

The correlation between intelligence and competitive activities of elite female handball players

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Abstract:

Performing complex tactical routines in handball, in variable game situations, necessary displaying an understanding the actions and movements requires a great deal of athlete's intellectual readiness. *Aim:* to investigate the influence of intellectual qualities on the efficiency of elite female handball players' competitive activity. *Materials and methods:* the study was conducted on the basis of women team of Super League, bronze medalist of the Handball Championship of Ukraine. In accordance with the aim, using the Culture Free Intellect Test (CFIT) and INTEST computer test, the level of intellectual qualities of female handball players was investigated. Using developed by coaching staff of Handball Club (HC) “Dnipryanka” team methods for determining useful activities, the features and efficiency of handball players' playing functions were studied and the correlation between these indexes was determined. Experimental study was conducted during the 2018-2019 season. *Results:* it was found that according to CFIT method the highest result in intellectual qualities backs showed – 95 points, centres – 92 points, wings showed satisfactory level – 89 points, and average IQ of the team was within 92 points. According to the results of the INTEST there is substantial advantage in logical and operational thinking demonstration, namely the backs showed 100 %, pivots also showed 100 % and centres - 95 %. The backs were slightly lower in efficiency. The effectiveness of competitive activity in the team was following: the most effective players are wings (9.5 points), virtually the same result was shown by pivots (9.4 points) (8,9 %) and centres (7,8 points). Goalkeepers' efficiency ratio was 7,5 points. *Conclusions:* it was found that there is the correlation between level of intellectual qualities development and competitive activity efficiency of elite female handball players. Backs have the highest correlation between IQ indexes according to CFIT and efficiency of competitive activity ($r=0,765$), but centres have the highest correlation relations between indexes of competitive activity efficiency and associative ($r=0,616$) and operational ($r=0,818$) thinking. The goalkeepers to play effectively need high level of abstract thinking ($r=0,702$). The correlation between efficiency of the performing competitive activities and intellectual qualities display of the other positions is minor.

Keywords: handball, intellect, competition, thinking, position, correlation.

Introduction

The development of modern Olympic sports requires a new approach to the training system in the process of long-term sports improvement, the top of which is the acquisition of high skill by athlete to ensure success in international competitions (Strikalenko, Shalar, Huzar, Andrieieva, Zhosan, & Bazlyyev, 2019; Bolotin, & Bakayev, 2017; Huzar, 2001b). In sports games, where most national and club teams reach almost the same level of physical and technical abilities of players, the victory of the team is associated with the psychological and intellectual readiness of athletes (Gryn, 2015; Ilyin, 2010; Weinberg, & Gould 1998).

Intellectual abilities in sports are a component of an athlete's skill in terms of the theory and methodology of sports, and are included in his tactical training (Piaget, 2003; Zhanneta K., Irina S., Tatyana B., Olena R., Olena L., & Anna I. 2015; Huzar, 2000b). D. Harre psychologically regarded tactical action as the product of complex psychomotor processes that proceed consistently and jointly. He points to three phases of psychomotor processes, where first the perception and analysis of the situation go (the basis of subsequent phases), and only then the mental process of solving a specific tactical problem. Memory plays here a crucial role. He points out that the tactical problem is first solved mentally and then in movements.

The beginning of the search for methods of diagnosing giftedness, namely intelligence, as a general ability of the individual to act expediently, effectively, think rationally, according to D. Seligman was conducted by A. Binet, T. Simon, W. Stern, L. Termen and others since the beginning of the twentieth century (Seligman, 1995)

In modern science, various conceptual solutions are discussed and developed, which focus their attention on certain aspects of the mental phenomena of gifted people. Psychophysiological indicators of athletes in game sports are being actively studied, but no adequate methodology based on game situations has been created yet, particularly in handball. There is no such methodology which can track the dynamics of changes in specific types of thinking in the process of sports training, as well as the influence of intellectual qualities on the manifestation of competitive efficiency (Lozhkin, 2011; Strykalenko, & Shalar, 2017; Yakovlev, & Babushkin, 2016).

In modern handball, the issue of the influence of intellectual qualities on the performance of elite female handball players has not been sufficiently studied, so our study is relevant. **The research aim is** research of the influence of intellectual qualities on the efficiency of competitive activity of elite female handball players.

