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Acute effects of basketball competition on physical performance factors in under-18 female players

Influencia de la competición sobre los factores de rendimiento físico en jugadoras de baloncesto sub-18

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Abstract

The aim of this study was to analyse and quantify the acute effects of competition on several performance factors in young female basketball players, between playing positions. To this end, 37 regional league players (17.21 ± 0.44 years) performed various tests to measure the rate of perceived of effort, sprint times and jump capacity immediately pre-match (T1), at half-time (T2) and post-match (T3). Tests included measuring perceived effort (RPE), sprinting for 20 metres based on time across 10 m and 20 m and performance of countermovement jumps (CMJ). For subsequent analysis, the sample was divided into three playing positions: guards (n=11), forwards (n=15) and centres (n=11). Associated with the expected increases of RPE (from 0.3-0.5 to 7.1-7.3), results showed very likely negative effects with performance decreased from T1 to T3 measures in 20 m (3.51% for guards) and in CMJ (13.7% for forwards). We found likely and very likely negative effects between T1 and T2 in all positions but we did not between T2 and T3 in CMJ. These findings highlight the need to individualise fitness training, taking into account the match needs and demands of the different playing positions in order to minimise the effects of match fatigue and accelerate post-match recovery.

Key words: fatigue; countermovement jump; perceived effort; sprint capacity.

Resumen

Este estudio trató de analizar la evolución del rendimiento de las fases de juego y la forma de puntuar a lo largo El objetivo de este estudio fue analizar y cuantificar los efectos agudos de la competición en distintas capacidades físicas en jugadoras sub-18 de baloncesto. Para tal fin, 37 jugadoras de nivel regional (17,21 ± 0,44 años) mostraron el esfuerzo percibido (RPE), realizaron un sprint de 20 m y se les midió la capacidad de salto inmediatamente antes del inicio partido (T1), en el descanso (T2) y después del partido (T3). En la prueba de sprint se registraron los tiempos en los 10 m iniciales y en el total de los 20 m, mientras que la capacidad de salto se valoró con un salto con contramovimiento (CMJ). Para el análisis posterior, la muestra se dividió en tres posiciones de juego: bases (n = 11), aleros (n = 15) y pívots (n = 11). Asociados con los aumentos esperados de RPE (de 0,3-0,5 a 7,1-7,3), los resultados mostraron una disminución del rendimiento con efectos "muy probables" de T1 a T3 en 20 m (3,51 % para las bases) y en CMJ (13,7 % para las aleros). Encontramos efectos negativos "probables" y "muy probables" entre T1 y T2 en todas las posiciones, pero no entre T2 y T3 en CMJ. Estos hallazgos ponen de manifiesto la necesidad de individualizar el entrenamiento físico, teniendo en cuenta las necesidades y demandas del partido de las diferentes posiciones de juego para minimizar los efectos de la fatiga del partido y acelerar la recuperación a su finalización.

Palabras clave: fatiga; partido de baloncesto; esfuerzo percibido; capacidad de esprintar; salto con contramovimiento.

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Introduction

Along the last decades, the emergence of the need to further understand the demands (for example, those of a technical, tactical and physical nature) of basketball match play has led researchers to study several dimensions of the requirements of high-level players and team performances (Abdelkrim et al., 2007; Gómez et al., 2008; Trninić et al., 2002). As a team sport, basketball requires power of jumping, agility with and without the ball, and speed of cyclic or acyclic movements (Erculj et al., 2010; Ziv & Lidor, 2009), and repeat sprint ability (RSA) to performing in the game (Paulauskas et al., 2018).

The evaluation of adolescent basketball players is important as it forms the basis for the transition from a promising junior player to an established senior player (Delextrat & Cohen, 2008; Drinkwater et al., 2008). This period is characterized as a time when players can tolerate high training loads and demands in competition, as well as improve their levels of technical and tactical performance (Fort et al., 2016). During puberty, female basketball players' growth follows a genetically determined pattern, despite substantial variations among players in both tempo and timing (Carvalho et al., 2019).

