

**Talent Selection for Bowling by the Analytical Hierarchy Process (AHP)**

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ORIGINAL RESEARCH

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**Öz**

Bu araştırmanın temel amacı bowling disiplinde gerekli kriterleri ortaya koymak, Analitik Hiyerarşi Süreci (AHS) yöntemini kullanarak bu kriterlerin branşa yetenek seçimi açısından önemini belirlemek ve bowling için yetenek seçimi sürecine basit bir temel oluşturmaktır. Bu amaçla 2022 Avrupa Gençler Bowling Şampiyonasına katılan çeşitli ülkelerin milli takım antrenörlerinin AHS yönteminin temelini oluşturan görüşlerinden yararlanılmıştır. Yapılan ikili karşılaştırmalar sonucunda bowling branşına yönelik yetenek seçiminde ihtiyaç duyulan dört ana kriter arasında bilişsel özellikler en önemli kriter olup bunu sırasıyla psikososyal özellikler, motorik özellikler ve antropometrik ve fiziksel özellikler takip etmektedir. Ana kriterlere ilişkin alt kriterler incelenip bütünleştirildiğinde bilişsel özellikler arasında en yüksek yüzdesel ağırlığa sahip alt kriter öz denetimdir. Buna karşılık en düşük ağırlığa sahip alt kriter problem çözme yeteneğidir. Psikososyal özelliklere ilişkin ağırlık yüzdesi ile en önemli alt kriter özgüven yaklaşımı iken, en az önemli olan alt kriter ise dışa dönük kişilik özelliğidir. Motorik özelliklere ilişkin ağırlık yüzdesi en yüksek olan alt kriter denge ve koordinasyon iken, en düşük ağırlık yüzdesine sahip alt kriter ise anaerobik güçtür. Son olarak antropometrik ve fiziksel özellikler alt kriterlerinden en yüksek ağırlık yüzdesi vücut ağırlığı, en düşük alt kriterler ise deri kıvrımı ve çevre ölçümleridir. Bowling branşında genel olarak yetenek seçiminde en önemli kriterler otokontrol, odaklanma, denge ve koordinasyon olmuştur.

**Anahtar kelimeler:** Bowling, Analitik Hiyerarşi Süreci, Yetenek Seçimi, Spor.

**Talent Selection for Bowling by the Analytical Hierarchy Process (AHP)**

**Abstract**

The main purpose of this research is to reveal the necessary criteria in the bowling discipline, to determine the importance of these criteria in terms of talent selection for the branch using the Analytical Hierarchy Process (AHP) method, and to create a simple basis for the talent selection process. For this purpose, the opinions form the basis of the AHP method of the national coaches of various countries participating in the 2022 European Youth Bowling Championship were used. As a result of pairwise comparisons, four main criteria which are needed for the bowling branch in talent selection; cognitive features are the most important criteria, followed by psychosocial characteristics, motoric characteristics, and anthropometric and physical characteristics, respectively. When the sub-criteria related to the main criteria are examined and integrated, self-control is the sub-criterion with the highest percentage weight among the cognitive characteristics. In contrast, the sub-criterion with the lowest weight is problem-solving ability. Whereas the most important sub-criterion with a weight percentage related to psychosocial characteristics is the self-confidence approach, the least important sub-criterion is the extrovert personality characteristic. The sub-criterion with the highest weight percentage related to motoric characteristics is balance and coordination, while the sub-criterion with the lowest weight is anaerobic power. Finally, among the anthropometric and physical characteristics sub-criteria, the highest weight percentage is body weight, while the lowest sub-criteria are skinfold and circumference measurements. Generally, the most important criteria for talent selection in the bowling branch have been self-control, focusing, balance, and coordination.

**Keywords:** Bowling, Analytic Hierarchy Process, Talent Selection, Sport.

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## Introduction

The concept of talent is a term debated in terms of its psychological, pedagogical, and sociological aspects by different researchers. Talent selection in sports includes individuals who are assumed to have a high level of competence in sports activities (Demiral, 2007). This competence can be innate or acquired later in life (Demiral, 2007). This concept is still under debate. For instance, Özal et al. (2003) have argued that talent is a natural ability to learn or do something, whether it is an innate power or acquired later. Talent selection in sports can be determined through a natural process or scientific methods. A person's inclination towards a sport they love or the direction towards a branch by various intermediaries (coaches, teachers, etc.) in the natural course of life and success in that branch represents natural talent selection (Bompa and Haff, 2009). However, in recent years, scientific talent selection has been formed through scientific screenings, tests, surveys, etc., increasingly producing more accurate results in talent determination (Bompa and Haff, 2009).

