Anthropometric and fitness profiles of young basketball players according to their playing position and time

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Abstract:

Basketball is considered a physical contact game that demands high rates of anthropometric and fitness characteristics for all the players. However, it has been found that players differ significantly from each other concerning their characteristics. Basketball parameters such as the playing position and the playing time associated to players' characteristics. Besides that, one factor that has not been examined before is the relationship between balance and anthropometric-fitness characteristics. Therefore, the aim of the study was to examine the anthropometric and fitness differences of young basketball players according to their playing position and playing time, as well as to examine differences of players' balance. The results revealed differences among players of different playing position and time concerning their height, weight, BMI, balance, lower limb endurance and vertical jump. Finally, the correlations between balance and anthropometric-fitness characteristics indicated that balance is highly related to all these characteristics.

Key words: Basketball - performance, vertical jump, balance, BMI, physical characteristics.

Introduction

Basketball game is a physical contact sport that demands high levels of anthropometric and fitness characteristics for all the players. A high level of mental, technical and tactical skills, as well as anthropometric and fitness skills are required for a successful participation in this sport. Physical abilities (i.e. jumping) are very important predictors of performance (Tsunawake et al., 2003; Ziv & Lidor, 2009). Many studies address anthropometric (i.e. height, weight, body fat) or fitness (i.e. jump, endurance, VO₂max, agility) differences among adult players of various sports (Apostolidis, Nassis, Bolatoglou, & Geladas, 2004; Bayios, Bergeles, Apostolidis, Noutsos, & Koskolou, 2006; Gaurav, Singh, & Singh, 2010). However there is a lack of research concerning fitness characteristics of young basketball players such as the balance ability. Limited research showed that dynamic balance, as part of the coordination ability, is associated with athletic performance and the rest of fitness characteristics (Bressel, Yonker, Kras, & Keath, 2007; Hobbs, 2008). Balance is the ability to maintain the center of gravity over a base of support while sitting, standing, bending, reaching, and lifting on one foot. It is divided in static balance, the ability to maintain a base of support with minimal movement, and dynamic balance, the ability to perform a task while maintaining a stable position (Ricotti, 2011). Somatosensory, visual and vestibular information determine the balance performance (Grigg, 1994). Balance also protects players of getting injured. Findings showed that specific balance training reduces the number of knee and hamstring injuries, ankle sprains, tendinopathies and rehabilitation time (Emery, Cassidy, Klassen, Rosychuk & Rowe, 2005; Kraemer & Knobloch, 2009; McGuine, Greene, Best & Levenson, 2000; McGuine & Keene, 2006). Many lower extremity injuries are frequently caused as a result of impaired stability and balance during landing after jumping (Griffin et al., 2000; Plisky, Rauh, Kaminski & Underwood, 2006; Wikstrom, Powers, & Tillman, 2004). Since basketball involves abrupt and intense direction changes, high frequencies of starting, stopping, and a physical contact game, there is a relationship between balance and basketball playing ability (Hobbs, 2008), as well as balance and technical ability (Kostopoulos, Bekris, Apostolidis, Kavroulakis, & Kostopoulos, 2012). Furthermore, in basketball, which is one of the most demanding sports in coordination training, coordination motor skills are considered as an important aspect of performance (Dembiński, 1997; Glasauer & Nieber, 2000; Kubaszczyk, 2001). Therefore, the significance of assessing the balance ability in basketball is double fold as it is linked to injuries' frequency and to coordination ability that are both related to performance. Based on the definition of balance and the required motor skills associated with high levels of performance, dynamic balance presents significant interest in basketball.

