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ORIGINAL RESEARCH ARTICLE

Player Profiling and Monitoring in Basketball: A Delphi Study of the Most Important Non-Game Performance Indicators from the Perspective of Elite Athlete Coaches

Michael Rogers[1] · Alyson J. Crozier[1] · Natasha K. Schranz[1,2] · Roger G. Eston[1] · Grant R. Tomkinson[1,3]

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Abstract

Background Little is known about which indicators of performance elite athlete coaches (i.e., professional coaches who coach at the national or international levels) consider to be important for basketball.

Objective Using a Delphi procedure, the aim of this study was to identify the non-game performance indicators elite athlete coaches consider to be important for the recruitment/selection of basketball players.

Methods Ninety elite athlete coaches (basketball coaches ($n=71$) and strength/conditioning coaches ($n=19$) who coached men ($n=60$), women ($n=23$), or both ($n=7$)), employed in 23 countries across six continents, participated in a three-round online Delphi survey. Round 1 asked coaches to identify the non-game performance indicators (i.e., measures other than game statistics) they currently used (or would like to use) for player recruitment/selection, with common indicators combined into single indicators. Round 2 asked coaches to rate the importance of each performance indicator using a Likert scale (range: 0 = no importance whatsoever to 10 = extremely important). Round 3 asked coaches to identify the single best test measure for each indicator rated ≥ 6 (i.e., important to extremely important) in Round 2. Results were reported descriptively.

Results A total of 608 responses (344 after removal of duplicates) were reported in Round 1, which were collapsed into 35 indicators, all of which were rated as 'important' in Round 2. Psychological and game intelligence indicators were typically rated as very important to extremely important (i.e., median = 9), with physical fitness and movement skills typically rated as very important (i.e., median = 8). For most indicators, coach observation was identified as the best test measure, with unique objective performance/anthropometric tests identified for all physical fitness indicators.

Conclusion This study identified a range of psychological, game intelligence, physical fitness, and movement skill indicators that were considered by elite athlete coaches to be important to extremely important for the recruitment/selection of basketball players. These findings may inform the development of a basketball-specific test battery for recruiting/selecting and monitoring players.

1 Introduction

The success of elite athletes depends on numerous factors, including anthropometric, physiological, psychological, skill (technical/tactical), social, and emotional factors [1]. Any measured factor that defines an aspect of successful sporting performance is a 'performance indicator' [2]. Performance indicators include both non-game indicators (e.g., anthropometric, physiological, skill) and game (box score) statistics collected over multiple games or an entire season (e.g., the number of field goals attempted, total points scored) [3]. While game statistics are commonly used to assess current performance [4] and to predict future performance [5], elite athlete coaches (i.e., professional coaches who coach at the national or international levels) also use established test batteries to help recruit/select and monitor players. In basketball, for example, the National Basketball Association (NBA) Combine [6] and the Basketball Australia test batteries [7] have been used to assess the physical and technical abilities of basketball players. Collectively, these test batteries include acceptable, feasible, ecologically valid, widely

✉ Michael Rogers
michael.rogers@mymail.unisa.edu.au

1 Alliance for Research in Exercise, Nutrition and Activity (ARENA), Allied Health and Human Performance, University of South Australia, Adelaide, SA 5001, Australia

2 Wellbeing SA, Adelaide, SA, Australia

3 Department of Education, Health and Behavior Studies, University of North Dakota, Grand Forks, ND, USA

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Key Points

In sport, a 'performance indicator' is any measured factor that defines an aspect of successful performance, and includes both non-game factors and game (box score) statistics. Little is known about which non-game performance indicators elite athlete coaches (i.e., professional coaches who coach at the national or international levels) consider to be important for basketball.

Using a Delphi procedure, an international panel of elite athlete coaches identified and then rated 35 unique non-game performance indicators as 'important' (i.e., ≥ 6 on an 11-point Likert scale ranging from 0 = no importance whatsoever to 10 = extremely important). Psychological and game intelligence indicators were rated as more important than physical fitness and movement skill indicators.

Coach observation was most often identified as the single best test measure for each indicator.

These findings have implications for the development of a basketball-specific test battery for recruiting/selecting and monitoring players.

used, and scalable measures of a range of physical (e.g., body size/proportions, physical fitness, fundamental movement skills) and technical abilities (e.g., basketball-specific skills, game play through scrimmages) [6, 7]. While some of these non-game performance indicators discriminate between basketball players at different competitive standards [8–12] and correlate with game statistics [6, 9, 13–18], there is currently no consensus among elite athlete coaches as to which performance indicators are important for the recruitment/selection of basketball players [19].

Successful talent recruitment is challenging due to the multidimensional nature of sport, with coaches often relying on their knowledge and perceptions of players, or their instinct, to make decisions [19]. Coach opinion has been shown to be effective when evaluating an athlete's ability, for both identifying and differentiating players across a range of skills and competitive standards in both team (e.g., basketball [20], rugby league [21], American football [22], soccer [23], volleyball [24]) and individual sports (e.g., gymnastics [25], swimming [26], skiing [27], orienteering [28]). Specific to basketball, there are objective, non-game performance measures (e.g., speed, vertical jump, height) that are positively associated with subjective coach rankings of ability among elite junior players [29]. At the professional level (e.g., in the NBA), coach observation of basketball scrimmages is used as a key selection tool [6]. Similar findings have been observed in other sports such as soccer, with evidence indicating that the combination of subjective coach/scout assessments and objective multidisciplinary measures (e.g., physical, psychological) is optimal for talent recruitment [30, 31]. Furthermore, in team sports such as rugby and soccer, psychological, tactical/technical skills, and cognitive indicators are considered by coaches as relatively more important for talent recruitment compared to physiological and anthropometric indicators [21, 32].

Using a Delphi procedure, the aim of this study was to identify the non-game performance indicators elite athlete coaches consider to be important for the recruitment/selection of basketball players. Developed at the RAND Corporation in the 1950s [33], the Delphi procedure is a systematic expert consensus methodology for gathering the most reliable consensus of opinion from a group of independent experts over multiple rounds [34]. Delphi is often used to achieve a consensus among a large number of experts who cannot meet simultaneously for logistic or economic reasons [35]. The results of this Delphi study could inform the development of a basketball-specific test battery for recruiting/selecting and monitoring players and could help guide more meaningful and focused basketball-specific research.

2 Methods

2.1 Overview

This study employed a Delphi procedure, a qualitative research approach that is appropriate for research questions that cannot be answered with complete certainty, but rather by the subjective opinion of a group of informed experts [36]. The use of the Delphi procedure has increased in popularity in recent decades, with online delivery commonly used [37]. Delphi has been used in the sport/exercise sciences for talent recruitment in sport [21, 32, 38] and dance [39], and for the selection of fitness-performance tests [40]. It is feasible for surveying large numbers of participants, with participant anonymity helping to avoid persuasion and group consensus thinking [41]. This study was approved by the University of South Australia's Human Research Ethics Committee (HREC-0000035180) and was performed in accordance with the standards of ethics outlined in the Declaration of Helsinki.

