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ORIGINAL RESEARCH

Exploring decision indicators for selecting elite players in youth male singles badminton: based on anthropometric indicators

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Abstract

This study aims to explore selection indicators for elite male youth singles badminton player based on anthropometric through a Delphi survey. To achieve this, five badminton experts reviewed previous studies and held meetings to derive preliminary indicators. Based on these preliminary indicators, 14 experts conducted two rounds of Delphi surveys. Finally, 13 experts calculated the importance and priority of the indicators derived from the Delphi surveys through an analytic hierarchy process. The results of the study are as follows: first, through a literature review and expert meetings, two primary indicators (physique and motor performance), five secondary indicators (length, circumference, composition, physical strength and coordination ability) and 32 tertiary indicators were constructed to determine the selection criteria for elite players. Second, by conducting two rounds of Delphi surveys, seven sub-indicators for physique (length = 3, circumference = 2, composition = 2), and eight sub-indicators for motor performance (physical strength = 6, coordination ability = 2) were selected. Finally, based on the indicators selected through the Delphi survey, the analytic hierarchy process revealed that height was the top priority for physique (length), followed by thigh circumference for physique (circumference), fat-free mass for physique (composition), agility for motor performance (physical strength) and visual ability for motor performance (coordination ability). These findings can be used as objective indicators to select and evaluate elite young male singles badminton players in future sports settings.

Keywords

Badminton; Selecting elite players; Men's singles player; Delphi; Analytic hierarchy process

1. Introduction

The selection of elite athletes in sports involves their performance evaluation. The results of performance evaluations are linked to college admissions, employment, professional entries and national team selection [1], necessitating scientific and objective assessment methods. Similarly, various methods have been proposed in the sports field to perform objective athlete selection and performance evaluation [2–5].

Athletic performance is determined by factors such as physiology, psychology, skills, tactics, body composition and environment [6, 7]. The performance of youth athletes is assessed not only for current ability, but also for potential growth, as this period is critical for talent development and discovery [8, 9]. Albaladejo-Saura *et al.* [10] and Johnston *et al.* [11] identified physical characteristics and functions as critical factors for evaluating growth potential. Previous studies that have identified elite athletes based on physical characteristics and functions report differences between elite and non-elite athletes [12, 13], demonstrating the feasibility of predicting athlete selection based on these attributes [14].

Badminton, a sport with sustained global popularity, consists of five events (men's/women's singles, men's/women's doubles and mixed doubles). Because the game involves players rapidly exchanging a shuttlecock over a net until it is out of play, badminton requires physical characteristics [15] and abilities [16, 17], which are crucial in influencing performance.

These physical characteristics and abilities vary according to sex, age and event type. Male singles players have longer legs [18], a lower body mass index and superior muscular endurance [19] compared with doubles players. Although no significant physical differences have been observed between female singles and doubles players, muscular endurance is better in doubles players [20]. Additionally, the body composition of elite male athletes varies with age [21].

A review of previous studies on performance indicators to select and evaluate badminton players revealed the development of selection criteria based on physical attributes, types, functions, psychological traits and intelligence indicators [3].

Studies have also established a fitness evaluation system for wheelchair badminton players [22]. These studies have academically advanced athlete selection by exploring various indicators and ranking them according to the characteristics of each event. However, there are limitations in practical applications, as they do not provide selection criteria that distinguish athletes by age, sex or event.

Therefore, this study explored selection indicators for elite youth male badminton singles players. Specifically, the study identified indicators for selecting elite players based on their physique and motor performance through a Delphi survey. In this study, elite youth male singles players were defined as those who ranked third or higher in domestic competitions and were eligible to participate in junior international tournaments organized by the Badminton World Federation. The findings can be used as scientific and objective indicators to select and evaluate elite youth male badminton singles players in future sports settings.

2. Participants and methods

2.1 Participants

In this study, badminton experts applied the Delphi and analytic hierarchy process (AHP) methods to reach a consensus on the selection indicators for elite young male singles players. The criteria for selecting the expert group were as follows: first, individuals were selected if they had >10 years of experience as a national or youth representative coach (or manager) for the South Korean badminton team, or if they had >5 years of experience in training or match analysis-related fields in badminton. Second, experts who voluntarily agreed to participate after receiving a detailed explanation of the study were included. Through this process, five experts participated in the derivation of preliminary indicators, followed by 14 experts participating in the Delphi survey. Based on prior research recommendations that a Delphi survey should include a minimum of 10 experts (Murry & Hammons, 1995), this study selected 14 experts. Finally, 13 experts participated in the AHP survey. The specific characteristics of the study participants are presented in Table 1.

