Chapter 6

Towards the elite level in basketball; the importance of position-related characteristics and individual profiles

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Abstract

The aim was to identify general (position- and non-position-related) performance characteristics for talented basketball players of different positions. Furthermore, to investigate whether players who achieved the elite level of performance in adulthood performed better on performance characteristics during youth compared to players who did not attain this level, and whether the elites distinguish themselves from their talented peers more on position-related versus non-position-related characteristics. Finally, to examine whether developmental pathways towards the elite level are similar. MANCOVA's were performed regarding multidimensional characteristics of 61 basketball players (aged 16-19). Z-scores and radar graphs were shown for eleven players who attained the elite level in adulthood. Position-related characteristics were identified for guards and centers. Players who achieved the elite level performed better on general basketball-related performance characteristics compared to peers of the same position who did not achieved this level (Z-scores>0). In contrast to guards and forwards, centers who achieved the elite level distinguished themselves from their talented peers on position-related characteristics (effect size 2.64). Individual profiles showed multiple ways of development towards the elite level. Both position- and non-position-related characteristics are important for performance, while at the same time individual variations in the development towards the elite level should be acknowledged.

Keywords: talent development, athletic performance, athletes, individuality

Introduction

Research regarding basketball and other team sports has advocated a multidimensional and longitudinal approach to gain more insight into the development of talented youth athletes towards the elite level of performance in adulthood[1-3]. It has been shown that it is important for basketball players who aim to achieve the elite level of performance to excel in anthropometrical (e.g., height), physiological (e.g., repeated sprint), technical (e.g., ball control), and psychosocial characteristics (e.g., reflection and effort)[4-6]. These multidimensional performance characteristics are thought to improve over time through maturation, learning, and training[5,7,8].

Players within a basketball team can generally be divided into three playing positions (guard, forward, center), which all have slightly different requirements to perform well. Guards initiate and coordinate the offence in which ball control, i.e., quickly move the ball down the court, plays an important role[9-11]. Therefore, guards are often involved in high intensity activities such as sprints and dribbles[9,12]. Consistent with these task requirements, players of the guard position are often the smallest players with the best performances on sprint and agility tests[10,13,14]. In contrast to guards, centers are mostly positioned near the basket and are usually responsible for the team's defense during the game[9]. In order to execute these tasks well, centers are commonly the tallest and heaviest players[10,13,14]. Forwards are positioned between the guards and centers in the field, and play on a multidisciplinary position[9,15]. In summary, although players within a basketball team share general basketball-related performance characteristics, they have different position-related requirements in order to play well. Therefore, the general basketball-related performance characteristics can be divided into position-related and non-position-related characteristics.

In literature, it is suggested that there is variation in the development of general basketball-related performance characteristics of athletes who attain the elite level of performance[16-18]. Therefore, an individual focus seems valuable to gain more insight into the development of talented youth athletes[2,3,18]. Interviews with (inter)national athletes and their coaches emphasize the importance of multidimensional approaches with an individual focus towards athletes in order to optimize the pathway towards expertise[2]. However, it is a considerable challenge how to apply an individual focus in research regarding talent development. Till et al. (2013) made an attempt by introducing a method with Z-scores to compare performances of individual players with the performances of all other players of different ages and positions[3]. Cobley et al. (2014) elaborated this approach by using age-specific reference value to calculate the Z-scores[19]. To take this method one step further, the current study will use position-related reference values of players (aged 16-19) to calculate Z-scores (i.e., guards will only be compared with guards, forwards with forwards, and centers with centers).

This study investigated three aims to unravel the development of talented youth basketball players in more detail. The first aim was to investigate whether it was possible to identify position-related characteristics for each

playing position. The second aim was to examine whether basketball players who achieved the elite level of performance in adulthood perform better during youth (16-19 years) on the general basketball-related performance characteristics (position-related and non-position-related) than their peers who did not attain the elite level, and whether, compared to their talented peers, the elite players perform better at position-related characteristics than at non-position-related characteristics. Finally, the individual development of the general basketball-related performance characteristics at age 16-19 of elite players of different playing positions (2x guard, 2x forward, 2x center) were demonstrated to illustrate possible individual differences in their pathways towards the elite level.