2.2 Sampling Procedures and Participants

Elite athlete coaches were defined as professional basketball or strength/conditioning coaches (head, associate, or assistant coaches) with a minimum of 1 year of coaching experience at the senior national (i.e., club coach in a country's highest senior league) or international level (i.e., national

coach in an International Basketball Federation (FIBA) tournament or Olympic Games) within the past 5 years (from initial recruitment). Participant coaches were identified from as many of the 215 FIBA countries as possible through the following steps:

(a) Basketball South Australia coaching networks;
(b) Coaches comprising the World Association of Basketball Coaches (WABC) Executive Committee (https://wabc.fiba.com/about-wabc/);
(c) US college basketball coaches from university websites;
(d) Coaches listed in professional league websites;
(e) Personal contacts; and
(f) Referrals from other identified elite athlete coaches.

Using purposive sampling, 3194 coaches were invited to participate in the online Delphi survey via email across the 2-month recruitment period. Of these, 113 coaches accepted the invitation, with 12 asking for more details, resulting in 125 coaches being sent a link to Round 1. A total of 90 coaches completed Round 1, with 81 and 56 coaches completing Rounds 2 and 3, respectively. Table 1 shows the national leagues and international competitions from which the participant coaches were recruited. Figure 1 shows the number of participant coaches who were invited to participate and those who accepted.

2.3 Survey Process

This Delphi study comprised three structured rounds each involving data collection and analysis. The survey was administered using the *SurveyMonkey*® online survey tool (San Mateo, CA, USA), with each round open for 2 weeks and separated by 1 week. Reminder emails were sent at 7 days, 3 days, and 1 day before each round closed (Fig. 1). To commence each round, coaches were sent an email containing a direct link to the online questionnaire. All rounds were completed between September and November 2016. Written consent was obtained from all coaches before the start of the study.

2.3.1 Round 1

Round 1 required coaches to answer the question "what are the non-game 'performance indicators' you currently use, or would use if you had the time and resources, to assess basketball performance and/or compare the ability of your athletes?" We defined a non-game performance indicator as any indicator a coach measures or quantifies outside of a basketball game to rank players, assess potential, or to predict or monitor performance, including physiological, physical, technical, biomechanical, game intelligence, emotional, psychological, or social indicators. Basketball statistics (e.g., total rebounds, points per game) were excluded as performance indicators. In order to progress to Round 2, each participant coach must have identified at least one performance indicator in Round 1, provided a brief description of each indicator identified, and/or the reason why they identified the indicator.

Round 1 data were downloaded into an Excel spreadsheet (Microsoft, Redmond, WA, USA) prior to analysis. Two researchers (MR and GRT) independently reviewed all performance indicators identified in Round 1 and combined common indicators into unique (summary) indicators (based on participant coaches' comments and common naming conventions, e.g., "speed", "quickness", and "sprint" were collectively called "speed"), with consensus required for final inclusion. The final list of unique performance indicators that summarized the coach-reported indicators is shown in Appendix S1 in the Electronic Supplementary Material (ESM). When necessary, discrepancies between researchers were resolved by a third researcher (RGE) prior to reaching consensus. Prior to Round 2, participant coaches were informed that the list of indicators from Round 1 was collapsed, with common indicators represented as single indicators, and that the indicators reported in Round 2 may differ from those that they identified in Round 1. Participant coaches were given 3 days to proof these indicators and to suggest possible changes. Only one email response was received, with no change made following review by study authors.

2.3.2 Round 2

In Round 2, coaches were asked to review all Round 1 indicators and to rate the importance of each using an 11-point Likert scale (0 = no importance whatsoever, 2 = very little importance, 4 = moderately important, 6 = important, 8 = very important, and 10 = extremely important). Round 2 responses were collated and descriptively summarized using the median and the interquartile range (IQR). We used Spearman's rank correlation coefficients to calculate the strength of the association between the ratings of different types of coaches (e.g., basketball coaches vs. strength/conditioning coaches, coaches of male players vs. coaches of female players). The magnitude of correlation was interpreted as negligible ($r_s \leq 0.10$), weak ($r_s = 0.10$–0.29), moderate ($r_s = 0.30$–0.49), strong ($r_s \geq 0.50$–0.69), very strong ($r_s \geq 0.70$–0.89), or nearly perfect ($r_s \geq 0.90$) [42]. Because our aim was to identify the non-game performance indicators elite athlete coaches consider to be important, only indicators with a median of ≥ 6 (i.e., rated as at least 'important') were carried forward to Round 3.

Table 1 Leagues/competitions from which elite athlete coaches ($n=90$) who participated in Round 1 were identified

League/competition		*n*
Australian Basketball Centre of Excellence (COE)		1
National Basketball League (NBL) (including the Australian and New Zealand NBL)		5
Women's National Basketball League (WNBL)		3
National collegiate competitions	Association of Christian College Athletics (ACCA)	1
	Canadian Collegiate Athletic Association (CCAA)	3
	National Collegiate Athletic Association (NCAA)	30
	National Association of Intercollegiate Athletics (NAIA)	3
	United States Collegiate Athletic Association (USCAA)	1
	National Junior College Athletic Association (NJCAA)	2
	National Christian College Athletic Association (NCCAA)	1
National Basketball Association (NBA)		5
Women's National Basketball Association (WNBA)		3
Chinese Basketball Association (CBA)		2
Serbian Basketball League (KLS)		2
Portuguese Basketball Association (LPB)		1
(German) Basketball Bundesliga (BBL)		2
Turkish Basketball Superleague (BSL)		2
National French Pro League (LNB Pro A)		1
Finnish Basketball League (Korisliiga)		1
Austrian Basketball League (ÖBL)		1
Italian League (LBA)		2
Slovakian ExtraLiga		1
EuroLeague		3
Coaches representing their country at international events	FIBA Eurocup	2
	FIBA European Championships	2
	FIBA Asian Championships	2
	FIBA African Championships	1
	FIBA World Championships	2
	Olympics	4
	World University Games	1

n number of coaches

2.3.3 Round 3

In Round 3, coaches were asked to identify the single best test measure for each indicator carried forward from Round 2. In order to be counted as participating in Round 3, each coach must have identified at least one test measure for at least one indicator. Round 3 responses were collated and descriptively summarized using the mode.

3 Results

3.1 Participant Demographics

Ninety professional coaches, employed in 23 countries across six continents, participated in Round 1, with 46% (41/90) having coached a US college team (e.g., National Collegiate Athletic Association (NCAA), National Association of Intercollegiate Athletics (NAIA)), 23% (21/90) having coached a professional national league team (e.g., NBA, Women's National Basketball Association (WNBA), National Basketball League (NBL)), and 31% (28/90) having coached a national team in international competition (e.g., FIBA Championships, Olympic Games) (see Table 2). While these percentages were broadly similar across all Delphi rounds, only 62% (56/90) of coaches, employed in 19 countries, completed all three rounds. Table 3 indicates the country of employment for the participant coaches across all Delphi rounds, while Fig. 2 visualizes the countries of employment of those who completed Round 3. Participant coaches included basketball coaches ($n=71$) and strength/conditioning coaches ($n=19$) who coached men ($n=60$), women ($n=23$), or both ($n=7$).

