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PHYSIOLOGICAL PROFILE OF SPEED, AGILITY AND JUMPING ABILITY OF ELITE U16 BASKETBALL PLAYERS

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ABSTRACT

The purpose of the study was to record the physiological profile of the U16 elite men basketball players of national teams per playing position as well as to compare the differences of those physiological profiles between the playing positions. The study involved 17 young male basketball players (average weight 84 kg, average height 1.97 cm, average age 15.9 years). Players were classified according to their positions in Guards (G: n = 7), Forwards (F: n = 6), and Centers (C: n = 4). In order to determine the physiological profile of the elite players of the study, tests were performed which were divided into 3 characteristics: speed (5m-10m Sprint), agility (T-drill) and jumping ability / anaerobic power (CMJ, DJ, SJ). In the inductive analysis, the possible differences between the different positions of the players were examined through the one-way ANOVA tests. The main findings suggest that the physiological profile of speed, agility and jumping ability of the U16 male players of the Greek National Basketball Team is at a high level. Specifically, the Guards recorded an average of jump height 41.73 cm for the 3 trials (CMJ, SJ, DJ) and times 0.73 ± 0.03 (s), 1.87 ± 0.04 (s) for the 5m. and 10m. sprints and 8.39 ± 0.23 (s) for the T-drill test. Respectively, the Forwards of the research recorded average jump heights of 40.12 cm for the 3 trials (CMJ, SJ, DJ) and times 0.75 ± 0.07 (s), 1.93 ± 0.12 (s) for the 5m, and 10m sprints, and 8.48 ± 0.47 for the T-drill test. Finally, the Centers recorded an average of jump height 42.82 cm for the 3 trials (CMJ, SJ, DJ) and times 0.74 ± 0.05 (s), 1.89 ± 0.04 (s) for the 5m. and 10m. sprints and 8.48 ± 0.31 (s) for the T-drill test. The findings showed that there were no differences between the 3-position players in the 5m / 10m speed tests as well as in the T-drill agility test. On the other hand, in the jump tests, paradoxically, the elite U16 players from the Centers position had the best performance in general in the 3 jump tests and in particular in the CMJ and SJ and the Guards players had the best performance in the DJ. The Forwards position players had the worst performance in all 3 jump tests.

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INTRODUCTION

Assessing the physiological characteristics of team sport players is an essential element in the process of designing training programs and monitoring players' progress during the season. In recent years, the analysis of the physiological requirements of the sport of basketball has provided interesting data on the changes and developments that take place in the nature and in the way the sport is now played. Indeed, recently during basketball games it has been found that players cover on average 6-8 km performing over 2000 movements of different intensities, with these movements decreasing significantly as we approach the end of the games (Abdelkrim et al., 2010; García et al., 2020; A. Scanlan et al., 2011). However, basketball is a team sport with dynamic behavior that combines high-intensity actions with specific technical and tactical skills of the sport, which differ by position. More specifically, frontcourt players have superior anthropometric characteristics than backcourt players due to their role (they play closer to the basket) but worse performances in speed, agility, jumping ability and endurance than them (Boone & Bourgois, 2013; Lockie et al., 2020; Sallet et al., 2005; Scanlan et al., 2014).Thus, it is understood that the physiological profile of basketball players differs from position to position with weight, shuttle run performance (5x10) and sprints according to Pion (Pion et al., 2018) being the main factors separating these positions.

In addition to the differences in the physiological profiles of players of different positions, there are also significant differences in the physiological profiles of players depending on age. In the developmental categories, research has shown that male basketball players in the U18 age groups are the fastest and most agile, followed by players in the U16 age group (Gonzalo-Skok et al., 2017; Mancha-Triguero et al., 2021).In terms of external loads at these ages, the Forward position players seem to be the most agile, with the Guard position players covering longer distances and all the players (Guards, Forwards, Centers) performing 33.3 ± 4.9 jumps and 210.3 ± 31.5 sprints per game (Hůlka et al., 2013; İMer & Yapici, 2018; Vázquez-Guerrero et al., 2019). Furthermore, the physiological profile seems to differ significantly depending on the level of the basketball players. Delextrat & Cohen (Delextrat & Cohen, 2008) in their study recorded significantly better performances of elite male players in tests of strength, agility and jumping ability compared to sub-elite players while similar results for the superiority of elite players, with further differences in speed and endurance, were also recorded in young elite U14 players (Torres-Unda et al., 2013). Similarly, the gender of the players affects the physiological profile of the basketball players. Gómez-Carmona, Mancha-Triguero, Pino-Ortega, & Ibáñez, (Gómez-Carmona et al., 2021) in their study found that male basketball players performed better in curvilinear movements, jumping, accelerations /decelerations, and aerobic fitness tests compared to female players. In contrast, basketball players seem to be disadvantaged in terms of speed, compared to handball players (Kumar, 2016).