The Analytic Hierarchy Process (AHP) method is one of the most widely used methods in multi-criteria decision analysis across various fields of science. This method is also an effective tool for managing multi-criteria processes, such as talent selection of sports science; there is limited literature on using AHP. In football, studies such as "Evaluation of Talent Selection in Football Using Analytic Hierarchy Process and TOPSIS Method" by Esen and Uslu (2020) and "Evaluation of Forward Players' Abilities and Skills with the Analytic Hierarchy Process (AHP) Technique" by Sipahi and Or (2005) have utilized the AHP method for talent selection. AHP is a multi-criteria decision-making method that effectively achieves success by scoring and ranking decision alternatives using multiple factors (Zahedi, 1986). AHP is based on pairwise comparisons of criteria. In this context, using the AHP method can simplify determining the importance of criteria specific to talent selection in a sport and, ultimately, the integrated importance of these criteria for the sport.

Bowling is a discipline that requires goal-oriented and manipulative skills. Despite not involving direct competition or physical contact, this discipline requires many characteristics, including physical, cognitive, and psychological attributes. When reviewing the relevant literature, it is evident that talent selections are made not only through natural means but also with scientific measurements. However, without systematic processing of the numerical values obtained through these methods, effective results may not be achieved. The use of the AHP method in data processing and preference modeling in this context will contribute significantly to the literature.

This study aims to identify the important values of criteria for talent selection in bowling using the AHP method by defining the criteria that present requirements in the discipline. Thus, a simple hierarchy will be created for the talent selection process. In the context of bowling, no study in the

literature evaluates talent selection criteria using this method. The research data contributes to the literature by being the first of its kind in the context of bowling but also provides valuable insights to relevant individuals and institutions. This reveals the importance and unique value of our research.

## Materials and Methods

This study utilized the survey model. The competencies foreseen for the bowling branch were collected under "criteria." The AHP method was used to determine the importance levels in the context of these criteria. In the pairwise comparison process of the criteria in question, the opinions of experts (coaches with a 2nd-level or above bowling coach certificate) who have been coaching for a minimum of 5 years were used. The outputs of the experts' opinions, the pairwise comparison matrix, constituted the input data of the AHP method.

During the current research, we acted within the framework of the "Higher Education Institutions Scientific Research and Publication Ethics Directive".

### *Analytic Hierarchy Process Method*

The Analytic Hierarchy Process (AHP) is a method that facilitates reaching the correct result in the multi-criteria problem-solving process proposed by Thomas Saaty (Saaty, 1980) in the 1970s. AHP more easily solves problems that cannot be solved with daily methods and where there are difficulties in solving problems (Jabri, 1990). Additionally, AHP is a method that provides easy analysis by classifying the data collected for problems using various sources in order of importance (Wind and Saaty, 1980). In the first stage of AHP, the main target is determined, the necessary criteria for this target are determined, and pairwise comparison matrices (Equation 1) of the selected criteria are created. Thus, the complex decision-making process between criteria is reduced to a single level, and the relative importance values of the criteria are obtained.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \quad \text{Equation 1}$$

Where  $a_{nn}$  denotes the  $n$ th indicator unit, and  $a_{nn}$  indicates the decision matrix elements.

The importance of the criteria against each other is done using values ranging from 1-9 (Table 1).

Table 1

Saaty's Relative Importance Scale (Saaty, 2008).

Degree of Importance	Definitions	Explanations
1	Equal Importance	The options contribute equally to the objective.
3	Moderate Importance	Experience and judgment favor one criterion over the other.

5	Strong Degree of Importance	One criterion is much more favorable than the other.
7	Very Strong Degree of Importance	One criterion is superior to the other, and experiments prove this.
9	Absolute Importance	The preponderance of one criterion gave the most evident results in the experiments compared to the other.
2-4-6-8	Intermediate Values	Situations where no clear decision can be reached according to the results of the experiment.

