2024
06

ORIGINAL ARTICLE

Ways to improve methods of monitoring the coordination abilities of young basketball players aged 13-14

Roman Boichuk[1ABCDE], Mykola Nosko[2ABCDE], Yuliya Nosko[3ABCDE], Zhanna Grashchenkova[4ADE], Iryna Petrenko[5ADE], Ivan Vaskan[6ABE], Andriy Shankovskyi[1ABE]

[1]*Department of Physical Education and Sports, Ivano-Frankivsk National Technical University of Oil and Gas, Ukraine*

[2] *Department of Pedagogy, Psychology and Methods of Physical Education; T.H. Shevchenko National University "Chernihiv Colehium", Ukraine*

[3] *Department of Preschool and Primary Education, T.H. Shevchenko National University "Chernihiv Colehium", Ukraine*

[4] *Department of Olimpic and Professional Sports, Kharkiv State Academy of Physical Culture, Ukraine*

[5] *Department of Physical Culture Management, Kharkiv State Academy of Physical Culture, Ukraine*

[6] *Department of Physical Culture and Health Basics, Yuriy Fedkovych Chernivtsi National University, Ukraine*

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Background and Study Aim Coordination skills are an important indicator of success for young athletes in team sports. Therefore, the methods used to monitor these skills should include reliable and valid tests of coordination. The purpose of this study is to identify ways to improve the monitoring of coordination abilities in young basketball players aged 13–14 years.

Material and Methods Basketball players aged 13–14 years participated in the study (n=35, training experience – 3–5 years). Twelve tests were used to assess the level of technical and tactical preparedness of the athletes. The reliability of these tests was evaluated by determining the correlation coefficients between the results of the first test and subsequent tests. The criteria for the informativeness of the tests were based on the experts' rank assessments of the coordination and technical preparedness of young basketball players. A 10-point scale was used for the expert assessment of players' technical skills, with each indicator evaluated from 1 to 10 points.

Results The data obtained indicate that all selected tests demonstrated reliability with correlation coefficients above r = 0.5. Tests assessing muscle effort, adjusting motor activity, sense of rhythm, spatial orientation, and reaction speed showed reliability coefficients sufficient for both individual and group assessments (r > 0.70). Slightly lower reliability coefficients were observed in the time taken to perform individual motor tasks. The validity of the tests was evaluated based on ratings of coordination and technical readiness, as well as overall test battery ratings. In most cases, the validity was not lower than r = 0.3, with some tests exceeding r = 0.5. The correlation coefficient between grades and the total rank score based on the coordination test battery ranged from r = 0.5 to 0.7. The coefficient of concordance showed a high level of agreement among experts regarding the effectiveness of the technical and tactical actions of young basketball players.

Conclusions The conducted study demonstrated the importance of developing and monitoring the coordination abilities of young basketball players during adolescence. The use of several homogeneous tests to assess each individual coordination ability allows for a more reliable evaluation. The need to identify specific types of coordination skills that play a key role in competitive basketball activities has been emphasized. Additionally, the use of a latent indicator in evaluating the coordination abilities of young basketball players will contribute to optimizing a differentiated approach in the training process.

Keywords: basketball, players, coordination, abilities, methods, monitoring.

Introduction

Monitoring coordination abilities in team sports, including basketball, plays a key role in evaluating and improving athletes' performance. Effective monitoring allows coaches to track the development of essential skills and adjust training programs accordingly. This requires refining existing approaches to ensure that the tests used are both reliable and valid.

In this context, one of the key tasks in sports games, and basketball in particular, is to assess the coordination readiness of young players [1, 2, 3]. According to the authors [4, 5], the development of methods and criteria for assessing coordination abilities is necessary to solve a number of interrelated scientific and applied problems. In particular, this

doi:10.15561/26649837.2024.0603

includes determining the level of coordination abilities in young basketball players, establishing the structure of these abilities in players of different ages, genders, and levels of preparedness. Equally important is determining the relationships between motor coordination indicators and physical qualities, technical preparedness, somatic indicators, and psychophysiological functions of basketball players. Moreover, a high level of coordination abilities is a prerequisite for selecting and orienting children towards basketball [6, 7, 8].