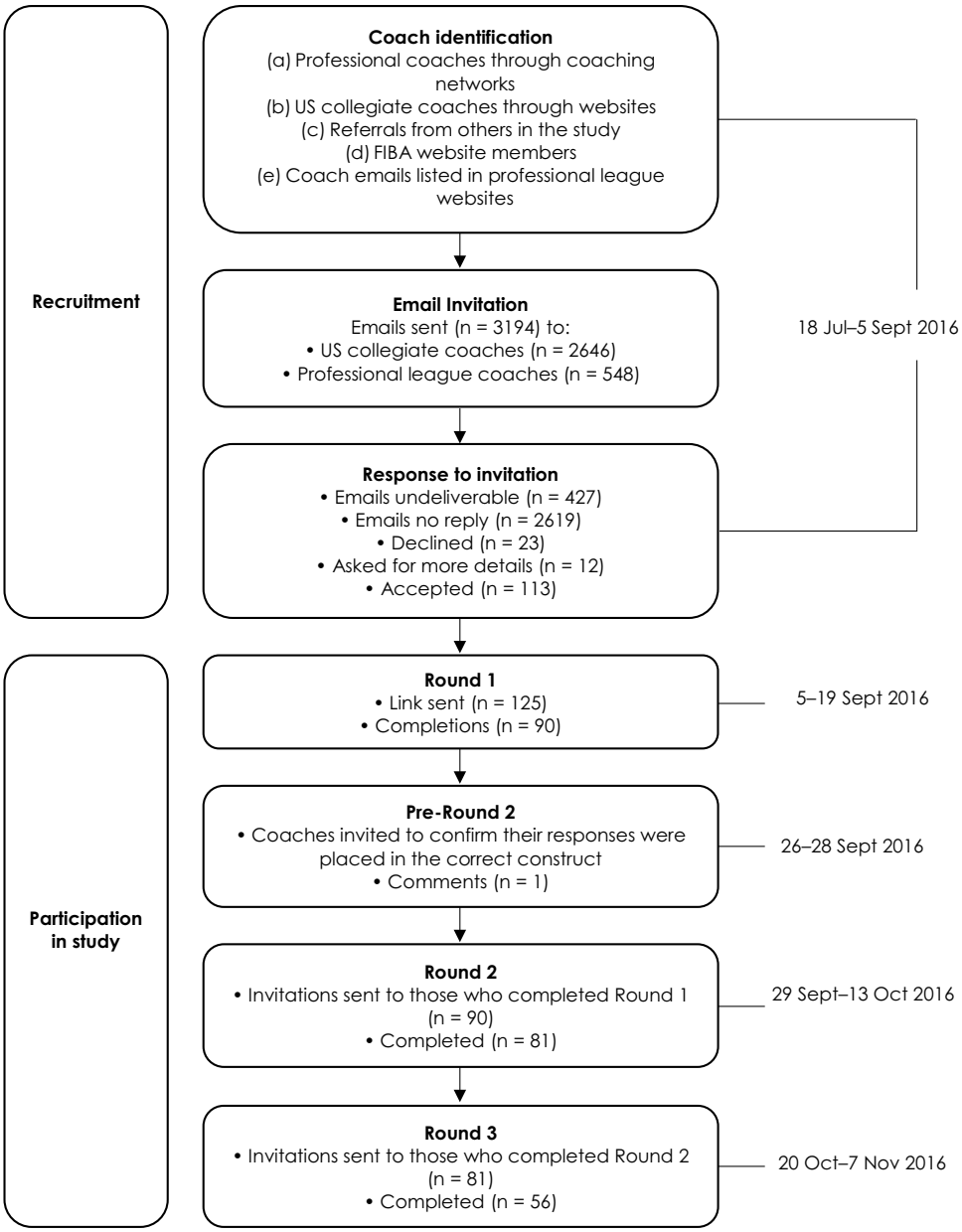

Fig. 1 Elite athlete coach recruitment and participation summary

3.2 Round 1

In Round 1, coaches reported 608 performance indicators, with some reporting specific test measures (e.g., the vertical jump) and others reporting underlying constructs (e.g., lower body muscular power). Eight per cent (50/608) of responses were excluded as they were not considered to have indicated basketball performance (e.g., religion, family, box score statistics, training loads, in-game player tracking). After de-duplication, 344 responses remained and were reduced by combining common indicators into 35 unique indicators across four broad categories—Physical Fitness ($n = 15$), Psychological ($n = 14$), Movement Skills ($n = 4$), and Game Intelligence ($n = 2$)—by consensus. The following unique indicators were carried forward to Round 2 (see Appendix S2 in the ESM for broad definitions of each performance indicator):

Table 2 Elite athlete coaches' self-reported highest competitive standard as a frequency (and percentage) of the total number of coaches

Competitive standard	Round 1	Round 2	Round 3
Collegiate	41 (45.6%)	37 (45.7%)	20 (35.7%)
Professional (national) league	21 (23.3%)	18 (22.2%)	14 (25.0%)
International	28 (31.1%)	26 (32.1%)	22 (39.3%)
Total	90	81	56

- *Physical fitness*: Aerobic endurance, agility, anaerobic endurance, anaerobic power, anthropometry, athleticism/fitness, body composition, flexibility, injury history, muscular endurance, muscular strength, muscular power, reaction time, speed, and speed endurance;
- *Psychological*: Attitude, character, coachability, communication, competitiveness, confidence, emotional control, leadership, mental health/cognition, motivation, resilience/toughness, responsibility, team player, and work ethic;
- *Movement skills*: Balance/stability, general, locomotor, and object control; and
- *Game intelligence:* Basketball intelligence and decision making.

Table 3 Country of employment for the elite athlete coaches who completed each Delphi round

Country	FIBA rank	Frequency (percentage)		
		Round 1	Round 2	Round 3
Australia	4	10 (11.1%)	8 (9.8%)	5 (8.9%)
Bulgaria	65	1 (1.1%)	1 (1.2%)	1 (1.7%)
Canada	7	3 (3.3%)	3 (3.7%)	3 (5.3%)
China	12	2 (2.2%)	2 (2.4%)	1 (1.7%)
Croatia	14	1 (1.1%)	1 (1.2%)	0 (0.0%)
Finland	56	1 (1.1%)	1 (1.2%)	1 (1.7%)
France	3	1 (1.1%)	1 (1.2%)	1 (1.7%)
Germany	30	3 (3.3%)	2 (2.4%)	2 (3.5%)
Great Britain	37	1 (1.1%)	1 (1.2%)	0 (0.0%)
Greece	15	1 (1.1%)	1 (1.2%)	0 (0.0%)
Indonesia	74	1 (1.1%)	1 (1.2%)	1 (1.7%)
Italy	17	4 (4.4%)	4 (4.9%)	4 (7.1%)
Maldives	*>133	1 (1.1%)	1 (1.2%)	0 (0.0%)
Morocco	84	1 (1.1%)	1 (1.2%)	1 (1.7%)
New Zealand	27	3 (3.3%)	3 (3.7%)	3 (5.3%)
Norway	*>133	1 (1.1%)	1 (1.2%)	1 (1.7%)
Portugal	50	2 (2.2%)	1 (1.2%)	1 (1.7%)
Qatar	79	1 (1.1%)	1 (1.2%)	1 (1.7%)
Serbia	9	2 (2.2%)	1 (1.2%)	1 (1.7%)
Spain	2	2 (2.2%)	2 (2.4%)	2 (3.5%)
Turkey	10	2 (2.2%)	2 (2.4%)	2 (3.5%)
USA	1	45 (50%)	41 (50.6%)	24 (42.8%)
Venezuela	28	1 (1.1%)	1 (1.2%)	1 (1.7%)
Total		90	81	56