For the aforementioned reasons, it is necessary to carry out different assessments and physiological tests at different times during the season, in order to control the development of physical abilities and the individual adjustment of external and internal workloads during training and competitions. In fact, according to Morrison (Morrison et al., 2022) there is still no gold standard in the tests of evaluation of physiological characteristics of basketball players, with the main tests concerning the physical abilities of endurance, strength, agility and aerobic/anaerobic capacities (Gottlieb et al., 2021). Therefore, the selection processes in basketball are mainly based on morphological, functional, technical and kinetical characteristics that differ from one level to another

(Trunić & Mladenović, n.d.). Specifically, Ferioli (Ferioli et al., 2018) showed that elite male basketball players have a higher physiological profile compared to players of other categories, as they had a greater ability to cope better with high-intensity interval training.

Given the existing findings in this area, it is considered useful to further investigate the physiological profile of young basketball players, emphasizing the speed, agility and jumping ability of the elite U16 national team players. Given that there are only a few studies in the international literature that examine in detail the physiological profile of elite male basketball players aged U16 (İMer & Yapici, 2018; Mancha-Triguero et al., 2021; Orhan et al., 2019), there seems to be a lack of data in this field. In order to assess the physiological profile of elite U16 male national team players, physiological field tests or laboratory tests, previously validated and adapted to the sport of basketball, should preferably be used. Therefore, the aim of this study was: a) to examine and record the physiological elite profile of U16 national team players per position in terms of speed, agility and jumping ability b) to compare the differences of physiological profiles between competing positions.

MATERIALS AND METHODS

Participants

Players before participating in the procedures of the study, were checked by a certified doctor for any injuries of the lower extremities. Only players who had not had any lower limb injuries in the last six (6) months and were perfectly healthy were included in the study. The sample of the research consisted of 17 young male basketball players, who participated in this study (average weight 84 kg, average height 1.97 cm, average age 15.9 years). Players were classified according to their positions in Guards (G: n = 7), Forwards (F: n = 6), and Centers (C: n = 4). The players participated in the Development Program of the Hellenic Basketball Federation in the year 2021 and were preparing for their possible selection and participation in the Greek National Team, which would participate in the U16 European Basketball Championship of the same summer. Upon arrival at the training facilities, the players and their parents were thoroughly informed about the procedures and content of the research, the risks involved and the benefits that the players would gain from the results of the study. The written consent was then obtained from the parents or legal guardians for the participation of their children in the study procedures, while the research was reviewed and approved by the ethics committee of the School of Human Movement and Quality of Life, Department and Sports Administration, University of Peloponnese, Sparta, Laconia and was in line with the Principles of the Helsinki Declaration (2008).

Procedures

Each athlete was examined in 2 separate cases and performed a total of 6 physiological tests. The sessions were completed within the first 2 days with a rest period of at least 24 hours between sessions. All the physiological tests took place in July 2021,on the first and second day of the players' presence at the National team camp and all of the participants were relaxed with a good level of physical condition. After a thorough explanation of the experimental procedures, the players completed a standardized warm-up consisting of running on a treadmill at 6–10 km / h (5 minutes) and stretching the lower limb muscles. The 2 sessions were presented in random order as described below. Session 1 took place on the basketball court used for basketball

practices. It consisted of 3 field tests presented in this series: Counter-movement Jump (CMJ), Squat Jump (SJ) and Drop Jump (DJ).

