TREBALL FINAL DE GRAU

Grau en Ciències de l'Activitat Física i de l'Esport

Escola Universitària de la Salut i l'Esport (EUSES), Centre adscrit a la Universitat de Girona

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A COMPARISON OF TRAINING AND COMPETITION DEMANDS OF 5VS5 AMONG PROFESSIONAL MALE BASKETBALL PLAYERS

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A la meva mare,
tot això és per ella.

Índex

Introducció

Aquí presento el meu treball final de grau. En aquest treball s'exposen i s'interrelacionen coneixements i competències prèvies que he anat adquirint al llarg de tot el grau. A més, també es construeixen nous aprenentatges a partir de la cerca constant de nova informació i la seva interacció amb els aprenentatges previs ja anteriorment adquirits. El treball està basat en la realització d'un article científic. En ell es desenvolupa tot un treball de recerca amb les diferents parts que el componen. L'objectiu de l'article és comparar les exigències d'esforç físic dels partits d'entrenament 5vs5 a tota la pista i els partits oficials mitjançant tecnologia de microsensors.

El que m'ha portat a desenvolupar aquesta tasca és l'oportunitat de poder relacionar l'àmbit professional en què estava desenvolupant les meves pràctiques amb el vessant més acadèmic que es desenvolupa en aquest treball. La possibilitat de trobar sinèrgies entre aquests dos àmbits m'ha motivat a desenvolupar la feina que es troba a continuació.

Artícle científic

Abstract

The aim of this study was to compare demands on physical exertion from 5vs5 full-court Training games and official Match-Plays using microsensor Technology. Twelve professional male basketball players who played in the second-tier Spanish basketball competition (mean ± SD, age: 28 ± 5,4 years; height: 196 ± 9,2 cm) were all routinely recorded during the competitive period (October-April) throughout fourteen training sessions and fifteen matches. Each variable analyzed in the study showed moderate to very large differences between Training games and Match-play (MP > TG). All Training games were aimed at reproducing real competition conditions and data were collected using triaxial accelerometers. The main conclusion of the study was that none of the physical demands analyzed in the TGs matched the needs of the real competition among professional male basketball players. A comparison of the asymmetry index in the changes of direction for each player between competition and training has also been carried out. The results reveal a tendency towards right-sided dominance. Our results could help to broaden the understanding of the external demands across official matches and training games. The present study provides valuable data suggesting that Training games were not sufficient to overload the athletes in order to build adaptations above and beyond competition demands.

Key words: Training, competition, training games, match-play, tracking system.

Introduction

In the literature on team sports coaching and physical preparation literature, it is often stated that training should provide athletes with the opportunity to experience the demands of the game prior to competition (Dawson et al., 2004).

Seeking to gain a competitive advantage and manage injury risk, team sports organizations are investing in tracking systems that can measure training and competition characteristics. It is hoped that such information can support objective decision-making for training load prescription and manipulation (Torres-Ronda et al., 2022). The emergence of handheld and miniaturized intelligent sensor devices has brought new directions for research in sports science, including the research of team sports requirements (Montgomery et al., 2010). State-of-the-art microtechnology allows the monitoring of players' locomotor movements and favors the search for novel approaches to the study of sports performance that are based on the recognition of the most demanding passages or scenarios of match play (Vázquez-Guerrero et al., 2020). Thorough knowledge of the physical requirements throughout basketball competition is crucial for a better prescription of the training load towards optimizing individual and team performance (García et al., 2022).

Although the demands imposed and responses experienced during training plans are expected to adequately prepare players for competition, more straightforward comparisons between

training and game environments in basketball are needed. Hence, it is unclear whether the training plans that are prescribed trigger responses that match or exceed those that are evidenced during the competition (Fox et al., 2018). In contrast to what we might hypothesize, the Fox et al. (2018) study found that the absolute and relative external demands experienced by male semi-professional basketball players from physical conditioning training and game-based training exceeded those experienced during competition. Nevertheless, the previous investigation has shown that sub-elite basketball players experience lower running and jogging demands compared to elite players during competition (Scanlan et al., 2011), which could support the differences in reported intensities between studies (Fox et al., 2018).