*Togo is ranked 132nd currently on 0.6 points, all other countries below them are currently on 0 points, and have no ranking; coaches from seven of the world's top 10-ranked basketball nations participated, with only Russia (fifth), Argentina (sixth), and Brazil (eighth) absent

3.3 Round 2

Collectively, psychological and game intelligence indicators were typically rated as very important to extremely important (i.e., median = 9), with physical fitness and movement skills typically rated as very important (i.e., median = 8). The median and IQR importance values for the performance indicators identified in Round 1 are shown in Table 4. Performance indicators are presented in descending order based on the median (i.e., the most important towards the top) and then in ascending order based on the IQR (i.e., the least variable responses towards the top). The first four indicators, all of which were psychological indicators, were typically rated as extremely important (i.e., median = 10), with competitiveness and work ethic the least variable. Collectively, the next 12 indicators were generally rated as very important to extremely important, the majority (67% or 8/12) of which were psychological indicators, and the remainder of which were physical fitness (2/12) and game intelligence (2/12) indicators. The next 15 indicators were rated as very important, with most (60% or 9/15) being physical fitness indicators, and the remainder being movement skills (4/15) and psychological indicators (2/15). The bottom four were physical fitness indicators. Correlations between the ratings of different types of coaches were very strong (basketball coaches vs. strength/conditioning coaches: $r_s = 0.70$, $p < 0.0001$; coaches of male players vs. coaches of female players; $r_s = 0.89$, $p < 0.0001$).

3.4 Round 3

Coaches identified an average (SD) of 19 (12) test measures, with only 11% (6/56) identifying at least one test measure for all 35 indicators. The modal best test measure(s) for each performance indicator is/are shown in Table 5, with coach observation the modal best test measure for most indicators (54% or 19/35) and unique objective performance/anthropometric tests identified for all physical fitness indicators. Multimodal tests were identified for anaerobic endurance (the line drill (also referred to as "suicide") and the Yo–yo test), muscular endurance (the maximum number push-ups, pull-ups, and repetitions using a fixed sub-maximal weight on the bench press), and speed endurance (Running-based Anaerobic Sprint Test (RAST), 20-m shuttle run, and 400-m run).

4 Discussion

The current study aimed to identify a range of performance indicators that were considered by elite athlete coaches to be important for the recruitment/selection of basketball players. Coaches identified 35 unique indicators, which were

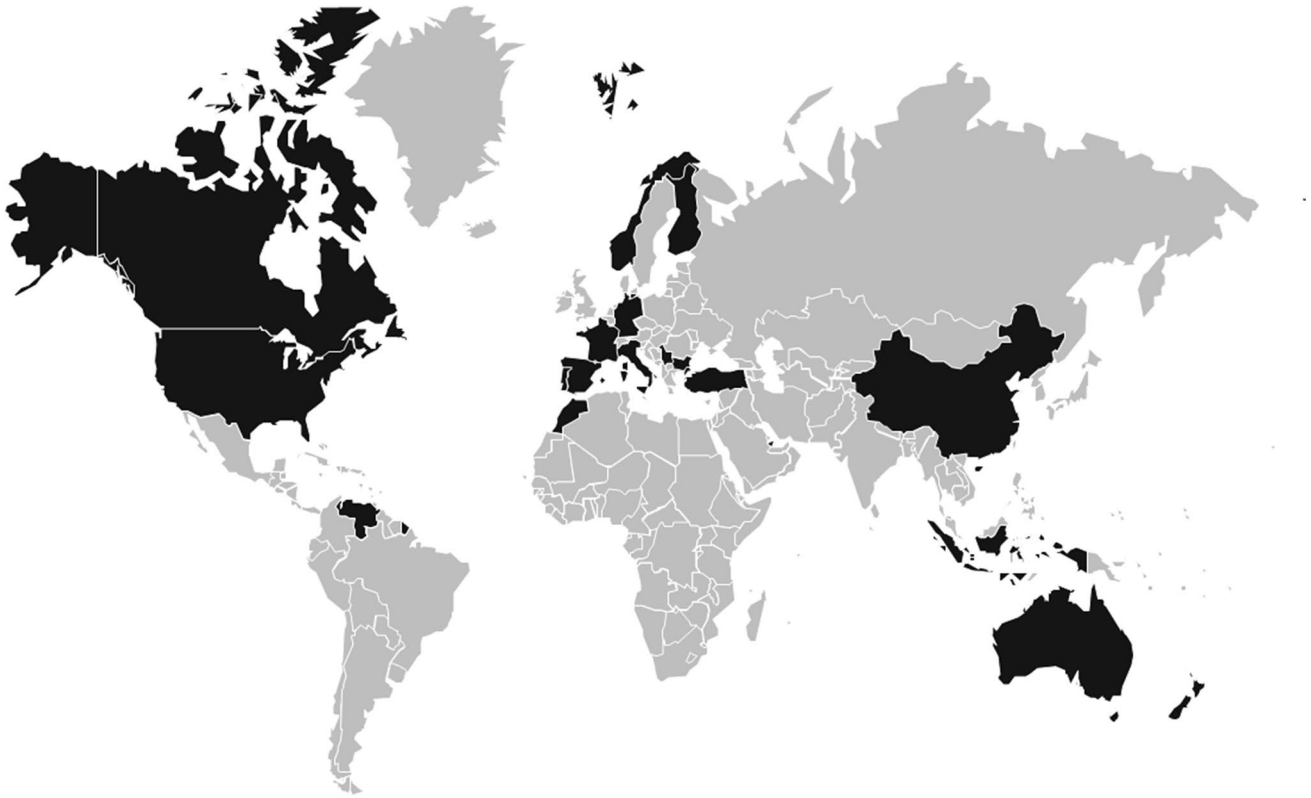

Fig. 2 World map showing the country of employment for the elite athlete coaches who completed Round 3

typically rated as important to extremely important, across four different categories: psychological skills, physical fitness, game intelligence, and movement skills. Psychological skills and game intelligence indicators were rated as more important compared to physical fitness and movement skill indicators. For most indicators, coach observation was identified as the best method of assessment, with unique objective performance/anthropometric tests identified for all physical fitness indicators. These findings have implications for the development of a basketball-specific test battery for talent recruitment/selection and monitoring of player progress.