Methods

Participants

Male basketball players aged 16-19 of one of the regional training centers in the Netherlands were monitored in a multidimensional and longitudinal way. The study included 1056 data points from 61 individual basketball players. Anthropometrical, physiological, technical, and psychosocial characteristics were measured on twelve different test periods during the seasons 2008-2009 to 2012-2013. The basketball players had on average 7.00 ± 2.04 years of experience at a basketball club. This study focused in particular on players who attained the elite level in adulthood (age > 20 years; n=11). The elite level of performance was defined as playing at the highest level possible in the Dutch basketball league. The study was approved by the ethics committee of the local university, and players and parents/guardians gave written consent to participate.

Measurements

Height measurements (± 0.01 m) were performed with a body length meter while players were standing barefoot against a wall (Schinkel Medical, Nieuwegein, The Netherlands). The plan of Frankfort was used to ensure all measurements have been carried out the same way[20]. In the same position, both arms were spread horizontally at shoulder height to measure the wingspan from the longest fingertip at one hand to the longest fingertip at the other hand.

Players performed the Shuttle Sprint and Dribble Test (SSDT) to measure the (repeated) sprint (without ball) and (repeated) dribble (with ball) as suggested by Lemmink et al. (2004)[21]. Time measurements were performed with photocell gates (Eraton BV, Weert, The Netherlands). Outcome measures consist of the fastest time of the three attempts (s), and the total time of the three attempts together (s) for the sprint as well as dribble part. The reliability and validity of the SSDT has been confirmed[21].

The STARtest was used to measure change-of-direction speed (without ball) and ball control (with ball) as suggested by te Wierike and collegues[22]. This basketball-specific test consists of a trajectory in which player had to sprint and dribble in different directions (forwards, backwards, sideways). Time measurements were performed with electronic timing gates (Eraton BV, Weert, The Netherlands). Outcome measures were change-of-direction speed (s) and ball control (s). The reproducibility and validity of this test has been proven[22].

Reflection and effort are two components of self-regulation[23]. Reflection is the extent to which players are able to appraise what they have learned and to adapt their past knowledge and experiences in order to improve future performance[24]. Effort is defined as the willingness to reach the set goals[24]. Both skills were measured with the Self-Regulation of Learning Self-Report Scale (SRL-SRS)[23]. Reflection was measured on a Likert scale from 1-5 (5 questions), and effort on a scale from 1-4 (10 questions). Reliability and validity of the SRL-SRS has been confirmed[23].

Statistical analysis

To investigate the first aim of this study, i.e., whether position-related characteristics can be identified for each playing position, Multivariate Analyses of Covariance's (MANCOVA's) were performed (IBM SPSS Statistics software version 20.0; Inc., Chicago, Illinois, USA). Due to missing values, three separate MANCOVA's were performed (i.e., for the anthropometrical, the physiological and technical, and the psychosocial characteristics) with the general basketball-related performance characteristics as dependent variables, position as fixed factor, and age as covariate. Age 15.50-16.49 was defined as 16 year, 16.50-17.49 as 17 year and so on. One mean score per age category was calculated for players with multiple measurements at the same age. A performance characteristic is considered position-related when the main effect for position is significant and players of that position have the best score compared with players of both other positions. Level of significance was set at 0.05.

Eleven players achieved the elite level of performance (guard n=3, forward n=5, center n=3). Z-scores were calculated to compare the performance of these elite players with the population (aged 16-19) of the corresponding position (Z-score = (individual score – mean score population) / SD (mean population)). For example, the performance characteristics of an elite guard are compared with the performance characteristics of all other guards in the age of 16-19 year. For tests in which a lower time indicates a better performance, the scores were reversed in the formula. A positive Z-score therefore always reflects a better performance compared to peers of the same position. To examine on which characteristics (position-related or non-position-related) elite players score best compared to the population, the mean Z-score of position-related characteristics are compared to the mean Z-score of non-position-related characteristics by using effect sizes (Cohen's d). An effect size of 0.20 was considered as small, around 0.50 as moderate, and around or > 0.80 as large[25]. Finally, to show individual pathways towards the elite level, individual radar graphs with Z-scores of the general basketball-related performance characteristics were made for two players of each position who achieved the elite level.

Results

Descriptive data per position and results of the MANCOVA's are shown in table 6.1.