At the other hand, nonetheless, the study by Montgomery et al., (2010) examined the differences between match play (MP) and half-court 5vs5 games among junior players also by looking at a single variable, acceleration load per minute (AL/min). It was noticed that MP places a greater physical demand on players than half-court 5vs5 game (279±58 as compared to 171±84 a.u.$\cdot \boldsymbol{min^{-1}}$). It is worth noting that, so far, only very few studies have presented objective MP data with microsensor technology in elite basketball and scanty studies have provided a comparison of any Small-Sided Game (SSG) or Training game (TG) with the MP.

The utilization of modern technology, such as triaxial accelerometry, provides robust data for external load prescription and management. For instance, keeping the workload ratio in the range of 1 to 1.5 might be optimal to reduce the risk of injury in the professional basketball player (Svilar et al., 2018). Furthermore, the results obtained by Román et al., (2019) among women's amateur basketball players, revealed that the workload which was experienced under competition was significantly higher as compared during training (Heart Rate, Player Load, Steps, Jumps, and Impacts).

A common approach taken by professionals is to advance toward training activities that are more closely reflected in competition performance (Brooks et al., 2021). The present study aims to compare different variables, such as Player load per minute (PLmin), accelerations (ACC), decelerations (DEC), changes of direction (CoD), and jumps (JUMP) across TG and MP. Doing so may help to relate the needs more effectively for making fine-grained decisions in the task design aimed at professional players.

Methods

Subjects

The subjects included in this study were twelve professional male basketball players who played in the second-tier Spanish basketball competition (mean ± SD, age: 28 ± 5,4 years; height: 196 ± 9,2 cm). They were all players from the same team, who currently were in the squad at the end of this study. The subjects were all routinely recorded in the competitive period (October-April) throughout the

training sessions and matches in the 2021/2022 season.

Everyone voluntarily agreed to release the data to the club and was informed of the intentions of the follow-up.

Design

A non-experimental, descriptive, comparative design was applied to analyze the differences between TGs and MPs. The purpose of this study is to compare the training and competition demands among professional male basketball players.

Out of all records, fifteen games competed in the Spanish second division (LEB Oro) and fourteen training games were registered during the competitive period (October–April). All matches were held on the same court when the participants competed as home games during the regular season. Likewise, the TGs were also recorded on the same basketball court where the MPs were played under similar environmental conditions to each other.

Procedures

Prior to all training sessions, each player put on a vest with a microsensor device under their regular sporting attire. The external training load was recorded using Catapult Innovations T6 devices (Melbourne, Australia) that include accelerometer, gyroscope, and magnetometer technologies.

For each TG or MP, data were entered into the system by the researcher to classify the type of task and identify the number of players. To differentiate TG and MP, all recorded periods were tagged as "game" or "5vs5real" respectively. This process allowed us to classify the information and thus easily extract the data.

Every TG tried to reproduce the real competition. Due to the time differences between TGs and MPs, two different types of variables are presented in this study. For one side, the Player Load is a variable relative to the time played (PLmin). However, on the other side, for a better understanding of the reality experienced by subjects throughout the season, the rest of the variables achieved have been quantified using the total value of each variable instead of the relative value.

The different variables analyzed in the study were collected using triaxial accelerometers. These devices have the capability to represent gross fatigue movements, not just locomotor performance (Boyd et al., 2011). The PLmin has been registered in all the axes of the internal triaxial accelerometer during motion, according to the established formula developed at the Australian Institute of Sport. The ACC stands for the total inertial movements recorded in a forward acceleration vector within the high band (>3.5 $m \cdot s^{-2}$); the DEC represents the total inertial movements recorded in a forward deceleration vector within the high band (<-3.5 $m \cdot s^{-2}$). The CoD means total inertial movements recorded in a lateral vector to the right/left within the high band (<-3.5 $m \cdot s^{-2}$). The bilateral asymmetry index (AI) for coD was also calculated from the formula provided by Carpes et al., 2010. In addition, the total number of jumps performed by each

player in both TG and MP were also recorded.