Research describing women's basketball matches is particularly scarce (Delextrat et al., 2015; Matthew & Delextrat, 2009; Narazaki et al., 2009; Reina et al., 2020; Reina et al., 2019). Therefore, physical conditioning for female basketball players is often informed by male data, despite the previously reported major gender differences in match activities (Scanlan et al., 2012; Portes et al., 2020).

The analysis of the physical fitness of basketball players through specific field tests provides objective and reliable knowledge to the coach and the physical coach (Mancha-Triguero et al., 2020). In basketball, a small number of studies have investigated the effects of fatigue induced by a match on sprinting ability (Caprino et al., 2012; Cortis et al., 2011; Meckel et al., 2009). The number of sprints ranged from 49 to 108 (1.7 to 2.7 per min), while there were 52 to 295 runs (1.7 to 7.3 per min) and 67 to 551 jogs (2.2 to 13.6 per min). Oliveira et al. (2013) showed the anaerobic capacity seems to be a better predictor of female basketball performance; and only guards seem to have a specific movement pattern different from that of centres or forwards. In this sense, the shooting guard and power forward experience higher match loads than the rest of the team (Reina et al., 2019). Cortis et al. (2011) demonstrated a significantly reduced performance in single 10 m sprint with and without the ball after compared to before a junior match. Scanlan et al. (2012) recorded the duration of the movements performed in female basketball, showing an average sprint duration of 2.43 s. Accordingly, the appropriate testing distances in basketball are 20 m and 10 m (Cortis et al., 2011; Pliauga et al., 2015). Meckel et al. (2009) found that ideal and total sprint times were significantly better at half time compared to pre-match values, with no significant difference between pre- and post-match measurement. They did not report significant variation in the performance decrement between measurements.

The height of a vertical jump plays a key role in shooting at the basket and in rebounds. Rodríguez-Rosell et al. (2017) suggest that countermovement jump is one of the most reliable tests for the estimation of explosive force in basketball players in different age categories. Some recent data showed that university- and state-level female basketball players performed between 35 and 43 jumps per match, corresponding to about 1 jump per minute (Matthew & Delextrat, 2009; Narazaki et al., 2009). The acute effect of fatigue on jumps postmatch has also been demonstrated in other sports such as football (Gil et al.; Malina et al., 2004), handball (Thorlund, Michalsik, Madsen, & Aagaard, 2008) and rugby (McLellan, Lovell, & Gass, 2011), but not in basketball (Cortis et al., 2011; Pliauga et al., 2015).

In sports, and particularly in exercise testing, the rating of perceived exertion (RPE), as measured by scales of perceived exertion (RPE scale), is a frequently used quantitative measure of perceived exertion during physical activity. In the case of basketball, recent studies have analysed the relationships between fitness variables and perceived exertion during full-sided and small-sided games (Clemente et al., 2019; Scanlan, Fox, Borges, & Dalbo, 2017).

Sprint action and the vertical jump (and perceived exertion) are among the most easily measured acyclic actions due to their simplicity of execution and ease of reproduction. Although these actions exert a major influence on performance in basketball, their variations have not been extensively studied in a competitive context. In this sense, we expected to find a general decline in performance players in these variables due the load demands of the match. Consequently, the aim of the present study was to analyse and quantify the acute effects of a basketball match on the performance of under-18 female players by testing jump capacity, sprint times and perceived exertion pre-match, at half time and post-match, and by contrasting results according to age and playing position. In view of the above, we hypothesized that match fatigue would cause reductions in the values obtained for the variables analysed in some players, expecting changes in results according to the under-18 female players' playing position.

Methods

We used a repeated measures design to assess the effects of regular basketball matches on various performance factors in young female players. In order to determine the influence of accumulated match fatigue, the study was conducted during the second half of the playing season, analysing official federation matches. This study was conducted in accordance with the guidelines found in the Helsinki Declaration, which establishes ethical principles for investigations using human beings. The ethics committee of the University of León approved the study (ULE/2019/B84).

