

Comparison of the Movement Characteristics Based on Position-Specific Between Semi-Elite and Elite Basketball Players

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Abstract

The aim of study is to comparison of the movement characteristics based on position-specific between world-class elite and semi-elite basketball players. 24 basketball players were selected from Spanish U18 semi-elite (Guards=5; Forwards=5; Centres=2) and World-class elite basketball players (Guards=5; Forwards = 4; Centres= 3), respectively. Physical demands were assessed using WIMU PRO Local Positioning System (Realtrack Systems, Almeria, Spain) during practices. The differences between Spanish U18 semi-elite and World-class elite basketball players from different position were tested by independent sample t-test. Our result showed that Spanish U18 semi-elite basketball players from all position, made more movement of acceleration and deceleration per average minutes than their counterpart World-class basketball players. Moreover, Spanish U18 guards have better performance in the performance profiles of g-force acceleration (ES=0.88) and deceleration (ES=0.98) than World-class guards, as the same results as Spanish U18 centres (g-force acceleration, ES=0.44; and g-force deceleration, ES=0.53). Conversely, World-class forwards have better performance in max acceleration (ES=0.42) and deceleration (ES=0.42) than Spanish U18 forwards. In conclusion, differences in distribution of accelerations and decelerations appeared between player positions, which would be of importance when monitoring training and game loads and when prescribing specific training exercises.

Keywords: movement characteristics; position specific; basketball players; acceleration and deceleration profiles.

Introduction

The development of sports technology makes it possible to get the better understanding of teams' and players' performance in the sport sciences. The use of smart sensor devices in basketball may appropriately provide important information about the physical and physiological demands to maximize athletes' physical performance while avoiding overtraining and injury, during the training and competition (Dalbo et al., 2016; Fox, Scanlan, & Stanton, 2017).

Basketball is highly intermittent in nature and relies on significant energy contributions from both the anaerobic and aerobic energy systems (Fox, Stanton, & Scanlan, 2018; Scanlan et al., 2014; Stojanović et al., 2017). During basketball match-play, periods of high-intensity activity are interspersed with periods of low- to moderate-intensity activities. These activities differ in terms of movement pattern (e.g. running, jumping, shuffling), intensity, distance, frequency, and duration (Ferioli et al., 2018; Scanlan, Dascombe, Reaburn, & Dalbo, 2012; Schelling and

Torres-Ronda, 2013). In addition, the ability of basketball players to perform the above high-intensity actions over short distances can be linked with common basketball-specific requirements such as contesting for the ball in one-on-one situations. The capacity to accelerate can be an important factor for isolation with ball and getting rid of defence without ball (Schelling and Torres, 2016). It has been theorised that accelerating on flat terrain is energetically equivalent to running on an uphill terrain and is therefore more energetically demanding than constant speed running, even when accelerating from lower speeds (Chaouachi et al., 2012). In addition, the capacity to decelerate can be associated with the change of direction ability (Svilar, Castellano, & Jukić, 2018), which is important for regaining the ball after a loss of possession and performing the offensive motion of backdoor cut. It has been suggested that repeated deceleration might increase fatigue due to the rapid eccentric contractions required and therefore hinder performance (Román, García-Rubio, Feu, & Ibáñez, 2018). Further, a deceleration combined with a change of

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direction has been identified as a common movement that precludes non-contact playing injuries such as anterior cruciate ligament (ACL) injury (Hewit, Cronin, Button, & Hume, 2011). Therefore, game-specific training of acceleration and deceleration ability may assist in optimising game performance and prevent injury.

