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Monitoring and Interpreting External Load in Basketball: a Narrative Review

Rubén Portes[1] , Rafael Manuel Navarro[2], Carlos Sosa[3], Juan Jesús Trapero[4] & Sergio L. Jiménez[5]

Abstract

External load monitoring brings valuable information to practitioners and coaches about the physical requirements of the activity developed by their players, according to their level of competition, age and gender. This information can be used to individualize training programs and to optimize the time invested in them, making coaches and players more efficient in the process. This review asses the results reflected in the existing bibliography about the measurements of external load in the sport of basketball, synthesizing them in one article for the scientific reader. Data from 29 scientific papers has been organized and discussed, providing relevant insights about the goals and findings, sample, measurement variables and technology for monitoring external load in basketball.

Keywords: external load, accelerometry, performance enhancement, injury prevention, GPS, time-motion analysis, player monitoring

Introduction

External load (EL) is defined as the work completed by the athlete, measured independently of his or her internal characteristics (Wallace, Slattery and Coutts, 2009), while internal load (IL) is the physical response of the athlete to the work completed (Drew and Finch, 2016). EL quantifies the stimulus on players, that can be measured for the entire session, volume, or relative to time or intensity (Narazaki, Berg, Stergiou and Chen, 2009), the IL measures the physical or psychological responses of the athletes to the EL imposed on them (Halson, 2014). Common measures of external load include: power output, speed, acceleration, Time-Motion Analysis (TMA), Global Positioning System (GPS) parameters and accelerometer derived parameters, while IL measures include heart rate, oxygen consumption, lactate concentration or ratings of perceived exertion (RPE) (Bourdon et al., 2017).

Regarding EL measures, TMA has been used to analyze player performance (Dawson, Hopkinson, Appleby, Stewart and Roberts, 2004) but this process has several limitations. These include the time taken to complete the analysis, the definition of the movement categories, the parallax error and the lack of reliability (Dobson and Keogh, 2007). GPS has been applied to team sports, in an attempt to overcome some of the problems with TMA. There are several advantages of using GPS. These include the ability to monitor multiple players at once, the time effectiveness of the analysis and the ability to receive information in real-time (Aughey and Falloon, 2008). In addition, other authors have proved that moderate correlations exist between GPS (Global Positioning System) load variables and IL variables such as RPE (Rate of Perceived Exertion) (Bartlett, Torres-Ronda, O'Connor and Robertson, 2016). Accelerometers offer distinct advantages compared with TMA, as accelerometer data is relatively simple to analyze using either proprietary or user-defined algorithms which quantify movement (Fox, Scanlan and Stanton, 2017). Although these advantages seem clear, research and improvement on this technology and its attachment to the body of the athlete needs to continue, as some concerns regarding the reliability of measures of vertical accelerations have arisen lately (Edwards, White, Humphreys, Robergs and O'Dwyer ,2018).

Although, as stated by scientific literature (Aoki et al., 2016; Montgomery, Pyne and Minahan, 2010; Peterson and Quiggle, 2017; Torres-Ronda, Ric, Llabres, De las Heras and Schelling, 2016), both load measures (EL, IL) are important in understanding the work experienced by the athlete, the aim of this study is to review articles monitoring EL to bring conclusions and practical recommendations regarding these measures. This will help to bring valuable information that assists coaches and conditioning professionals in adapting training processes to the exact specifications of their athletes.

1 Department of Sports Science, European University of Madrid. Corresponding author: Rubén Portes Sánchez, Club Baloncesto Torrelodones. Plaza Jose María Unceta 4-6, 28250, Torrelodones, España. E-mail address: rubenportes@btorrelodones.com, pl: rubenportes@yahoo.es

2 Department of Sports Science, European University of Madrid

3 Department of Sports Science, European University of Madrid

4 Department of Sports Science, European University of Madrid

5 Department of Sports Science, European University of Madrid

Method

The search for articles monitoring EL in basketball was carried out in the following websites: WOS, PubMed and MEDLINE. Information regarding these articles was registered in Table.2, and the main findings discussed in the following sections.

Study Goals

Monitoring and interpreting EL brings vital information to practitioners and coaches. The ability to identify the specific information that we want to retrieve from the monitoring process plays an equally vital role. There are a variety of options and monitoring tools available on the market to obtain information from the load imposed on players during the training process. How this information can be used is also more diverse than ever.

This review pays special attention to the goals of the study: injury prevention, performance enhancement and gender comparison. Fig 1. shows the percentage of studies reviewed dedicated to each goal.

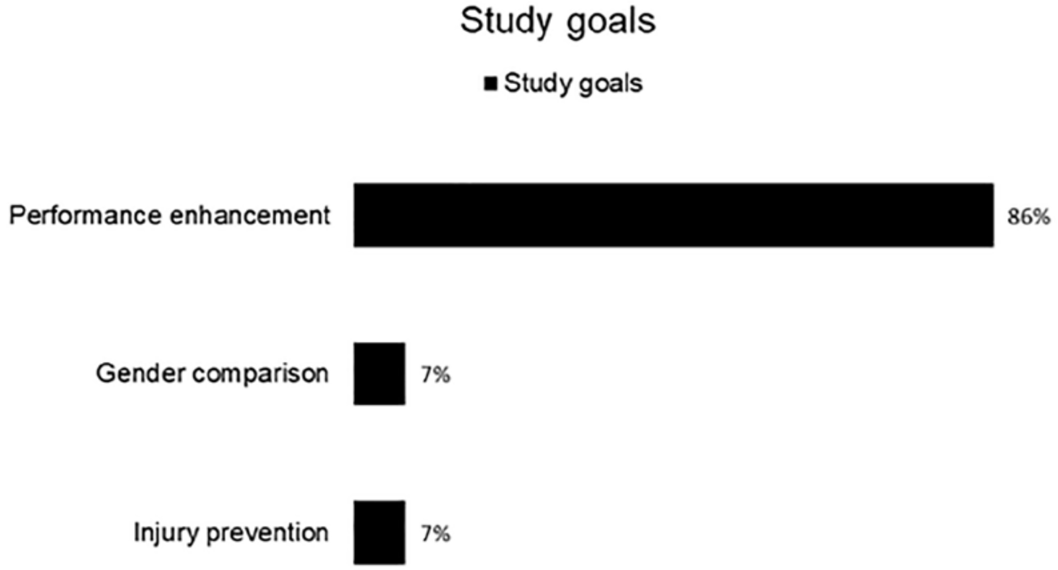

Figure 1. Goals of the studies reviewed

Performance Enhancement

Improving performance or adjusting training programs to the demands of the different playing positions of the players on the court takes up 86% of the studies of this review. One of the main findings in the results of the studies suggests that EL should be monitored and correctly interpreted, in addition to IL, to have a better understanding of the training process and help coaches build better strategies and better training programs with the maximum adaptation to competition (Aoki et al., 2016; Montgomery, Pyne and Minahan, 2010; Peterson and Quiggle, 2017; Reina, Mancha, Feu and Ibáñez, 2017; Scanlan, Wen, Tucker and Dalbo, 2014; Torres-Ronda, Ric, Llabres, De las Heras and Schelling, 2016). Related to this matter, findings of the studies show that the sRPE (session Rate of Perceived Exertion) shows greater a correlation with external variables compared to the RPE (Svilar, Castellano, Jukic and Casamichana, 2018). More specifically, the number of changes of direction and decelerations show strong correlations with Player Load and sRPE (Svillar, Castellano and Jukic, 2018).