2.2 Procedure

The procedure used in this study is illustrated in Fig. 1. A literature review and expert meetings were conducted in Step 1 (determining the primary indicators). Step 2 (selecting indices) conducted a Delphi survey. Step 3 (determining the weight) conducted an AHP survey. The detailed research procedures and data-processing methods for each step in the following subsections.

2.2.1 Determine primary indicators

In Step 1, a preliminary selection of indicators was considered to select elite male youth singles badminton players. First, a literature review was conducted to compile the initial selection indicators [4, 18, 20, 23], and expert meetings confirmed the final preliminary indicators. Specifically, five experts (two coaches and three badminton professors) participated in this process, and the indicators that were unanimously agreed upon were selected as the preliminary indicators.

2.2.2 Selecting indicators

In Step 2, two rounds of Delphi surveys were conducted with 14 experts to finalize the selection indicators for the players. The first round of the Delphi survey was conducted over 15 days, from 07 to 21 October, 2023. The expert opinions on the necessity of each indicator selected in Step 1 were collected using a 5-point Likert scale (“strongly agree” to “strongly disagree”). The second round was conducted over eight days, from 22 to 29 October, 2023. Expert opinions on the necessity of the indicators selected in the first round were collected using a 7-point Likert scale (“strongly agree” to “strongly disagree”). Delphi surveys typically consist of 2 to 3 rounds [24], as typically reported. Additionally, according to Ulrike’s study [25], consensus among experts can be achieved within 2 rounds; therefore, this study also conducted its survey over 2 rounds.

2.2.3 Determining the weight

In Step 3, to calculate the importance and priority of the indicators considered for selecting [26] the players established in Step 2, an AHP survey was conducted with 13 experts using pairwise comparison questions to determine relative importance, employing a 9-point scale. The importance values ranged from 0 to 1, with higher values indicating greater importance of the indicators. The AHP survey was conducted over a period of 15 days, from 03 to 17 November, 2023.

2.3 Statistical analysis

All Delphi surveys were conducted using Google Survey. The results were analyzed using Microsoft 365 Excel (Microsoft Corporation, Redmond, WA, USA) to calculate the mean, standard deviation, consensus, convergence, and content validity ratio (CVR) for each indicator. The AHP survey results, based on the Delphi survey results, were analyzed using DRESS Ver 1.7 (Copyright © CHOISH Software, South Korea) and Microsoft Excel to calculate the consistency index (CI) and consistency ratio (CR).

2.3.1 Delphi survey

The Delphi survey is used to reach a consensus among a group of experts [27] in which qualitative opinions are collected through open-ended questionnaires and feedback is provided in a quantitative form through closed-ended questionnaires [28]. In this study, preliminary indicators for selecting elite male youth singles badminton players were chosen based on prior research and meetings with five experts. Two rounds of closed-ended Delphi surveys helped obtain quantitative feedback. In Delphi surveys, the Likert Scale is commonly used with either a 5-point or 7-point scale [29]. Accordingly, a 5-point scale was employed in Round 1 and a 7-point scale was used in Round 2 of this study. Transitioning to a 7-point Likert scale in Round 2 achieved a more precise and detailed measurement of expert opinions compared to Round 1 [30]. After each round, the convergence, consensus and CVR were used to determine the acceptance of the indicators.

TABLE 1. Characteristics of research participants.