One factor that appears to differentiate players concerning their anthropometric and fitness characteristics is their playing position and time (Hobbs, 2008; Latin, Berg, & Baechle, 1994; Ostojic, Mazic, & Dikic, 2006). In basketball in contrast to other sports that players are placed in certain positions, it is very

common for the players to change roles and responsibilities during the transition game. With all the players freely moving around the court in attack and defense, positions in basketball are very fluid. However, for tactical reasons players participate in certain positions with responsibilities regarding their physical, technical and physiological characteristics. The three most common positions are guards (G), forwards (F) and centers (C). Which characteristics differentiate basketball players regarding their position? Specifically, it has been found that guards are the shortest, lightest, with the lowest body fat percentage, while centers are the tallest, heaviest, with the highest body fat percentage. In addition, guards perform the best vertical jump, speed and strength scores while centers perform the worst agility (Bale, 1991; Latin et al., 1994; Ostojic et al., 2006). Ostojic and colleagues (2006) added that centers perform lower VO₂max than guards and forwards. Adult players' anthropometric and fitness characteristics also differ regarding their playing time. Hoffman and colleagues (1996) found that leg strength, vertical jump, speed and agility affect the playing time. However, levels greater than those of average university players do not offer any further benefits in playing time (Hoffman, Tenenbaum, Maresh, & Kraemer, 1996). Hobbs (2008) concluded that players with most minutes of playing time perform greater vertical jump, speed, acceleration and leg strength than the players with the least minutes. But are these differences obvious also for young U16 years old players?

What the current study adds to the literature review of basketball is to address the differences among young players in anthropometric and fitness characteristics according to their playing position and time. Furthermore, the researchers shed light in balance parameters that have not examined before in young players. Therefore, the aim of the study is to examine the anthropometric and fitness differences of young basketball players according to basketball parameters (playing position and playing time), as well as to examine differences of players' balance. The hypotheses assumed the existence of anthropometric and fitness differences related to playing position and time among young basketball players as well as differences in their balance ability. It is also hypothesized that balance is a variable that associated to anthropometric and fitness characteristics of the players.

Material & methods

Participants

In the current study participated 22 amateur basketball players (Age: $M= 15.33$, $SD= .48$; Height: $M= 174.38$, $SD= 9.03$; Weight: $M= 72.56$, $SD= 16.07$). Parents and guardians of the players were informed of the research procedures, risks and benefits before giving an informed consent. The University Research Ethics Committee also approved the study.

Procedure

The researchers examined anthropometric and fitness characteristics of the players in the beginning of the season. Players with sport shoes performed a standardized warming-up before the indoor (height, weight, body fat, BMI, dynamic balance, lower limb endurance and vertical jump) and outdoor tests (running speed). The players had at least 3 minutes of recovery before each trial and each test.

Instruments

Height: To measure the height (cm), the participants should stand with their back to the height rule. The back of the head, back, buttocks, calves and heels touch the upright. Then the researchers measured the height with a cursor.

Weight-Body fat-BMI: To measure the weight (kg), the body fat (%) and the BMI (kg) the researchers used a weighting scale (BC1000, Tanita, Japan) and a connected computer at which the results for each participant were transmitted.

Dynamic balance: To measure the dynamic balance (sec), the researchers created a 3X3 grid comprised of 9 small boxes (30cm wide and 30cm long). It looks like an oversized tic-tac-toe grid. The researchers asked from the participants to balance on one leg (left) in the center box, hop on from the center box to the top center box and back to the center, hop to the upper left corner box and back to the center, hop to the box to the left and back again etc. Similarly they asked the participants to continue this pattern moving clockwise around the entire grid. Then the participants used the other leg (right) by going counter clockwise. The researchers recorded the best time of three trials.

Lower limb endurance-Vertical jump: To measure the lower limb endurance (cm) and the vertical jump (cm) the researchers used the OptoJump System (Microgate, Bolzano, Italy) which is an optical measurement system consisting of a transmitting and a receiving bar. The bars contain photocells which communicate continuously. A personal computer records any interruptions in communication between these bars. Thus it is possible to measure the endurance of the lower limb by the mean height of 15 continuous jumps, and the vertical jump by highest jump of three continuous jumps.

Running speed: To measure the running speed (sec) of the participants the researchers used 2 pairs of photocells (Microgate, RACETIME 2), placed on the beginning and in the end of a 10m distance. The researchers recorded the best of the two trials for each participant.