Monitoring external load can provide useful feedback to practitioners and coaches about the physical demands of the completed activity (Portes et al., 2019). Likewise, Catapult technology could be an effective instrument for daily monitoring of athletes' performance. Previous research to evaluate the reliability of triaxial accelerometers (MinimaxX 2.0, Catapult, Australia) claimed that they proved an acceptable level of technical reliability for measuring physical activity in team sports. MinimaxX accelerometers vary by <2% during both laboratory and field testing, which indicates acceptable reliability (Boyd et al., 2011). Further research is needed to determine if the use of this type of technology over time optimizes future training sessions throughout the year, mitigates overuse injuries, and provides parameters for return to play after injury (Heishman et al., 2018).

Throughout the entire competitive period, up to fourteen training games have been registered but they have not always had the same duration between them. As shown in the study carried out by Svilar et al., (2018) according to the training plan, players also performed 2-3 sets, with a 2-minute typical rest period (±30 seconds). Each series had a duration of 4 minutes. TGs were performed with the same official basketball rules in the regular 5vs5 format on the full court implemented in MPs. However, some modifications were made to adapt the rules to the available playing time: after the second foul, each foul was penalized as bonus free throws, although the official regulation is from the fourth foul onwards. In addition, each team also was led by the head coach or assistant coach, and one time-out was allowed per set. The referee was not always the same person, but the different coaches of the technical staff took turns. Lastly, all players performed a standardized 15-minute warm-up before each training session and a 25-minute pre-match warm-up.

The researcher entered each TG series into the system and stopped recording at the end of each period, so only the actual playing time was considered. Moreover, when a player was substituted by another player during the TG, the researcher manually removed the substituted player from the system and in turn introduced the new player. Thus, it was only intended to record the real-time that players were performing.

Over the same period, fifteen official regular season matches (MP) were also recorded. Only each of the four quarters (10-minute quarters) of the game was recorded, stopping recording at the end of each quarter to consider only the actual playing time as in the TGs. The breaks were those of the official competition. In addition, at the end of each game, the team's physical trainer always manually cut the breaks of the players who were resting at any time. Therefore, only the time that the player is performing on the court has been tracked.

The obtained TG and MP data were then downloaded and analyzed with Openfield software, version 1.17.

Statistical Analysis

Statistical analysis was carried out using Matlab software (version 9.5 for Windows, 2018). Descriptive statistical findings from TG and MP were reported by using the mean and SD (±SD). Normality of data distribution and homogeneity have been determined using the Shapiro Wilk test and F-test and the statistical significance was set at $p \leq 0.05$. Furthermore, magnitude-based inferences (MBIs) are used to assess the data, according to the recommendations of Batterham & Hopkins, 2006. MBI was performed using a custom Excel spreadsheet (imported and adjusted via www.cem.org/effect-size-calculator).

We assessed the differences observed in TG and MP by means of standardized mean differences (Cohen's d and 90% confidence limits). Standardized effect size (ES) interpretative thresholds corresponded to 0.2 (trivial), 0.2-0.6 (small), 0.6-1.2 (moderate), 1.2-2.0 (large) and.2.0 (very large).

Results

The descriptive values of TG and MP for each physical demand, such as the mean, standard deviation and sample of the variables used in the study (n), as well as the effect size of each physical demand are presented in Table 1.

Most variables displayed normality ($p \leq 0.05$) and all data showed homogeneity from the F-test.

Figure 1 plots the ES of each variable compared between TG and MP. The variable that demonstrated the greatest effect was right high coD (4,18 ± 0,66; 12,81 ± 4,42). Likewise, the lowest values are from High Decel (3.22 ± 0.96 9.39 ± 4.98). Differences can be observed in all variables tested. PLmin shows a moderate effect (MP > TG), two variables exhibit large effect -Total jumps and High Decel (MP > TG). The rest of the variables- Right coD, Left coD and High Accel reported very large effect (MP > TG).

Figure 2 represents a comparison in the players' asymmetry index between competition and training. The results present a tendency towards the right side, however, regardless of the dominance of each player, in almost all cases the dominance is maintained during the match as well as during training.

Table 1. Mean, ± SD, attributed to every variable in the training game (TG) and match-play (MP).