In the second stage of the AHP methodology, the geometric mean of the criteria (equation 2) is computed, and their normalized weights are defined.

$$W = \frac{G_m}{\sum_{n-1}^n G_m} \quad \text{Equation 2}$$

Where  $W$  is the eigenvector, and  $G_m$  is the geometric mean of the  $i^{\text{th}}$  row of the decision.

In the last stage of AHP calculations, the consistency of the normalizations of the criteria is tested using Equation 3. If  $CR$  is less than 0.10, it indicates that the normalized weight values of the criteria are consistent after pairwise comparisons, and if it is greater than 0.10, it shows that pairwise comparisons should be designed again.

$$CR = \frac{CI}{RI} \quad \text{Equation 3}$$

Where  $CR$  is the consistency ratio,  $CI$  is the consistency index calculated by equation 4, and  $RI$  is the randomness index determined according to the number of criteria in Table 2.

Table 2

$RI$  Values for the Matrix of Various Numbers (Saaty, 1980).

N	1	2	3	4	5	6	7	8	9	10
<b>RI</b>	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad \text{Equation 4}$$

Where  $\lambda_{max}$  is the maximum eigenvalue of the decision matrix calculated by Equation 5.

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^n \frac{(A_w)_i}{w_i} \quad \text{Equation 5}$$

### Research Group

The research group of the study consists of national bowling coaches from various countries coaching in the European Youth Bowling Championship held in Wittelsheim, France, in 2022. Among the selection criteria of the research group, in addition to participating in this tournament, being at least a 2nd-level bowling coach approved by the European Bowling Federation was considered.

### ***Determination of Talent Criteria for the Bowling Discipline***

The criteria that present requirements for talent selection in the bowling discipline were determined through bilateral interviews with expert coaches affiliated with the Turkish Bocce, Bowling, and Dart Federation, as well as through studies conducted in the literature on the bowling discipline (Kirschenbaum et al. 1982; Tan et al., 2000; Crust, 2007; Hon et al., 2009; Fuss, 2009; Abdollahipour et al., 2017; Stefopoulos et al., 2020; Petrie, 2020). In this context, as seen in Table 3, four main criteria and their corresponding sub-criteria were identified as the criteria to be used for talent selection in the bowling discipline.

Table 3

Main Criteria for Talent Selection in Bowling and Their Sub-criteria.

<b>Main Criteria</b>	<b>Anthropometric and Physical Characteristics</b>	<b>Cognitive Characteristics</b>	<b>Motoric Characteristics</b>	<b>Psychosocial Characteristics</b>
<b>Sub-criteria</b>	Body Weight	Problem Solving Skills	Anaerobic Strength	Coping With Stress
	Body Height	Attention Level	Aerobic Strength	Self-Confidence Approach
	Skinfold	Focusing	Flexibility	Emotional Intelligence Level
	Circumference (Biceps, Calf) Measurements	Perception	Promptness	Moral Decision- Making Attitude
	Width(Elbow,Knee) Measurements	Self Control	Balance And Coordination	Learning Attitude
	Fathom And Leg Lenght			Group Dynamics (Ability to work with a team)
	Forearm Lenght			Extrovert Personality
	Hand Size			Decision Making

### ***Data Collection Tools***

The form shown in Table 4 was utilized to obtain the data for this research. In the form, importance ratings for each criterion ranged from "1 for very low importance" to "10 for extremely high importance." Before filling out the form, all participating coaches were provided with a detailed explanation of the form, and then the data was collected digitally. Based on the evaluations received from the coaches, the importance value for each criterion was determined by calculating the arithmetic means. Subsequently, these arithmetic means were used to create input data for the "Analytic Hierarchy Process Method" in the form of comparison matrices.

Table 4

Criteria Importance Assessment form for Expert Opinions.