4.1 Performance Indicators

A total of 14 psychological constructs were identified as very important to extremely important, with four of them (attitude, coachability, competitiveness, and work ethic) considered the most important indicators overall. Collectively, these four indicators suggest that basketball players who are optimistic, easily taught and trained to do something better, and determined to be more successful or to work harder than others, are favored by coaches. Participant coaches indicated that players with a negative attitude are undesirable because they are often *"more worried about their individual statistics rather than winning"*, and that they wanted *"positive players for good team chemistry"*; coachability is important for players to *"play a role in the team"*; and work ethic is important for players to *"reach their potential"* (e.g., by getting *"extra shots up outside of scheduled training"* to improve their shooting ability). Our findings suggest that despite players needing certain physical attributes to compete, participant coaches considered psychological constructs as very important to extremely important for recruitment/selection. This is consistent with previous research, which indicates that while physical characteristics (such as body size and physical fitness) are important in team sports, they do not determine success alone, with psychological characteristics highly important [43] or crucial [44] for team sporting success. For example, basketball players who achieve higher competitive standards have a greater will to compete [45], excel [45, 46], work [45, 46], and win [46]. Participant coaches indicated *"if you are not mentally tough, then you will not be focused on every play, especially when tired, which may cost your team a win"*. This suggests that whilst some players have the physical capability to compete, they do not have the requisite resilience or motivation to consistently give their best effort in every possession of a game.

Similarly, Gucciardi et al. [43] noted that while physical talent is a strong determinant of whether or not an athlete will reach the elite level, mental toughness will help

Table 4 Median and interquartile range (IQR) importance values for each performance indicator, calculated from data supplied by the elite athlete coaches ($n = 81$) who participated in Round 2

Performance indicator	Category	Median	IQR
Competitiveness	Psychological	10	1
Work ethic	Psychological	10	1
Attitude	Psychological	10	2
Coachability	Psychological	10	2
Resilience/toughness	Psychological	9	2
Agility	Physical fitness	9	2
Confidence	Psychological	9	2
Motivation	Psychological	9	2
Basketball intelligence	Game intelligence	9	2
Reaction time	Physical fitness	9	2
Character	Psychological	9	2
Team player	Psychological	9	2
Decision making	Game intelligence	9	2
Communication	Psychological	9	2
Emotional control	Psychological	9	2
Responsibility	Psychological	9	2
Muscular strength	Physical fitness	8	2
Balance/stability	Movement skills	8	2
Object control	Movement skills	8	2
Muscular power	Physical fitness	8	2
Anaerobic endurance	Physical fitness	8	2
Anaerobic power	Physical fitness	8	2
Speed endurance	Physical fitness	8	2
Locomotor	Movement skills	8	2
General	Movement skills	8	2
Athleticism/fitness	Physical fitness	8	2
Leadership	Psychological	8	3
Speed	Physical fitness	8	3
Aerobic endurance	Physical fitness	8	3
Muscular endurance	Physical fitness	8	3
Mental health/cognition testing	Psychological	8	3
Flexibility	Physical fitness	7	2
Body composition	Physical fitness	7	2
Injury history	Physical fitness	7	3
Anthropometry	Physical fitness	6	3

Likert scale ratings: 0 = no importance whatsoever, 2 = very little importance, 4 = moderately important, 6 = important, 8 = very important, and 10 = extremely important

IQR interquartile range

discriminate between 'best' and 'rest' players once they have reached the elite level. For example, participant coaches considered mental toughness as the ability to recover from, or easily adjust to, adversity or change, which one coach noted was observed as a player's ability to *"focus on next play"* considering the outcomes of previous plays. Players who are poor communicators may struggle at the elite level because there needs to be regular communication of offensive and defensive systems during game play to facilitate team success. A lack of emotional control suggests that players may struggle to respond to situations, control their emotions, and/or behave appropriately when dealing with others. Players who are effective leaders are inspiring and can promote team harmony [47], which participant coaches indicate are an "*extension of the coach on the floor"* and enable their coaching systems to be *"better executed"*.

In addition to the psychological indicators, game intelligence (i.e., the ability to read the game) was identified as a very important indicator by international basketball coaches for athlete recruitment/selection. While game intelligence in team sport is difficult to quantify and is considered an acquired skill [48], it was evidenced in this study by basketball-specific IQ and decision making. This suggests that athletes with an enhanced ability to (a) recognize and anticipate plays, patterns, actions, and/or situations in real-time, and (b) make and execute decisions or problem solve within the context of the game, are more likely to be recruited/selected by basketball coaches. Participant coaches noted that it is important for players to *"understand the offense"*. As the game has evolved over time, players have become more patient, moved the ball more frequently, and set more on-ball screens [49], and players therefore have had to update their game intelligence for better basketball performance. Understanding the offense is important as pick and roll offense has been shown to be a significant part in determining ladder position in EuroLeague competition [50], with winning teams more successful with high on-ball screens than losing teams [51].

Interestingly, the least important indicators identified by participant coaches were physical fitness and movement skills. It is possible that basketball coaches initially filter athletes based on physical and skill-based characteristics to quickly generate a pool of athletes from which to choose, and then recruit/select players based on the more important psychological characteristics through a lengthy coach observation period. Notwithstanding, basketball performance has been positively related to body size [52], with basketball players who achieve a higher competitive standard tending to be taller [9, 10, 53–59], heavier [9, 10, 53, 56, 59–63], and have longer torsos [53, 57, 58, 64], larger body surface areas [65, 66], broader shoulders, elbow, hips, and knees [53, 58], longer arms and legs [9, 53, 57, 58], bigger hands and feet [9, 53, 58], and larger chest, arm, and leg musculature [53, 58, 62]. Participant coaches rated physical performance characteristics as more important than anthropometry. For example, they indicated that aerobic endurance was important for *"recovery"* and to *"withstand the rigors of the game"*; agility was specific to the *"demands of the game"* because basketball requires quick changes in speed and direction; and athleticism (as indicated by vertical jump performance) *"improves shooting and rebounding ability"*,

Table 5 Modal best test measure(s) for each performance indicator, calculated from data supplied by the elite athlete coaches ($n=56$) who participated in Round 3

Categories	Performance indicator	Test	*n*
Physical Fitness	Aerobic endurance	20-m shuttle run	15
	Agility	Lane agility	10
	Anaerobic endurance	Line drill (suicide)/Yo–yo	4
	Anaerobic power	Wingate	6
	Anthropometry	Height	13
	Athleticism/fitness	Vertical jump	10
	Body composition	Skinfolds	15
	Flexibility	Sit and reach	15
	Injury history	Database of previous injuries	8
	Muscular endurance	Maximum push-ups, maximum pull-ups, maximum bench press reps	3
	Muscular strength	≤3RM squat	6
	Muscular power	Vertical jump	22
	Reaction time	Fit light	5
	Speed	20-m sprint	16
	Speed endurance	RAST, 20-m shuttle run, 400-m run	2
Psychological	Attitude	Coach observation	14
	Character	Coach observation	10
	Coachability	Coach observation	18
	Communication	Coach observation	17
	Competitiveness	Coach observation	16
	Confidence	Coach observation	14
	Emotional control	Coach observation	13
	Leadership	Coach observation	10
	Mental health/cognition	Coach observation	6
	Motivation	Coach observation	9
	Resilience/toughness	Coach observation	9
	Responsibility	Coach observation	7
	Team player	Coach observation	12
	Work ethic	Coach observation	10
Movement skills	Balance/stability	Y-balance	4
	General	Coach observation	8
	Locomotor	Coach observation	8
	Object control	Coach observation	7
Game intelligence	Basketball intelligence	Coach observation	18
	Decision making	Coach observation	23