Variables	TG (n=14)	MP (n=15)	Effect Size
PLmin ($n \cdot min^{-1}$)	6,60 ± 0,48	7,98 ± 2,04	0,93
Total jumps	11,24 ± 6,15	33,25 ± 24,80	1,22
Right High coD	4,18 ± 0,66	12,81 ± 4,42	2,73
Left High coD	3,70 ± 0,85	11,70 ± 4,69	2,37
High Accel	3,85 ± 0,94	9,74 ± 3,17	2,52
High Decel	3,22 ± 0,96	9,39 ± 4,98	1,72

**PLmin is Player load per minute, Right High coD is s total movements registered in a rightward lateral vector per minute within the high band (<-3.5 $m \cdot s^{-2}$), Left High coD is total movements registered in a leftward lateral vector per minute within the high band (<-3.5 $m \cdot s^{-2}$), Total jumps is the number of jumps, High acceleration is the total inertial movements recorded in a forward acceleration vector within the high band (>3.5 $m \cdot s^{-2}$), High deceleration represents the total inertial movements recorded in a forward deceleration vector within the high band (<-3.5 $m \cdot s^{-2}$).*

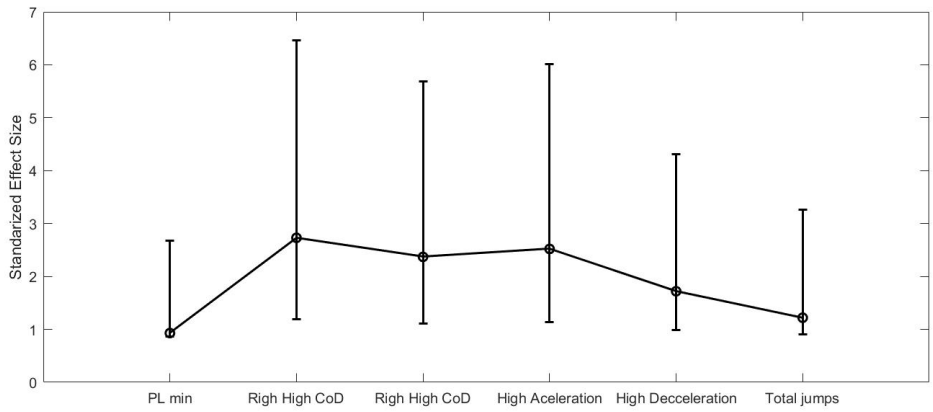

Figure 1. *Cohen's d coefficient based on Training games and Match-Plays for the variables: PLmin is Player load per minute, Right High coD is s total movements registered in a rightward lateral vector per minute within the high band (<-3.5 $m \cdot s^{-2}$), Left High coD is total movements registered in a leftward lateral vector per minute within the high band (<-3.5 $m \cdot s^{-2}$), Total jumps is the number of jumps, High acceleration is the total inertial movements recorded in a forward acceleration vector within the high band (>3.5 $m \cdot s^{-2}$), High deccelaration represents the total inertial movements recorded in a forward deceleration vector within the high band (<-3.5 $m \cdot s^{-2}$).*