Counter-movement Jump (CMJ) Test

Players started by standing with their hands on their hips (ie, without swinging their arms). They were then instructed to bend their knees (approximately 90 °) as fast as possible and then jump as high as possible in the next concentric phase. The test was held on the wooden floor of the basketball court and each athlete was given a 45-second break between jumping repetitions, while allowing 4 minutes of rest until the next jump test. The players made 3 jumps and the best result was recorded.

Squat Jump (SJ) Test

Players started from the upright position with their hands on their hips and then were instructed to bend their knees and hold a predetermined knee position (approximately 90 °) and the examiner then measured for 3 seconds. In measurement 3, the athlete was instructed to jump as high as he could without performing any reverse movement before performing the jump. The test was held on the wooden floor of the basketball court and each athlete was given a 45-second break between jumping repetitions, while allowing 4 minutes of rest until the next jump test. The players made 3 jumps and the best result was recorded.

Drop Jump (DJ) Test

The players started on a 50 cm Box. The hands are placed on the hips and remain there throughout the test. The athlete then falls from the box onto the floor, bending the knees slightly without the heels coming in contact with the ground during landing, and then immediately makes a maximum vertical jump. The test was held on the wooden floor of the basketball court and each athlete was given a 45-second break between jumping repetitions, while allowing 4 minutes of rest until the next jump test. The players made 3 jumps and the best result was recorded.

The Optojump system (Optojump Next®, Italy) measured the flight time of the jumps with an accuracy of 1/1000 seconds (1 kHz) for all 3 tests through the height of the jumps (in cm). Session 2 took place on the basketball court used for practices. It consisted of 3 field tests presented in this order: 5-10m. Sprint, Agility T-drill.

5m.-10m. Sprint Tests

Players started from an upright position behind the starting line when they were ready. The sprint time was recorded by photocells (Wireless speedtrap2; Brower Timing Systems, Draper, UT), as they passed through the 3 gates (0-5-10m.) With the command "Let's go", the players ran 10 meters as fast as possible. When they crossed the finish line, the time of 5m. and 10m. were recorded. 3 attempts were made with the best one per distance being recorded. These distances were chosen because at developmental ages the majority of basketball sprints lasted up to 2 sec (Hůlka et al., 2013).

Agility T-drill Test

During the test, participants started in an upright position behind the permanent position on the bottom line of the basketball court, sprinted 9.15 m in a straight line, touching cone A, sliding in a defensive position and touching cone B which was 4.55 m to the left of cone A, made a defensive slip on cone C, which was 4.55 m to the right of cone A (9.10-m from cone B), defensive slip back to cone A, which was at 4.55-m from cone C

and completed by running back to the starting line. The sprint time started to be recorded by the photocells (Wireless speedtrap2; Brower Timing Systems, Draper, UT), placed in the starting position and stopped as soon as they passed the same position again.The fastest of the 2 attempts was recorded.

In total, the parameters measured to determine the physiological profile of the elite Greek male U16 basketball players were divided into 3 characteristics: speed (5m-10m Sprint), agility (T-drill) and jumping ability / anaerobic power (CMJ, DJ, SJ).

Statistical analysis

The data was recorded using Microsoft Excel software. The data was then transferred to IBM statistical software, Statistical Package for Social Sciences (SPSS), version 25. For descriptive analysis of the results, mean values and standard deviations were used to form the general image of the sample. In the inductive analysis, the possible differences between the different positions of the players were examined through the one-way ANOVA tests. As there were three playing positions studied, Bonferroni's multiple-comparison control was applied to the significant results. The significance level of the research was set at a = 0.05.

RESULTS

Below are the measurements made to assess the speed of players (Table 1) in terms of their position on the court. The unit of measurements for all the following performances is in seconds (s). At the 0-5m and 0-10m acceleration sprint tests, the lowest average times were recorded by the Guard players (5m = 0.73 | 10m = 1.87), followed by the Centers (5m = 0.74 |10M= 1.89) and the Forwards (5m = 0.75 |10m = 1.93). For the "T-drill" test, the Guard players showed the best times (M = 8.39), compared to Forwards (M = 8.48) and Centers (M = 8.48). There were no statistically significant differences between the positions in any of the 3 tests.