Items	Expert group interview participants (n = 5)		Delphi participants (n = 14)		AHP participants (n = 13)	
	Number of experts	Composition ratio (%)	Number of experts	Composition ratio (%)	Number of experts	Composition ratio (%)
Sex						
Male	2	40.0	7	50.0	7	53.8
Female	3	60.0	7	50.0	6	46.2
Occupation						
Coach	3	80.0	6	42.9	6	46.2
Scientific researcher	2	20.0	4	28.6	3	23.1
Others (trainer or analyst)	-	-	4	28.6	4	30.8
Educational background						
Undergraduate	-	-	5	35.7	5	38.5
Master’s degree	2	40.0	3	21.4	3	23.1
Doctoral degree	3	60.0	6	42.9	5	38.5
Professional title						
Professor	3	60.0	1	7.1	1	7.6
Researcher	-	-	3	21.4	2	15.4
International-class coach	2	40.0	6	42.8	6	46.2
Former national team player	-	-	4	28.6	4	30.8
Research direction						
Strength and conditioning	1	20.0	2	14.3	2	15.4
Sport analysis	2	40.0	2	14.3	1	7.7
Badminton	2	40.0	10	71.4	10	76.9

Note: AHP, Analytic hierarchy process.

2.3.1.1 Consensus

Consensus refers to the degree to which expert opinions are deemed in agreement, with a value close to 1 indicating a high level of consensus among experts. A consensus can be assessed using the median of the quartile deviations. In this study, a threshold of 0.75 or higher was established as the criterion for consensus among experts [31]. The consensus is calculated as follows:

$$Convergence = 1 - \frac{Q3 - Q1}{Md}$$

Q3 = Evaluation score corresponding to the 75th percentile from the bottom of the distribution.

Q1 = Evaluation score corresponding to the 25th percentile from the bottom of the distribution.

Md = Median.

2.3.1.2 Content validity ratio (CVR)

Content validity was confirmed using the CVR. According to Lawshe [32], a minimum CVR of 0.51 is required when the panel consists of 14 members. In this study, because a panel of 14 experts was used, a CVR value of ≥0.51 was determined as the acceptable threshold for content validity. The CVR was calculated as follows:

$$CVR = \frac{n_e - (N/2)}{N/2}$$

n_e = Number of panel member of panel members indicating an item “essential”.

N = Number of panel members.

2.3.1.3 Convergence

Convergence refers to the extent to which expert opinions converge toward a specific response. The calculated value approaches zero as opinions converge toward a particular consensus, whereas the value increases as opinions diverge. In this study, a criterion for assessing inter-rater agreement among experts was set at ≤0.5 [33]. The convergence was calculated using the following formula:

$$Convergence = 1 - \frac{Q3 - Q1}{2}$$

Q3 = Evaluation score corresponding to the 75th percentile from the bottom of the distribution.

Q1 = Evaluation score corresponding to the 25th percentile from the bottom of the distribution.