Participants

Participants comprised thirty-seven healthy female basketball players with a mean age of 17.21 ± 0.44 years old and a mean of 7.54 ± 2.82 years' experience of playing on federation basketball teams. Participants belonged to three different Spanish youth teams of the same geographic area (Castilla y León, Spain). These teams competed at regional level in the same youth category and engages in regular training. All subjects were in good health and were not taking medication or nutritional supplements that could influence the tests results. Participants were divided by their coaches into three groups based on playing position, player characteristics and according their predominant role in the game: guards (n=11), forwards (n=15) and centres (n=11). Demographic and anthropometric data are shown in Table 1. Study participation was voluntary. All players, parents and coaches were notified of the research procedures, requirements, benefits and risks before giving written informed consent.

Table 1. Demographic and anthropometric data of the players. Values are given as mean ±SD.

	N	Age (y)	Maturity Age (y)	Height (cm)	Weight (kg)	Body Mass Index (kg/m^2)	Experience (y)
All players	37	17.21±0.44	4.64±0.41	177.54±5.35	67.06±8.15	21.25±2.25	7.54±2.82
Guards	11	17.16±0.44	4.40±0.29	172.63±2.80	63.5±6.40	21.32±2.34	6.90±2.98
Forwards	15	17.36±0.44	4.67±0.54	177.46±5.09	66.76±9.02	21.15±2.47	7.73±3.19
Centres	11	17.06±0.42	4.86±0.41	182.54±2.25	71.04±7.28	21.31±2.03	7.90±2.21

Procedures

Prior to data collection at matches, players were familiarized with the tests by performing them during training. Considering the high multidimensional correlation between the field tests and the match performance index (Zarić et al., 2018). the tests were then conducted at twelve different matches, played in the second part of analysed season. We selected players who would play for the maximum number of minutes; such players were identified via a prior conversation with the coach. To ensure efficiency and to interfere as little as possible in match preparation, the tests were conducted with 7 players for each match, including at least two players for each of the three positions analysed. In addition, player data were included for analysis provided they met the following criteria: they did not suffer injury during the game and they played in the same position throughout the entire game (Vázquez-Guerrero et al., 2018). To standardize procedure, all tests were performed using the same protocol and in the same order before, during and after the match. As can be seen in Figure 1, the tests were performed after pre-match warm up (T1), at half time (T2) and post-match (T3). If a player did not play at least 50% of each half, she was not included in the data testing. None of the matches analysed required extra time to be played. All matches were played on and all testing measures were carried out on a wood surface. The tests have a strong relationship to physical training in basketball (Mancha-Triguero., 2019).

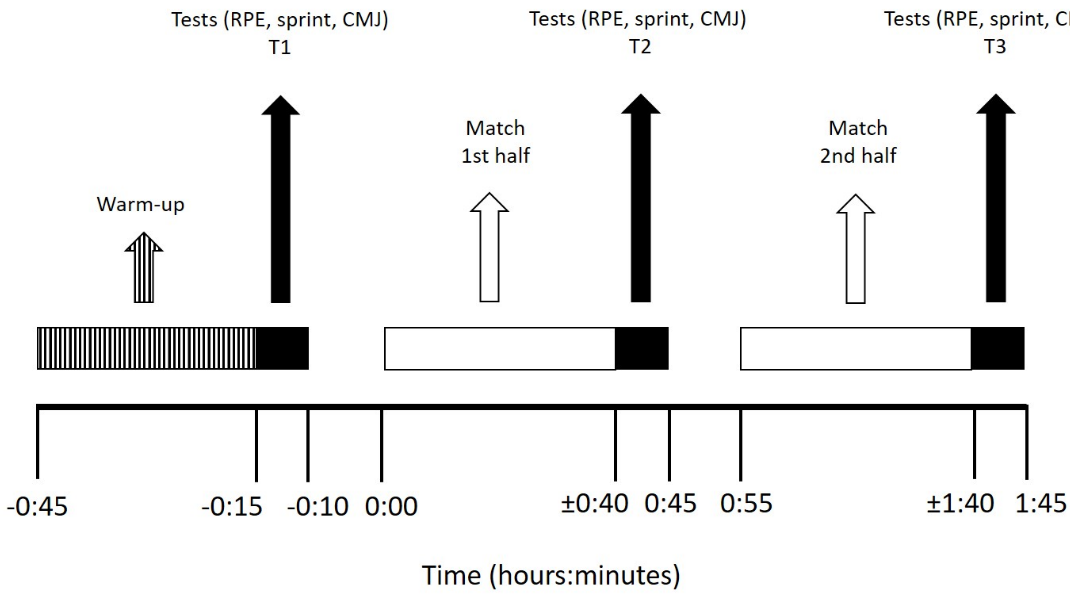

Figure 1. Timing and order of tests.