Table 6.1: Descriptive data and results of the MANCOVA's of players aged 16 to 19 according to their playing position. Adjusted means ± standard errors are shown.

	Guards	Forwards	Centers
Anthropometrical characteristics	[illegible]	[illegible]	[illegible]
Height (cm)	[illegible]	[illegible]	[illegible]
Wingspan (cm)	[illegible]	[illegible]	[illegible]
Physiological characteristics	[illegible]	[illegible]	[illegible]
Repeated sprint-best of three (s)	[illegible]	[illegible]	[illegible]
Repeated sprint-total (s)	[illegible]	[illegible]	[illegible]
Change-of-direction speed (s)	[illegible]	[illegible]	[illegible]
Technical characteristics	[illegible]	[illegible]	[illegible]
Repeated dribble-best of three (s)	[illegible]	[illegible]	[illegible]
Repeated dribble-total (s)	[illegible]	[illegible]	[illegible]
Ball control (s)	[illegible]	[illegible]	[illegible]
Psychological characteristics	[illegible]	[illegible]	[illegible]
Reflection	[illegible]	[illegible]	[illegible]
Effort	[illegible]	[illegible]	[illegible]

[illegible]

Results of the MANCOVA's showed that guards have the best score on repeated sprint-best of three ($F(2,99) = 3.45$; $p = 0.04$), change-of-direction speed ($F(2,99) = 11.91$; $p < 0.01$), repeated dribble-best of three ($F(2,99) = 13.98$; $p < 0.01$), repeated dribble-total ($F(2,99) = 5.15$; $p < 0.01$)), and ball control ($F(2,99) = 7.52$; $p < 0.01$). As such, these characteristics were defined as the position-related characteristics for guards. Height, wingspan, repeated sprint-total, reflection, and effort were defined as non-position-related characteristics for guards. Regarding the forwards, there were some characteristics in which these players performed better than guards or centers (for example repeated dribble-best of three), however, they never performed as best of the three positions. Therefore, no position-related characteristics were determined, only general basketball-related performance characteristics could be identified (height, wingspan, repeated sprint-best of three and total, change-of-direction speed, repeated dribble-best of three and total, ball control, reflection and effort). Centers on the other hand were significantly taller ($F(2,84) = 50.28$; $p < 0.01$), had a larger wingspan ($F(2,84) = 34.90$; $p < 0.01$), and scored highest on effort ($F(2,76) = 3.40$; $p = 0.04$) compared to the other position(s). Height, wingspan, and effort were consequently defined as the position-related characteristics for centers, while repeated sprint-best of three and total, change-of-direction speed, repeated dribble-best of three and total, ball control, and reflection were defined as non-position-related characteristics for centers.

Table 6.2: Z-scores of guards, forwards, and centers who achieved the elite level of performance in adulthood*.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table 6.2 shows the Z-scores for the general basketball-related performance characteristics as well as for the position-related and non-position-related characteristics for guards, forwards, and centers who attained the elite level of performance in adulthood.

As shown in table 6.2, when they were aged 16-19, guards who attained the elite level in adulthood scored better on the general basketball-related performance characteristics compared to their peers who did not attain the elite level of performance (indicated by a positive Z-score of 0.18 ± 0.30). More specifically, it is shown that guards who attained the elite level performed better on both position-related and non-position-related performance characteristics compared to their peers who did not attain the elite level (Z-scores of 0.17 ± 0.20 for position-related and 0.20 ± 0.40 for non-position-related characteristics). In comparison to their peers who did not achieve the elite level, the guards who achieved the elite level did not score better on position-related characteristics than on non-position-related characteristics, indicated by the small effect size (0.09).