Statistical analysis

The SPSS package (v.17) was used for the statistical analyses of the data. In the beginning, descriptive statistics of the variables were counted for all the players. Then the researchers performed descriptive statistics of the variables for the players according to their playing position and their playing time respectively. The relationship between balance with anthropometric and fitness characteristics was assessed by Pearson correlations. Normality and homogeneity were tested by Kolmogorov-Smirnov and Levene's control respectively ($p > .05$). Afterwards, ANOVA analyses were counted to examine the anthropometric and fitness differences among players of different playing position and playing time. The significance level was defined at $p < .10$. Finally, Tukey's comparisons were used to reveal which groups differentiated from each other.

Results*Data controls*

The researchers evaluated all the 24 participants with the measurements described. The Kolmogorov-Smirnov tests showed that there was normality in distribution for all the variables ($p > .05$). Levene's test also showed a significance value greater than $p > .05$ which means that the variances are not significantly different and there is homogeneity.

Descriptive statistics

The following table shows the descriptive statistics for the anthropometric and fitness characteristics of the players in total, and also according to their playing position and playing time (Table 1).

Table 1- Descriptive statistics of anthropometric and fitness characteristics.

Variables	Total M (SD)	Playing position M (SD)			Playing time M (SD)		
		G	F	C	Low	Medium	High
Height	174.38 (9.03)	167.75 (7.38)	179.67 (2.88)	182.33 (5.68)	170.39 (9.37)	179.50 (7.37)	177.50 (5.09)
Weight	72.56 (16.07)	63.75 (11.52)	72.90 (9.12)	89.83 (16.35)	68.06 (11.90)	74.68 (17.19)	76.63 (21.53)
Body fat	16.58 (6.16)	15.70 (5.26)	14.50 (5.34)	20.40 (7.77)	16.60 (4.65)	14.30 (6.83)	16.50 (8.56)
BMI	23.67 (3.90)	22.53 (3.25)	22.60 (2.80)	27.00 (4.59)	23.29 (2.94)	23.03 (4.13)	24.17 (5.83)
Left-leg balance	7.67 (1.16)	7.51 (.66)	7.02 (.88)	8.66 (1.64)	7.52 (.85)	7.66 (1.06)	7.58 (1.51)
Right-leg balance	7.95 (1.49)	7.76 (.87)	6.89 (1.14)	9.39 (1.82)	7.82 (1.01)	7.92 (1.57)	7.61 (1.81)
Lower limb endurance	22.71 (6.81)	22.58 (7.19)	25.20 (5.94)	20.48 (7.15)	21.43 (5.64)	20.15 (2.80)	28.27 (8.80)
Vertical jump	29.52 (7.20)	29.26 (7.15)	32.00 (7.75)	27.57 (7.33)	28.06 (6.13)	26.80 (5.10)	35.52 (8.40)
Running speed	2.02 (.16)	2.00 (.12)	1.98 (.19)	2.10 (.20)	2.02 (.11)	2.05 (.13)	1.96 (.22)

Balance correlations

Pearson r was used to examine the relationship between balance with anthropometric and fitness characteristics. The results showed that left-leg balance was significantly correlated with height ($r = .358$, $p < .10$), weight ($r = .465$, $p < .05$), BMI ($r = .357$, $p < .10$), and running speed ($r = .527$, $p < .01$). On the other hand right-leg balance was significantly correlated with height ($r = .367$, $p < .10$), weight ($r = .547$, $p < .01$), body fat ($r = .417$, $p < .05$), BMI ($r = .477$, $p < .05$), lower limb endurance ($r = -.420$, $p < .05$), vertical jump ($r = -.416$, $p < .05$), and running speed ($r = .714$, $p < .001$).