Materials and methods

Experimental study was conducted on the basis of women team of Super League, bronze medalist of the Handball Championship of Ukraine, which is experienced team in the field of sports in the city of Kherson and Kherson region. This Ukrainian handball club is first and foremost known for its trainees, who, having received a good school, successfully prove themselves in the leading clubs of Ukraine and Europe.

Total of 14 players took part in the study, with different ages, different weight, height and position (centre, back, pivot, wing and goalkeeper). It should be noted that the girls have different integrated training. Due to the team's youth movement, the test was passed by underage players with little experience. The aim was to determine the level of intellectual qualities development of the female handball players of different game positions. The study took place in the sporting complex of the Kherson Higher School of Physical Education.

According to this goal, the level of intellectual qualities of female handball players was investigated using the CFIT and INTEST computer test. Using developed by coaching staff of HC "Dniproanka" team methods for determining useful activities, the features and efficiency of handball players' playing functions were studied and the correlation between these indexes was determined. Experimental study was conducted during the 2018-2019 season.

During the assessment of the elite female handball players' intellectual qualities, the following tests were used - CFIT and INTEST. CFIT is culturally free intelligence test of R. Kettell. Each test task has only one correct answer. It should be remembered that the most important intellectual component of creativity is the predominance of so-called divergent thinking, which implies that there can be many equally correct and equitable answers to the same question. Thus, the test is generally focused on the opposite - convergent - type of thinking, aimed at finding a single solution that eliminates the problem, designed to measure the level of intellectual development regardless of environmental factors.

The next research was conducted with the help of INTEST automated methodology, our aim was to identify the dominant thinking of skilled female handball players. Objects (geometric figures) and verbal (names of plants and non-living objects) symbols are used as a load for information processing. The state of psychophysiological functions of qualified female athletes was studied using the INTEST automated technique. The structure of the methodology included blocks of tests to determine perception, memory, thinking, as well as a latent period of visual and audio motor response. The study used a block of tests aimed at "Thinking" study. Before testing the female handball players, the task was explained in detail.

"Thinking" testing. Characteristics of thinking functions were determined using five blocks that reflect *abstract, associative, logical, operational, and spatial thinking*.

Abstract thinking. The list of five words was displayed, four of them were connected. The task was to find the odd word.

Associative thinking. Three words were displayed, two of them were connected. The task was following: from the five words below, choose a word that is related to the third word exactly like the first word to the second one.

Logical thinking. A series of ten two-digit numbers was displayed. The task was to find the smallest number.

Operational thinking. On the screen were presented 10 arithmetic problems. The task was to solve the problems and enter the answers.

Spatial thinking. Three pictures were displayed on the monitor sequentially. Each contained a set of figures in three rows. Each picture in the third row lacked one figure. The task was to determine the regularity of combining the figures in rows and choosing necessary figure from the spare part of the picture. The answer to each picture was completed by pressing a key corresponding to the selected figure number.

Methodology of determining the effectiveness of competitive activity (Table 1) used during the experimental study was developed by coaching staff of HC "Dniproanka". It was actively used in the competitive and training process. Using this technique, coaches receive unbiased information about female handball player's activity during the game.

Table 1. The criteria for evaluating the effectiveness of competitive activity of elite female handball players in HC "Dniproanka" (points)

Throws		2-minute penalties		7-meter throw		Turnover		Toward player		Yellow card		Stopping the attack	Blocking	Assist
+	-	+	-	+	-	+	-	+	-	+	-	0.2	0.3	0.6
1	-0.8	0.4	-0.4	0.6	-0.6	0.5	-0.5	0.3	-0.3	0.1	-0.1			

The essence of this technique is to monitor the game and record the positive and negative technical and tactical actions of each player. The positive actions include: scored goals (1 point), assists (goals), turnover to counter attack, 7-meter throw and 2-minute penalties, blocking the opponent's ball and the player is the defensive action, when a player is crashing into the standing opponent. Also stopping the attack of the opponent, which is 0.2 points, is considered as a positive technical tactical action, such a low score is accrued because opponent keeps the ball. Negative techno-tactical actions include: no goals scored, giveaway, 7-meter throw and 2-minute penalties, yellow cards. Using the table of criteria for evaluating the effectiveness of competitive activity, we can count the amount of points that indicate the effectiveness of each individual player's game.

Results

The term "intellect" is used as a synonym of the word "mind". However, it is wrong to reduce the intellect only to thinking. Intellectual abilities are the basis of intellect, but attention (potential), memory (mnemonic), imagination (imaginative) and other types of mental abilities are also essential elements of intellect.