Indeed, the assessment of acceleration and deceleration efforts is crucial in quantifying the repeated intermittent efforts performed by players because speed threshold measurements in isolation ignore that, even at low absolute speeds, acceleration and metabolic demand can still be maximal (Conte, Kolb, Scanlan, & Santolamazza, 2018; Vigh-Larsen, Dalgas, & Andersen, 2017). To date, the performance profile of accelerations and decelerations of basketball players has been documented in the studies (Schelling and Torres, 2016; Svilar, Castellano, Jukic, & Casamichana, 2018), but little is known regarding the difference of the movement characteristics between semi-elite and world-class elite basketball players according to playing position. Consequently, comparison of the movement characteristics from different levels of position-specific basketball players would provide deeper understanding for the development of specific training plans and transitioning of players to higher competitions. Also, understanding these results will probably make a contribution to better understand the dose-response mechanism of these training tasks in a way to allow fine-tuning periodization according to the level of congested fixtures calendars.

Based on the above consideration, the aim of study is to comparison of the movement characteristics based on position-specific between Spanish U18 semi-elite and World-class elite basketball players. It was hypothesized that substantial differences would exist between positional demands in terms of the number of accelerations and deceleration per average minutes. Furthermore, we expect that World-class elite basketball players may have better performance in the performance profile of acceleration and deceleration compared with their counterpart Spanish U18 semi-elite basketball players.

Method

Sample

24 basketball players were selected in the current study. 12 basketball players from Spanish U18 team (Guards=5; Forwards=5; Centres=2) (age, 17.6 ± 0.4 years; height, 194.42 ± 7.0 cm; weight, 88.6 ± 5.6 kg), and were qualified as “*semi-elite players*” (Swann, Moran, & Piggott, 2015). Semi-elite players are those whose highest level of participation is below the top standard possible in their sport (e.g., in talent development programs). These players competed at the highest national level and occasionally in some international competitions. In addition, 12 world-class elite basketball player from part of one professional men’s basketball team competing in the Spanish First Division

(ACB) (Guards=5; Forwards = 4; Centres= 3) (age: 28 ± 3.9 years; height, 199.7 ± 10.5 cm; weight, 97.9 ± 13.7 kg), who were identified as “*world – class elite players*” (Swann, et al., 2015), which means that the players have experience of sustaining success at the highest level, with repeated wins over a prolonged period of time.

Design and Variables

A total of 120 drills of 5x5 full courts were recorded (65 of the U18 semi-elite players and 55 of the world-class elite players). The acceleration/min, deceleration/min, max acceleration, max deceleration, g-force accelerations and deceleration (the number of jumps and impacts that exceed 5 G’s forces, measured with the inertial accelerometer in the z, x, and y axes, respectively) of both groups, was measured using a portable local positioning system (WIMU PRO; Realtrack Systems SL) (Vazquez-Guerrero et al., 2018) using 6 antennas.

Reliability and Validity of Data

Data were analysed using the system-specific software (WIMU Software; Realtrack Systems SL). The reliability and validity of WIMU Realtrack Systems was identified to reach an acceptable level (Gómez-Carmona et al., 2018). Recently, the WIMU PRO system showed better accuracy (bias: 0.57–5.85%), test-retest reliability (% technical error of measurement [%TEM]: 1.19), and interunit reliability (bias: 0.18) in determining distance covered than the GPS technology (bias: 0.69–6.05%; %TEM: 1.47; bias: 0.25) overall (Bastida Castillo, Gómez Carmona, De la Cruz Sánchez, & Pino Ortega, 2018). Also, it showed better results (bias: 0.09; intraclass correlation [ICC] = 0.979; bias: 0.01) for mean velocity measurement than GPS (bias: 0.18; ICC = 0.951; bias: 0.03) (Bastida Castillo, et al., 2018). All of the players and coaches were informed about the research protocol, requirements, benefits, and risks, and their written consent was obtained before the study began. The project was approved by the local Scientific and Ethics Committee and all procedures complied with the Declaration of Helsinki. Each subject gave their informed consent to participate in the study.

Statistical Analysis

This study employed a descriptive design (Thomas, Nelson, & Silverman, 2018).

Data were tested for normality using a Shapiro–Wilk test, with all data shown to be normally distributed ($p > 0.05$). The differences between U18 semi-elite players and world-class elite basketball players considering specific-position were tested by independent sample t-test. Mean differences between two groups, 95% confidence intervals (CI) and Cohen’s d effect sizes (ES) were calculated for all differences. Effects were classified as trivial (0.0–0.2), small (0.2–0.5), moderate (0.5–0.8), and large (>0.8) (Tomczak and Tomczak, 2014). Statistical analyses were conducted in IBM SPSS Version 22.0 (IBM Corporation, Somers, New York, USA).