Main Criteria	Sub-Criteria	Very Low	Very Low to Low	Low	Low to moderate	Moderate	Moderate to High	High	High to Very High	Very High	Extremely High
Anthropometric and Physical Characteristic	Body Weight										
	Body Height										
	Skinfold										
	Circumference (Biceps, Calf) Measurements										
	Width (Elbow, Knee) Measurements										
	Fathom And Leg Lenght										
	Forearm Lenght										
	Hand Size										
	Problem Solving Skills										

Cognitive Characteristics	Attention Level
	Focusing
	Perception
	Self Control
Motor Characteristics	Anaerobic Strength
	Aerobic Strength
	Flexibility
	Promptness
	Balance And Coordination
Psychosocial Characteristics	Coping With Stress
	Self-Confidence Approach
	Emotional Intelligence Level
	Moral Decision- Making Attitude
	Learning Attitude
	Group Dynamics (Ability To Work With A Team)
	Extrovert Personality
	Decision Making

## Findings

This research section presents matrices and weight value tables obtained from the pairwise comparisons conducted in the AHP process. These tables include pairwise comparison matrices for each main criterion (Table 5) and their sub-criteria (Table 6). Table 5 contains the weight table for the main talent selection criteria in the bowling discipline. According to this weight table, cognitive characteristics have the highest weight percentage, at 46.0%, followed by psychosocial characteristics, at 27.2%. The main criteria with the lowest weight percentages are motoric characteristics at 18.0% and anthropometric and physical characteristics at 8.8%, respectively.

Table 5

The Pairwise Comparison Matrix and Normalized Weight ( $w_i$ ) of the Main Criteria of Talent Selection for Bowling with Percentage Weight (%).

Main criteria	(1)	(2)	(3)	(4)	$w_i$	% weight
(1) Anthropometric and Physical Characteristics	1				0.088	8.8
(2) Cognitive Characteristics	4	1			0.460	46.0
(3) Motoric Characteristics	3	1/3	1		0.180	18.0
(4) Psychosocial Characteristics	3	1/2	2	1	0.272	27.2

According to the pairwise comparison matrix for anthropometric and physical characteristics, the highest weight percentage is body weight at 28.6%, followed by hand size at 22.6% (Table 6). The anthropometric and physical characteristics with the lowest weight percentages were skin thickness and circumference measurements at 3.8%. According to the pairwise comparison matrix for cognitive characteristics, the characteristic with the highest weight percentage is self-control at 40.0%, followed by focusing at 26.6% (Table 6). The cognitive characteristics with the lowest weight percentages were perception and problem solving skills at 10.7% and 6.3%, respectively. When the pairwise comparison matrix for motoric characteristics is analyzed, it is seen that the criterion with the highest weight percentage is balance and coordination at 48.4%, followed by flexibility at 22.9% (Table 6). The cognitive characteristics with the lowest weight percentages were aerobic strength at 9.5% and anaerobic strength at 4.5%, respectively. In terms of psychosocial characteristics, the

highest weight value was the self-confidence approach at 21.3%, followed by decision-making characteristic at 21.2%, while the cognitive characteristics with the lowest weight percentage were moral decision-making attitude at 5.8% and extroverted personality characteristic at 3.2%, respectively (Table 6).

When the final weight values of all sub-criteria on talent selection for bowling ( $r_i \times w_i$ ) are examined, it is seen that the most important criterion is self-control at 18.40%, followed by focusing at 12.24%, balance and coordination at 8.71%, attention level at 7.54% and self-confidence approach at 5.79% (Table 6). The rest of the sub-criteria complete the remaining half (47.32%) of the total weight.

Table 6

The Pairwise Comparison Matrix and Normalized Weight ( $w_i$ ) of the Sub-criteria with Standardized Ratings ( $r_i$ ), Final Weight ( $r_i \times w_i$ ), and Percentage Weight (%) on Talent Selection for Bowling.

