investigation of the demands of team sports. The suggestion is that among others, measurements derived from accelerometers like velocity, accelerations, decelerations, sprints etc., should be included to achieve a more integrated and ecological image of training loads. As well as this type of variables, those related to the kinematic load shed more light on the actions performed by the players, whether distance covered, number of impacts received, jumps or steps. From a practical point of view, the use of this technology in official competitions would make it possible to monitor the players more closely with regard to the load imposed by a match, providing an important reference for training prescription as well as per-

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mitting coaches and scientists to identify fatigue (Barrett et al., 2016).

The use of accelerometry and GPS has increased considerably in the last few years in team sports practised outdoors like football or rugby (Halson, 2014; Jaspers et al., 2018; Schuster et al., 2018). Acute increases in load during the training week have been associated with a greater risk of injury during competition (Gabbett, 2016). However, few studies have analysed team sports played indoors like basketball that have evaluated the load imposed on the players using inertial devices during training or sports competition. In the case of junior women's basketball the situation is even more worrying, as no information is available to date. For these reasons the objective of this study was firstly to determine the load profile of the training session as a function of when it was carried out during the week, and secondly, to compare the load in the different sessions with the sports competition.

Method

Research Design

This study followed an associative strategy where an attributive variable was used to examine the differences among groups (Ato, López, and Benavente, 2013). It was an observational and longitudinal study as no type of intervention was performed, and the training sessions and matches were treated ecologically.

Participants

Data was collected from an U-13 women's basketball team composed of 12 players (1.63±0.06 m height; 56.65±6.62 kg weight; 3.96±0.38% bone; 23.24±6.88% fat and 72.85±6.54% muscle). All the players completed a pre-season conditioning programme of eight weeks which consisted of a plan that combined components of agility, plyometrics, and anaerobic and endurance work, to ensure optimal fitness. Once this preparatory period was over, the team followed a regular training plan of four days a week including a weekly competition. All the players and coaches were informed about the research protocol, requisites, benefits and risks, and gave their written consent before the start of the study, which was approved by the Ethics Committee of the University of Extremadura (n° 67/2017).

Sample

The performance of each player was recorded during the training sessions as a function of when they took place during the week and the matches played, both individually and as a group, during a competitive period. To be precise, data were collected during the second phase of the competition, corresponding to the months of February, March and April (11 weeks of training). The final sample included 35 training sessions (n=420) and 8 matches (n=96).

Variables

The order in which the training sessions were performed in the week and the match were the independent variables: session 1 (S1), session 2 (S2), session 3 (S3), session 4 (S4) and Match (M). Two categories of dependent variables were established: Internal Training Load (average heart rate, percentage of maximum heart rate and work zones) and External Training Load (number of steps, number of jumps and PlayerLoad).

The Internal Training Load (iTL): quantifies the demands of training and competition in the players using their heart rate (HR) which is measured as the number of beats. The values are expressed as (i) Average heart rate (HRavg) and (ii) % of maximum heart rate (%HRmax).

The External Training Load (eTL): quantifies the load imposed on the players using the following variables: (i) Number of steps: movements which involve advancing with an elevation of less than 400ms of flight; (ii) Number of jumps: movements which involve jumping from the ground with an impulse involving more than 400 ms of flight, to land in the same or another place; (iii) PlayerLoad (PL): the vectorial magnitude derived from the triaxial accelerometer data which quantifies the movement in high resolution, being the vector sum of the accelerations of the device in its 3 axes as indicated in the following formula. PlayerLoad as a unit for measurig the load has a moderate-high degree of reliability and validity (Barreira et al., 2017).

$$PlayerLoad_{t=n} \sum_{t=0}^{t=n} \sqrt{(Z_{t=i+1} - Z_{t=i})^2 + (X_{t=i+1} - X_{t=i})^2 + (Y_{t=i+1} - Y_{t=i})^2}$$

Instruments

The data related to the iTL were recorded with a GARMIN™ heart rate band worn by each player. The data related to the eTL were recorded using the WIMU™ inertial device (RealtrackSystem, Almería, Spain). The device contains different sensors, and in this study the four triaxial sensors were used (±2g, ±16g, ±100g, ± 400g) with a sampling frequency of 100 Hz, without depending on data coming from global positioning systems (GNSS), as this study was conducted indoors. All the data recorded from the inertial devices were automatically analysed and sent to the computer screen in real time. The SPRO™ software system was used for the subsequent analysis of the data.