Modern Western experts define intellect as the ability to think logically, plan, solve problems, think abstractly, perceive complex ideas, learn quickly and learn from experience (Weinberg, & Gould, 1998).

The complexity of the attack and defense tasks that determine the tactics of the team depends on the level of integral training of the players. In the modern interpretation of the players' thinking is defined as their ability to quickly evaluate and effectively solve game situations in the implementation of numerous technical and tactical tasks of the team or adapt to new conditions. Adaptation to the new conditions is the most appropriate for studying the intellectual abilities of female handball players.

When determining the dominant type of thinking athletes were tested using automated INTEST methodology. The main objective of this technique was to identify the dominant type of thinking of elite female handball players in relatively simple conditions.

The indexes of the types of thinking of highly skilled female handball players, according to the game position, are shown in Table 2.

Table 2. Different thinking types' indexes of female handball players of different game positions in HC "Dniproanka" (%)

Position	Types of thinking				
	Abstract	Associative	Logical	Operational	Spatial
Wing	60	30	95	60	50
Back	40	30	100	65	33
Centre	65	30	95	90	65
Pivot	70	50	100	80	66
Goalkeeper	70	40	80	60	65
Average	61	36	94	71	56

Based on the data processed by INTEST automated technique, it was found that female athletes have a high level of logical, operational and abstract thinking. According to many authors, these indicators significantly affect the level of intellectual readiness of players. Thus, logic plays a fundamental role in the effective thinking of the athlete, and logical thinking is a fundamental element in the work of the whole complex of mental functions.

Subsequently, during the experiment, a study was conducted according to CFIT method of R. Kettel. Unlike classical intellectual tests, based on the theory of general abilities and measured depending on education and experience gained, the results of the cultural-free test are relatively independent.

According to Kettell, from our birth, we have the potential intelligence that underlies our ability to think, abstract, and reason. This study is intended to measure the level of intellectual development irrespective of environmental factors (culture, education, etc.).

The test consists of two parts, each of which has four subtests. All tasks have a graphical form. The results of the assessment of intellectual abilities according to the game position are represented in Table 3.

Table 3. The indexes of intellectual qualities of elite handball female players of the different positions according to CFIT (points)

#	Position	Average according to CFIT	Average IQ
1.	Goalkeeper	57	90
2.	Centre	58	92
3.	Back	60	95
4.	Wing	56	89
5.	Pivot	57	90

The results indicate that according to the test, all players received approximately the same level, the average score – 92 points. In our view, this is due to the fact that, according to Ketell's method, which involves establishing a sequence in a certain series of images and requiring the only correct answer (the only correct variant of the attack), the field players, namely the backs, during the competitive activity, this particular manifestation of intellectual qualities is peculiar.

The next step of the study was to analyze the INTEST and CFIT and compare the results according to the game positions of elite female handball players. It means that the intellectual qualities average level of different positions players and the average percentage of manifestation of different thinking types were determined and compared with each other. Indexes of the overall IQ ratio and different types of thinking of different game position players are represented in Fig. 1.