Round 1 of the Delphi survey had 32 indicators (the eval-

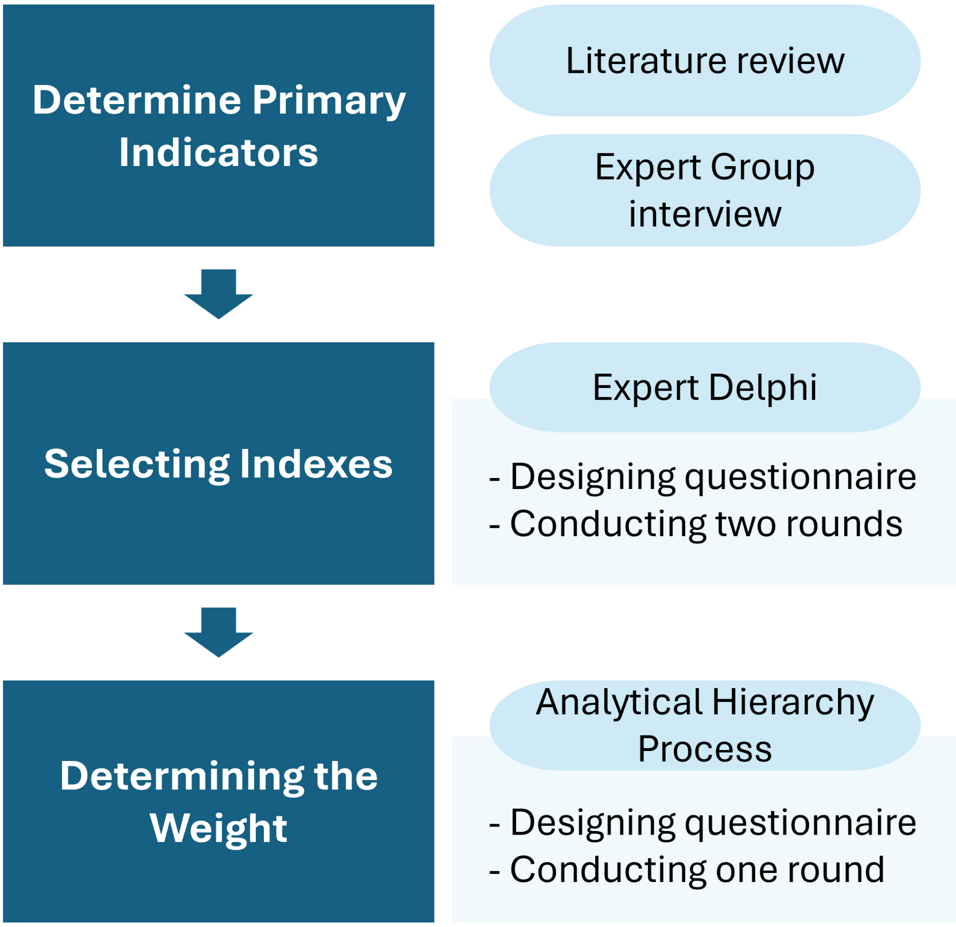

FIGURE 1. The flowchart of research process.

uation index had a coefficient α of 0.752), whereas Round 2 had 22 indicators (the evaluation index had a coefficient α of 0.977). The validity of the questionnaire was assessed using Cronbach's alpha values, resulting in an average of 4.21 and 6.21 for Rounds 1 and 2, respectively. These results indicate that the average value exceeded the median, suggesting the high validity of the Delphi survey.

2.3.2 Analytic hierarchy process survey (AHP)

The analytic hierarchy process survey evaluates priorities or importance based on human judgment of aspects that cannot be measured directly [26]. In this study, the AHP technique was applied to calculate the importance and priority of indicators for selecting elite male youth singles badminton players in South Korea, which were finalized through a Delphi survey. The CI and CR were used to determine whether respondents maintained judgement consistency. A CR value of $\leq$0.1 or less indicates consistency, and a CR value of $>$0.1 indicates inconsistency, leading to exclusion from the analysis [34]. RI (Random Index) is the average of the consistency index of reciprocal matrices randomly arranged with numbers from 1 to 10. Table 2 presents the RI values.

3. Results

3.1 Preliminary indicator selection

Table 3 presents the preliminary indicators to be considered for selecting elite male youth badminton singles players based on a literature review [4, 18, 20, 23] and expert meetings. The indicators were categorized into two primary, five secondary and 32 tertiary indicators. These initial indicators were unanimously agreed upon through expert meetings and served as the basis for conducting the Delphi survey among the expert group.

3.2 Delphi survey results

Table 4 presents the results of the Delphi Rounds 1 and 2. Both rounds were conducted with 14 experts using closed-ended questionnaires. Based on the results of Round 1, 22 of the initial 32 detailed indicators were selected. Specifically, 10 indicators (physique (length): sitting height, thigh length and lower leg length; and physique (circumference): neck, chest, waist, arm, wrist, hip and ankle circumference) were excluded as they did not meet the CVR ($\geq$0.51) criterion. Among the excluded indicators, two (sitting height and wrist circumference) also did not meet the consensus criterion ($\geq$0.75). In Round 2, 15 of the 22 indicators selected in Round 1 were retained. Specifically, seven indicators (composition: skeletal muscle mass and body weight; motor performance (fitness): muscular strength, flexibility, aerobic capacity and coordination; and motor performance (coordination): auditory ability) were excluded as they did not meet the convergence

TABLE 2. RI values.

N	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

$$CI = (\lambda max - n)/(n - 1)$$

$$CR = (CI/RI) \times 100\%$$

Note: RI, Random index; CI, Consistency index; CR, Consistency ratio.

TABLE 3. Preliminary indicator selection.