Table 1. Means and standard speed deviations between positions

Variables	Mean ± SD		
	Guards	Forwards	Centers
0-5m Sprint	0.73 ± 0.03	0.75 ± 0.07	0.74 ± 0.05
0-10m Sprint	1.87 ± 0.04	1.93 ± 0.12	1.89 ± 0.04
T-Drill Test	8.39 ± 0.23	8.48 ± 0.47	8.48 ± 0.31

Source: personal data

Then ,the results were recorded from the performance of the players in various jumps, and the results are presented per position in Table 2. The unit of measurement is the centimeters (cm). The highest mean Counter movement Jump was recorded by the Centers (M = 41.40), followed by the Guards (M = 38.31) and finally the Forwards (M = 37.37). There were statistically significant differences in favor of the Centers compared to the other two positions $p < 0.05$. In any test in which more than one jump was made, the measurements relate to the average of the individual jumps. The same pattern was observed in Squat Jumps, where the highest performance was recorded by the Centers (M = 42.43), followed by the Guards (M = 41.71) and the Forwards (M = 39.93). There were only statistically significant differences in favor of the Centers in relation to Forwards $p < 0.05$. Finally, in the Drop jump test, the Guards (M = 45.19) had the best performances, followed by Centers (M = 44.63) and finally the Forwards (M = 43.07). There were

statistically significant differences in favor of the Guards in relation to the Forwards p <0.05.

Table 2. Means and standard jump deviations between positions

Variables	Mean ± SD		
	Guards	**Forwards**	**Centers**
Countermovement Jump	38.31 ± 4.29	37.37 ± 3.01	41.4 ± 1.43
Squat Jump	41.71 ± 4.07	39.93 ± 3.95	42.43 ± 2.49
Drop Jump	45.19 ± 5.65	43.07 ± 3.5	44.63 ± 4.03
Mean of 3 Jumps	41.73 cm	40.12 cm	42.82 cm

Source: personal data

DISCUSSION

The present study is one of the first attempts to record and compare between the different competing positions the physiological profile of speed, agility and jumping ability of elite U16 basketball players in Greece. The first objective of the study was to record the physiological profile of the U16 elite male players of national teams per playing position. The main findings suggest that the physiological profile of the U16 male players of the Greek National Basketball Team is at a high level, similar to that of national teams of other countries. Specifically, the Guards recorded an average of jump height 41.73 cm for the 3 jump tests (CMJ, SJ, DJ) and times 0.73 ± 0.03 (s), 1.87 ± 0.04 (s) for the 5m. and 10m. sprints and 8.39 ± 0.23 (s) for the T-drill test. Respectively, the Forwards recorded average jump heights of 40.12 cm for the 3 jump tests (CMJ, SJ, DJ) and times 0.75 ± 0.07 (s), 1.93 ± 0.12 (s) for the 5m. and 10m. sprints and 8.48 ± 0.47 for the T-drill test. Finally, the Centers recorded an average of jump height 42.82 cm for the 3 jump tests (CMJ, SJ, DJ) and times 0.74 ± 0.05 (s), 1.89 ± 0.04 (s) for the 5m. and 10m. sprints and 8.48 ± 0.31 (s) for the T-drill test. The results of the assessment of the physiological profile of the players are almost similar to that of Turkish players of the same age with the only exception being that of the times in the T-drill agility test where the elite players of the present study recorded significantly lower times in all 3 positions (Guards, Forwards, Centers) (İmer & Yapici, 2018).In addition, the T-drill test times of the players in our study were better compared to those of amateur college-level male basketball players in the same test (Bal et al., 2011). In fact, the differences were greater than -1.5 sec in favor of the players in this study when compared to amateur male players, which shows that the elite teenage players of the U16 national teams have a higher level of agility than amateur male players (Kryeziu et al., 2019; Sudhakar et al., 2016).