Procedure

Before data collection the devices were calibrated according to the manufacturer's instructions. The inertial device was attached to each player between the shoulder blades using a snugly fitting anatomical harness. A different protocol was established in the training sessions and the competition.

1. Training analysis: In each training week 4 one hour and a half sessions were performed plus the corresponding match. All the training sessions started with 15 minutes of a standard warm-up based on dynamic stretching exercises and running. The players were allowed to drink water during the recovery periods. All the training sessions were designed, directed and supervised by the team's technical staff. The training sessions were mainly based on shooting exercises in competition, small-sided games, tasks with number superiority or inferiority and 5 vs. 5 tasks.

2. Match analysis: the match was analysed in real time in the four quarters in which the competition was divided, excluding the rest intervals between quarters and timeouts. Only the players on the court were monitored.

Statistical Analysis

For the statistical analysis all the data were normalised to the practice time (repetitions per minute). A descriptive analysis was performed followed by a k-means cluster analysis of the variables in order to characterise the sample as a function of the category chosen, using means and standard deviations. Then the differences between type of session and match were studied as a function of the iTL and eTL variables using an ANOVA. Differences were also identified in more detail with the Bonferroni post-hoc test. Effect size was calculated using Cohen's d, the F-test for pairwise comparisons and Eta2 for comparisons among groups (Thalheimer and Cook, 2002). The statistical analysis was performed with SPSS v.21 software (IBM, Armonk, NY, USA). Statistical significance was set at p <.05 (Field, 2009).

Results

The results of the ANOVA showed significant differences in the iTL variables in HRAvg (F=81.824; *p*= .000; η^2=.457; ϕ= *1*) and %HRMax (F=17.658; *p*=.000; η^2= .155; ϕ= 1) among the weekly sessions and the competition (Figure 1). The between group comparisons revealed a higher HRAvg and %HRMax (*p*<.05), with the exception of S3, in competition compared to all the training sessions. Regarding the comparison among sessions, higher values were observed in S3 than S1 with respect to HRAvg (*p*=.000) and %HRMax (*p*=.005).