Results

Our results show that Spanish U18 semi-elite basketball players, from all position, made more movement of acce-

leration and deceleration per average minutes than their counterpart World-class elite basketball players.

Table 1
Comparison of Guards' movement characteristic between sub-elite and elite players

Variables	Guards		t	Sig.	Mean (95%CL)	Effect size
	Sub-elite	Elite				
Accelerations/min	18.63±2.40	18.24±1.94	0.64	0.524	0.39 (-0.84; 1.63)	0.18
Decelerations/min	18.57±2.37	18.18±1.91	0.64	0.527	0.39 (-0.83; 1.61)	0.18
Max Acceleration (m/s ²)	3.50±0.41	3.48±0.36	0.26	0.799	0.03 (-0.19; 0.25)	0.05
Max Deceleration (m/s ²)	-3.58±0.59	-3.52±0.40	-0.38	0.709	-0.05 (-0.34; 0.23)	0.12
AVG Accel (G)	0.90±0.12	0.81±0.08	3.20	0.002	0.09 (0.03; 0.15)	0.88
AVG Dec (G)	-0.88±0.11	-0.79±0.07	-3.32	0.002	-0.09 (-0.14; -0.03)	0.98

Table 2
Comparison of Centers' movement characteristic between sub-elite and elite players

Variables	Centers		t	Sig.	Mean (95%CL)	Effect size
	Sub-elite	Elite				
Accelerations/min	18.11±2.95	17.35±2.55	0.758	0.209	0.75 (-1.27; 2.78)	0.28
Decelerations/min	18.09±2.98	17.39±2.52	0.705	0.184	0.70 (-1.33; 2.73)	0.25
Max Acceleration (m/s ²)	3.15±0.25	3.12±0.22	0.347	0.852	0.02 (-0.14; 0.20)	0.13
Max Deceleration (m/s ²)	-3.14±0.35	-3.03±0.24	-1.020	0.442	-0.11 (-0.33; 0.11)	0.37
AVG Accel (G)	0.80±0.10	0.76±0.08	1.415	0.033	0.04 (-0.02; 0.11)	0.44
AVG Dec (G)	-0.78±0.08	-0.74±0.07	-1.475	0.099	-0.04 (-0.09; 0.02)	0.53

Table 3
Comparison of Forwards' movement characteristic between sub-elite and elite players

Variables	Forwards		t	Sig.	Mean (95%CL)	Effect size
	Sub-elite	Elite				
Accelerations/min	18.50±1.74	17.77±1.75	0.642	0.524	0.39(-0.84; 1.63)	0.42
Decelerations/min	18.47±1.78	17.67±1.75	0.638	0.527	0.39(-0.83;1.61)	0.45
Max Acceleration (m/s ²)	3.15±0.30	3.29±0.37	0.256	0.799	0.03 (-0.19; 0.25)	0.42
Max Deceleration (m/s ²)	-3.11±0.34	-3.27±0.42	-0.376	0.709	-0.05(-0.34; 0.23)	0.42
AVG Accel (G)	0.81±0.09	0.81±0.09	3.204	0.002	0.09(0.03; 0.15)	0.00
AVG Dec (G)	-0.79±0.09	-0.79±0.09	-3.319	0.002	-0.09(-0.14; -0.03)	0.00

According to the position-specific, Spanish U18 guards have better performance in g-force acceleration (ES=0.88) and deceleration (ES=0.98) than World-class elite guards.

The same results for Spanish U18 centres (g-force acceleration, ES=0.44; and g-force deceleration, ES=0.53).

Conversely, World-class elite forwards have better performance in max acceleration (ES=0.42) and deceleration (ES=0.42) than Spanish U18 forwards.