Although some fitness tests identified by the participant coaches are not validated measures of the corresponding performance indicators, they were nonetheless included as they reflect the modal best test measure that was identified. The final column shows the number of coaches that identified the reported test in Round 3. Single test measures could be used across multiple performance indicators if coaches identified them

3RM 3-repetition maximum, *n* number of coaches, *RAST* Running-based Anaerobic Sprint Test

which *"correlates highly with game performance"*. These coach observations are consistent with previous research. For example, Castagna et al. [55] and Hoffman et al. [67] suggested that a minimal level of aerobic endurance is required to adequately compete [38] and recover [67] at the professional and collegiate levels, and that higher levels are unlikely to confer an additional performance or recovery advantage. Vertical jump ability is positively associated with the number of steals per game [61], points per game [9], minutes per game [17], and 3-point shooting accuracy [60, 68].

4.2 Measuring the Performance Indicators

Coaches identified numerous tests to assess basketballers for the performance indicators presented in Round 2. Coach

observation was identified most across the psychological, game intelligence, and movement skill indicators, with objective performance/anthropometric tests identified for all physical fitness indicators. The finding that all psychological and game intelligence (and all but one of the movement skill) characteristics were determined through coach observation is consistent with research by Butterworth et al. [4], who suggested that coaching decisions are often based on feelings, intuitions, events, and previous experience [4] rather than objective measurement. Similarly, Hoffman et al. [20] found that the best predictor of basketball playing time was the coach's perception of players' basketball ability relative to their teammates and opposition. In the current study, participant coaches indicated that they wanted players who *"pushed themselves in practice and games"*, *"changed things in the game"*, and *"stayed calm in critical situations*". It is also possible that coach observation is used to assess psychological characteristics because there is a lack of consensus on how best to measure such characteristics [44]. Several participant coaches acknowledged in Round 3 that it was challenging to define and measure many of the identified psychological indicators, which might indicate why coaches choose to make most decisions through observation. In contrast, participant coaches were better able to identify specific physical fitness tests. This could be because test batteries such as the NBA Combine [6] and the Basketball Australia [7] test batteries have been widely used to measure anthropometry [6, 7], body composition [6, 7], speed [6, 7], strength [6, 7], agility [6, 7], muscular power [6, 7], muscular endurance [6], flexibility [7], aerobic endurance [7], and anaerobic endurance [7].

4.3 Strengths and Limitations

This is the first study to examine key indicators for recruitment/selection in basketball using a large international panel of elite athlete coaches from numerous FIBA ranked countries. We attempted to avoid league-specific trends by recruiting broadly and by pooling our results internationally. We found very strong agreement between the importance ratings of different types of coaches, which indicated that our main findings were broadly universal. The Delphi procedure ensured that persuasion and group consensus thinking was avoided, and that less experienced coaches, or coaches in countries that were of a lower FIBA rank, did not conform to the opinions of more experienced coaches.

This study was not without limitations. Although our participant coaches were employed in 23 countries across six continents, most were from Asia, Australia, Europe, and North America. Despite using a short turnaround time between rounds to minimize participant dropout, we unfortunately observed 40% dropout post-Round 1, with Round 3 participants employed in 19 of the 23 countries represented by Round 1 participants. This reduced the generalizability of our findings to all leagues and countries represented by coaches who participated in Round 1. We also did not include a test–retest reliability of participant coach ratings. Since rule changes are thought to be responsible for altering the tactical and physiological demands of basketball, by speeding up the pace of the game and modifying the physiological and morphological characteristics of the players [12], there may be geographical differences in coach opinions regarding the relative importance of performance indicators within their league. It was nonetheless beyond the scope of this study to examine geographical differences in coach identified indicators or ratings of importance.

4.4 Implications for Future Research

Future research should look to identify acceptable, feasible, and scalable tests for the performance indicators rated by coaches as 'important', especially for the psychological and game intelligence indicators, which may benefit from objective measurement. Relationships between objective measures and subjective coach ratings could then be quantified. For example, while Hoare [29] reported good agreement between coach ratings of player ability and objective physical fitness measures (e.g., anthropometry (height, sitting height, arm span), speed agility, muscular power, aerobic endurance) among junior Australian basketball players, corresponding data for other performance indicators are lacking. It is of course likely that a combination of objective and subjective measures will improve talent recruitment/selection outcomes [30, 31].

Researchers should also examine whether these performance indicators are meaningfully associated cross-sectionally with game statistics. While several studies have quantified relationships between physical fitness indicators (e.g., anthropometry [9, 14, 15, 17], speed [9, 14, 17, 18], agility [14, 18], aerobic endurance [9, 13, 14, 18], explosive strength [9, 14, 17, 18]) and basketball statistics (e.g., games played [14, 18], minutes per game [13, 14, 17, 18], total rebounds [13, 14, 18], assists [13–15, 18], turnovers [13–15], steals [13–15, 18], blocks [13–15, 18], fouls per game [13, 15], points per game [9, 13, 14, 17, 18]), few have examined the relationships between psychological or game intelligence indicators and basketball performance (see Schild [69] for an examination of relationships between personality traits and fouls per minute). Research could examine whether subjective coach ratings of these performance indicators relate well to corresponding objective measures or examine relationships between longitudinal changes in these performance indicators and corresponding changes in basketball statistics. Future studies could also examine differences in

coach-identified indicators or ratings of importance between geographic regions, competitive standards, and/or genders.

5 Conclusions

Using a Delphi survey of international basketball coaches, 35 psychological, game intelligence, physical fitness, and movement skill indicators were considered by coaches to be important to extremely important for the recruitment/selection of basketball players. Participant coaches typically rated psychological and game intelligence indicators as more important than physical fitness and movement skills, and coach observation was commonly used for measuring the psychological, game intelligence, and movement skills characteristics of players. While game statistics are used to assess performance, the performance indicators identified in this study could be used as complementary measures to help coaches make better recruitment/selection decisions or to help players better understand what elite athlete coaches recruit/select for. These findings may also inform the development of a basketball-specific test battery for monitoring player progress. This might be useful when recruiting/selecting players from different leagues, where the rules and style of play may differ and impact a player's game statistics, allowing coaches additional insight into factors considered important for elite basketball performance. Our findings may also help guide talent development pathways/programs for basketball clubs to accelerate the development of young players towards their sporting potential and recruitment at the elite level.

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Declarations

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Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication Not applicable.

Availability of data and material The data analyzed in this study are available from the corresponding authors on reasonable request.