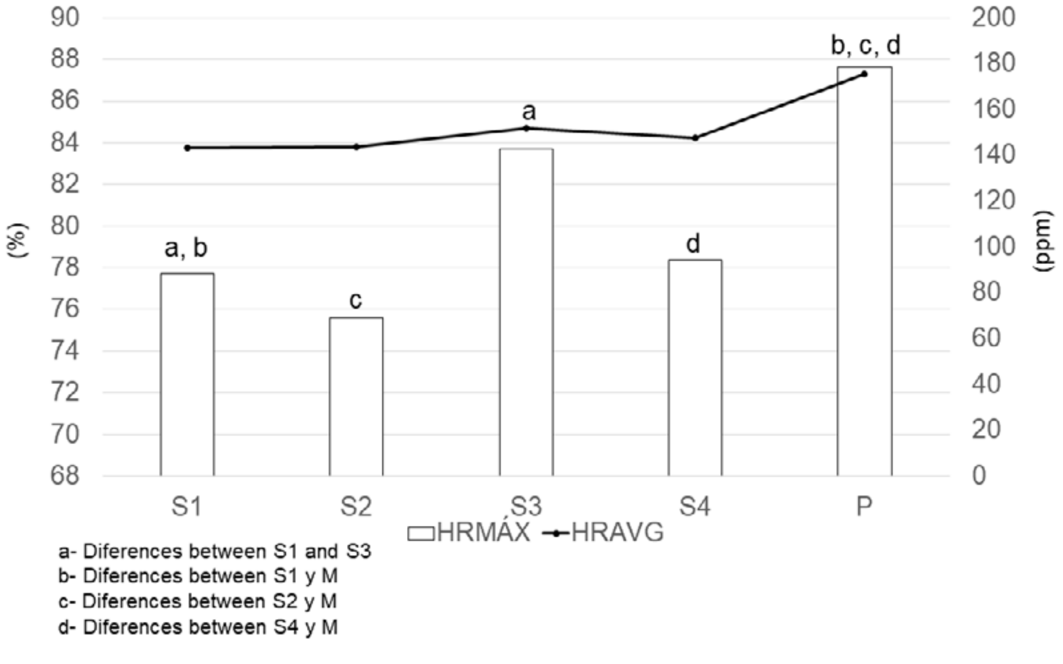

Figure 1. Cardiac variability as a function of the training session

In the case of the eTL variables, statistically significant differences were also found among the sessions as a function of when they were performed in the week and in comparison with the competition in PL (F=514.420; *p*= .000; η2=.842; ϕ= 1), number of steps (F=746.769; *p*= .000; η2=.888; ϕ= 1) and number of jumps (F=58.478; *p*= .000; η2=.373; ϕ= 1) (Figures 2, 3, and 4).

In the PL variable statistically significant differences ($p<.005$) were found in all the sessions in comparison with S1, where the load values were the lowest (31.13 load units). With regard to the competition there were significant differences in the PL/min variable compared to the training sessions, with higher loads per minute during the match (1.19 load units/min).

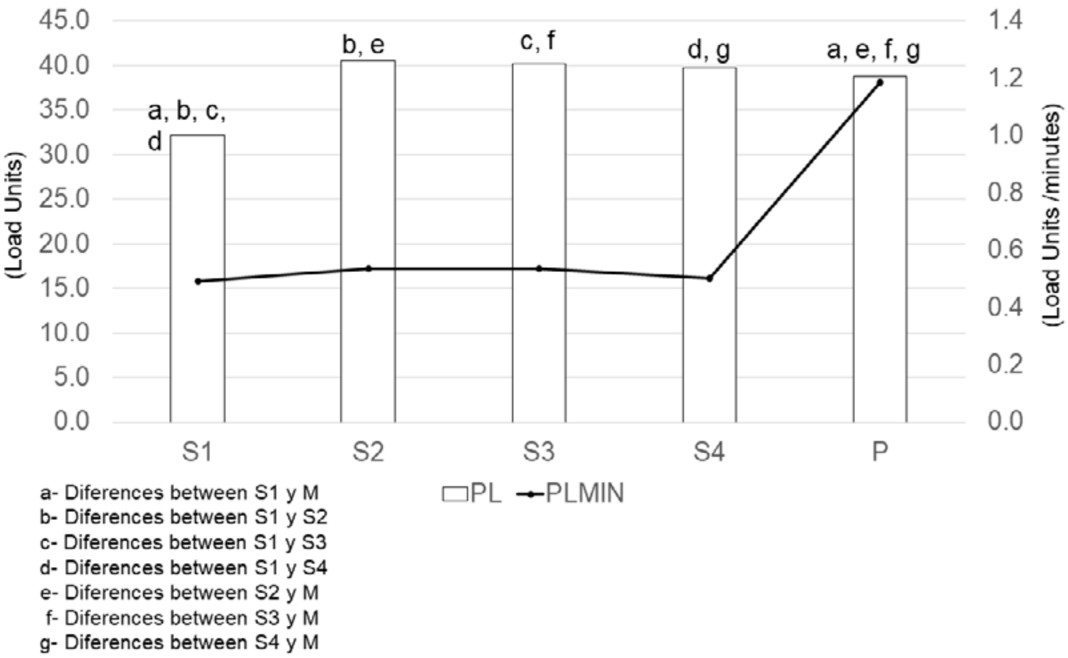

Figure 2. Load variability as a function of the training session

With respect to the steps variable, statistically significant differences ($p<.005$) were found in all the sessions compared to S1, with the latter recording the lowest number of steps per session and per minute (21.45 steps/min). Regarding the competition there were significant differences in the variable of steps/min compared to the training sessions with a higher number of steps recorded during the match (71.60 steps/min).