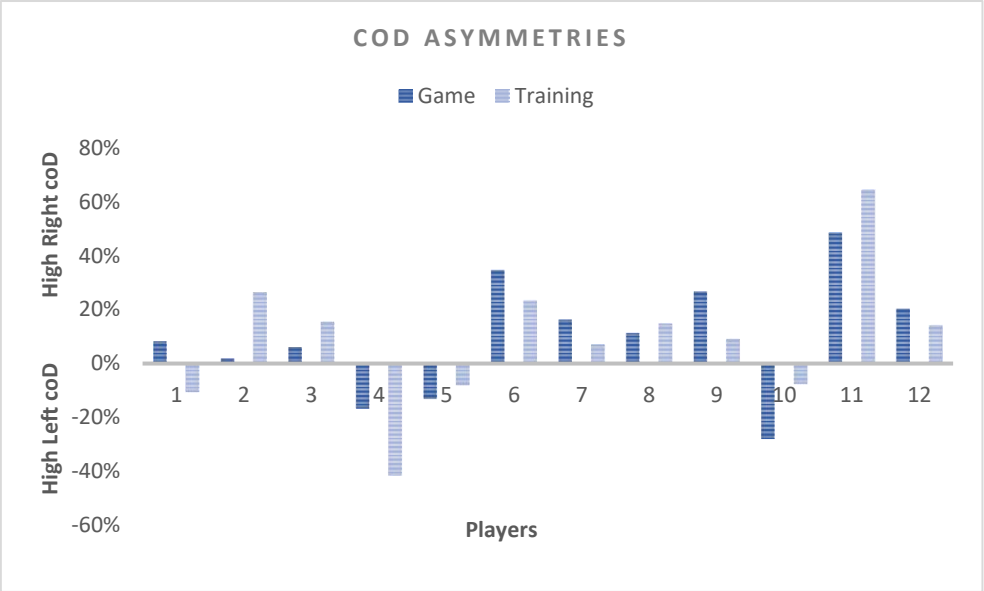

Figure 2. *Percentage of asymmetry index (ASI) of each participant in relation to coD across Training games and Match-Play (positive= high right coD dominance; negative= high leg coD dominance).*

Discussion

The purpose of this study was to compare demands on physical exertion from TG and MP among professional basketball players. To our knowledge, only two studies have been done as described above using microsensor technology, and one of those only made the comparison during the most demanding scenarios.

The main conclusion of the study was that none of the physical demands analyzed in the TGs matched the needs of the real competition among professional male basketball players. The results of the descriptive analysis show a tendency to elicit a greater external load during competition than during the 5v5 full court training games. This would support previous research that has already suggested the need to be aware of those constraints applicable to TGs that may help in prescribing the training load according to the contextual requirements of the competition (Svilar et al., 2018; Torres-Ronda et al., 2016). Furthermore, underloaded athletes have an increased risk of injury, so enhancing external load may reduce the risk of injury in professional basketball (Caparrós et al., 2018).

The results of the current study indicate that right high coD is the variable analyzed wich reveals the greatest effect (ES=2,73; very large). Likewise, in the case of the left high coD, it is the third variable that exhibits the greatest effect (ES=2,37; very large). We can also observe that most of the analyzed players have dominance towards the right coD. Moreover, except for one player, all of them have asymmetry towards the same side both in TGs and MPs (Figure 2). Physical traits that would be likely beneficial to athletes through competition might be related to the capacity to change direction quickly and repeatedly throughout the match (McInnes et al., 1995). Therefore, knowing the differences in the tendency

of players to change direction, could be valuable information for coaches when planning training sessions or proposing certain strategies in the official competition.

In line with our results, in the study conducted by García et al., (2022) most of the physical demand peaks reported during the official matches were higher than those during the training sessions. Moreover, as in our case, more high-intensity accelerations than decelerations were observed in both TGs and MPs. These data disagree with previous investigations where a different trend was observed (Vázquez-Guerrero et al., 2018).

Following the same confluence, the study by Montgomery et al., (2010) comparing MP to half-court 5vs5 training games, reports that MP has substantially greater physical and physiological demands compared to half-court 5vs5 games. However, previous studies have shown that the larger the dimensions of the court, the higher the physical load (distance covered, player load and maximum speed), also identifying a pronounced effect on high-intensity actions, high-intensity accelerations, and high-intensity decelerations (García et al., 2022).

Contrary to our results, a study with fifteen semi-professional men's basketball players by Fox et al., (2018), found that absolute and relative external demands were higher during the TG compared to the official competition. This could be explained by methodological differences between both studies. In the aforementioned study, players were followed during full matches, which included the associated rest periods, unlike our study, which only includes actual playing time. Moreover, prior research has shown that semi-professional basketball players undergo lower running and jogging demands in comparison to elite players during the competition (Scanlan et al.,2011).

Another study by Svilar et al., (2018) involving professional basketball players also reported a trivial difference in external load measurements between MP and TG in almost all variables. The difference was reported only for the total number of accelerations per minute between MP and TG (MP > TG). In parallel, the results of this study coincide with those of the study by Torres-Ronda et al., (2016), which did not identify differences in the relative frequency of movement between friendly matches and TG in elite male basketball players. However, it would be reasonable to hypothesize that friendly matches do not meet the physical demands of real competition, since there are environmental changes that can affect the athlete's willingness to compete.