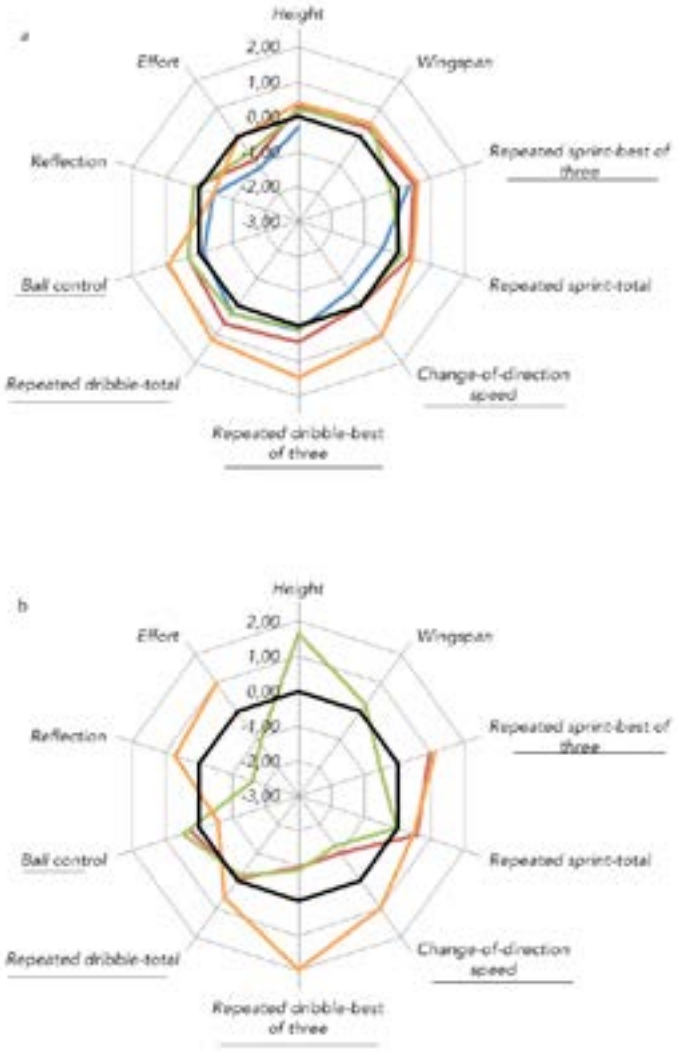
The forwards who achieved the elite level showed that when they were 16-19 years, they performed better on the general basketball-related performance characteristics than forwards who did not achieve the elite level of performance (Z-score of 0.35 ± 0.35).

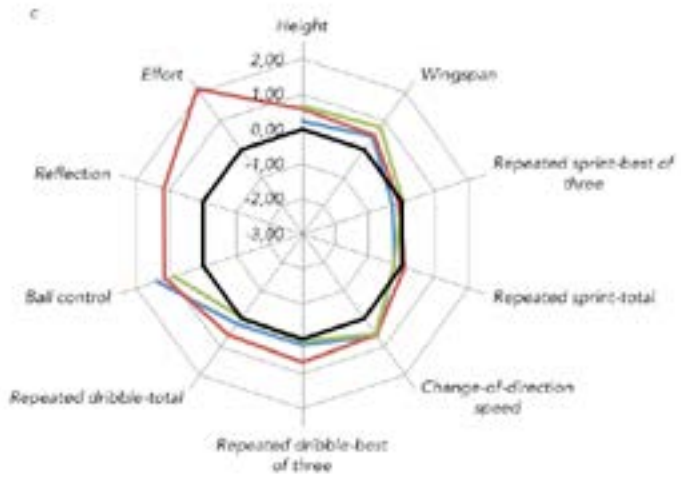
Centers who attained the elite level of performance also performed better compared to the non-elite centers on the general basketball-related performance characteristics (Z-score of 0.03 ± 0.58). More specifically, centers who attained the elite level of performance in adulthood performed better than centers who did not attain the elite level on position-related characteristics during their youth (Z-score of 0.76 ± 0.52), but not on non-position-related characteristics (Z-score of -0.28 ± 0.20). In comparison to their peers who did not achieve the elite level, the centers who achieved the elite level performed better on position-related characteristics than on non-position-related characteristics, indicated by the large effect size (2.64).