Primary indicator	Secondary indicator	Tertiary indicator
Physique		
	Length	Height
		Sitting height
		Arm length
		Leg length
		Thigh length
		Lower leg length
	Circumference	Neck circumference
		Chest circumference
		Waist circumference
		Arm circumference
		Wrist circumference
		Hip circumference
		Thigh circumference
		Calf circumference
		Ankle circumference
	Composition	Body fat percentage
		Fat free mass
		Skeletal muscle mass
		Weight
Motor performance		
	Physical strength	Muscular strength
		Muscular endurance
		Speed
		Power
		Agility
		Balance
		Flexibility
		Aerobic capacity
		Anaerobic capacity
	Coordination ability	Coordination
		Spatial perception ability
		Visual ability
		Auditory ability

(≤0.5) and consensus (≥0.75) criteria. Among the excluded indicators, one (body weight) did not meet the CVR (≥0.51) criterion.

3.3 Analytic hierarchy process analysis result

Based on the indicators selected through the Delphi survey, prioritization was derived through AHP analysis. The responses from the experts consistently met the consistency criterion (CR <0.1), and the AHP analysis was conducted once. For the primary indicators, both physique and motor performance were indicated as being 50% important. For the secondary indicators, among the somatotype factors, length and composition were indicated as being 45% important, whereas circumference accounted for 10%. Among the motor performance factors, physical strength was indicated as being 51% important, which was slightly higher than coordination ability at 49%. Upon examining the tertiary indicators, height was prioritized in physique (length), thigh circumference in physique (circumference), body fat percentage in physique (configuration), agility in motor performance (physical strength) and visual ability in motor performance (coordination ability). Comprehensively, body fat percentage within the somatotype factors emerged as the most crucial indicator for selecting outstanding male singles badminton players. Visual acuity in motor performance ranked second, followed by height in the somatotype, spatial ability in motor performance and agility in motor performance as the third, fourth and fifth priorities, respectively. Calf circumference was the least significant indicator (Table 5).

4. Discussion

This study explored indicators for selecting elite male youth badminton singles players. Specifically, this study used a Delphi survey to identify selection indicators for these players based on their physical characteristics and abilities. To achieve this, a preliminary set of indicators was derived through literature review and expert meetings. Based on these initial indicators, a Delphi survey was conducted to reach a consensus among the experts. Finally, the indicators derived from the Delphi survey were used to calculate their importance and priority through AHP.

This study used the Delphi method to select factors for identifying elite youth male badminton singles players. Despite several limitations of the Delphi method, including potential researcher bias, challenges in expert selection, and limited communication methods [35], it is widely used across various fields due to its advantage of reaching a consensus among experts without face-to-face interaction. Specifically, the Delphi method eliminates the influence of other experts as it avoids face-to-face interaction, and it allows for repeated feedback to achieve expert consensus [36]. Previous studies utilizing the Delphi method in the field of sports have demonstrated its applicability. For instance, the Delphi method was applied to define the concept of youth sports specialization [37], to select non-game indicators for basketball player selection [4] and to establish a physical fitness evaluation system for wheelchair badminton players [22].

This study selected anthropometric characteristics as the primary factors for selecting elite male youth badminton singles players. This is supported by numerous previous studies that have suggested anthropometric characteristics as key factors for evaluating the growth potential and performance of young athletes [4, 10]. However, evaluating the performance and growth potential based solely on anthropometric characteristics has limitations, and future studies should also consider various psychological and environmental factors.

The Delphi method was used to explore the selection factors for elite male youth badminton singles players. This method is a generalized research technique to validate content by solving problems based on expert opinions [38–40], making the expert selection crucial. The study selected only Korean experts, which could be a limitation. However, South Korea has demonstrated high badminton performance levels, winning 20 medals since the 1992 Barcelona Olympics, when badminton was first included as an official sport, to the 2020 Tokyo Olympics [41], maintaining a leading position in the badminton world. In addition, during the 2023 Hangzhou Asian Games, South Korea won seven medals, reinforcing its reputation as a badminton powerhouse. Korean badminton coaches are also sought internationally, with notable examples including Park Joo-bong in Japan, Kang Kyung-jin in China and Kim Ji-hyun in India [42, 43]. This shows that the expertise of Korean badminton coaches is globally recognized, suggesting that the study findings may be appropriate for selecting elite male youth badminton singles players in various Asian countries.