Considering possible differences in demands between the different playing positions on the court, authors conclude that perimeter players decelerate the most out of all the players on the court, especially the Point Guards (Vazquez-Guerrero, Suarez-Arronez, Casamichana and Rodas, 2018). All these facts elevate the external load data of this group to higher values than the ones obtained for the rest of the players, especially the Power Forwards who had the lowest load values out of all the groups (Vazquez-Guerrero, Suarez-Arronez, Casamichana and Rodas, 2018).

The difference in size and mass between players should be taken into consideration when applying load on them as guards or smaller players in general complete a higher number of accelerations during game time, probably explained by the fact that the smaller the player, the easier it is to accelerate with less applied force (Schelling and Torres, 2016). Taking this differentiation of demands into account, the centers seem to be the players taking less load during playing time, although there seem to be no differences between guards and forwards (Puente, Abián-Vicén, Areces, López and Del Coso, 2017). Therefore, coaches should consider the playing position when planning the physical conditioning and training to meet the demands of the different players participating in the game (Delextralt et al., 2015).

The studies evaluation of the overall demands of the game of basketball in this review seem to agree about the need for the players to be able to repeat short, linear sprinting and high intensity actions, such as shuffling and changes of direction, during playing time (Conte et al., 2015; Delextralt et al., 2015; Leite, Coutinho and Sampaio, 2013; McInnes, Carlson, Jones and McKenna, 1995). Coaches should also consider evaluating the Live Time/Stoppage Time ratio which occurs during competition games, to be able to apply it during the training process and make it as specific as possible (Conte, Tessitore, Smiley, Thomas and Favero, 2016). When comparing game and scrimmage demands, the studies show different results; while one concludes that training demands exceede the competition demands (Fox, Stanton and Scanlan, 2018), another concludes that game play has a greater physical load than scrimmage play (Montgomery, Pyne and Minahan, 2010). Differences between these conclusions might be attributed to methodological differences between studies, and the fact that Montgomery et al. (2010) examined elite-level players while Fox et al. (2018) examined semi-professional players. Previous research has shown that sub-elite basketball players experience reduced running and jogging demands compared with elite players during competition (Scanlan et al., 2011). This fact might also explain the difference between the results of both studies mentioned. These differences can also be observed during the different quarters of a single game as the fourth quarter seems to be less demanding on professional players and to a lesser degree on semiprofessionals. This is most likely attributed to physical, tactical and game-related factors (Scanlan et al., 2015).

Differences also exist between the demands on the defensive and the offensive side of the court. There seems to be more distance covered while jogging on the offensive court: (38.15 ± 12.17 m/min offensive court vs. 32.94 ± 10.84 m/min defensive court, $p < 0.05$) compared with running on the defensive side of the court: (16.41 ± 10.27 m/min offensive court vs. 19.56 ± 10.29 m/min defensive court, $p < 0.05$) according to (Sampaio et al., 2016). There are also differences between activity performed during the mornings compared with during the afternoons. Authors conclude that performance is suppressed during morning trainings and this is associated with a decrease in self-reported quality of sleep (Heishman et al., 2017). They therefore recommend that training should be performed in the afternoon to obtain more benefits and reduce the negative effects.

The dimensions of the space used in different training drills also has an influence on the accumulated external load as bigger court dimensions develop higher external load volumes on players (Vazquez-Guerrero, Reche, Cos, Casamichana and Sampaio, 2018). Authors state that if the court dimensions are reduced, the accelerations and decelerations are subsequently reduced, and less load is therefore accumulated.

Gender Comparison

Not many studies have highlighted the differences between genders in the sport of basketball. Evidence seems to indicate that some differences do exist between men and women if we compare players of the same level. Authors investigated these differences and concluded that female backcourt players carry out significantly more low-intensity shuffling and jumping activity and spend significantly longer jogging compared with male backcourt players (Scanlan, Dascombe, Kidcaff, Peucker and Dalbo, 2015). Female frontcourt players perform significantly more upper-body activity than male frontcourt players (Scanlan, Dascombe, Kidcaff, Peucker and Dalbo, 2015). Overall, female players cover significantly greater distances running than male players, while male players spend significantly longer dribbling during which time, they travel significantly larger distances than female players (Scanlan, Dascombe, Kidcaff, Peucker and Dalbo, 2015). Evidently wider differences might exist when comparing the demands between genders of different levels. However, they also occur when comparing same gender players from different levels (Ben Abdelkrim, Castagna, El Fazaa and El Ati, 2010). Therefore, the studies targeting comparisons between genders should test players from the same competition levels in order to obtain more consistent results. Compared to male players of a similar standard, female basketball match-play also involves extensive intermittent activity and comparable activity demands, and therefore female conditioning programs may be able to incorporate similar intermittent training to male programs when matched for playing standard (Scanlan, Dascombe, Reaburn and Dalbo, 2012).

Injury Prevention

The injury prevention process is affected by many factors in the competitive level including exposure time to practice and competition. While this increasing practice and competition time is related to greater team performance, the number of injuries also increases as shown in Table 1. However, higher injury rates are not associated with a worse overall team performance (Caparrós et al., 2016). While these injuries may not affect the team's success during the season, it is important to monitor the exposure of each player to avoid the additional risk of injury, as these injuries are likely to occur both to the best players and during matches rather than during team practices (Caparrós et al., 2016). Load management by a reduction in the number of practices and their duration has been shown to reduce injury rates and fatigue (Gabbett, 2004). The challenge is therefore to provide adequate training loads to improve performance and fitness but with enough protective effect against injuries (Drew and Finch, 2016). These are not the only factors that should be taken into consideration while imposing external load on players. This is because unloaded players have a greater risk of injury, if you consider the number of decelerations and the total distance covered, (Caparrós, Casals, Solana and Peña, 2018). A player can achieve accelerations (Schelling and Torres, 2016), but the risk of injury might be more related to the ability of decelerating at a high intensity, and how the players' muscles can recover from these repeated efforts (Caparrós, Casals, Solana and Peña, 2018). Therefore, High levels of EL could put players in danger of injury just as much as low levels of EL. The challenge is therefore to provide players with the correct load in order to try to reduce these injury risks as much as possible.