Differences among subgroups

Analysis of variance (ANOVA) was used in order to examine the significance of the differences among players of different playing position concerning their anthropometric and fitness characteristics. Then Tukey's tests were used for the differences among the sub-groups (Guards; Forwards; Centers). The ANOVA revealed statistically significant main effects at the $p < .05$ level, for playing positions concerning height $\{F_{(2, 21)} = 4.089$, $p = .000\}$, weight $\{F_{(2, 21)} = 8.895$, $p = .002\}$, BMI $\{F_{(2, 21)} = 3.588$, $p = .046\}$, left-leg balance $\{F_{(2, 21)} = 4.129$, $p = .031\}$, and right-leg balance $\{F_{(2, 21)} = 6.531$, $p = .006\}$. However, there were not significant main effects at the $p < .05$ level, for the different playing positions concerning lower limb endurance $\{F_{(2, 21)} = .705$, $ns\}$, vertical jump $\{F_{(2, 21)} = 1.009$, $ns\}$, and running speed $\{F_{(2, 21)} = .563$, $ns\}$. Post hoc comparisons using the Tukey's tests indicated that there were significant differences among the mean scores of playing positions. Regarding the

anthropometric characteristics, G presented lower height than F ($p < .01$) and C ($p < .001$), lower weight ($p < .001$) and better BMI ($p < .05$) than C. Moreover, F presented lower weight ($p < .10$) and better BMI than C ($p < .10$). Regarding the fitness characteristics, G performed better left-leg ($p < .10$) and right-leg ($p < .05$) balance than C, while F performed better left-leg ($p < .05$) and right-leg ($p < .001$) balance than C (Table 2).

Table 2- ANOVA analyses and Tukey's comparisons among players of different playing position.

Height	SS	df	ANOVA MS	F	p
Between groups	1074.708	2	537.354	14.089	.000
Within groups	800.917	21	38.139		
Total	1875.625	23			
<i>Tukey's comparisons</i>				G<F; G<C	
Weight					
Between groups	2722.295	2	1361.148	8.895	.002
Within groups	3213.563	21	153.027		
Total	5935.858	23			
<i>Tukey's comparisons</i>				G<C; F<C	
BMI					
Between groups	88.907	2	44.453	3.588	.046
Within groups	260.207	21	12.391		
Total	349.113	23			
<i>Tukey's comparisons</i>				G<C; F<C	
Left-leg balance					
Between groups	8.696	2	4.348	4.129	.031
Within groups	22.113	21	1.053		
Total	30.809	23			
<i>Tukey's comparisons</i>				G>C; F>C	
Right-leg balance					
Between groups	19.495	2	9.748	6.531	.006
Within groups	31.345	21	1.493		
Total	50.840	23			
<i>Tukey's comparisons</i>				G>C; F>C	

Analysis of variance (ANOVA) was used in order to examine the significance of the differences among players of different playing time concerning their anthropometric and fitness characteristics (Table 3). Then Tukey's tests were used for the differences among the sub-groups (High; Normal; Low playing time). The ANOVA revealed statistically significant main effects at the $p < .10$ level, for playing time concerning height $\{F_{(2, 20)} = 2.703, p = .091\}$, lower limb endurance $\{F_{(2, 20)} = 2.915, p = .077\}$, and vertical jump $\{F_{(2, 20)} = 3.079, p = .068\}$. However, there were not significant main effects at the $p < .10$ level, for playing time concerning weight $\{F_{(2, 20)} = .718, ns\}$, body fat $\{F_{(2, 20)} = .223, ns\}$, BMI $\{F_{(2, 20)} = .127, ns\}$, left-leg $\{F_{(2, 20)} = .024, ns\}$, and right-leg balance $\{F_{(2, 20)} = .078, ns\}$, and also running speed $\{F_{(2, 20)} = .566, ns\}$. Post hoc comparisons using the Tukey's tests indicated that there were significant differences among the mean scores of playing time. Regarding the fitness characteristics, players with high playing time presented greater rates of lower limb endurance ($p < .10$) and vertical jump ($p < .10$) than players with low playing time.

Table 3- ANOVA analyses and Tukey's comparisons among players with different playing time.

Height	SS	df	ANOVA MS	F	P
Between groups	363.727	2	181.864	2.703	.091
Within groups	1345.577	20	67.279		
Total	1709.304	22			
<i>Tukey's comparisons</i>					
Lower limb endurance					
Between groups	230.927	2	115.464	2.915	.077
Within groups	792.331	20	39.617		
Total	1023.258	22			
<i>Tukey's comparisons</i>				High p.t.>Low p.t.	
Vertical jump					
Between groups	271.367	2	135.683	3.079	.068
Within groups	881.379	20	44.069		
Total	1152.746	22			
<i>Tukey's comparisons</i>				High p.t.>Low p.t.	