Of course, in different types of motor activity, separate tests are used to evaluate certain indicators of coordination preparedness. However, the standards related to sports games, qualification level, age, and gender are presented in a fragmented manner in the literature and do not cover all aspects of various types of coordination abilities. Additionally, in practice, complex tests are used more frequently than those focusing on specific types of coordination abilities. It is particularly challenging to assess the degree to which any specific type of coordination ability is manifested [9, 10].

Furthermore, such tests include elements of technical actions from various sports. These tests are convenient and easy to use for practitioners, making them quite common. However, according to [11, 12], this type of test is unsuitable for research purposes. The use of complex tests that include technical elements hinders the possibility of comparing the indicators of athletes from different sports, as each sport has its own specific tests. The results of testing with complex tests significantly depend on the athlete's qualification level and mastery of the technical arsenal. However, these tests do not purely reflect the level of coordination abilities. Moreover, it is known that the mechanisms responsible for different types of coordination abilities are ambiguous and often have little influence on each other. For instance, a high level of reaction speed does not necessarily imply the same level of ability to differentiate movement parameters, and so on. Thus, while using complex tests may provide a quick overall assessment of a player's coordination preparedness, it does not offer insight into the development of specific coordination abilities [13, 14, 15].

Clearly, the testing program for assessing coordination preparedness can and should include complex tests with elements of basketball technique, but it should not be limited to them. An important factor in developing the testing program is the appropriate selection of tests that evaluate different types of coordination abilities. In this regard, it is crucial to identify the most significant abilities for a specific sport and focus on assessing them during testing [16, 17, 18].

In addition to highlighting certain types of coordination abilities, when evaluating the coordination preparedness of young basketball players, it is important to understand that there are basic coordination abilities [19, 20]. These abilities are largely determined genetically and form the foundation of all human activity (household, labor, sports, etc.). In the process of playing basketball, specific abilities are developed and manifested based on these general coordination abilities. This process continues throughout the entire period of long-term sports improvement.

It is clear that as the level of preparedness increases, the importance of specific coordination abilities also grows. This should be taken into account when assessing the coordination preparedness of young basketball players. Based on this, experts agree that at the stage of initial training, it is advisable to include only basic tests in the testing program. Subsequently, the proportion of basic and specific tests shifts towards the latter. Research on this topic indicates that in the training process of young basketball players who have achieved a high level of skill, 70% of the time spent assessing coordination preparedness should be dedicated to specific tests [21, 22].

The testing program allows you to determine the level of development of coordination abilities and, depending on the results, make necessary adjustments to the training process of young athletes at all stages of their long-term sports improvement. At the initial training stage, the coordination preparedness of young basketball players is usually assessed as a whole. However, as noted by Starosta [23], the need for individual evaluation increases as special preparedness grows. According to the researcher, athletes involved in a particular sport for a long time exhibit significant fluctuations in coordination ability indicators during the annual training cycle. Such strong variations in the results of the same player indicate that the mechanisms responsible for coordination abilities are influenced by internal and external factors. These factors presumably include fatigue, the stage of the annual cycle, time of day, season, mental state, etc. According to [24, 25], the amplitude of fluctuation in test results at different stages of the annual cycle is greatest in tests evaluating reaction speed, balance, and kinesthetic differentiation. This example highlights the potential for using coordination tests for the early diagnosis of fatigue and overtraining during basketball training.

Experimental studies by several authors have shown that one of the most effective ways to improve a player's technical and tactical skills is to purposefully develop various coordination abilities [26, 27]. In light of this, the authors sought to identify the key types of coordination abilities that have the most significant impact on achieving high results in basketball [28, 29, 30]. The coordination abilities that received the highest rankings include the ability to adjust movements, spatial orientation, reaction speed, the ability to differentiate movement parameters, sense of rhythm, and dynamic balance.