Perceived exertion (RPE)

The reporting of player RPE was used as a subjective parameter of exercise intensity and was employed using the protocols described by Foster (1995). The RPE scale is a category-ratio scale characterized by scores and verbal links (i.e., from “rest” to “maximal”), referring the athlete’s perception of efforts to a numerical score between 0 (i.e., rest) and 10 (i.e., maximal).

Sprint capacity

Sprint capacity was assessed by means of a 20 m sprint test conducted in an adjoining court with an identical surface to that where the match was played, and it was timed using a single beam photocell system (DSD Laser System, León, Spain). Two photocells were sited at the start, another 2 at 10 m and 2 at 20 m. Players started the sprint test half a meter behind the first two photocells (García López et al., 2012). A visual stimulus was used to indicate to players when the cells were ready to start, and then players could start, on their own, a 20 m sprint at maximum intensity. They performed this test once, and times for the first 10 m and the total 20 m were analysed.

Jump capacity

Players' jump capacity was measured using a laser platform (SportJUMP System PRO, DSD Inc., Spain), placed in a small area adjacent to the corner of the court with a surface similar to that of the match surface. Keeping their hands at the waist, players made 3 attempts at the CMJ (Garcia-Lopez et al., 2005), with 45–60 seconds' rest between jumps. The best result in centimetres was analysed for the CMJ variable.

Statistical analysis

Descriptive results are presented as mean ± SDs. All analyses were performed using a custom-made spreadsheet (Hopkins, 2007). All data were log- transformed for analysis to reduce bias arising from non-uniformity error and then analyzed for practical significance using magnitude-based inferences (Hopkins et al., 2009). Practical significance was assessed by calculating Cohen's d effect size (Cohen, 1988). Effect sizes (ES) between ,0.2, 0.2–0.6, 0.6–1.2, 1.2–2.0, and 2.0–4.0 were considered as trivial, small, moderate, large, and very large, respectively (Hopkins et al., 2009). Probabilities were also calculated to establish whether the true (unknown) differences were lower, similar, or higher than the smallest worthwhile difference or change [using standardized difference (0.2) and its 90% confidence limits (CL), based on Cohen's effect size principle]. Qualitative assessment of the magnitude of change was also included. Quantitative changes of higher or lower differences were evaluated qualitatively as follows: <1%, almost certainly not; 1–5%, very unlikely; 5–25%, unlikely; 25–75%, possible; 75–95%, likely; 95–99%, very likely; >99%, almost certain (Hopkins, 2007). If the 90% confidence limits (CL) overlapped, indicating smaller positive and negative values, the magnitude of the correlation was termed "unclear"; otherwise it was deemed as the observed magnitude. Changes in the performance variables presented as positive (i.e. increased time in a sprint test) or negative differences (i.e. reduced CMJ height) are in the opposite direction although both represent a performance decrease.

Results

Between playing position comparisons it can observed (Table 2) that a likely effect is shown regarding 10 m: forwards in T2 *vs* T3 (ES = 0.54) and T1 *vs* T3 (ES = 0.66). With regard to 20 m: T2 *vs* T3 in forwards (ES = 0.53) and in T1 *vs* T3 in guards (ES = 0.76), forwards (ES = 0.72) and (ES = 0.69). Lastly, with regard to CMJ: T1 *vs* T2 in guards (ES = -0.94), forwards (ES = -1.03) and centres (ES = -0.75); and regard T1 *vs* T3 were observed likely effect in centres (ES = -0.86), very likely effects in guards (ES = -1.18) and almost certain effects in forwards (ES = -1.18).