Sub-criteria	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	$r_i$	$w_i$	$r_i \times w_i$	% weight
<i>Anthropometric and Physical Characteristics</i>										0.088		
(1) Body Weight (kg)	1								0.286		0.025	2.52
(2) Body Height	1/3	1							0.125		0.011	1.10
(3) Skinfold	1/5	1/3	1						0.038		0.003	0.33
(4) Circumference (Biceps, Calf) Measurements	1/5	1/3	1	1					0.038		0.003	0.33
(5) Width (Elbow, knee) measurements	1/4	1/3	2	2	1				0.057		0.005	0.50
(6) Fathom And Leg Length	1/3	1/2	3	3	2	1			0.085		0.007	0.75
(7) Forearm Length	1/3	1	4	4	3	3	1/4		0.144		0.013	1.27
(8) Hand Size	1/2	2	5	5	5	4	1/2	1	0.226		0.020	1.99
<i>Cognitive Characteristics</i>										0.460		
(1) Problem Solving Skills	1								0.063		0.029	2.90
(2) Attention Level	3	1							0.164		0.075	7.54
(3) Focusing	4	2	1						0.266		0.122	12.24
(4) Perception	2	1/2	1/3	1					0.107		0.049	4.92
(5) Self Control	5	3	2	3	1				0.400		0.184	18.40
<i>Motoric Characteristics</i>										0.180		
(1) Anaerobic Strength	1								0.045		0.008	0.81
(2) Aerobic Strength	3	1							0.095		0.017	1.71
(3) Flexibility	5	3	1						0.229		0.041	4.12
(4) Promptness	4	2	1/2	1					0.147		0.026	2.65
(5) Balance and Coordination	7	5	3	4	1				0.484		0.087	8.71
<i>Psychosocial Characteristics</i>										0.272		
(1) Coping with Stress	1								0.148		0.040	4.03
(2) Self-confidence Approach	2	1							0.213		0.058	5.79
(3) Emotional Intelligence Level	1/2	1/2	1						0.098		0.027	2.67
(4) Moral Decision- Making Attitude	1/3	1/3	1/2	1					0.058		0.016	1.58
(5) Learning Attitude	1	1/2	2	3	1				0.144		0.039	3.92
(6) Group Dynamics (Ability to work with a team)	1/2	1/2	1	2	1/2	1			0.094		0.026	2.56
(7) Extrovert Personality	1/5	1/6	1/4	1/3	1/4	1/3	1		0.032		0.009	0.87
(8) Decision Making	2	1	2	4	2	2	4	1	0.212		0.058	5.77

## Discussion and Conclusion

This study aims to create a simple and usable framework for talent selection in the bowling discipline using the Analytic Hierarchy Process (AHP) method. For this purpose, the opinions of the coaches of various countries involved in an international bowling tournament were used as a basis. In this context, the natural talent selection criteria for bowling were categorized under four main criteria. The first of these criteria is bowling athletes' anthropometric and physical characteristics. According to bowling coaches, the most important anthropometric and physical characteristics a bowling athlete should possess are body weight and hand size. Following these characteristics, findings included other parameters such as forearm length and body height. When examining the parameter of body weight in bowling athletes, the research conducted by Tan et al. (2000) supports our findings. Researchers found, through kinematic and kinetic analyses, that body weight plays an important role in the footwork a bowling athlete applies for a throw and affects the performance of the throw. On the other hand, Hon et al. (2009) stated that hand size and arm length in the upper extremities are this discipline's most fundamental biomechanical parameters. According to researchers, these fundamental biomechanical parameters are crucial in bowling for grasping the bowling ball more comfortably and are essential for applying swing, angular velocity, rolling, inclination angle, and acceleration during intervention with the ball, depending on arm length. Additionally, according to the national coaches in our research group, one of the most essential characteristics a bowling athlete should possess is body height. When examining relevant studies, a biomechanical correlation between body height and hand size in terms of grasping the bowling ball was observed in the literature, and this relationship was found to be related to athletic performance in bowling (Zahudi et al., 2023). Since bowling is a sports branch that requires goal-oriented manipulative skills, based on both our research findings and the studies in the literature on the subject, as a predictor of successful performance in bowling, Anthropometric and physical characteristics such as body weight, hand size, forearm length, and body height are thought to be important in the talent selection process.

According to our research findings, it is possible to say that cognitive characteristics such as self-control, focusing, and attention level are the most important characteristics according to the parameters that bowling coaches consider by considering cognitive characteristics in the talent process with the analytic hierarchy process. When the findings of researchers who studied various cognitive characteristics in bowling athletes were examined, data that overlapped with our results were found (Kirschenbaum et al., 1982; Crust, 2007; Abdollahipour et al., 2017). The first of these studies is Kirschenbaum et al. (1982). In this study, the researchers examined the relationship between various cognitive performances and bowling performances of 60 amateurs and 67 professional