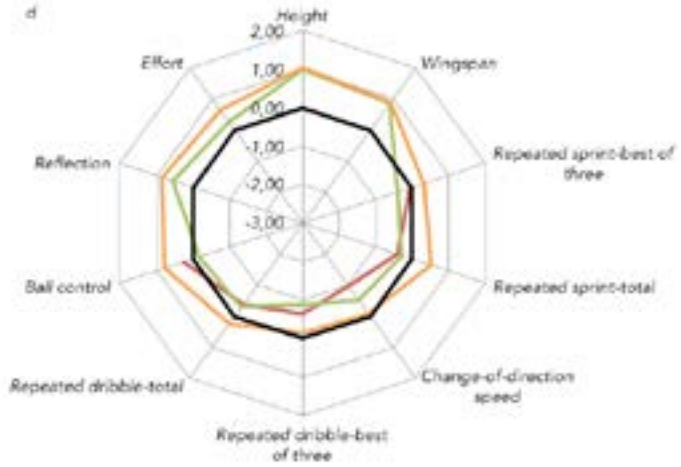
To illustrate the variation in individual pathways towards the elite level of performance in adulthood, figure 6.1 shows the developmental trajectories per characteristic (Z-scores) of two guards, two forwards, and two centers. Guard 1 (figure 6.1a) performed from the age of 17 better than peers playing at the same position, except for repeated sprint-best of three and the psychosocial skills (effort and reflection). In general, his superiority relative to his peers increased over the years (except at age 18). Figure 6.1b shows that guard 2 only excelled in the position-related and non-position-related characteristics compared to his peers at age 19 (except for ball control).

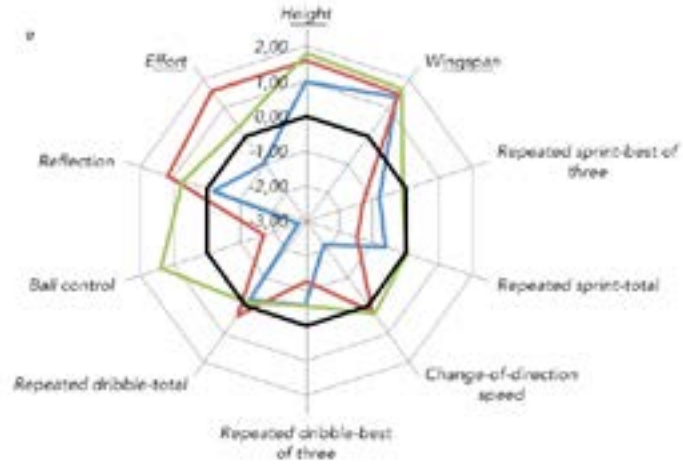
The development of both individual forwards were similar to a certain extent. Both forwards were taller and had a larger wingspan during their development compared to their peers. In addition, they increased these anthropometrical advantages over the years. Forward 1 (figure 6.1c) scored in particular better than his peers on the technical and psychosocial characteristics at age 16, 17, and 18. Forward 2 (figure 6.1d) does not show superiority relative to his peers of the same position until the age of 19, except for anthropometrical and psychosocial characteristics.

Figure 6.1e and 6.1f demonstrate the development of two centers who achieved the elite level of performance in adulthood. Center 1 (figure 6.1e) showed much variation in his development over the years, while center 2 (figure 6.1f) showed in general an improvement in characteristics (compared to his peers of this position) from age 17 to 18. In addition, center 1 showed large advantages relative to his peers on anthropometrics and both psychosocial characteristics, while center 2 showed the best performances compared to peers on two physiological characteristics.