Table 2. Results and practical differences in the fitness parameters between Test 1 (T1), Test 2 (T2) and Test 3 (T3) for each playing position. Values are presented as mean±*SD*.

Variables	T1	T1 vs. T2 and MBI ES (90% CL)			T2	T2 vs. T3 and MBI ES (90% CL)			T3	T1 vs. T3 and MBI ES (90% CL)		
GUARDS												
RPE	0.55±0.52				4±0.77				7.27±1.1			
10 m	1.9±0.11	0.01 (-0.99;1.01)	37/27/36	possibly	1.9±0.18	0.11 (-0.66;0.88)	42/33/24	possibly	1.92±0.21	0.2 (-0.92;1.33)	50/23/27	possibly
20 m	3.15±0.14	0.28 (-0.46;1.02)	57/29/14	possibly	3.19±0.15	0.45 (-0.45;1.35)	68/20/11	possibly	3.26±0.22	0.76 (-0.18;1.7)	84/11/5	likely
CMJ	31.95±3.12	-0.94 (-1.82;-0.06)	2/6/92	likely	28.75±4.45	-0.17 (-0.73;0.39)	13/41/46	possibly	27.94±1.91	-1.18 (-1.77;-0.58)	0/1/99	very likely
FORWARDS												
RPE	0.6±0.51				4.47±1.13				7.2±1.08			
10 m	1.92±0.09	-0.15 (-0.91;0.6)	22/33/46	possibly	1.9±0.14	0.54 (-0.03;1.12)	84/14/2	likely	1.98±0.13	0.66 (-0.07;1.39)	85/12/3	likely
20 m	3.21±0.14	0.05 (-0.63;0.73)	35/38/27	possibly	3.22±0.17	0.53 (-0.09;1.14)	81/16/3	likely	3.32±0.19	0.72 (0;1.44)	89/9/2	likely
CMJ	33.86±3.71	-1.03 (-1.64;-0.41)	0/1/99	very likely	29.82±4.03	-0.14 (-0.67;0.39)	14/43/43	possibly	29.22±3.19	-1.18 (-1.73;-0.63)	0/0/100	almost certain
CENTRES												
RPE	0.36±0.5				4.45±1.13				7.09±0.83			
10 m	1.93±0.14	-0.26 (-0.91;0.38)	11/32/57	possibly	1.89±0.13	0.15 (-0.53;0.83)	45/36/19	possibly	1.91±0.13	-0.13 (-0.77;0.51)	19/38/43	possibly
20 m	3.21±0.13	0.05 (-0.78;0.93)	40/31/29	possibly	3.22±0.19	0.42 (-0.27;1.11)	71/22/7	possibly	3.31±0.19	0.69 (-0.18;1.56)	83/13/5	likely
CMJ	32.28±3	-0.75 (-1.48;-0.01)	2/9/89	likely	29.04±3.95	0.1 (-0.54;0.74)	40/39/21	possibly	29.49±3.46	-0.86 (-1.59;-0.12)	1/6/93	likely

CMJ= counter-movement jump; RPE= rating of perceived exertion; ES = standardized difference; MBI = magnitude-based inference; CL= confidence Limits

Regarding the performance decrease quantification between pre-match and post-match test, it can observed (Figure 2) that the highest values were found in CMJ in forwards (13.70%). With regard to 10 m in forwards (3,28%) and finally in 20 m in guards (3.51%).