bowlers. In the research results, they found a relationship between cognitive skills such as focusing and attention level and bowling sports performance and that professional athletes had more advanced cognitive skills (such as focusing, attention level, and self-control). Crust (2007), on the other hand, examined the cognitive skills of bowling athletes by considering their throwing performance scores (above and below 170 points). In this study, it was determined that cognitive characteristics such as attention level and focusing were directly related to bowling sports performance and that athletes with an average score above 170 had more focusing and attention skills. These results indicate similar findings in adolescent athletes as in adult bowlers. Abdollahipour et al. (2017) emphasized that in order for adolescent bowlers to have a successful sportive performance and to provide internal/external control, the athletes in this period should have a high level of self-control and attention level as well as a strong focusing. Varol and Türkmen (2021), who worked with similar age groups, stated that goal-oriented disciplines such as bocce, bowling, and darts improve cognitive features such as focusing and attention levels in individuals of all age groups. Considering the research results that are in parallel with our findings, it is thought that the development of athletes' self-control, attention level, and focusing by cognitively controlling internal and external factors is very important for the success of the performance to be exhibited in bowling sport.

When examining the findings related to the third criterion, motor characteristics, which are considered for talent selection in bowling sports in the study, it is evident that the research group gave the highest importance to balance and coordination. Following this motor characteristics, flexibility, and promptness were also found to be important for talent selection in bowling. To explain these findings, it is necessary first to analyze the biomechanics of a bowling shot. Fuss (2009) analyzed the equipment and bowling shot performance used in bowling sports. The results indicated that for each bowling shot technique, it is essential to properly coordinate the entire body during the ball's grip, the required steps, and finally, the ball's release from the hand. Fuss emphasized the importance of bowlers having developed balance skills to achieve this coordination. The literature on this topic is consistent with both the aforementioned study and our research findings. Stefopoulos et al. (2020) conducted a study with male bowling athletes; their findings can serve as an example. These researchers examined athletes' postural control level and stated that the most important motor skills in bowling are dynamic balance, coordination, and hip flexibility. On the other hand, Hung et al. (2012) mentioned motoric characteristics such as strength and promptness in the movements required for sportive performance in bowling and examined the importance of these parameters in both the upper and lower extremities. They stated that the predominant focusing of the strength mentioned here is the throwing shoulder and knees. As a result, it is thought that parameters such as balance, coordination, flexibility, and promptness are prioritized among the motoric characteristics that should be considered for talent selection in bowling.

When the priority ranking of psychosocial characteristics in the talent selection process in bowling sport based on the opinions of the coaches in our research group is examined, it was found in our research result that self-confidence, decision-making, and coping with stress are respectively. Petrie (2020) examined various psychosocial parameters of bowling athletes and emphasized that bowling shots cause a severe stress load in athletes and that these athletes should have high self-confidence and skills to cope with stress. Gordon (2020) conducted qualitative research on decision-making in goal-oriented sports. In this study, the researcher stated that in the bowling discipline, it is essential to have the ability to make clear and accurate tactical decisions under pressure. Similar results were obtained in bocce and darts disciplines that require shooting at the targeted point, like bowling. Uluç and Akçakoyun (2022) stated that focused attention skills could predict sportive success in these disciplines. As a result, it is thought that characteristics such as self-confidence, decision-making, and coping with stress in bowling discipline stem from the critical shots inherent in the nature of the sport. Because the possibility of a bowler making a strike with one shot in a frame is as high as the possibility of being split due to environmental and psychological conditions. Therefore, in the case of a split, which occurs when two pins stand far from each other, the athletes are expected to make the right decision by trusting themselves and realizing the shot by coping with the stress of that moment. In summary, it is thought that our findings and the research results in the literature on the subject show such a distribution for this reason.

Table 6 shows the weight analysis of the sub-criteria under the four main criteria determined for the bowling branch on talent selection. Firstly, when the main criteria are considered, according to the weight ratios ( $w_i$ ), the main criterion of cognitive characteristics ranks first at 46.0%. This criterion is followed by psychosocial characteristics at 27.2% and motoric characteristics at 18.0%. The main criterion with the lowest weight percentage is anthropometric and physical characteristics at 8.8%. When the final percentage importance values ( $w_i \times r_i$ ) related to the AHP talent selection sub-criteria in bowling are analyzed, it is seen that the most important criterion is self-control at 18.40%, followed by focus at 12.24%, balance and coordination at 8.71%, attention level at 7.54% and self-confidence approach at 5.79%. In this context, there are not enough studies on the criteria related to talent selection specific to bowling sport. However, the results obtained when the studies on talent selection of goal-oriented sports branches are examined, although they are not specifically about bowling sport, align with our findings. Soeed's (2016) research on the criteria related to the talent selection processes of sports branches related to young Malaysian athletes from various sports is an example. In this study, it was stated that parameters such as speed, quickness, agility, reaction time, and cardiovascular endurance do not directly contribute to sporting performance in goal-oriented disciplines, including bowling, but parameters such as concentration, self-control, self-confidence, and motivation are very important both in the talent selection process and in the sporting