Table 1
Number of practices and games, hours of exposure, incidence and number of injuries, and performance by season. Data presented as total frequency and mean (SD). (Caparrós et al., 2016)

Seasons	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Exposure							
Total number of practices	283	276	268	288	281	305	304
Total numer of games	78	79	78	72	76	88	85
Total number of exposure hours	4540	4788	4438	4416	4060	5364	5063
Total number of game hours	244	248	227	216	243	286	264
Total practice exposure hours	4296	4540	4212	4200	3817	5077	4799
Injuries							
Total number of injuries	13	18	21	26	17	37	29
Total number of injuries during practice	8	11	12	11	11	16	22
Total number of injuries during game	5	7	9	15	6	21	7
Total injury incidence per 1000 h	2.9	3.8	4.9	5.9	4.2	6.9	5.7
Total injuries per 1000 h per practice	1.9	2.4	2.8	2.6	2.9	3.1	4.6
Total injuries per 1000 h of games	20.5	28.2	39.7	69.4	24.7	73.4	26.5
Performance							
Total outcomes achieved	1	2	3	2	3	2	2
Total team ranking	5406	6285	6465	5795	6344	7952	7427
Team mean game ranking	77.4 (15.3)	91.7 (17.8)	94.1 (19.3)	88.2 (14.9)	88.9 (18.2)	92.7 (20.0)	93.8 (20.9)

Conclusions and Practical Recomendations

Regarding the monitoring of EL, these are the main findings of this review:

- EL measures should be monitored, interpreted and compared to IL measures to take decisions regarding changes in training programs and competition strategies.
- Changes of direction and acceleration/deceleration ratio correlate positively with Player Load.
- Repeating linear sprinting and intensity actions are crucial to meet the demands of the sport of basketball. Therefore, including them in conditioning programs seems crucial in order to meet game demands.
- Perimeter players decelerate the most out of all the players on the court

and therefore, their player load is higher when compared to post players.

- Due to the previous findings, training processes should be individualized by position in order to reproduce competition demands during training.
- Male players seem to have similar demands than female players of the same or similar levels of competition, therefore training programs could also include similar content for both.
- Reducing the number and duration of practices seems to have a positive impact on the reduction of injuries by reducing the load on players.
- It is crucial to reach an intermediate point when talking about load management as unloaded players seem to be at a similar risk of injury to those players experiencing high amounts of load.
- The risk of injury is highly related to the ability to decelerate at high intensity and the capability of recovering from these decelerations. These actions should be consistently included during training to help players to prevent injuries related with the lack of those abilities.

Table 2
Data extracted from the articles reviewed

AUTHORS	YEAR/ QUARTILE	SUBJECTS	GENDER	COMPETITION	QUANTIFICATION	TECHNOLOGY / MEASUREMENT VARIABLES	RESULTS	GOAL
Abdelkrim, N,B. El Fazaa, S. El Ati, J.	2007 / Q1	38 elite under-19-year-old basketball players (mean age 18.2±0.8y; stature 1.89±0.05; mass 80.3±6.7 kg)	Male	Tunisian under-19-year-old basketball championship	6 play off games	Video recordings collected using one immobile camera (SONY, DSR-PD170P, Tokyo, Japan) / *standing still, walking, jogging, running, sprinting, jumping and low, moderate, high- specific movement*	Games with the actual game rules are played at a slightly higher intensity than the ones played with the previous ones.	Performance enhancement
Abdelkrim, N,B. Castagna, C. El Fazaa, S. El Ati, J.	2010 / Q2	38 elite under-19-year-old basketball players. 22 national level players (mean age 18.2 ± 0.8y; stature 1.89 ± 0.05; mass 79.6 ± 6.3 kg) 16 international level players (mean age 18.3 ± 0.4y; stature 1.88 ± 0.06; mass 81.2 ± 7.4 kg)	Male	Tunisian under-19-year-old basketball championship	6 play off games	Video recordings collected using one immobile camera (SONY, DSR-PD170P, Tokyo, Japan) / *standing still; walking; jogging; running; sprinting; jumping; and low-, moderate-, high-shuffling movement.*	Game work rate of elite-level basketball players is higher than that of lower level players (i.e., high-intensity construct validity)	Performance enhancement
Caparrós et al.	2016 / Q2	44 professional players (mean age of 27.6±4.1 y, stature: 2.00±0.09 m; mass: 98.5±12.6 kg)	Male	ACB (Spain)	556 games and 2005 practices	Hours of exposure	Increasing practice and competition time is related to greater team performance but it also increases the number of injuries. However, higher injury rates were not associated with worse overall team performance.	Injury prevention
Caparrós, T. Casals, M. Solana, A. Peña, J.	2018 / Q2	33 Professional players (mean age 24.9±2.9 y, stature: 1.95±0.09 m, mass: 98.9±12 kg)	Male	NBA	246 games	SportsVU (Northbrook, IL, USA) / *Physiological Load,Physiological Intensity, Deffensive Average Speed, Offensive Average Speed, Distance, Mechanical Load,Mechanical Intensity, Acceleration, Deceleration, Walk Maximal Speed, Run Maximal Spèed, Sprint Maximal Speed, Maximal Speed.*	Unloaded players have a greater risk of injury, inreasing the external load may reduce the risk of injury in professional basketball.	Injury Prevention
Conte, D. Tessitore, A. Smiley, K. Thomas, C. Favero, T. G.	2016 / Q3	13 American and European players (mean age: 21±1 y, stature: 1.96±0.09 cm, mass: 92.6±14.0 kg)	Male	NCAA Division 1	10 division I men's college basketball games (7 home and 3 away), 15 defensive, 14 offensive and 6 scrimmage-type drills of the same team were analysed	fixed camera (Sony HDR-FX7E, Tokyo, Japan, 50 Hz) / *Live- Stoppage Time*	Results encourage coaches to use game-based conditioning drills to replicate the LT/ST ratio documented during games.	Performance enhancement
Conte et al.	2015 / Q2	12 elite basketball players (mean age: 27 ±4 y, stature: 1.84± 0.09 cm; mass: 77.56±15.1 kg).	Female	Serie A1 Italy	5 home games (3 Serie A1 games and 2 Euroleague games)	fixed camera (Sony HDR-FX7E, Tokyo, Japan, 50 Hz) / *High-intensity activity (HIA), sprint activity, and repeated sprint events (RSEs)*	Results encourage coaches to include repeated sprint ability with mainly linear and short sprints into a comprehensive training program	Performance enhancement