It is prudent to recognize some limitations of the present study. One of the potential limitations is the sample size, especially the number of players per position. This study is limited to comparing the external load of athletes in competition and the simulation of the same across pieces of training, without considering the position of each player or their body composition. Nevertheless, previous research has shown differences in playing position and physical demands most required for each position

(Svilar et al., 2018). In a study undertaken by García et al., (2020), depending on the playing position, and often related to body size, the smaller the player, the greater the acceleration load. This could be explained because the smaller the body mass, the easier it is to accelerate with lower applied force. (Portes et al., 2019).

In addition to the foregoing, the present study has only limited itself to comparing the external training load, even though while significant intercorrelations between the internal and external training load models have been found, the size of the correlations and the poor overlap suggests that the internal training load models measure different constructs of the training process than the basketball accelerometer training load model (A. T. Scanlan et al., 2014).

Increased practice and competition time are linked to increased team performance, nonetheless, it also drives an increase in the incidence of injuries. (Caparrós et al., 2016). Further research is needed to identify the possible implications of over- or under- applying external loads during TGs regarding performance optimization and injury risk in elite basketball.

Practical Applications

In elite sport, a large volume of reliable data is needed. One approach widely adopted by practitioners is to move towards training situations that more accurately simulate the reality of competition. This study provides a direct comparison between real competition environments and their simulation through regular training. These results provide valuable data on professional basketball players and may be useful in subsequent studies to aid decision-making when prescribing exercises that attempt to replicate actual competition conditions

Conclusions

The results of this study indicate that none of the analyzed physical demands required in the competition are covered by their simulation in training. The biggest changes between training and competition are found in coD and accelerations. Another slight trend reveals more accelerations than left coD in TG, while in MP the reverse is true. Overall, our findings suggest that TG was not enough to overload athletes to build adaptations above the demands of competition.

More research is needed to underpin objective decision-making in training load prescription.