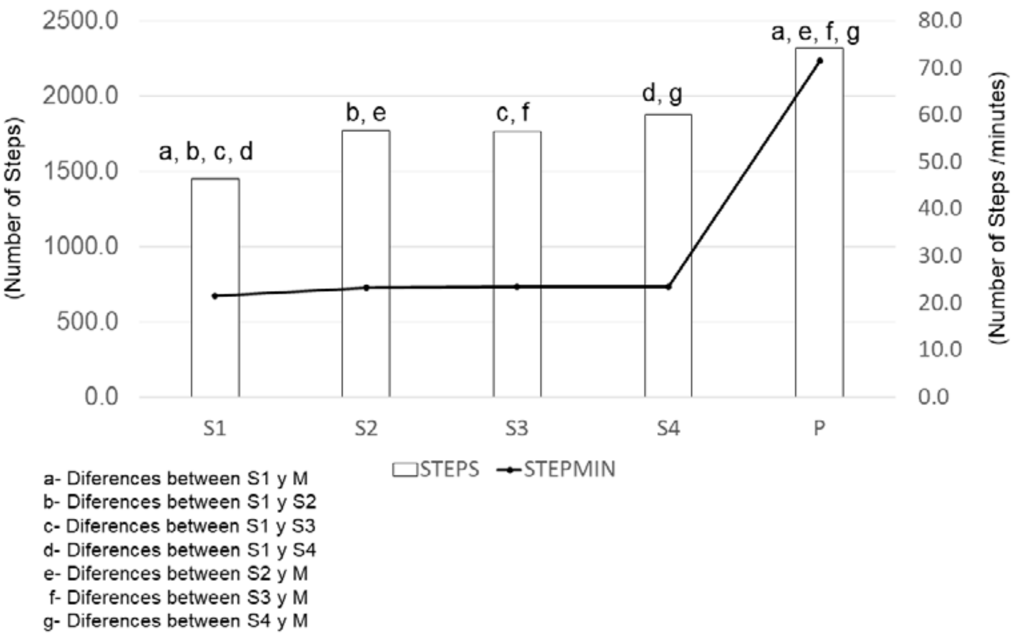

Figure 3. Step variability as a function of the training session

Statistically significant differences (*p*<.005) were found in the jumps variable between S1 and S2, and S4 and S2/S3. S2 was the session where the highest number of jumps per minute was recorded (0.74 jumps/min). Regarding the competition there were significant differences in the jumps/min variable compared with all the training sessions, with a lower number of jumps per minute during the match (0.24 jumps/min).