Exploring different aspects of coordination qualities and associated psychophysiological functions in children, Ljach [31] found that the greatest increase in these indicators occurs between the ages of 7 and 11–12. In the later part of secondary school age, different coordination abilities evolve in a more differentiated and sometimes contradictory manner. After a decline between the ages of 12 and 13, boys aged 13 to 15 continue to improve the absolute indicators of coordination abilities in cyclic and acyclic locomotion, acrobatic exercises, and ballistic movements. According to Hirtz and Starosta [13], these growth rates are associated with parallel increases in strength and speed-strength qualities. While individual indicators of coordination abilities from ages 12 to 13 and 13 to 14 remain at the level of 12-year-old boys, in girls, they temporarily deteriorate. The optimal period for developing spatial orientation ability is in early adolescence. From 11 to 13 years, improvement in this ability slows somewhat, but from ages 13 to 15–16 (especially in boys), there is a further increase in performance.

Consequently, a contradictory situation has emerged between the need to improve the methodology for monitoring the coordination abilities of young basketball players aged 13–14 years, and the insufficient scientific development of methodological support to address this pedagogical problem. This highlights the practical and scientific relevance of the research problem.

Hypothesis. It is assumed that optimizing the methodology for monitoring the coordination preparedness of young basketball players will enhance the effectiveness of the training process. This approach will ultimately improve the players' performance in competitive activities.

Study purpose. The purpose of this study is to identify methods to improve the monitoring of coordination abilities in young basketball players aged 13–14 years.

Materials and Methods

Participants

Basketball players aged 13–14 years participated in the study (n=35, training experience – 3–5 years). Both the adolescents and their parents were fully informed about all study procedures, and written informed consent was obtained from both the players and their parents prior to participation. The study adhered to ethical standards in accordance with the Declaration of Helsinki, ensuring the participants' rights, safety, and confidentiality throughout the research process. The research protocol was reviewed and approved by the relevant institutional ethics committee.

Research Design

Based on a theoretical analysis, the types of coordination abilities that play a key role in the successful execution of basketball activities were identified. These include the ability to modify the motor program, rhythmic ability, reaction speed, spatial orientation, the ability to link phases of movement, dynamic balance, and kinesthetic differentiation. The tests we selected were verified according to the principles of motor quality testing theory and methodology. The reliability of these tests was evaluated by calculating the correlation coefficients between the results of the initial test and subsequent tests, conducted 7–14 days later (retest). The criteria for test informativeness were the coaches' rank assessments of the coordination and technical preparedness of young basketball players. In addition to absolute indicators of coordination abilities, relative indicators such as rhythmic ability, spatial orientation, and the abilities to couple and modify movements were also considered.

Test 1: The accuracy of estimating and measuring spatial movement parameters was assessed using a specially designed graduated screen. The player was given the task of reproducing the amplitude of 50% of a reference movement in the shoulder joint on the frontal plane. The movements were performed without visual control, using the player's dominant hand, with the shoulder joint positioned at the center of the graduated screen. During the study, the accuracy of the reproduced movements was not communicated to the player. The error was determined by comparing the reproduced movement value with the actual reference value. The average absolute value of the inverse proportion characterized the accuracy of the estimation and measurement of movement amplitude [32].

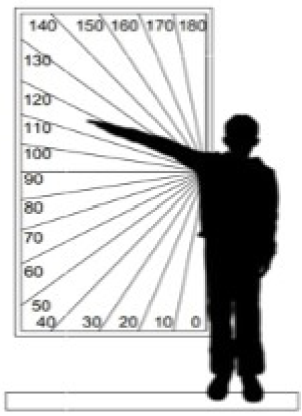

Figure 1. Determining the accuracy of estimation of spatial parameters of movements

Test 2: The accuracy of assessing and measuring the value of muscle effort was evaluated using a wrist medical dynamometer. While standing with the arm extended to the side, the player applied maximum effort. In the following three attempts, the player was tasked with reproducing 50% of the maximum effort value. The inverse proportion of this task characterized the accuracy of assessing and measuring muscle efforts [33].