Discussion

The current study principally aimed to identify the differences of anthropometric and performance characteristics of basketball players aged U16 years old according to their playing position. Although some anthropometric and fitness characteristics have been identified in the past, the current study adds findings for young players' characteristics as well as for characteristics that had not been examined before such as balance ability. There was the tendency the guards to be the shortest and the lightest players of the teams, finding that is supported by the literature review (Ostojic et al., 2006). They also presented low levels of body fat and BMI (Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005). Concerning their fitness characteristics it was found that guards performed average level of left-leg and right-leg balance, lower limb endurance, vertical jump and running speed. On the other hand, there was the tendency the centers to be the tallest, the heaviest, with the most body fat and BMI levels in their teams, finding that the literature review supports (Cormery, Marcil, & Bouvard, 2008).

They also performed the lowest left-leg and right-leg balance ability as well as running speed. Similarly, literature review supports the finding that centers perform the lowest running speed performance (Köklü, Alemdaroğlu, Koçak, Erol, & Fındıkoğlu, 2011). Finally regarding the forward players of the teams there was a tendency to be the players' category with the least body fat as well as low BMI value. However, they presented average levels of height and weight, finding that are supported by the literature review (Abdelkrim, El Fazaa, & El Ati, 2007). Regarding their fitness characteristics they performed the greatest levels of left-leg and right-leg balance, lower limb endurance, vertical jump and running speed. Concerning running speed the finding that forwards performed the best rates was interesting because the players that perform most sprints in games are the guards (Abdelkrim et al., 2007). However this finding might be explained by the fact that running speed is not a significant predictor of elite performance as much as other variables such as agility (Delextrat & Cohen, 2008), anaerobic capacity (Sallet et al., 2005) and aerobic fitness (Ziv & Lidor, 2009). Although the study revealed many tendencies, it was found that only some sub-groups differentiate from each other significantly. Specifically, the guards differed significantly from centers in height, weight, BMI, as well as left-leg and right-leg balance. Similarly, the forwards differed significantly from centers in weight, BMI, as well as left-leg and right-leg balance. In conclusion some tendencies in fitness characteristics are probably explained by factors such as the body size effects (Bradic, Bradic, Pasalic, & Markovic, 2009). However, the non-significant results are also explained by the fact that these are heightened only after the post pubertal age (Abdelkrim, Chaouachi, Chamari, Chtara, & Castagna, 2010). Then the researchers examined the differences of anthropometric and performance characteristics of basketball players according to their playing time. The descriptive statistics showed the tendency of the players with the highest playing time to be taller, heaviest, with greater rates of lower limb endurance, vertical jump and running speed. On the other hand players with the lowest playing time were shorter and lightest with the worse rates of lower limb endurance and vertical jump. However, the differences were significant for least and most playing time player regarding their height, lower limb endurance and vertical jump ability. The literature review of adult players also supports the findings concerning the relationship between playing time with height, leg strength, vertical jump and running speed (Angyan, Teczely, Zalay, & Karsai, 2003; Hobbs 2008; Hoffman et al., 1996). The significance of fitness characteristics in playing time is probably explained by the fact that basketball involves physical contact very frequently. Concerning the gap in youth basketball literature about balance, the study revealed differences among players with different positional role. Adding that past findings showed a relationship between balance and performance (Glasauer & Nieber, 2000; Hobbs, 2008; Kostopoulos et al., 2012), it was important to examine the players' characteristics with which balance is associated. The correlations indicated that balance is highly related to all the anthropometric and fitness characteristics that are considered as performance predictors.

Conclusions

In conclusion, the findings of the current study shed light to players' anthropometric and fitness characteristics that are considered essential for their performance. It is suggested that trainers and coaches should take into account the findings so as to improve their players' abilities. Specific fitness training must be undertaken according to playing position and time. Furthermore, they should add balance training in practice sessions according to the needs of each player. Future research is suggested to examine the relationship between technical characteristics and the factors that predict these.

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