AUTHORS	YEAR/ QUARTILE	SUBJECTS	GENDER	COMPETITION	QUANTIFICATION	TECHNOLOGY / MEASUREMENT VARIABLES	RESULTS	GOAL
Delextralt et al.	2015 / Q4	42 elite basketball players (mean age: 25.9±4.3 y, stature: 183.4±9.0 cm)	Female	Liga Femenina 1 (Spain)	3 matches from each team	LINCE multiplatform sport analysis software (Observesport, Lleida, Spain) / *Standing still, walking, jogging-running, sprinting, jumping, low- (less than ~6 km.h-1), moderate- (from ~6 km.h-1 to ~9 km.h-1) and high-intensity (> ~9 km.h-1) specific movements (shuffling as well as any foot action that differed from ordinary walking or running, such as roll, reverse and cross-over run), and static exertion.*	Findings suggest that physical conditioning by playing position and training the capacity to repeat high-intensity actions might be worth considering by coaches.	Performance enhancement
Heishman et al.	2017 / Q2	10 elite NCAA Division 1 basketball players from the University of Virginia (mean age 20.9±1.2 y, stature 188.0±7.9 cm,mass 100.8±9.2 kg)	Male	NCAA Division 1 - Top 10 ranked team (Virginia University)	5 week pre-season training period (16 sessions total)	Catapult Optieye S5 (Catapult Innovations, Melbourne, Victoria, Australia) / *Player Load tm*	We conclude that performance is suppressed with morning training and is associated with a decrease in self-reported quantity of sleep.	Performance enhancement
Heishman et al.	2018 / Q2	10 elite basketball players (mean age: 20.9±1.2 yrs, stature: 188.0±7.9 cm, mass: 100.8±9.2 kg)	Male	NCAA Division 1 - Top 10 ranked team (Virginia University)	5 week pre-season training period (16 sessions total)	Catapult Optieye S5 (Catapult Innovations, Melbourne, Victoria, Asustralia) / *Player Load tm*	Omegawave and Catapult technologies may be effective tools for monitoring athlete performance on a daily basis. Individuals with higher readiness scores and/or individuals lower training loads during preseason have better performance on subsequent training days. Additional work is required to determine if use of these technologies over time optimizes future training sessions throughout the year, attenuates overuse injuries, and provide parameters for return to play after injury.	Performance enhancement
Leite, N. Coutinho, D. Sampaio, J.	2013 / Q4	10 baketball players (mean age: 17.5±0.3 y, stature 175.4±4.83 cm, mass 64.5± 6.44kg)	Male	Portugal Junior League	Two sessions: session a) game continuous 1 (C1) 10 minutes (min) - yo-yo intermittent recovery test level 1(YYIRTL1) - 1 min timeout – game continuous 2 (C2) 10 min. session b) game interrupted 1 (I1) 5 min - 1 min timeout - 5 min game YYIRTL1 - 1 min timeout – game interrupted 2 (I2) 5 min - 1 min timeout - 5 min game	GPS (SPI Elite. GPSports Systems, Australia) / *Distance covered at different speed zones, number of actions performed at speeds ≥ 18 km/h*	Accumulated fatigue in games with time-out doesn't affect significantly the physiological and time-motion variables, however were recorded better patterns of spatial coordination in relation to team geometric center. The results also showed that with the accumulated fatigue the players covered a less total distance and in a slower speed zone	Performance enhancement

AUTHORS	YEAR/ QUARTILE	SUBJECTS	GENDER	COMPETITION	QUANTIFICATION	TECHNOLOGY / MEASUREMENT VARIABLES	RESULTS	GOAL
McInnes, S. E. Carlson, J. S. Jones, C. J. McKenna, M. J.	1995 / Q1	8 elite basketball players (mean age: 23.5±3.2 y, stature: 191.0±10.2 cm; mass: 91.8±11.8 kg)	Male	NBL australian top basketball competition	8 games (one player measured in each game)	National M-7 video camera / *Stand/ walk,Jog,Run,Stand/sprint,Low shuffle,Medium shuffle,High shuffle,Jump.*	Physical attributes likely to benefit players during competition may be related to the ability to change direction quickly and repeatedly and maintain high-intensity shuffling movements throughout the game.	Performance enhancement
Montgomery, P. G. Pyne, D. B. Minahan, C. L.	2010 / Q1	11 basketball players (mean age: 19.1±2.1 y, stature: 1.91±0.09 m, mass: 87.9±15.1 kg)	Male		3 full competition games durind 3 days (1 game per day). 5on5 scrimmage competition in reduced court dimensions on seven separate occasions over 2 wk.	Triaxial accelerometer (MiniMaxX, Catapult Innovations, Melbourne, Australia) / *Accumulated Load*	Physical load was moderately greater in game play compared with a 5on5 scrimmage (85.2%; ±40.5); with a higher mean heart rate (12.4%;±5.4).-Accelerometers are useful for differentiating basketball demands.	Performance enhancement
Peterson, K. D. Quiggle, G. T.	2017 / Q1	5 Division 1 NCAA basketball players (mean age: 20±1.0 y, stature: 1.78±14 m, mass: 22.8±2.0 kg)	Female	NCAA Division 1	Every practice scrimmage and competition within a 20 week season period.	Catapult Optimeye S5 / *PlayerLoad™ and IMA™*	The degree of linearity found between intensive external loads (IMA™) and internal loads lead us to suggest that the readinessof an athlete's tissue may be more sensitive to relative changes in IMA™ registered compared with PlayerLoad™ accumulated.	Performance enhancement
Puente, C. Abián-Vicén, J. Areces, F. López, R. Del Coso, J.	2017 / Q2	25 basketball players from different nationallevel teams (mean age: 25.6±5.2 years,stature: 187.5± 8.5 cm, mass: 83.8± 9.3 kg)	Male	Different leagues from the Spanish Basketball Federation (FEB)	A competitive game	15-Hz global Positioning System accelerometer unit./ *Instantaneous running speeds, number of body impacts above 5 g, and the number of accelerations and deceleration)*	The centers were the basketball players who showed lower physiological demands during a game, whereas there were no differences between guards and forwards.	Performance enhancement
Reina, M. Mancha, D. Feu, S. Ibáñez, J.	2017 / Q4	10 basketball players (mean age: 21,7±3,65 y, stature: 168,5±3,56 cm, mass: 59,5±12,27 kg)	Female	Extremadura state level competition (Spain)	2 games, a friendly match and a competition game.	WIMU (tracking and accelerometry) / *Impacts/min,steps/min,jumps/min*	External and internal loads depend of different situations in female basketball, being the competitive aspect of the game the most demanding situation af all. Similar demands should be imposed during team practices.	Performance enhancement
Sampaio et al.	2016 / Q1	21 international players (mean age: 16.05±2.09 y, stature:183.10±5.88 cm, mass: 73.13± 8.10 kg)	Male	International level players from different clubs.	2 10min basketball quarters	Ubisense Real Time Location System (mean sampling rate 3.74 ± 0.45 Hz per transmitter/player) / *Positional Data*	There was more distance covered while jogging in the offensive court (38.15 ± 12.17 m/min offensive court vs. 32.94 ± 10.84 m/min defensive court, p < 0.05) and more distance covered while running in the defensive court (16.41 ± 10.27 m/min offensive court vs. 19.56 ± 10.29 m/min defensive court, p < 0.05)	Performance enhancement