Acknowledgments

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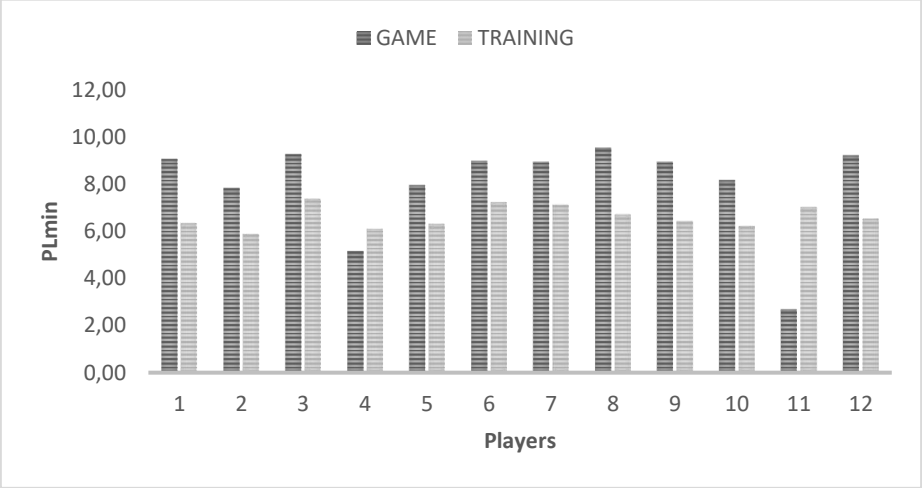
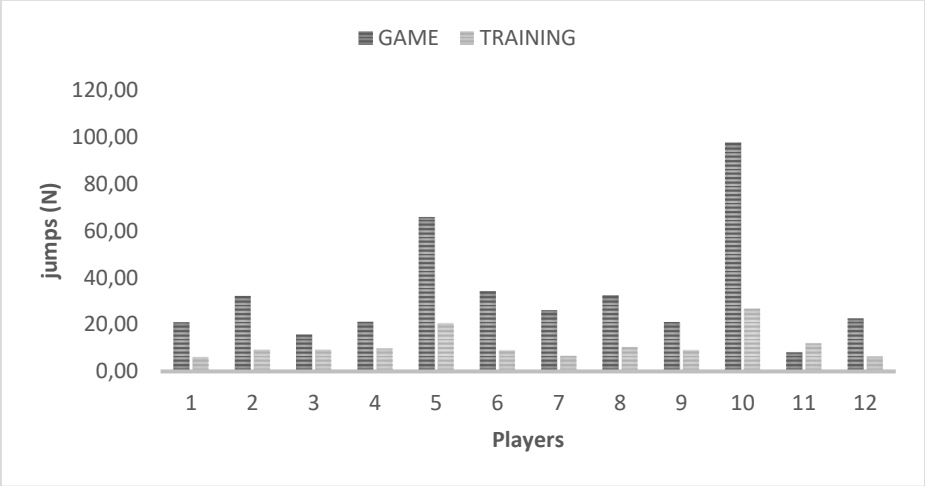
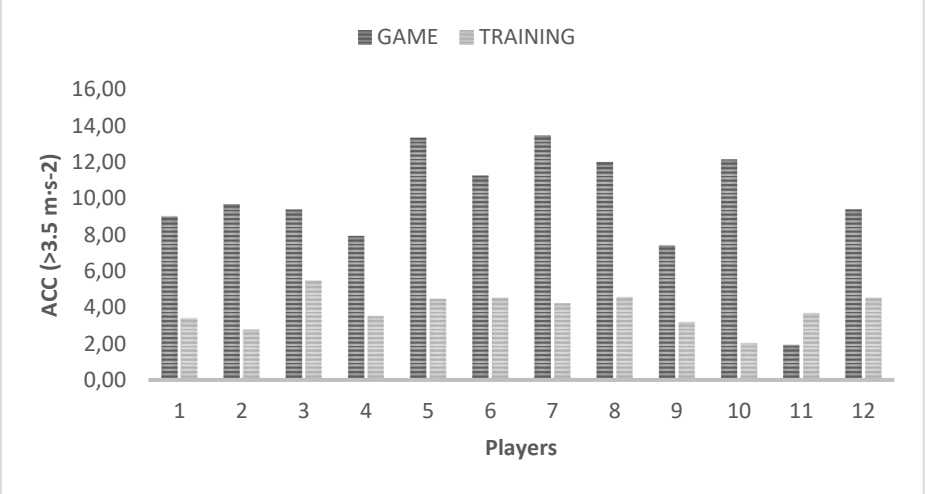
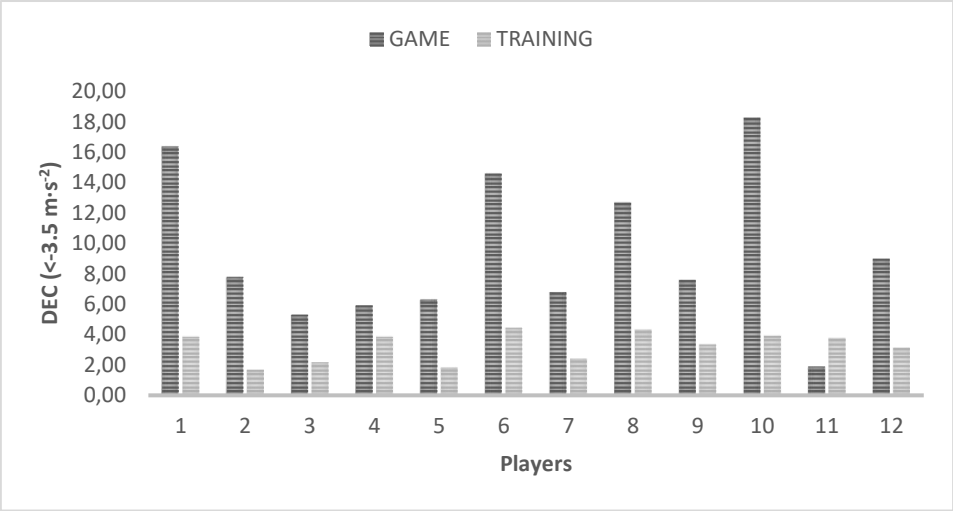
Annexos

Annex 1. Anàlisi per jugador de cadascuna de les variables de l'article.