Discussion

The main findings of the present study were that Spanish U18 semi-elite basketball players from all different positions made more movement of acceleration and deceleration per average minutes than their counterpart World-class elite basketball players. In addition, World-class elite basketball players did not have better performance in the performance profiles of g-force acceleration and deceleration compared with the Spanish U18 semi-elite basketball players. Furthermore, accelerations and decelerations seem to be sensitive and valid markers of physical game performance with significant differences existing during 5x5 full court games.

It is worth noting that Spanish U18 semi-elite basketball players from all position made more movement of the accelerations and decelerations per average minutes than World-class elite basketball players. A possible explanation for Spanish U18 semi-elite basketball players with higher number of accelerations and decelerations per average minutes could be its ecological validity, since the cognitive and physical requirements are closer to an actual basketball game, as well as it may help players to maintain higher levels of motivation in comparison with less specific training scenarios (Reilly, Morris, & Whyte, 2009; Schelling and Torres, 2016). In addition, some studies [pointed out](#) that expert players make more informed decisions on when and where to run in offence and defence compared with unexperienced players; therefore, those players possibly covered shorter distances at lower average velocities to reach their destinations (Zhang, Lorenzo, Gómez, Liu, et al., 2017; Zhang, Lorenzo, Gómez, Mateus, et al., 2017).

Additionally, Spanish U18 guards and centres have better performance in the performance profiles of g-force acceleration and deceleration than world-class elite guards and centres. These results are supported by the studies of Ferioli et al. (2019) who suggested that there are differences in terms of the activity profile of acceleration and deceleration among position-specific as well as between different competitive levels. In fact, Svilar, Castellano, & Jukić (2018) have pointed out that player load showed very strong correlations with the number of jumps, and these findings could be explained by physical demands of basketball game, which involves a more frequent stress caused by changes of direction and jumps. The jump ability of basketball player is mainly associate with the ability of shooting and securing rebounds (Stojanović, et al., 2017). In fact, Zhang et al. (2018) suggested that comparing with the younger players, expert players can accurately judge the fall of the ball and select optimal moment and position in which the defensive pressure is less to shoot through perceiving environmental information and adapting their behaviour accordingly. In addition, player from lower-level utilised possession based on more individual action instead

of effective interaction in offence and defence and the fluctuations in shooting activity may cause more fight for offensive and defensive rebounds, this is possibly why players from Spanish U18 made more in the number of jumps compared with World-class players (Ferioli, et al., 2019).

World-class elite forwards have better performance in max acceleration and deceleration than Spanish U18 forwards. In fact, max acceleration means that a player would take shorter to reach any given speed, and may therefore be required to run shorter, thus covering a shorter distance at high speed (Akenhead, Hayes, Thompson, & French, 2013). This may also explain why the forwards often played a key role in transition and fast-break during the game-play. Furthermore, in basketball, the act of rapidly slowing the body (deceleration) is critical to the success of the movement. Deceleration is often employed in sports that require an immediate or gradual stop or to decrease the body's velocity before a change in direction (horizontal, lateral, or vertical). The forces applied to the body when decelerating can be exceptionally large in magnitude, especially when the time over which these forces must be absorbed is small (Hewit, et al., 2011). Therefore, appropriate technique is essential for not only decreasing the risk of injury but also controlling balance and effectively transferring accumulated elastic energy into the subsequent movements (Hewit, et al., 2011).

Conclusion

In summary, our result showed that Spanish U18 semi-elite basketball players, from all position, made more movement of acceleration and deceleration per average minutes than their counterpart World-class elite basketball players. Moreover, Spanish U18 guards and centres have better performance in the performance profile of g-force acceleration and deceleration than their counterpart World-class elite basketball players. Conversely, World-class elite forwards have better performance in max acceleration and deceleration than Spanish U18 forwards. These results would make contribution to basketball scouts and coaches to designing appropriate physical training session and developing effective basketball talent project. In addition, our study recommended that technical and tactical strategies can be designed by the characteristics of the explosive and braking ability based on position-specific players between different competitive levels. For example, players from Spanish U18 may allow guards directly pass the ball to the centre to complete Alley Oop for tactical strategies in the baseline while players from World-class level should take advantage of the cutter role of forwards during the game-play.