Then, the results of the players of the present study are better in terms of jumping performance compared to Turkish amateur players U16 years old as well as Spanish players of the national categories of the ages U14 / U16 / 18 (Mancha-Triguero et al., 2021; Orhan et al., 2019; Torres-Unda et al., 2013). Also, regarding the speed tests of 5m.-10m. the players in this study showed similar performances than elite U16 and U14 players competing in the Spanish developmental leagues of the 1st division of the Spanish Championship (ACB) (Gonzalo-Skok et al., 2017). In contrast, Shalfawi, et al. (Shalfawi et al., 2011), and Altavilla, et al., (Altavilla et al., 2018) in their studies on male professional basketball players recorded better jumping performances on the CMJ and DJ tests than the elite U16 players of the present study and also Scanlan (Scanlan et al., 2014) recorded slightly better speed performances of semi-professional players, especially in the Guards / Backcourt positions compared to the performance of the players in this study. Although the players analyzed formed a U16 national basketball team, in which the most mature,

tallest, fastest and heaviest players (Arede et al., 2021) are usually selected, the above results showed that the Greek elite U16 male players have high level physiological characteristics.

The secondary aim of the study was to compare the differences of physiological profiles between the 3 competing Centers / Forwards / Guards positions. The main findings showed that there were no differences between the 3-position players in the 5m / 10m sprint tests as well as in the T-drill agility test. The results are opposite to those recorded at the male level. Specifically, Scanlan (Scanlan et al., 2014) Boone & Bourgois, (Boone & Bourgois, 2013) and Lockie (Lockie et al., 2020) recorded faster times for player on the Guard position in sprint tests than those of players in Forwards / Centers positions something which did not happen with the players in this study. It seems that the physiological profile of players per playing position in terms of speed is significantly influenced by the maturity status with the tallest and heaviest male players in the Forwards / Centers position to perform worse, something that is not evident in the elite level of the U16 players in this study.

On the other hand, in the jump tests, paradoxically, the elite U16 players of the Center position had the best performance in general in the 3 jump tests with 42.82 (cm) and especially in the CMJ and SJ test and the Guards players had the best performances in the DJ test. The Forward position players had the worst performance in all 3 jump tests. The results contradict the existing literature on players of the same age of YAPICI & İMER (İMer & Yapici, 2018), in which Forwards had the best jumping performance. This fact may be explained by the differences in normal maturation, which also occur between competing positions (Guards, Forwards, Centers) of the same age (te Wierike et al., 2015).Furthermore, in the international literature the findings are somewhat vague. Cui (Cui et al., 2019) and Boone & Bourgois, (Boone & Bourgois, 2013) in their studies of elite male professional basketball players reported that Center players had the worst jumping performance while Altavilla (Altavilla et al., 2018) and Pion (Pion et al., 2018) recorded better jumping performance for this position than the rest. Respectively, in the present study the Centers prevailed in CMJ and SJ test with 41.4 ± 1.43 (cm) and 42.43 ± 2.49 (cm), mainly against Forwards (37.37 ± 3.01 (cm) and 39.93 ± 3.95 (cm) with the Guards prevailing compared to the rest in the DJ test with 45.19. 5.65 (cm). Therefore, although there are data on the superiority of the physiological profile of the elite U16 players of the Center and Guard positions, in the present study in terms of jumping ability, further tests should be performed to extract safer results.

The present study encountered some limitations. Initially, the sample size could be quite larger including other players from previous years or from other age groups (eg U18), which was not possible. The larger number of participants would have provided even greater integrity and reliability to the results so that the physiological profiles of the elite Greek U16 basketball players can be diagnosed even better and with greater clarity. Secondly, the study did not perform aerobic / anaerobic endurance tests due to limited processing time, which would provide a more complete picture of the physiological profile of elite U16 basketball players and each individual position separately. Thirdly, the study did not take into account the biological maturation status of the players in the sample. The researchers were not able to know the biological maturation of the players of each position separately.

CONCLUSION

The main findings indicate that the physiological profile of the U16 male players of the Greek National Basketball Team is at a high level in terms of speed, agility and jumping ability in all 3 (Guards / Forwards / Centers) positions analyzed. In addition, it was found that there were no statistically significant differences in speed and agility between the positions while the Centers in particular and the Guards had better jump performances than the Forwards. These findings can be used as an aid by coaches, strength & conditioning specialists and all those involved in the selection processes of players in the sport of basketball for the preparation of specialized training programs in order to improve the parameters of the physiological profiles of U16 players and also for the better and more targeted selection for players ages U16 of the national teams of the countries, as well as for the staffing of domestic championship clubs.

CONFLICT OF INTEREST

All the authors state that there is no conflict of interest.

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