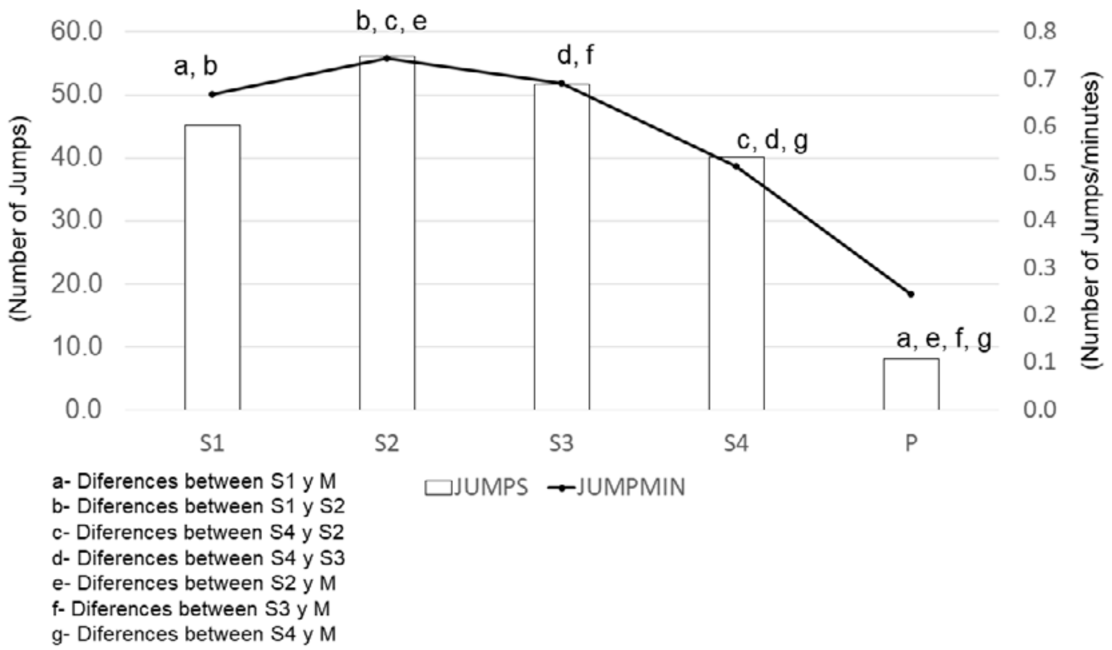

Figure 4. Jump variability as a function of the training session

In the analysis of the competition, the variables analysed were weighted to repetitions per minute, as there is a time difference between sessions and matches. Statistically significant differences were found in all the variables analysed except %HRMax, as S3 equalled the demands of the competition. For the rest of the variables the demands imposed by the competition were greater than those produced during the training sessions, with the exception of jumps per minute, which was higher during the training sessions. Table 1 below shows the inferential statistics which support the above-mentioned observations.

Discussion

The main objective of the study was to determine the load profile of the training session as a function of when it was performed during the week and the sport competition. The definition of these profiles made it possible to compare the load in the different sessions with the sports competition. The quantification of the load using inertial devices during a competitive phase has made it possible, for the first time, to ascertain the distribution of the load stimuli in weekly training and the match in junior basketball. After analysing the load corresponding to the 35 training sessions and 8 matches that made up the competitive period, it was observed that the distribution of the matches conditioned the planning of the sessions. The sessions were recorded ecologically, with no incidents occurring in the process, making it possible to objectively assess the modulations of the loads imposed on the team.

According to Vargas Fuentes et al. (2015), the training load should be modulated in microcycles determined by the matches, reducing fatigue and preparing the necessary effects for facing the competition in the best possible condition. Gómez-Díaz, Pallarés, Díaz, and Bradley (2013) concluded that the players that had maintained themselves in the more intense zones during the match, had performed the weekly training sessions with a high level of physical stress. So pre-competition sessions with a high load should not negatively affect performance, but rather generate positive adaptations that reduce the risk of injury, provided that acute changes do not occur in short periods of time (Gabbett, 2016). In the case of the team analysed in this study, the load in the training sessions was observed to fluctuate as the week went by.

A load profile was established and a constant pattern in the modulation of the load was identified and was repeated during all the weeks which included a match. In this weekly profile, S1 recorded lower values than the rest of the week and. S2 and S3 were revealed to produce the highest values which decreased in S4. Consequently, a first recovery session was established after the match, two sessions with a physical load in the middle of the week, and lastly a pre-competition adjustment session.

Regarding the post-match training session load, the literature consulted in different opposition-collaboration sports, coincides in that this session is planned to imply a lesser demand. Marcos, González, and Oliva (2013) observed that in junior football the first weekly session is less intense, without at any time passing the 80% HRMax level. García-Rubio, Parejo and Cañadas (2010) also detected the tendency to begin the week at a lower level of intensity than the rest of the training sessions.

The intermediate sessions were the ones that produced the highest load in the week, to be precise S3. According to the principles of sports training, this is based on the overcompensation principle, where after the application of a stimulus like for example a competitive match, a recovery period is given to the players which allows them to continue at an optimal level during the rest of the week (Platonov, 1995).