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Comparación de las características de movimiento basadas en la posición específica entre los jugadores de baloncesto semi-élite y elite

Resumen

El objetivo del estudio ha sido comparar las características de los movimientos realizados por los jugadores de baloncesto, de acuerdo a la posición específica de juego, en jugadores de élite y semi-élite. Se seleccionaron 24 jugadores de baloncesto semi-élite U18 (Bases = 5; Aleros = 5; Pivots = 2) y jugadores de élite de clase mundial (Bases = 5; Aleros = 4; Pivots = 3), respectivamente. Las demandas físicas se evaluaron utilizando el sistema de posicionamiento local WIMU PRO (Realtrack Systems, Almería, España) durante los entrenamientos. Para observar las diferencias entre los jugadores de baloncesto semi-élite U18 y de élite de clase mundial desde diferentes posiciones se utilizó la prueba t de muestra independiente. Los resultados mostraron que los jugadores de baloncesto semi-élite U18, independientemente de la posición de juego, hicieron más movimientos de aceleración y desaceleración por minuto promedio que los jugadores de baloncesto de clase mundial. Además, los bases U18 tuvieron un mejor rendimiento en los perfiles de rendimiento de aceleración de fuerza g (ES = 0.88) y desaceleración (ES = 0.98) que los bases de clase mundial, al igual que los pivots españoles U18 (g- aceleración de fuerza, ES = 0.44; y desaceleración de fuerza g, ES = 0.53). Por el contrario, los aleros de clase mundial tuvieron un mejor rendimiento en aceleración máxima (ES = 0.42) y desaceleración (ES = 0.42) que los aleros U18. En conclusión, aparecieron diferencias en la distribución de las aceleraciones y desaceleraciones entre las posiciones de los jugadores, lo que sería importante al monitorear el entrenamiento y las cargas del juego y al prescribir ejercicios de entrenamiento específicos.

Palabras clave: características del movimiento; posición específica; jugadores de baloncesto; perfiles de aceleración y desaceleración.

Comparação das características do movimento baseadas na posição específica entre jogadores de basquete semi-élite e elite

Resumo

O objetivo do estudo foi o de comparar as características dos movimentos realizados pelos jogadores de basquetebol, de acordo com a posição de reprodução em reprodutores de elite e semi-élite. Foram selecionados 24 jogadores de basquete sub-élite de sub-18 (Armadores = 5; Alas = 5; Pivôs = 2) e jogadores de elite da classe mundial (Armadores = 5; Alas = 4; Pivôs = 3), respectivamente. As demandas físicas foram avaliadas usando o sistema de posicionamento local WIMU PRO (Realtrack Systems, Almería, Espanha) durante o treinamento. Para observar as diferenças entre os jogadores de basquete semi-élite e elite de basquete de classe mundial de diferentes posições, foi utilizado o teste t de amostra independente. Os resultados mostraram que os jogadores de basquete Sub-18 semi-élite, independentemente da posição de jogo, fez mais movimentos de aceleração e desaceleração por classe média minuto mundo jogadores de basquete. Além disso, as armadores U18 tiveram melhor desempenho nos perfis de aceleração da força g (ES = 0,88) e desaceleração (ES = 0,98) do que as bases de classe mundial, assim como os pivôs espanhóis da U18 (g- aceleração da força, ES = 0,44; e desaceleração da força g, ES = 0,53). Pelo contrário, a classe alas mundo realizado melhor em aceleração máxima (ES = 0.42) e desaceleração (ES = 0.42) do que beirais U18. Em conclusão, eles apareceram diferenças na distribuição de acelerações e desacelerações entre as posições dos jogadores, seria importante para monitorar treinamento e jogo carrega e ao prescrever exercícios específicos de formação.

Palavras-chave: características de movimento; posição específica; jogadores de basquete; aceleração e desaceleração perfis.

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