performance of athletes competing in goal-oriented disciplines. On the other hand, Razman et al. (2012) examined only anthropometric and physical characteristics in a study conducted with elite and semi-elite bowlers and conducted a talent selection process by considering the criteria related to these characteristics in a sedentary research group of 33 individuals. From an anthropometric point of view, the researchers found that elite bowlers had high body weight, long lower legs and arms, and large hands despite bowling. Therefore, the study recommended that bowling coaches select bowlers with both these parameters: muscular forearm/wrist, internal rotation strength, and strong-arm flexors. Similar data were obtained in Razman's (2013) doctoral thesis study on critical parameters related to bowling. While these studies focused only on anthropometric and physical characteristics, according to our findings, no specific study was found on cognitive and psychosocial characteristics, the most important main criteria in bowling discipline. However, based on the results of studies examining various characteristics of bowling athletes (Kirschenbaum et al., 1982; Abdollahipour et al., 2017; Petrie, 2020; Varol and Türkmen, 2021) and our findings, it is thought that self-control, focus, balance and coordination, attention level and self-confidence parameters are among the most important criteria of goal-oriented bowling discipline.

With the use of the AHP method in bowling sport and the findings obtained as a result of this study conducted with the national team coaches of various countries to examine the talent selection criteria and taking into consideration the studies in the literature on the subject,

- It has been concluded that the most important anthropometric and physical characteristics in bowling sport are body weight and hand size, while skinfold and circumference measurements are the least important.
- It has been concluded that among the main criteria required for talent selection in bowling sport, the most important main criterion is cognitive characteristics, and the least important main criterion is anthropometric and physical characteristics.
- According to the importance weights related to the sub-criteria of all main criteria, the most important sub-criteria required for talent selection in bowling are self-control, focusing, balance and coordination, attention level, and self-confidence.
- According to the importance weights related to the sub-criteria of the main criteria, the least important sub-criteria required for talent selection in bowling sport are skinfold, circumference measurements, width measurements, extrovert personality characteristics, and anaerobic strength parameters.

Depending on the results obtained, recommendations for various individuals, institutions, and organizations related to the subject are given below.

- In the selection of competitive athletes in bowling, it is recommended to consider their cognitive and psychosocial characteristics and physical parameters.
- It is recommended to expand talent screening for bowling nationally and internationally.
- It is recommended that the relevant federations and ministries carry out talent screening for bowling sports for these suggested screening programs to have scientific features and for the appropriate parties to record this data systematically.
- In addition to scientific selection processes, in the case of natural selection in bowling clubs, it is recommended that bowling coaches make selections by considering all parameters.
- Considering that there is a lack of studies on the subject in both domestic and foreign literature that include cognitive and psycho-motor characteristics and turn these features into a talent selection norm, it is recommended to increase studies on this subject.
- At the same time, comparing the screenings carried out with scientific and natural selection regarding talent selection in bowling sport with long-term follow-ups is recommended.

### **Ethics Committee Permission Information**

Ethics review board: Bayburt University Ethics Committee

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### **Contributions**

This study was produced from the master's thesis study by Umut Diyar Gök, the first author, supervised by Mehmet Ali Ceyhan, Bayburt University Graduate School of Education, Department of Physical Education and Sports. In addition, it was published in the proceedings book of the 7th International Academic Sports Research Congress as an abstract text. The study's third author, Ümit Yıldırım, a Ph.D. student at Bayburt University, Graduate School of Education, Department of Physical Education and Sports, contributed to the study in Analytical Hierarchy Process calculations.

### **Conflict of Interest**

The authors declares no conflict of interest.

### **Statement of Support and Acknowledgements**

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