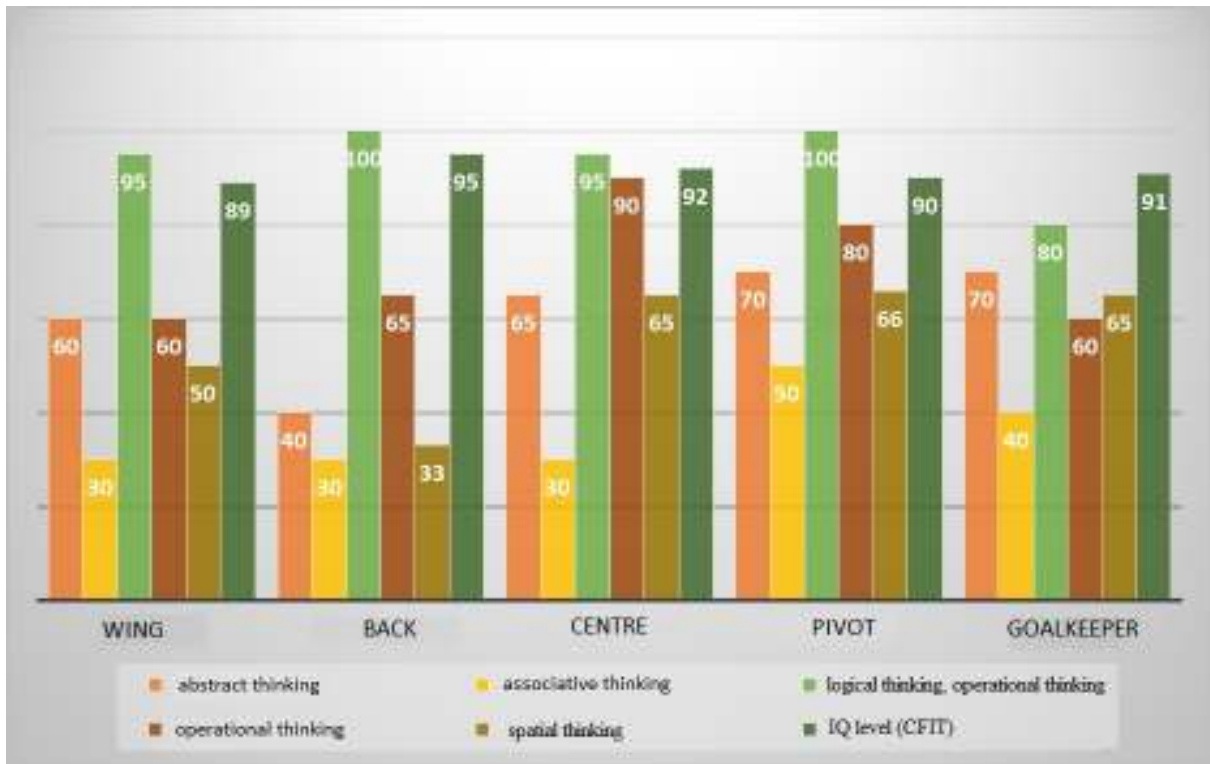


Fig. 1. The assessment of intellectual qualities and indexes of thinking according to the game position

INTEST automated techniques have shown that the highest level of all thinking is logical thinking, namely of backs and pivots. We suggest that with logical thinking the players are able to use their technical and tactical stock of actions in the necessary game situation.

Centres have almost the same result of two types of thinking, namely logical and spatial ones. Spatial thinking allows the player to react in a particular moment of the game, in defense or attack, centres have a high load through a very large area of responsibility. Their technical and tactical stock of actions is much greater than of backs. The centres in many cases, who manage the situation on the field.

Goalkeepers got a similar result between all kinds of thinking and IQ. It can be assumed that this result is related to the non-standard role of goalkeepers on the field. The tasks that goalkeepers face often do not coincide with the actions of the field players who need to throw the ball and secure the goal in their area. The goalkeeper must also protect the goal, return the ball and keep in touch with the field players in defense. The research we conducted to determine the level of intellectual qualities development in different position players, suggests that there is a certain correlation between the level of intellectual qualities, types of thinking and competitive activity, which is due to the peculiarities of the game functions performance.

The ever-increasing competition of teams in the Ukrainian Championship dictates the need for further improvement of the training system for elite female handball players. The whole training process is aimed at effective competitive activity. Competitive activities that decide the fate of both the match and the result of the team is of particular interest.

Unfortunately, there is insufficient attention in the specialized literature to describe the features, quantitative and qualitative indexes that have recently been achieved by leading teams of Ukraine in competitive activities, which deprives the coaches of the opportunity to effectively train them in the conditions of the training process.

According to the objectives of the study, the effectiveness of competitive activity and the average usefulness of different game positions female handball players in HC “Dniproanka” in the games of the Ukrainian Championship of 2018-2019 years were determined. The performance indexes of competitive activity are represented in Table 4.

Table 4. The indexes of competitive activity of different positions female handball players in HC “Dniproanka”

Position	Wings		Backs	Centres	Pivots
	Throws, number	+	23	23	21
	-	15	18	19	12
2-minute penalty, number	+	1	1	-	-
	-	3	3	4	3
7-meter throw, number	+	2	3	1	1
	-	3	3	2	3
Turnover, number	+	3	3	-	1
	-	2	5	10	4
Toward player, number	+	-	1	-	3
	-	-	4	3	-
Yellow card, number	+	-	-	-	2
	-	-	3	1	-
9-meter attack stop, number		3	15	6	7
Block, number		-	2	-	2
Assist, number		-	3	5	2
Competitive performance, points		9.5	8.9	7.8	9.4

Analyzing the results, we note that, unlike the general idea of the game, the most effective players in “Dniproanka” team were the wings (9.5 points). The pivots showed virtually identical result (9.4 points). The top three players are also backs (8.9 points).