Two rounds of Delphi surveys and AHP analysis ranked the importance of physique as height, arm length and leg length for length factors; lean body mass and body fat percentage for composition factors; and thigh and calf circumferences for circumference factors. The selection of leg length and thigh and calf circumferences in the length and circumference factors, respectively, can be attributed to the nature of singles matches, which require a broader range of movement than doubles matches [44]. Kim [45] supported the selection indicators of this study, suggesting that elite players tend to have longer legs; shorter torsos; larger hips; and smaller thigh, calf, and ankle circumferences, fitting a central somatotype [46]. Lean body mass ranked first overall, whereas body fat percentage ranked seventh, aligning with the use of these metrics to evaluate athletes' body composition [47]. The relationship between lean body mass and badminton performance has been further confirmed by studies showing that elite players with higher lean body mass have better jump performance, whereas excessive body fat negatively affects sprint and jump performance [48].

For motor performance, agility, explosiveness, muscular endurance, speed, balance and anaerobic capacity were identified as key indicators. In badminton, physical fitness significantly influences performance, accounting for 43.8% of performance variance [49]. Agility, muscular endurance, speed, explosiveness, balance and anaerobic capacity are critical, regardless of singles or doubles badminton [50–53]. Phomsoupha and Laffaye [23] also supported this by highlighting that badminton performance is determined by speed, agility, flexibility, mus-

TABLE 4. Delphi analysis results.

Primary indicator	Secondary indicator	Tertiary indicator	Round 1				Round 2			
			Convergence	Consensus	CVR	Result	Convergence	Consensus	CVR	Result
Physique	Length	Height	0.50	0.75	1.00	O	0.00	1.00	0.86	O
		Sitting height	0.50	0.67	−0.14	X				
		Arm length	0.50	0.75	0.86	O	0.00	1.00	0.71	O
		Leg length	0.00	1.00	0.86	O	0.00	1.00	0.71	O
		Thigh length	0.50	0.75	0.29	X				
		Lower leg length	0.00	1.00	0.43	X				
	Circumference	Neck circumference	0.38	0.75	−0.86	X				
		Chest circumference	0.50	0.75	0.29	X				
		Waist circumference	0.38	0.81	0.43	X				
		Arm circumference	0.38	0.81	0.43	X				
		Wrist circumference	0.50	0.67	−0.29	X				
		Hip circumference	0.50	0.75	0.14	X				
		Thigh circumference	0.38	0.81	0.71	O	0.38	0.85	0.57	O
		Calf circumference	0.00	1.00	0.71	O	0.38	0.85	0.57	O
		Ankle circumference	0.00	1.00	0.43	X				
	Composition	Body fat percentage	0.50	0.75	1.00	O	0.38	0.88	0.71	O
		Fat free mass	0.50	0.75	0.71	O	0.50	0.82	0.57	O
		Skeletal muscle mass	0.50	0.75	1.00	O	0.88	0.71	0.71	X
		Weight	0.38	0.81	0.86	O	1.00	0.67	0.14	X
Motor Performance	Physical strength	Muscular strength	0.50	0.80	0.86	O	0.88	0.71	0.71	X
		Muscular endurance	0.00	1.00	1.00	O	0.50	0.85	0.86	O
		Speed	0.00	1.00	1.00	O	0.50	0.85	0.86	O
		Power	0.00	1.00	1.00	O	0.50	0.83	0.86	O
		Agility	0.00	1.00	1.00	O	0.50	0.85	0.86	O
		Balance	0.50	0.75	0.86	O	0.50	0.83	0.86	O
		Flexibility	0.38	0.85	1.00	O	1.00	0.67	0.86	X
		Aerobic capacity	0.00	1.00	1.00	O	1.00	0.69	0.86	X
		Anaerobic capacity	0.50	0.75	1.00	O	0.38	0.88	0.71	O
	Coordination ability	Coordination	0.50	0.80	1.00	O	1.00	0.67	0.86	X
		Spatial perception ability	0.50	0.80	1.00	O	0.50	0.83	0.71	O
		Visual ability	0.00	1.00	1.00	O	0.50	0.83	0.71	O
		Auditory ability	0.38	0.84	0.86	O	0.88	0.68	0.71	X

O, reserve; X, exclude; CVR, content validity ratio.