AUTHORS	YEAR/ QUARTILE	SUBJECTS	GENDER	COMPETITION	QUANTIFICATION	TECHNOLOGY / MEASUREMENT VARIABLES	RESULTS	GOAL
Scanlan, A. T. Dascombe, B. J. Kidcaff, A. P. Peucker, J. L. Dalbo, V. J.	2015 / Q1	24 basketball player - 12 .female players (mean age: 22.5±4.6 y,stature: 177.9±7.6 cm, mass: 79.5±13.7 kg) 12 male players (mean age: 26.1± 5.3y, 85.9, stature: 191.4±7.6 cm, mass: 85.9±13.2 kg)	Male-Female	Queensland Basketball League	3 games each gender	Two wide-angle Basler A602FC color cameras (Basler Vision Technologies, Ahrensburg, Germany) / *Standing/walking (<3.6 km/h), jogging (3.61–10.8 km/h), running (10.81–25.2 km/h), sprinting (>25.2 km/h), low-intensity shuffling (multidirectional movement performed in a defensive stance <7.2 km/h), high-intensity shuffling (multidirectional movement performed in a defensive stance >7.2 km/h)*	Findings indicate that gender-specific running and dribbling differences might exist in semiprofessional basketball. Furthermore, position-specific variations between female and male basketball players should be considered.	Gender comparison
Scanlan, A. T. Dascombe, B. J. Reaburn, P. Dalbo, V. J.	2012 / Q1	12 basketball players (mean age: 22.0±3.7 y, stature: 174.2±6.9 cm, mass: 72.9±14.2 kg)	Female	Queensland Basketball League	8 competitive matches	Two wide-angle Basler A602FC cameras (Basler Vision Technologies, Ahrensburg, Germany) / *total duration (s) and total distance (m)*	Female basketball match-play involves extensive intermittent activity and elicits comparable activity demands to male competition of a similar standard.	Gender comparison
Scanlan et al.	2015 / Q2	10 professional players (mean age: 28.3±4.9 y, stature: 197.4±8.3 cm, mass: 97.0±13.9 kg) & 12 semiprofessional players (mean age: 26.1±5.3 y, stature: 191.4±7.6 cm, mass: 85.9±13.2 kg)	Male	NBL australian top basketball competition & Australian State Queensland Basketball League (QBL)	2 games, 1 at midseason and 1 toward the end of the 6-month season. Semiprofessional players were filmed across 3 games, 1 at the start, 1 at the middle, and 1 toward the end of the 4-month season	JVC Everio GZ-HD10 color camcorder (Hagemeyer, NSW, Australia) with a JVC GL-AT30 telephoto conversion lens (Hagemeyer) & Video data for the semiprofessional players were collected using 2 wide-angle Basler A602FC color cameras (Basler Vision Technologies, Ahrensburg, Germany) / *Total durations (in seconds), total distances (in meters), and mean velocities (in meters per second) were calculated for low-intensity movement (≤3 m·s), high-intensity movement (>3 m·s), shuffling, and dribbling activity*	The observed game activity fluctuations were likely because of a combination of physiological (e.g., muscle glycogen depletion, dehydration), tactical (e.g., ball control, game pace), and game-related (e.g., time-outs, player fouls) factors.	Performance enhancement
Scanlan, A. T. Wen, N. Tucker, P. S. Dalbo, V. J.	2014 / Q2	8 semiprofessional basketball players (mean age 26.3±6.7 y, stature 188.1±6.2 cm, mass 92.0±13.8 kg)	Male	Australian State Queensland Basketball League (QBL)	7-week period during the preparatory phase of the annual training plan.Total of 44 sessions	4 triaxial accelerometers (modelMMA7361L; Freescale Semiconductor, Inc., Austin, TX, USA) / *External Training Load*	Although significant relationships were found between internal and external training load models, the magnitude of the correlations and low commonality suggest that internal training load models measure different constructs of the training process than the accelerometer training load model in basketball settings. ing load models. Significant moderate relationships were observed between external training load and the sRPE.	Performance enhancement

AUTHORS	YEAR/ QUARTILE	SUBJECTS	GENDER	COMPETITION	QUANTIFICATION	TECHNOLOGY / MEASUREMENT VARIABLES	RESULTS	GOAL
Schelling, X. Torres, L.	2016 / Q2	12 professional basketball players ((mean age: 25.0±4.3 y, stature: 1.97±0.09 m, mass: 93.4±12.0 kg)	Male	(ACB) Spain	4 weeks, 16 sessions	Tri-axial accelerometer (X8-mini; 16-bit; Gulf Coast Data Concepts, USA) / *Acceleration data, interpreted as external load*	In conclusion, the results of this study revealed full-court 3v3 and 5v5 showed the highest external workload, measured by tri-axial accelerometer. According to playing position, and commonly related to body size, the smaller the player, the higher the acceleration load, which could be explained by the fact that the lower the body mass, the easier to accelerate with less applied force.	Performance enhancement
Staunton, C. Wundersitz, D. Gordon, B. Kingsley, M.	2017 / Q2	28 semi-professional basketball players (19 back-court players(mean age: 25 ±4 yrs,stature: 186±7 cm, mass: 82±5 kg) and 9 front-court(mean age: 26±3 y, stature: 201±4 cm, mass: 101 ±4 kg))	Male	Australian state level competition	Yo-Yo intermittent recovery test (Yo-Yo-IR1) five minute bout (10 circuits) of a basketball exercise simulation test (BEST)	Triaxial accelerometer (Link; Actigraph, FL, USA) video camera (Legria FS12; Canon, Japan) recording at 60 frames per second. / *Accelerometry-derived average net force (AvFNet) and PlayerLoadTM per minute (PL/min)*	These findings confirm the construct validity of AvF Net to quantify the external demand of basketball movements. Accelerometry derived net force has the potential to quantify the external demands of basketballers during training and competition.	Performance enhancement
Svilar, L. Castellano, J. Jukic, I.	2018 / Q3	13 professional basketball players participated in this study (mean age: 25.7 ±3.3 y, stature: 199.2 ±10.7 cm, mass: 96.6 ±9.4 kg)	Male	ACB (Spain´s top division) and Euroleague	300 Observations (16 weeks)	S5 devices (Catapult Innovations,Melbourne, Australia) / *Player load, accelerations, decelerations, jumps and changes of direction*	Number of changes of direction and decelerations, show strong correlations with PL and sRPE.	Performance enhancement
Svilar, L. Castellano, J. Jukic, I. Casamichana, D.	2018 / Q1	13 professional basketball players participated in this study (mean age: 25.7±3.3 y, stature: 199.2±10.7 cm, mass: 96.6±9.4 kg)	Male	ACB (Spain´s top division) and Euroleague	300 Observations (16 weeks)	Catapult Innovations S5 devices (Melbourne, Australia) / *Accelerations (ACC), decelerations (DEC), jumps (JUMP) and changes of direction (COD)*)	The sRPE shows greater correlation with external variables, compared to the RPE. acceleration and change of direction for centers, deceleration and high jumps for guards and high and total amount of deceleration and change of direction for forwards are specifically demanded in professional basketball training.	Performance enhancement
Torres-Ronda, L. Ric, A. Llabres-Torres, I. De Las Heras, B. Schelling I Del Alcazar, X.	2016 / Q2	14 professional elite basketball players (mean age: 25.5±4.7 y, stature: 198.8±8.8 cm, mass: 93.3±12.8 kg, playing position: point guards: 3; wings: 6; big men: 5),	Male	Spanish First Division (ACB)	32 basketball-specific team- training sessions, performed over an 8-week period and 7 friendly matches (FM) (7 matches for HR and 3 of these for time-motion analysis)	LINCE multiplatform sport analysis software (10,18) (Observesport, Lleida, Spain). Recordings of matches were taken at a sample rate of 25 Hz.	These results demonstrate that systematic monitoring of the physical demands and physiological responses during training and competition can inform and potentially improve coaching strategy, basketball-specific training drills, and ultimately, match performance.	Performance enhancement