The lowest indexes during the game got female handball players who are so-called “conductors” of the game and have positions of centres. Thus, including the losses and mistakes, the players of this position received the lowest result (7.8 points). The results obtained are closely related to the features of the team’s play, the tasks of their play and the quality of performance of game functions by female athletes. Throughout the game, the centres in most cases organized the attacking activities of the team, made a long pass to the goal line, and only in extreme cases, when time was running out, did they actually attack the opponent's goal, which was not always effective. However, the effectiveness of the team and the achievement of the winning result largely depends on the quality of one of the main players play – goalkeeper. That is why the next step in our research was to identify the average of the competitive performance of HC “Dniproanka” goalkeepers.

The efficiency of the goalkeeper's competitive activity in handball, according to practitioners, determines the success of the competitive activity of the team as a whole by 50%. On this basis, we note that the efficiency

of the goalkeeper's competitive activity is one of the leading factors in the competitive and training activities of elite handball players. However, we cannot compare their performance with the assessment methodology of field players, so we have separately determined the effectiveness of their game features. By the number of missed balls and saves, assists in the fast attack, we calculated the percentage of efficiency in the game. According to the results obtained, goalkeepers' efficiency in the Kherson HC "Dniproanka" is 7.5 points, which is slightly lower than the overall efficiency of the team. The spacious intellect is playing an increasing role in daily life. It is widely believed that it is people with spacious intellect who succeed in life and attain great heights in sports.

Exactly the impact of intellectual qualities on the effectiveness of elite female handball players was the main goal of the study. For this purpose, indicators of intellectual qualities were selected according to two methods: the cultural-free CFIT test with the INTEST test and correlation analysis was performed with the indexes of competitive activity on the field during the game. The results of the analysis are presented in Table 5.

According to the results of the correlation analysis, the highest correlation between IQ and competitive performance is observed in the average handball players ($r = 0.765$), due to the fact that the backs during the competitive activity have to perform complex tactical actions and interactions, to anticipate actions most of the players of the opposing team and clearly determine the direction of the ball, which requires them to think in a constantly changing situation. It is established that there is a high correlation between the effectiveness of competitive activity and the associative ($r = 0,616$) and operational ($r = 0,818$) thinking of centres. It is connected with the fact that most decisions made by such players depend on the effectiveness of the whole team.

Table 5. The correlation between intellectual qualities and effectiveness of competitive activity of HC "Dniproanka" female handball players (r)

Game positions	The indexes of intellectual qualities and types of thinking					
	Abstract	Associative	Logical	Operational	Spatial	IQ
Goalkeepers	0,702	0,554	0,314	0,254	0,402	0,314
Wings	0,03	0,301	0,485	0,401	0,03	0,485
Backs	0,121	0,496	0,639	0,596	0,121	0,765
Centres	0,511	0,616	0,524	0,818	0,511	0,524
Pivots	0,143	0,331	0,159	0,331	0,143	0,359

The study proved that goalkeepers need a high level of abstract thinking ($r = 0.702$) to play effectively. There is little correlation between the effectiveness of the competitive activities and the intellectual qualities of different positions players.

Discussion

Summarizing the results of the study, we note that the quality of playing sports is constantly increasing, handball is no exception. The game becomes faster, more complex in terms of technical and tactical actions, which requires players to improve their physical, technical, tactical and mental qualities. Thanks to the high level of speed endurance development elite football players make a rapid transition from defense to attack. (Gusev, Strykalenko, & Shalar, 2014; Huzar, 2000a). But, analyzing the fitness of the National Basketball Association (NBA) basketball players, they found that the players have a high level of speed and power-speed abilities development and average level of general endurance development. At the same time, basketball players of European clubs are characterized by a high level of general endurance development and an average level of speed and speed-power abilities development (Kochubeiy, Strykalenko, & Shalar, 2014). In the physical training of elite female handball players, special attention should be paid to the development of high-speed strength, especially of the wings who perform many passes and throws (Zhosan, Strykalenko, & Shalar, 2014). This has been confirmed in studies where the most important factor included speed-power readiness and accuracy of throws combined with anthropometric data. In other words, in modern handball the accuracy of throws should be combined with the speed-power readiness and high anthropometric data (Kozina, Slyusarev, & Volkov, 2004; Nesen, Pomeschchikova, Druz, Pasko, & Chervona, 2018).