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Author contributions MR, NKS, RGE, and GRT designed the study. MR and GRT were responsible for the ethics approval. MR collected, cleaned, and analyzed the data, and drafted the manuscript with assistance from GRT. All authors contributed to the interpretation of results, editing and critical reviewing of the final manuscript for important intellectual content, approved the final manuscript as submitted, agreed to be accountable for all aspects of the work, and agree with the order of presentation of the authors.

References

1. Lorenz DS, Reiman MP, Lehecka B, Naylor A. What performance characteristics determine elite versus nonelite athletes in the same sport? Sports Health. 2013;5(6):542–7.
2. Hughes MD, Bartlett RM. The use of performance indicators in performance analysis. J Sports Sci. 2002;20(10):739–54.
3. Reilly T. Assessment of sports performance with particular reference to field games. Eur J Sport Sci. 2001;1(3):1–12.
4. Butterworth A, O'Donoghue P, Cropley B. Performance profiling in sports coaching: a review. Int J Perform Anal Sport. 2013;13(3):572–93.
5. Berri D, Brook S, Fenn A. From college to the pros: predicting the NBA amateur player draft. J Prod Anal. 2011;35(1):25–35.
6. Teramoto M, Cross CL, Rieger RH, Maak TG, Willick SE. Predictive validity of National Basketball Association draft combine on future performance. J Strength Cond Res. 2018;32(2):396–408.
7. Pyne DB, Montgomery PG, Klusemann MJ, Drinkwater EJ. Basketball Australia fitness testing protocols. Canberra: Australian Institute of Sport/Basketball Australia; 2011.
8. Norton K, Olds T. Morphological evolution of athletes over the 20th century. Sports Med. 2001;31(11):763–83.
9. Torres-Unda J, Zarrazquin I, Gil J, Ruiz F, Irazusta A, Kortajarena M, et al. Anthropometric, physiological and maturational characteristics in selected elite and non-elite male adolescent basketball players. J Sports Sci. 2013;31(2):196–203.
10. Abdelkrim NB, Chaouachi A, Chamari K, Chtara M, Castagna C. Positional role and competitive-level differences in elite-level men's basketball players. J Strength Cond Res. 2010;24(5):1346–55.
11. Köklü Y, Alemdaroğlu U, Koçak FU, Erol AE, Fındıkoğlu G. Comparison of chosen physical fitness characteristics of Turkish professional basketball players by division and playing position. J Human Kinet. 2011;30:99–106.
12. Delextrat A, Cohen D. Physiological testing of basketball players: toward a standard evaluation of anaerobic fitness. J Strength Cond Res. 2008;22(4):1066–72.
13. Claramunt C, Guzman I, Solé J, Balagué N, Hristovski R. Aerobic training does not improve competitive performance in young elite basketball players. Baltic J Sport Health Sci. 2011;80(1):3–10.
14. Sporiš G, Naglić V, Milanović L, Talović M, Jelešković E. Fitness profile of young elite basketball players (cadets). Acta Kinesiologica. 2010;4(2):62–8.

15. Trninic M, Jelicic M, Papic V. Non-linear approach in kinesiology should be preferred to the linear—a case of basketball. Coll Antropol. 2015;39:117–24.
16. Pomeshchikova I, Ruban L, Nesen O, Mishyn M, Shaposhnykova I, Korsun S, et al. Influence of peripheral vision indicators on the efficiency of 15-year-old basketball players' game actions. Sport Sci. 2018;11(1):75–82.
17. Torres-Unda J, Zarrazquin I, Gravina L, Zubero J, Seco J, Gil SM, et al. Basketball performance is related to maturity and relative age in elite adolescent players. J Strength Cond Res. 2016;30(5):1325–32.
18. Fort-Vanmeerhaeghe A, Montalvo A, Latinjak A, Unnithan V. Physical characteristics of elite adolescent female basketball players and their relationship to match performance. J Human Kinet. 2016;53(1):167–78.
19. Roberts AH, Greenwood DA, Stanley M, Humberstone C, Iredale F, Raynor A. Coach knowledge in talent identification: a systematic review and meta-synthesis. J Sci Med Sport. 2019;22(10):1163–72.
20. Hoffman JR, Tenenbaum G, Maresh CM, Kraemer WJ. Relationship between athletic performance tests and playing time in elite college basketball players. J Strength Cond Res. 1996;10(2):67–71.
21. Cupples B, O'Connor D. The development of position-specific performance indicators in elite youth rugby league: a coach's perspective. Int J Sports Sci Coach. 2011;6(1):125–41.
22. Sawyer DT, Ostarello JZ, Suess EA, Dempsey M. Relationship between football playing ability and selected performance measures. J Strength Cond Res. 2002;16(4):611–6.
23. Hoare DG, Warr CR. Talent identification and women's soccer: an Australian experience. J Sports Sci. 2000;18(9):751–8.
24. Marey S, Boleach L, Mayhew J, McDole S. Determination of player potential in volleyball: coaches' rating versus game performance. J Sports Med Phys Fitness. 1991;31(2):161–4.
25. Vandorpe B, Vandendriessche J, Vaeyens R, Pion J, Lefevre J, Philippaerts R, et al. Factors discriminating gymnasts by competitive level. Int J Sports Med. 2011;32(08):591–7.
26. Mooney R, Corley G, Godfrey A, Osborough C, Newell J, Quinlan LR, et al. Analysis of swimming performance: perceptions and practices of US-based swimming coaches. J Sports Sci. 2016;34(11):997–1005.
27. Johansson A, Fahlén J. Simply the best, better than all the rest? Validity issues in selections in elite sport. Int J Sports Sci Coach. 2017;12(4):470–80.
28. Celestino TF, Leitão JCG, Sarmento HB, Routen A, Pereira AA. Elite coaches views on factors contributing to excellence in orienteering. Cultura Ciencia y Deporte. 2015;10(28):77–86.
29. Hoare DG. Predicting success in junior elite basketball players—the contribution of anthropometric and physiological attributes. J Sci Med Sport. 2000;3(4):391–405.
30. Dugdale JH, Sanders D, Myers T, Williams AM, Hunter AM. A case study comparison of objective and subjective evaluation methods of physical qualities in youth soccer players. J Sports Sci. 2020;38(11–12):1304–12.
31. Sieghartsleitner R, Zuber C, Zibung M, Conzelmann A. Science or coaches' eye?—Both! Beneficial collaboration of multidimensional measurements and coach assessments for efficient talent selection in elite youth football. J Sports Sci Med. 2019;18(1):32–43.
32. Roberts SJ, McRobert AP, Lewis CJ, Reeves MJ. Establishing consensus of position-specific predictors for elite youth soccer in England. Sci Med Footb. 2019;3(3):205–13.
33. Dalkey N, Helmer O. An experimental application of the Delphi method to the use of experts. Manage Sci. 1963;9(3):458–67.
34. Nair R, Aggarwal R, Khanna D. Methods of formal consensus in classification/diagnostic criteria and guideline development. Semin Arthritis Rheum. 2011;41(2):95–105.
35. Gustafson DH, Delbecq AL, Van de Ven AH. Group techniques for program planning: a guide to nominal group and Delphi processes. Middleton: Green Briar Press; 1986.
36. Yousuf MI. Using experts' opinions through Delphi technique. Pract Assess Res Eval. 2007;12(4):1–8.
37. von der Gracht H. Consensus measurement in Delphi studies: review and implications for future quality assurance. Technol Forecast Soc Change. 2012;79(8):1525–36.
38. Villiere A, Mason B, Parmar N, Maguire N, Holmes D, Turner A. The physical characteristics underpinning performance of wheelchair fencing athletes: a Delphi study of Paralympic coaches. J Sports Sci. 2021;39(17):2006–14.
39. McCormack MC, Bird H, de Medici A, Haddad F, Simmonds J. The physical attributes most required in professional ballet: a Delphi study. Sports Med Int Open. 2019;3(01):E1–5.
40. Robertson S, Kremer P, Aisbett B, Tran J, Cerin E. Consensus on measurement properties and feasibility of performance tests for the exercise and sport sciences: a Delphi study. Sports Med Open. 2017;3(1):2.
41. Linstone HA, Turoff M. The Delphi method: techniques and applications. New Jersey: New Jersey's Department of Information Systems; 2002.
42. Hopkins WG. A scale of magnitudes for effect statistics. N View Stat. 2002;502:411.
43. Gucciardi DF, Gordon S, Dimmock JA. Towards an understanding of mental toughness in Australian football. J Appl Sport Psychol. 2008;20(3):261–81.
44. Golby J, Sheard M, Van Wersch A. Evaluating the factor structure of the psychological performance inventory. Percept Mot Skills. 2007;105(1):309–25.
45. Gonçalves CE, Carvalhov HM, Gonçalves A. Achievement and competitiveness in elite youth basketball: what matters? Revista de Psicologia del Deporte. 2015;24(3):43–5.
46. Gonçalves CE, e Silva MJC, Carvalho HM, Gonçalves Â. Why do they engage in such hard programs? The search for excellence in youth basketball. J Sports Sci Med. 2011;10(3):458–64.
47. Price MS, Weiss MR. Peer leadership in sport: relationships among personal characteristics, leader behaviors, and team outcomes. J Appl Sport Psychol. 2011;23(1):49–64.
48. Lennartsson J, Lidström N, Lindberg C. Game intelligence in team sports. PLoS ONE. 2015;10(5):e0125453.
49. Štrumbelj E, Vračar P, Robnik-Šikonja M, Dežman B, Erčulj F. A decade of Euroleague basketball: an analysis of trends and recent rule change effects. J Human Kinet. 2013;38:183–9.
50. Marmarinos C, Apostolidis N, Kostopoulos N, Apostolidis A. Efficacy of the "pick and roll" offense in top level European basketball teams. J Human Kinet. 2016;51(1):121–9.
51. Koutsouridis C, Karamousalidis G, Galazoulas C. The efficacy of "High Pick and Roll" in relation to the defence's reaction and its effect on the result of the game. Int J Perform Anal Sport. 2018;18(4):554–67.
52. Drinkwater EJ, Pyne DB, McKenna MJ. Design and interpretation of anthropometric and fitness testing of basketball players. Sports Med. 2008;38(7):565–78.
53. Brasili P, Toselli S. The physical structure of basketball players: comparison between young and adult athletes. Med Sport. 2002;55(4):255–67.
54. Buśko K. Muscle torque topography in female basketball players. Biol Sport. 1998;15(1):45–9.
55. Castagna C, Chaouachi A, Rampinini E, Chamari K, Impellizzeri F. Aerobic and explosive power performance of elite Italian regional-level basketball players. J Strength Cond Res. 2009;23(7):1982–7.