AUTHORS	YEAR/ QUARTILE	SUBJECTS	GENDER	COMPETITION	QUANTIFICATION	TECHNOLOGY / MEASUREMENT VARIABLES	RESULTS	GOAL
Vazquez-Guerrero,J., Reche,X., Cos,F., Casamichana,D. Sampaio,J.	2018 / Q2	12 professional basketball players (mean age: 29,6±4.5 y, stature 1.99±9,6 m, mass 92,1±11.9 kg, playing positions, guards: n = 3; forwards: n = 6; and centers: n = 3)	Male	Spanish First Division (ACB)	18 week training period	WIMU PRO Local Positioning System (Realtrack Systems, Almeria, Spain).	The main findings seem to suggest that the greater the court dimen- sions, the higher the physical load (distance covered, player load, and peak speed), also with a strong effect being identified on high-intensity actions, high-intensity acceler- ations, and high-intensity decelerations.	Performance enhancement
Vazquez-Guerrero,J., Suarez-Arrones,L., Casamichana,D. Rodas,G.	2018/Q3	12 professional basketball players (mean age: 25.5±5.2 y, stature 201.4±8,6 m, mass 98.4±12.6 kg, playing positions, guards: n = 3; forwards: n = 6; and centers: n = 3)	Male	Spanish First Division (ACB)	2 games	Triaxial accelerometers (model ADXL326, Analog Devices, Inc., Norwood, U.S.A)/ *accelerations, decelerations,and external total load data.*	More maximal decelerations than accelerations were performed in all playing positionsduring elite basketball competition games. Furthermore, the acceleration:deceleration ratio (>3 m·s-2) was significantly lower in players on the perimeter (PG and SG) than in PF and C. This information should be taken into account in the design of strength/ conditioning programs, emphasizing maximal deceleration movements in perimeter players.	Performance enhancement

Monitoreo e interpretación de la carga externa en el baloncesto: una revisión narrativa

Resumen

La monitorización de la carga externa aporta información valiosa a los profesionales y entrenadores sobre los requisitos físicos de la actividad desarrollada por sus jugadores, de acuerdo con su nivel de competencia, edad y género. Esta información se puede utilizar para individualizar los programas de entrenamiento y optimizar el tiempo invertido en ellos, haciendo que los entrenadores y jugadores sean más eficientes en el proceso. Esta revisión evalúa los resultados reflejados en la bibliografía existente sobre las medidas de carga externa en el deporte del baloncesto, sintetizándolas en un artículo para el lector científico. Los datos de 29 artículos científicos se han organizado y discutido, proporcionando información relevante sobre los objetivos y hallazgos, muestra, variables de medición y tecnología para monitorizar la carga externa en el baloncesto.

Palabras calve: carga externa; acelerometría; mejora del rendimiento; prevención de lesiones; gps; análisis tiempo-movimiento; monitorización del jugador.

Monitorando e interpretando a carga externa no basquete: uma revisão narrativa

Resumo

O monitoramento de carga externa traz informações valiosas para os praticantes e treinadores sobre as exigências físicas da atividade desenvolvida por seus jogadores, de acordo com seu nível de competição, idade e sexo. Essas informações podem ser usadas para individualizar programas de treinamento e otimizar o tempo investido neles, tornando treinadores e jogadores mais eficientes no processo. Esta revisão avalia os resultados refletidos na bibliografia existente sobre as medidas de carga externa no esporte de basquete, sintetizando-as em um artigo para o leitor científico. Dados de 29 trabalhos científicos foram organizados e discutidos, fornecendo insights relevantes sobre os objetivos e descobertas, amostra, variáveis de medição e tecnologia para monitorar a carga externa no basquete.

Palavras-chave: carga externa; acelerometria; melhoria de performance; prevenção de lesões; GPS; análise de tempo-movimento; monitoramento de jogadores

References

Aughey, R. J., and Falloon, C. (2010). Real-time versus post-game GPS data in team sports. *Journal of Science and Medicine in Sport*, *13*(3), 348–349. doi.org/10.1016/j.jsams.2009.01.006

Aoki, M. S., Torres Ronda, L., Marcelino, P. R., Drago, G., Carling, C., Bradley, P. S., and Moreira, A. (2016). Monitoring training loads in professional basketball players engaged in a periodized training programme. *Journal of Strength and Conditioning Research*, *31*(2), 348–358. doi.org/10.1519/JSC.0000000000001507

Bartlett, J. D., O'Connor, F., Pitchford, N., Torres-Ronda, L., and Robertson, S. J. (2017). Relationships between internal and external training load in team-sport athletes: Evidence for an individualized approach. *International Journal of Sports Physiology and Performance*, *12*(2), 230–234. doi.org/10.1123/ijspp.2015-0791

Ben Abdelkrim, N. Ben, El Fazaa, S., and El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British Journal of Sports Medicine*, 41(2), 69–75. doi.org/10.1136/bjsm.2006.032318

Ben Abdelkrim, N., Castagna, C., El Fazaa, S., and El Ati, J. (2010). The effect of players' standard and tactical strategy on game demands in men's basketball. *Journal of Strength and Conditioning Research*, *24*(10), 2652–2662. doi.org/10.1519/JSC.0b013e3181e2e0a3

Bourdon, P. C., Cardinale, M., Murray, A., Gastin, P., Kellmann, M., Varley, M. C., and Cable, N. T. (2017). Monitoring athlete training loads: Consensus statement. *International Journal of Sports Physiology and Performance*, *12*, 161–170. doi.org/10.1123/IJSPP.2017-0208

Caparrós, T., Alentorn-Geli, E., Myer, G. D., Capdevila, L., Samuelsson, K., Hamilton, B., and Rodas, G. (2016). The relationship of practice exposure and injury rate on game performance and season success in professional male basketball. *Journal of Sports Science and Medicine*, *15*(3), 397–402.