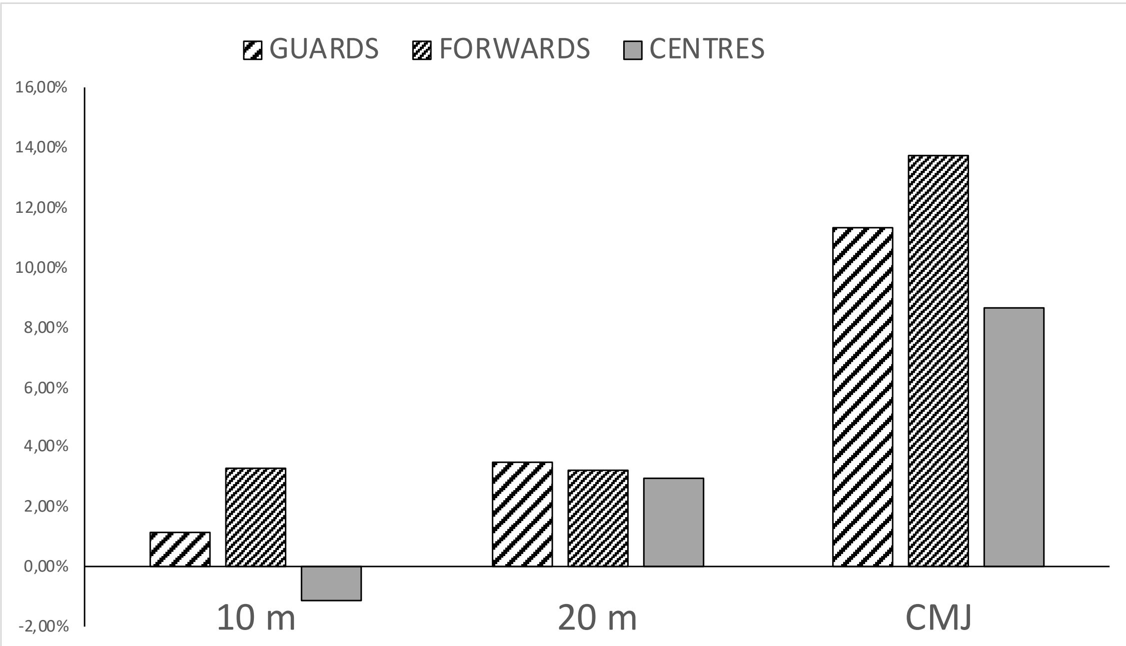

Figure 2. Percentage of change in performance between prematch and postmatch. Sprint tests (10 m and 20 m); CMJ: counter movement jump.

Discussion

Considering the paucity of research investigating in competitive contexts, the aim of the present study was to analyse the acute effects of a basketball match on perceived exertion, sprint times in under-18 female players. We expected to find a general decline in performance due primarily to muscle fatigue occasioned by the demands of the match (Enoka & Duchateau, 2008). We also expected to find that the effect of this fatigue would vary between players according to playing position, since each position involves specific features and functions (Scanlan et al., 2011; Scanlan et al., 2012). Both hypotheses were confirmed by our study. We found that performance declined over time for all the variables analysed, and also that this was associated with particular moments during the match and with particular playing positions.

In the case of basketball, postmatch fatigue has been shown to affect sprint capacity. In this sense, Paulauskas et al. (2018) described the dynamics of a repeated sprint ability (RSA) cycling protocol. Jump capacity has also been affected (Cortis et al., 2011), since basketball players regularly need to jump: each player on average performs 50 jumps per game (Drinkwater et al., 2008). Running and jump performance were related to body mass by Nikolaidis et al. (2015), and these findings were observed too in our results. The latter study concluded that an excess of body mass might have different implications for u15 basketball players than it does for u-18 players. In our study, we also found a significant decline in CMJ and 20 m sprint performance at the end of the match. Thus, it could be inferred that in the case of CMJ, changes related to muscle fatigue become evident immediately after the match and are long lasting (Gathercole et al., 2015), while in the case of sprints, the different rates of recovery between sprinting and jumping may be related to changes in biomechanical behaviour (the duration of concentric and eccentric phases), resulting in neuromuscular fatigue that affects jump performance to a greater extent (Gathercole et al., 2015). Studies have indicated that there are significant relationships between sprint times over 10 m and 20 m and all jump height measures (McBride et al., 2002; Young et al., 1995). In female basketball players, Delextrat et al. (2012) showed the relationship between the fatigue effects of CMJ and 20 m sprint during a typical in-season week. Both variables induced significant decreases. With regard to these two capacities, it has been demonstrated that in young footballers, mixed training programmes which include general and specific strength exercises improve their performance and may help combat performance loss due to fatigue (Maio Alves et al., 2010).