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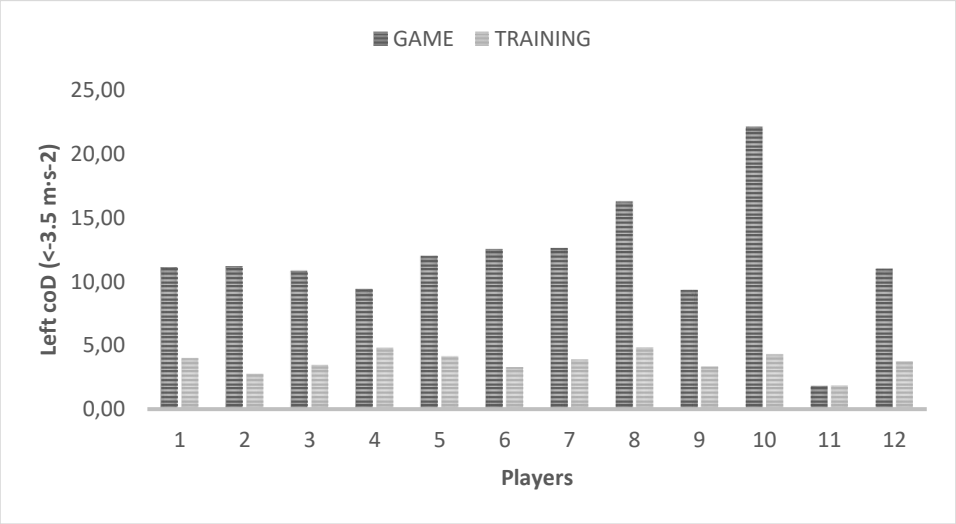
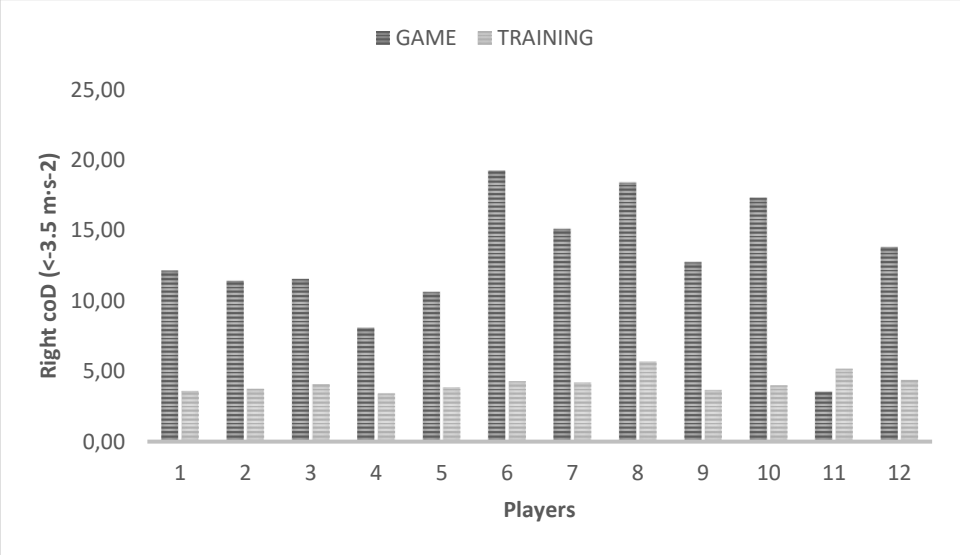
1 2 3 4 5 6 7 8 9 10 11 12
Players


GAME
TRAINING
Left coD (<-3.5 m·s-2)
25,00
20,00
15,00
10,00
5,00
0,00
1 2 3 4 5 6 7 8 9 10 11 12
Players


GAME
TRAINING
Right coD (<-3.5 m·s-2)
25,00
20,00
15,00
10,00
5,00
0,00
1 2 3 4 5 6 7 8 9 10 11 12
Players

Annex 2. Participació percentual de cada variable