TABLE 5. AHP analysis result.

Primary indicator	Secondary indicator	Tertiary indicator	Total weight	Priority rank	CR (CI)	Composite score	Rank
Physique (0.50)							
	Length (0.45)	Height	0.52	1	0.05 (0.02)	0.12	3
		Arm length	0.27	2	0.05 (0.02)	0.06	6
		Leg length	0.21	3	0.05 (0.02)	0.05	11
	Circumference (0.10)	Thigh circumference	0.73	1	0.00 (0.00)	0.04	12
		Calf circumference	0.27	2	0.00 (0.00)	0.01	15
	Composition (0.45)	Body fat percentage	0.26	2	0.00 (0.00)	0.06	7
		Fat free mass	0.74	1	0.00 (0.00)	0.17	1
Motor performance (0.50)							
	Physical strength (0.51)	Muscular endurance	0.19	3	0.01 (0.01)	0.05	9
		Speed	0.19	3	0.01 (0.01)	0.05	10
		Power	0.22	2	0.01 (0.01)	0.06	8
		Agility	0.25	1	0.01 (0.01)	0.06	5
		Balance	0.08	4	0.01 (0.01)	0.02	13
		Anaerobic capacity	0.07	5	0.01 (0.01)	0.02	14
	Coordination ability (0.49)	Spatial perception ability	0.45	2	0.00 (0.00)	0.11	4
		Visual ability	0.55	1	0.00 (0.00)	0.13	2

Note: AHP, Analytic hierarchy process; CR, Consistency ratio; CI, Consistency index.

cular endurance and explosiveness [54]. Furthermore, Huang, Lin & Hu [3] identified five indicators that should be considered in badminton player selection: body type, physical quality, physical function, psychological quality, and intelligence level. Among these, physical quality (speed, reaction, bounce, muscular endurance, flexibility) ranked the highest, aligning with the results of this study. The AHP overall ranking showed visual ability as the second most important coordination ability factor, which is crucial for the visual reaction time needed in badminton [55, 56]. Shim *et al.* [57] indicated the importance of visual reactions in racquet sports; elite players have faster visual reaction times [58, 59] and wider visual fields [60], further supporting the findings of this study.

The Korea Sports Association provides regulations and operational guidelines to ensure fair selection of athletes, specifying criteria, ratios, schedules and performance indicators for age group national team selections ("Amendment to the Regulations for Selection and Operation of National Representatives by the Korea Sports Association, 29 July 2021" [61]). However, irregularities in athlete selection continue to be reported. Elite badminton player selection lacks specific regulations and relies heavily on expert subjective opinions. Therefore, the study findings are expected to be practically applicable in future elite badminton player selection processes and can serve as foundational data across various sports disciplines.

5. Conclusions

This study explored the selection factors for elite male youth badminton players in South Korea based on physical characteristics and abilities using a Delphi survey. The study findings can serve as scientific and objective indicators to select and evaluate such players in the sports field.

However, this study has several limitations. First, the results were specific to male youth singles players, limiting their applicability to doubles players, female singles players, or adult players. Second, the experts selected for this study were Korean coaches and researchers, which may have resulted in differences in opinions and could have been avoided selecting coaches from other countries. Finally, this study focused solely on physical characteristics and abilities and neglected psychological, environmental and physiological factors.

Future research should expand to include doubles players and adult athletes, as well as gather opinions from coaches from various countries for a comparative analysis. Additionally, studies should be conducted considering psychological, environmental, physiological and epidemiological factors. The results of this study can be utilized in the practical selection of elite players and serve as foundational data for research that considers specific badminton events, age groups and sexes.

ABBREVIATIONS

AHP, analytic hierarchy process; CI, consistency index; CR, consistency ratio; CVR, content validity ratio; RI, Random index.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available upon reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

EJ and SEO—conceptualization, methodology. SEO—analyzed the data, writing manuscript. EJ—resources, writing manuscript, supervision. All authors have read and agree to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The Institutional Review Board of the Korea National University of Education approved this study and all tests were completed before the start of the season (KNUE-202209-SB-0404-01). All participants completed an informed consent form after being briefed on the procedures, in accordance with the Declaration of Helsinki on Human Experimentation.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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