Caparrós, T., Casals, M., Solana, Á., Peña, J., and Vic, U. De. (2018). Low external workloads are related to higher injury risk in professional male basketball Games. *Journal of Sports Science & Medicine*, (May 2017), 289–297.

Conte, D., Tessitore, A., Smiley, K., Thomas, C., and Favero, T. G. (2016). Performance profile of NCAA Division I men's basketball games and training sessions. *Biology of Sport*, *33*(2), 189–194. doi.org/10.5604/20831862.1200512

Conte, D., Favero, T. G., Lupo, C., Francioni, F. M., Capranica, L., and Tessitore, A. (2015). Time-motion analysis of italian elite women's basketball games: Individual and team analyses. *Journal of Strength and Conditioning Research*, *29*(1), 144–150. doi.org/10.1519/JSC.0000000000000633

Dawson, B., Hopkinson, R., Appleby, B., Stewart, G., and Roberts, C. (2004). Comparison of training activities and game demands in the Australian Football League. *Journal of Science and Medicine in Sport*, *7*(3), 292–301. doi.org/10.1016/S1440-2440(04)80024-0

Delextrat, A., Badiella, A., Saavedra, V., Matthew, D., Schelling, X., and Torres-Ronda, L. (2015). Match activity demands of elite Spanish female basketball players by playing position. *International Journal of Performance Analysis in Sport*, *15*(2), 687–703.

Dobson, B. P., and Keogh, J. W. L. (2007). Methosological Issues for the Application of Time-Motion Analysis Research. *Strength and Conditioning Journal*, *29*(2), 48–55.

Drew, M. K., and Finch, C. F. (2016, June 28). The Relationship Between Training load and injury, illness and soreness: A systematic and literature review. *Sports Medicine*. doi.org/10.1007/s40279-015-0459-8

Edwards, S., White, S., Humphreys, S., Robergs, R., and O'Dwyer, N. (2018). Caution using data from triaxial accelerometers housed in player tracking units during running. *Journal of Sports Sciences*, 1–9. doi.org/10.1080/02640414.2018.1527675

Foster, C., Rodriguez-Marroyo, J. A., and De Koning, J. J. (2017). Monitoring training loads: The past, the present, and the future. *International Journal of Sports Physiology and Performance*, *12*, 2–2. doi.org/10.1123/IJSPP.2016-0388

Fox, J. L., Scanlan, A. T., and Stanton, R. (2017, July). A review of player monitoring approaches in basketball: Current trends and future directions. *Journal of Strength and Conditioning Research*. doi.org/10.1519/JSC.0000000000001964

Fox, J. L., Stanton, R., and Scanlan, A. T. (2018). A comparison of training and competition demands in semiprofessional male basketball players. *Research Quarterly for Exercise and Sport*, *89*(1), 103–111. doi.org/10.1080/02701367.2017.1410693

Gabbett, T. J. (2004). Reductions in pre-season training loads reduce training injury rates in rugby league players. *British Journal of Sports Medicine*, *38*(6), 743–749. doi.org/10.1136/bjsm.2003.008391

Halson, S. L. (2014). Monitoring training load to understand fatigue in athletes. *Sports Medicine*, *44*, 139–147. doi.org/10.1007/s40279-014-0253-z

Heishman, A. D., Curtis, M. A., Saliba, E. N., Hornett, R. J., Malin, S. K., and Weltman, A. L. (2017). Comparing performance during morning vs. afternoon training sessions in intercollegiate basketball players. *Journal of Strength and Conditioning Research*, *31*(6), 1557–1562. doi.org/10.1519/JSC.0000000000001882

Heishman, A. D., Curtis, M. A., Saliba, E., Hornett, R. J., Malin, S. K., and Weltman, A. L. (2018). Non-invasive assessment of internal and external player load. *Journal of Strength and Conditioning Research*, 1. doi.org/10.1519/JSC.0000000000002413

Hulka, K., Cuberek, R., and Belka, J. (2013). Heart rate and time-motion analyses in top junior players during basketball matches. *Acta Gymnica*, *43*(3), 27–35. doi.org/10.5507/ag.2013.015

Hulka, K., Cuberek, R., and Svoboda, Z. (2014). Time-motion analysis of basketball players: A reliability assessment of Video Manual Motion Tracker 1.0 software. *Journal of Sports Sciences*, *32*(1), 53–59. doi.org/10.1080/02640414.2013.805237

Jennings, D., Cormack, S., Coutts, A. J., Boyd, L., and Aughey, R. J. (2010). The validity and reliability of GPS units for measuring distance in team sport specific running patterns. *International Journal of Sports Physiology and Performance*, *5*(3), 328–341. doi.org/10.1123/ijspp.5.3.328

Johnston, R. J., Watsford, M. L., Kelly, S. J., Pine, M. J., and Spurrs, R. W. (2014). Validity and interunit reliability of 10 Hz and 15 Hz GPS units for assessing athlete movement demands. *Journal of Strength and Conditioning Research*, *28*(6), 1649–1655. doi.org/10.1519/JSC.0000000000000323

Kirkup, J. A., Rowlands, D. D., and Thiel, D. V. (2016). Team player tracking using sensors and signal strength for indoor basketball. *IEEE Sensors Journal*, *16*(11), 4622–4630. https://doi.org/10.1109/JSEN.2016.2542359

Leite, N., Coutinho, D., and Sampaio, J. (2013). Effects of fatigue and time-out on physiological, time-motion indicators and in patterns of spatial organization of the teams in basketball. *Revista de Psicologia Del Deporte*, *22*(1), 215–218.