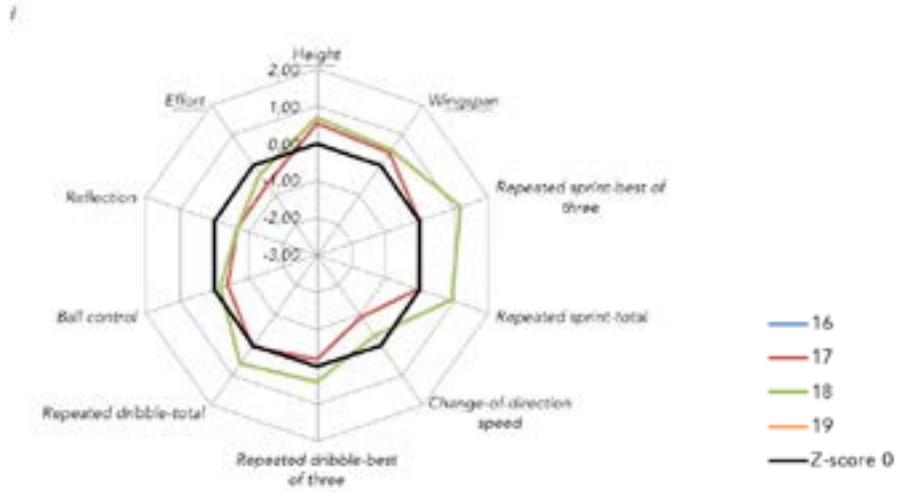


Figure 6.1: Individual profiles (Z-scores) of two guards (a and b), two forwards (c and d), and two centers (e and f) who all attained the elite level of performance in adulthood. A higher Z-score reflects better performances compared to peers of the same position who did not achieved the elite level. Note: Position-related characteristics for guards and centers are underlined. Note: Bold line shows Z-score of 0.

Discussion

This study focused on the development of talented youth basketball players towards the elite level of performance, while taking into account positional and individual differences between players. The first aim was therefore to examine whether it was possible to identify position-related characteristics for each playing

position. In addition, we investigated whether basketball players who achieved the elite level of performance in adulthood outscored their peers who did not attain the elite level on the general basketball-related characteristics during youth (16-19 years), and whether the elite players perform better at position-related characteristics compared to non-position-related characteristics. Finally, individual profiles of basketball players during their development towards the elite level of performance in adulthood were illustrated to demonstrate possible differences. The results of the first aim showed that there were position-related characteristics for guards and centers. Related to the second aim, it was shown that players of all three positions who attained the elite level in adulthood performed better on the general basketball-related performance characteristics at the age of 16-19 years compared to their peers of the same position who did not attain the elite level. Elite centers distinguished themselves especially on the position-related characteristics. Moreover, different pathways to achieve the elite level in adulthood have been identified for talented basketball players.

The position-related characteristics for players of the guard and center position as indicated by literature are confirmed in this study[9,13,14]. For centers it was found that their position-related characteristics are highly important to attain the elite level of performance since these players scored higher on these position-related characteristics compared to their non-position-related characteristics. This finding can be explained by the importance of height as found in this study. Results showed, as expected, that centers are the tallest players within a team. A more remarkable finding was that also within the group of guards and forwards, the tallest players were the ones who achieved the elite level of performance (indicated by positive Z-scores for the anthropometrical characteristics). This indicates the importance of height in basketball not only for centers, but also for players of the guard and forward position. Since height is categorized as a position-related characteristic for centers and not for guards, a high Z-score is added to the position-related characteristics for centers, while this high Z-score for the guards is added to the group of non-position-related characteristics. This might explain the differences in importance for position-related characteristics for players of both positions.

The abovementioned results already imply differences between players of the guard, forward, and center position in their development towards the elite level of performance. The individual radar graphs enhance this finding by not only showing differences between the playing positions, but also within players of the same position. The individual development of two elite players of the same position were compared with each other and showed variations. For example, center 1 scored better on effort and reflection at age 17 and 18 compared to peers of this position (indicated by positive Z-scores), while center 2 scored worse on these characteristics compared to the performances of the other centers. This finding is in line with recent studies that also indicated a non-linear trajectory in the majority of athletes who achieved the elite level[2,19,26].

In addition to the multidimensional and longitudinal aspects, this study considered individual profiles towards talent development which is suggested by recent literature[2,3,19]. For future research, it is suggested to make the reference values even more specific by using position as well as age-specific groups (i.e., comparing the individual scores of a 16-year-old guard with only 16-year-old guards). Due to a small number of players within each reference group this method was not applicable in this study.

Conclusion

It was possible to identify position-related performance characteristics for guards (repeated sprint-best of three, change-of-direction speed, repeated dribble-best of three, repeated dribble-total, and ball control) and centers (height, wingspan, effort). Players of all positions who attained the elite level of performance in adulthood performed better on the general basketball-related performance characteristics during their youth (16-19 years) compared to later non-elite players. Moreover, centers distinguished themselves most on their position-related characteristics compared to their non-position-related characteristics. Finally, it can be concluded that multiple pathways with different performances on the position-related and non-position-related characteristics can lead to the elite level of performance in basketball. A multidimensional, longitudinal approach with an individual focus (for example with Z-scores) seems, therefore, promising for coaches and trainers to monitor the performance development of their talented youth basketball players.

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