With respect to the training sessions prior to the sport competition, the load in the team analysed decreased. Terrados and Calleja-González (2008) identified that decreasing the load before competition provokes positive adaptations in performance. On the basis of the bibliography reviewed it is considered that, even without the research intervention, the planning of the loads during the week was optimal from the training principles point of view.

With respect to the sports competition, it was established that the load caused by the match was greater than that of the training sessions, independently of when they were performed during the week. Competition provoked significantly higher HRAvg and %HRMax than the training sessions with the exception of S3 where the cardiac values were similar to those of competition. PL and steps per minute were statistically higher in competition. In the case of jumps per minute, there was a higher load during the training sessions compared to competition. This may be due to the use of tasks in small-sided games in training, with specific aims which cause a greater use of jumps. Reina, Mancha, Feu and Ibáñez (2017), reported that both the analysis of the physical and physiological variables identify competition as the most demanding condition in women's basketball. Their results corroborate the existence of different effort patterns in competition compared to training. In the exception of number of jumps per minute, no significant differences were found between training and competition.

Conclusions

The findings in this study identified a pattern in the training load profile that was repeated week after week. In this pattern, S1 recorded the lowest load values, which increased in S2 and S3 and then decreased slightly in S4. Differences were also found between training and sports competition, with the match being the most demanding condition with the exception of the number of jumps. This profile can be used to monitor and design physical conditioning programmes to optimise performance in women's basketball players.

Acknowledgment

This work has been partially subsidized by the Help for Research Groups (GR18170) of the Junta de Extremadura (Ministry of Economy and Infrastructure); with the contribution of the European Union through the FEDER

Variabilidad en la carga de las sesiones de entrenamiento y la competición en baloncesto femenino de formación

Resumen

Para una correcta planificación de las cargas de entrenamiento, es necesario saber cómo se distribuyen los esfuerzos a lo largo de la semana de entrenamiento y también definir las demandas que genera la competición deportiva. Por tanto, el objetivo de este estudio fue determinar el perfil de carga de la sesión de entrenamiento en función de su orden semanal, además de la competición deportiva. Para ello se registró un periodo competitivo de un equipo sub 13 de baloncesto femenino dónde se monitorizó a cada jugadora con una banda de frecuencia cardíaca GARMIN™ y un sistema inercial WIMU™ durante el entrenamiento y la competición. El objetivo fue determinar el perfil de carga de la sesión en función de su orden semanal y compararlo con la competición deportiva. Los principales resultados identificaron un patrón constante en la modulación de la carga durante la semana. En dicho perfil, la primera sesión obtiene valores inferiores al resto de la semana y, son las sesiones intermedias las que obtienen valores superiores, disminuyendo en la última sesión pre partido. Estos resultados pueden ser utilizados para el diseño de programas de acondicionamiento físico que optimicen el rendimiento de las jugadoras de baloncesto.

Palabras clave: carga; iTL; eTL; variabilidad; entrenamiento.

Variabilidad em la carga de las sesiones de entrenamiento e la competición en baloncesto feminino de formación

Resumo

Para um planejamento adequado das cargas de treinamento, é necessário conhecer como os esforços são distribuídos ao longo da semana de treinamento e também definir as demandas geradas pela competição esportiva. Portanto, o objetivo deste estudo foi determinar o perfil de carga da sessão de treinamento com base em sua ordem semanal, além da competição esportiva. Para isso, foi registrado um período competitivo de um time de basquete sub 13 feminino, onde cada

jogador foi monitorado com uma faixa de ritmo cardíaco GARMIN™ e um sistema de inércia WIMU™ durante o treinamento e competição. O objetivo foi determinar o perfil de carga da sessão com base em sua ordem semanal e compará-la com a competição esportiva. Os principais resultados identificaram um padrão constante na modulação da carga durante a semana. Neste perfil, a primeira sessão obtém valores menores que o resto da semana e, são as sessões intermediárias que obtêm valores mais altos, diminuindo na última sessão pré-jogo. Esses resultados podem ser usados para projetar programas de condicionamento físico que otimizem o desempenho de jogadores de basquete.

Palavras-chave: carga; iTL; eTL; variabilidade; treinamento.

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