McInnes, S. E., Carlson, J. S., Jones, C. J., and McKenna, M. J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sports Sciences*, *13*(5), 387–397. doi.org/10.1080/02640419508732254

McLaren, S. J., Macpherson, T. W., Coutts, A. J., Hurst, C., Spears, I. R., and Weston, M. (2017). The relationships between internal and external measures of training load and intensity in team sports: A Meta-Analysis. *Sports Medicine*, 1–18. doi.org/10.1007/s40279-017-0830-z

Montgomery, P. G., Pyne, D. B., and Minahan, C. L. (2010). The physical and physiological demands of basketball training and competition. *International Journal of Sports Physiology and Performance*, *5*(1), 75–86. doi.org/10.1123/ijspp.5.1.75

Narazaki, K., Berg, K., Stergiou, N., and Chen, B. (2009). Physiological demands of competitive basketball. *Scandinavian Journal of Medicine & Science in Sports*, *19*(3), 425–432. doi.org/10.1111/j.1600-0838.2008.00789.x

Peterson, K. D., and Quiggle, G. T. (2017). Tensiomyographical responses to accelerometer loads in female collegiate basketball players. *Journal of Sports Sciences*, *35*(23), 2334–2341. doi.org/10.1080/02640414.2016.1266378

Puente, C., Abián-Vicén, J., Areces, F., López, R., and Del Coso, J. (2017). Physical and physiological demands of experienced male basketball players during a competitive game. *Journal of Strength and Conditioning Research*, *31*(4), 956–962. doi.org/10.1519/JSC.0000000000001577

Reina, M., Mancha, D., Feu, S., and Ibáñez, J. (2017). Is training carried out the same as competition? Analysis of load in women's basketball. *Revista de Psicología Del Deporte*, *26*(1), 9–13.

Ribeiro, R. A., Junior, A. C., Antônio, L., Misuta, M. S., and Mercadante, L. A. (2015). Physical activity demands in elite basketball games. *E-BALONMANO COM*, *12*(2), 109–118.

Sampaio, J., Gonçalves, B., Rentero, L., Abrantes, C., and Leite, N. (2014). Exploring how basketball players' tactical performances can be affected by activity workload. *Science and Sports*, *29*(4), e23–e30. doi.org/10.1016/j.scispo.2013.05.004

Sampaio, J., Leser, R., Baca, A., Calleja-Gonzalez, J., Coutinho, D., Gonçalves, B., and Leite, N. (2016). Defensive pressure affects basketball technical actions but not the time-motion variables. *Journal of Sport and Health Science*, *5*(3), 375–380. doi.org/10.1016/j.jshs.2015.01.011

Scanlan, A. T., Dascombe, B. J., Kidcaff, A. P., Peucker, J. L., and Dalbo, V. J. (2015). Gender-specific activity demands experienced during semiprofessional basketball game play. *International Journal of Sports Physiology and Performance*, *10*(5), 618–625. doi.org/10.1123/ijspp.2014-0407

Scanlan, A. T., Dascombe, B. J., Reaburn, P., and Dalbo, V. J. (2012). The physiological and activity demands experienced by Australian female basketball players during competition. *Journal of Science and Medicine in Sport*, *15*(4), 341–347. doi.org/10.1016/j.jsams.2011.12.008

Scanlan, A. T., Tucker, P. S., Dascombe, B. J., Berkelmans, D. M., Hiskens, M. I., and Dalbo, V. J. (2015). Fluctuations in activity demands across game quarters in professional and semiprofessional male basketball. *Journal of Strength and Conditioning Research*, *29*(11), 3006–3015. doi.org/10.1519/JSC.0000000000000967

Scanlan, A. T., Wen, N., Tucker, P. S., and Dalbo, V. J. (2014). The Relationships between internal and external training load models during basketball training. *Journal of Strength and Conditioning Research*, *28*(9), 2397–2405. doi.org/10.1519/JSC.0000000000000458

Schelling, X., and Torres, L. (2016). Accelerometer load profiles for basketball-specific drills in elite players. *Journal of Sports Science & Medicine*, *15*(4), 585–591. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/27928203

Silva, P., Santiago, C., Reis, L. P., Sousa, A., Mota, J., and Welk, G. (2015). Assessing physical activity intensity by video analysis. *Physiological Measurement*, *36*(5), 1037–1046. doi.org/10.1088/0967-3334/36/5/1037

Staunton, C., Wundersitz, D., Gordon, B., and Kingsley, M. (2017). Construct validity of accelerometry-derived force to quantify basketball movement patterns. *International Journal of Sports Medicine*, *38*(14), 1090–1096. doi.org/10.1055/s-0043-119224

Stojanović, E., Stojiljković, N., Scanlan, A. T., Dalbo, V. J., Berkelmans, D. M., and Milanović, Z. (2017). The activity demands and physiological responses encountered during basketball match-play: A systematic review. *Sports Medicine*, *48*(1), 111–125. doi.org/10.1007/s40279-017-0794-z

Svilar, L., Castellano, J., Jukic, I., and Casamichana, D. (2018). Positional differences in elite basketball: Selecting appropriate training-load measures. *International Journal of Sports Physiology and Performance*, *13*(7), 947–952. doi.org/10.1123/ijspp.2017-0534

Svilar, L., and Jukić, I. (2018). Load monitoring system in top-level basketball team. *Kinesiology*, *50*(1), 25–33. doi.org/10.26582/k.50.1.4

Torres-Ronda, L., Ric, A., Llabres-Torres, I., De Las Heras, B., and Schelling I Del Alcazar, X. (2016). Position-dependent cardiovascular response and time-motion analysis during training drills and friendly matches in elite male basketball players. *Journal of Strength and Conditioning Research*, *30*(1), 60–70. doi.org/10.1519/JSC.0000000000001043

Varley, M. C., Fairweather, I. H., and Aughey, R. J. (2012). Validity and reliability of GPS for measuring instantaneous velocity during acceleration, deceleration, and constant motion. *Journal of Sports Sciences*, *30*(2), 121–127. doi.org/10.1080/02640414.2011.627941

Vazquez-Guerrero, J., Reche, X., Cos, F., Casamichana, D., and Sampaio, J. (In press). Changes in external load when modifying rules of 5-on-5 scrimmage situations in elite basketball. *Journal of Strength and Conditioning Research*. doi.org/10.1519/JSC.0000000000002761

Vázquez-Guerrero, J., Suarez-Arrones, L., Casamichana Gómez, D., and Rodas, G. (2018). Comparing external total load, acceleration and deceleration outputs in elite basketball players across positions during match play. *Kinesiology*, *50*(2), 228–234. doi.org/10.26582/k.50.2.11

Wallace, L. K., Slattery, K. M., and Coutts, A. J. (2009). The ecological validity and application of the session-RPE method for quantifying training loads in swimming. *Journal of Strength and Conditioning Research*, *23*(1), 33–38. doi.org/10.1519/JSC.0b013e3181874512