Analyzing indicators of centres' technical and tactical actions (Strykalenko, Shalar, & Denechuk, 2018) and NBA forwards it was proved that the quality of these actions is influenced by the length of the season, the style of play, the physical and individual training of the basketball players. Investigating the technical and tactical actions of the best defenders of the 2014 FIFA World Cup (Zhosan, Homenko, & Shalar, 2016), it is found that 60% of all actions are short passes and tackles.

In our previous studies, much attention was paid to the psychological training of athletes in competitive sports (Huzar, Shalar, & Noryk, 2014; Huzar, 2001a). Characterological and intellectual indexes of elite table tennis female athletes were studied, where most tennis players (80%) have combined and defensive styles, with a

high level of intellectual qualities. However, attackers (60%) are motivated more (Shalar, Strykalenko, & Ivaschenko, 2013). Investigating temperamental and will attributes of female handball players of different positions it was found that almost all the handball players (75%) of HC "Dnipryanka" have extraverted personality type and the following strong-willed qualities (70%): endurance, self-control, determination, urgency (Shalar, Zhosan, Shum, & Strykalenko, 2014). Interpersonal relationships of female handball players also have a significant impact on competitive performance (Huzar, Shalar, & Mordjuk, 2016). This is the result of psychological compatibility in the women's handball team (Shalar, Snopova, & Strykalenko, 2010).

There is a growing demand for elite female handball players, which involves performing more complex combinational actions and schemes that require handball players to think fast in game situations, playground vision, and play two steps forward. This is due to the high level of intellectual qualities of elite female handball players, which is an integral part of the competitive activity of handball players. Previous studies have shown that the greatest correlation between intellectual potential (logical sequence of images) and competitive actions was observed in goalkeepers ($r=0,702$), and the average level of correlation is noted in centres ($r=0,511$). Also, the players of this position were found to have the highest correlation between the level of intellectual development (by Eysenck's method) and competitive activity. Their actions during complex game situations are logical and consistent (Strykalenko, & Shalar, 2017; Strykalenko, Zhosan, & Shalar, 2017).

In our study, it was experimentally found that there is a correlation between indexes of the level of development of intellectual qualities and the efficiency of competitive activity of elite female handball players. The greatest correlation between IQ and competitive performance is found in backs, between associative and operational thinking and competitive performance in centres, who, in our opinion, should be the "conductors" of the game and their play depends on the whole team during attack and defense. The presence of correlation shows that intellectual qualities significantly influence the efficiency of competitive activity of elite sportswomen.

Conclusions

In modern sports, handball players' competitive activity is characterized by a high intensity of performing various techniques in the shortest amount of time, significant complex interactions between players and the ability to make one maximally correct decision. All of the above points to the need for rational, balanced and maximally effective training of handball players during the training process. When performing complex tactical combinations, in constantly changing game situations, a manifestation of understanding of actions and movements is required, which requires the athlete considerable intellectual readiness.

The study found that according to CFIT method backs showed the highest score in intellectual qualities (95 points), centres showed 92 points, wings showed sufficient level – 89 points, and the average value in the team was within IQ - 92 points. According to the results of INTEST methodology, there is there is substantial advantage in logical and operational thinking demonstration, namely the backs showed 100%, pivots also showed 100% and centres - 95%. The effectiveness of competitive activity in the team, according to the methods of HC "Dnipryanka" coaches was following: the most effective players are wings (9.5 points), virtually the same result was shown by pivots (9.4 points) (8,9 %) and centres (7,8 points). Goalkeepers' efficiency ratio was 7,5 points. It was experimentally found that there is the correlation between level of intellectual qualities development and competitive activity efficiency of elite female handball players. Backs have the highest correlation between IQ indexes according to CFIT and efficiency of competitive activity ($r=0,765$), but centres have the highest correlation relations between indexes of competitive activity efficiency and associative ($r=0,616$) and operational ($r=0,818$) thinking. The goalkeepers to play effectively need high level of abstract thinking ($r=0,702$). The correlation between efficiency of the performing competitive activities and intellectual qualities display of the other positions is minor.

Promising area of further research is to determine the correlation between the effectiveness of competitive activity and the intellectual qualities in bigger amount of elite female athletes, the development of new modern methods for determining the intellectual qualities of athletes in other sports.

Conflict of interests. The authors note that there is no conflict of interests.

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