56. Drinkwater EJ, Hopkins WG, McKenna MJ, Hunt PH, Pyne DB. Modelling age and secular differences in fitness between basketball players. J Sports Sci. 2007;25(8):869–78.
57. Janeira MA. The relationship of somatotype and selected anthropometric measures to some performance in young male basketball players. In: Telama R, editor. Physical education and life-long physical activity: the proceedings of the Jyväskylä Sport Congress, June 17–22, 1989, at the University of Jyväskylä, Jyväskylä, Finland. Jyväskylä: Foundation for Promotion of Physical Culture and Health; 1990. pp. 206–215.
58. Karalejic M, Jakovljevic S, Macura M. Anthropometric characteristics and technical skills of 12 and 14 year old basketball players. J Sports Med Phys Fitness. 2011;51(1):103–10.
59. Nikolaidis P, Calleja-González J, Padulo J. The effect of age on positional differences in anthropometry, body composition, physique and anaerobic power of elite basketball players. Sport Sci Health. 2014;10(3):225–33.
60. Pojskić H, Šeparović V, Muratović M, Užičanin E. The relationship between physical fitness and shooting accuracy of professional basketball players. Motriz Revista de Educação Física. 2014;20(4):408–17.
61. Gomes JH, Rebello Mendes R, Almeida MBD, Zanetti MC, Leite GDS, Figueira Júnior AJ. Relationship between physical fitness and game-related statistics in elite professional basketball players: regular season vs. playoffs. Motriz Revista de Educação Física. 2017.
62. Hanne-Paparo N. Body measurements and physical fitness of elite young and adult basketball players. In: Ayalon A, editor. Biomechanics of sport games and sport activities. Netanya: Wingate Institute for Physical Education and Sport; 1979. p. 136–45.
63. Nikolaidis PT, Asadi A, Santos EJAM, Calleja-González J, Padulo J, Chtourou H, et al. Relationship of body mass status with running and jumping performances in young basketball players. Muscles Ligaments Tendons J. 2015;5(3):187–94.
64. Gerodimos V, Mandou V, Zafeiridis A, Ioakimidis P, Stavropoulos N, Kellis S. Isokinetic peak torque and hamstring/quadriceps ratios in young basketball players. Effects of age, velocity, and contraction mode. J Sports Med Phys Fitness. 2003;43(4):444–52.
65. Csanady M, Forster T, Hogye M. Comparative echocardiographic study of junior and senior basketball players. Int J Sports Med. 1986;7(3):128–32.
66. Vasiliauskas D, Venckunas T, Marcinkeviciene J, Bartkeviciene A. Development of structural cardiac adaptation in basketball players. Eur J Cardiovasc Prev Rehabil. 2006;13(6):985–9.
67. Hoffman JR, Epstein S, Einbinder M, Weinstein Y. The influence of aerobic capacity on anaerobic performance and recovery indices in basketball players. J Strength Cond Res. 1999;13(4):407–11.
68. Pojskic H, Sisic N, Separovic V, Sekulic D. Association between conditioning capacities and shooting performance in professional basketball players: an analysis of stationary and dynamic shooting skills. J Strength Cond Res. 2018;32(7):1981–92.
69. Schild C, Botzet LJ, Planert L, Ścigała KA, Zettler I, Lang JWB. Linking personality traits to objective foul records in (semi-)professional youth basketball. J Res Pers. 2020;87:103987.