The information about the match activities of young female basketball players by positions is limited. Nonetheless, in our research, we allowed a more detailed description of the fatigue in competition matches in sprint requirements of three playing positions. The fatigue produced over the course of a match was evident in all players analysed in our study. The results showed that guards´ performance decreased more (3.51%) than forwards´ and centres´ performance in terms of 20 m at the end of the match. The interpretation of the match effects allows us to determine that guards perform more movements than all other positions and more sprints than forwards and centres (A Delextrat et al., 2015). In accordance with this hypothesis, among female players Scanlan et al. (2012) found guards performed more dribbling actions than those in other positions did. However, the acceleration:deceleration ratio is lower in players on the perimeter (guards) than in forwards and centers (Vázquez-Guerrero et al., 2018).

In the case of forwards, the ES was also identified as a “moderate” performance decreased: 10 m (3.28%; ES = 0.66, likely), 20 m (3.23%; ES = 0.72, likely) and CMJ (13.70%; ES = -1.18, almost certain). These results show that in women’s basketball, forwards can do special physical efforts in the game in comparison with players in other positions. Accordingly, some authors argue that female forwards perform a larger number of runs (Scanlan et al., 2012) and are heavily involved in fast breaks, offence without the ball, and transition offence and defence (Trninić & Dizdar, 2000). In addition, the forwards play for more minutes, covering a greater distance and performing more sprints and high intensity (Reina et al., 2020), but also the actions movements that involve less running, inside shots, defensive and offensive rebound efficiency and screening are crucial for forwards (Delextrat et al., 2015).

When we contrasted results from the first half of the match with those of the second half, we did not find a "very likely" negative effects between half time and the end of the match in our players. However, we found more "likely" and "very likely" negative effects between T1 and T2 than we did between T2 and T3 in all playing positions but only for CMJ. In this area, Matthew & Delextrat. (2009) and Scanlan et al. (2012) did not report significant differences between quarters in female players. Thus, the female players studied by Delextrat et al. (2015) were recorded to have spent less time on running, sprinting and performing high-intensity actions in the fourth quarter compared to in the first quarter in all playing positions. It must be noted that during the fourth quarter of a match players have more time to rest due to the large number of breaks that take place in this quarter compared to other quarters. In this sense, the greatest physical demands reached during the first quarter are probably related to the fact that when teams started the games, obviously drawing, the starter players try to maintain high intensity activity in order to make differences on the score likely through faster transitions that produce shorter possessions (Vázquez-Guerrero et al., 2019). So, this last quarter not only reflects players' fatigue but also their pacing strategies, as well as the structure of the match and strategic decisions taken by coaches (i.e., increased timeouts, fouls and free throws) in order to win the match.

Although it is acknowledged that there are a number of limiting factors which may account for the present findings, we believe that the present design has high levels of validity and demonstrates the need for further research to continue identifying and quantifying the physical requirements—and their interrelationships—of the five playing positions (point guard, shooting guard, forward, power forward and centre) and to increase the sample size in each playing position. It must be taken into consideration that our sample not investigate the nature of the game (importance of the game or superiority of the opponent). Furthermore, it would be beneficial to explore other player profiles, levels and categories, such as professional or male basketball players, and to study these effects at different times of the playing season, because in the final months of the competitive mesocycle (a decisive phase in the season), the cumulative load of several months of training and competition may exert a different effect to the loads corresponding to other periods. In addition, it might be very interesting to analyse the influence of game outcome in each match quarter according the results in physical tests.

Conclusions

In this study, via tests of jump capacity and sprint times we have quantified performance decline produced as a result of the demands of a basketball match in the case of under-18 female players.

This decline in performance in the tests did not affect all playing positions equally, demonstrating the need for individualized fitness training. At the end of the match, forwards showed more performance decrease than in other playing positions. Nevertheless, the negative effects founded were higher in the first half than in the second half.

These results provide useful information for coaches and trainers with respect to the organization of training. In order to attain good physical performance, it is necessary to minimize the effects of match fatigue and accelerate postmatch recovery. This can be achieved by tailoring training strategies and programmes so that they cover the needs of each player.

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