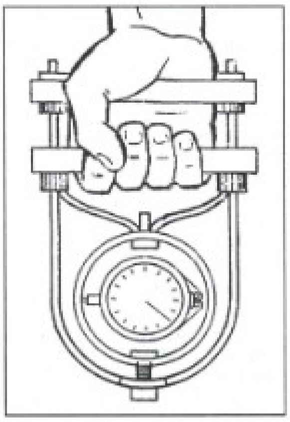

Figure 2. Determining of the accuracy of estimation of power parameters of movements

Test 3: "Slalom dribbling with two basketballs" [13]. *Equipment:* 3 cones, measuring tape, stopwatch, and basketballs. Three cones are placed in a straight line over a distance of 10 meters. The first cone is positioned 2.5 meters from the start line, with the remaining two cones spaced equally from each other. At the signal, the player runs the distance while basketball dribbling around the cones. The same task is then repeated, but with simultaneous dribbling of two basketballs. Instructions: Allow several minutes of rest between individual attempts.

Test 4: The time difference between performing a slalom while dribbling two basketballs versus one basketball.

Test 5: Balsom Agility Test [34]. This test measures both absolute and relative indicators of the ability to modify motor processes and speed. The test is performed both with and without basketball dribbling, and the difference between the two results is recorded. *Equipment:* stopwatch or timing system, ten cones. The cones are placed in pairs, two meters apart, with a line drawn between each pair. At a distance of 10 meters from the first pair "A" (starting line), pair "B" is placed, and 5 meters from "B," the pair of cones forming the finish line is positioned. At a distance of three meters from the right cone of pair "A," the left cone of pair "C" is placed (with the right cone two meters to the right). Pair "D" is placed 10 meters from pair "C."

Test 6: Balsom Agility Test with basketball dribbling.

Test 7: The time difference between the Balsom Agility Test with and without basketball dribbling.

Test 8: "Sprint at the Given Rhythm Test with basketball dribbling" [35]. This test is used to measure rhythm ability. Eleven gymnastic hoops were systematically placed as shown in Figure 4. The first three hoops were positioned next to each other, 5 meters from the starting line. Similarly, another three hoops were placed 5 meters from the finish line. The remaining five hoops were placed adjacent to each other in the middle of the running distance. The total distance from the start to the finish line is 30 meters. Additionally, two photocells were placed at the start and finish lines to measure the time. The test was demonstrated and explained to the participants before administration. The participants ran through the 11 hoops arranged at specific intervals, maintaining a set rhythm, and running at maximum speed, stepping between each hoop. They then repeated the task while basketball dribbling. The difference in time between the two attempts was recorded as the rhythm score.

Test 9: The time difference between the "Sprint at the Given Rhythm Test" and the "Sprint at the Given Rhythm Test with basketball dribbling."

Test 10: "Numbered medicine ball run test (s)" [35]. This test is used to measure orientation ability. As shown in Figure 5, five medicine balls weighing 3 kg each, and one medicine ball weighing 4 kg were placed on the ground in the shape of a pentagon. The 4 kg medicine ball was positioned at the center of the base edge, while the 3 kg medicine balls were arranged around it. The distance between the 3 kg balls was 1.5 meters, and their distance from the center ball was 3 meters. Before the start of the test, the participants were asked to stand behind a photocell positioned right behind the six medicine balls, facing the opposite direction. At the signal, the participant turned from their starting position, crossed the photocell, and touched the 4 kg medicine ball. At that moment, the tester called out the number of one of the 3 kg balls, directing the participant to it. The participant touched the ball whose number was called, then ran back to the 4 kg ball, again facing the opposite direction. There was no need to stop after crossing the photocell. The tester immediately restarted the test, directing the participant to touch the 4 kg ball first, and then another numbered ball. This process was repeated five times in total. For the final repetition, the participant crossed the photocell to complete the test. Each participant had one practice trial before performing the actual test. The time taken to complete the test was recorded in seconds. The test was administered twice, and the better score was recorded.

Test 11: Time difference between the "Numbered medicine ball run test" and shuttle running (5×3 m), in seconds.

Test 12: "Stopping the rolling ball" [13]. Description: Two benches (with a 5 cm gap between them) are leaned against a shell-board at a height of 120 cm, allowing a volleyball to roll between them. A meter gauge is attached to the surface of one of the benches. The examiner holds the ball at the top of the gauge. The participant stands at a starting

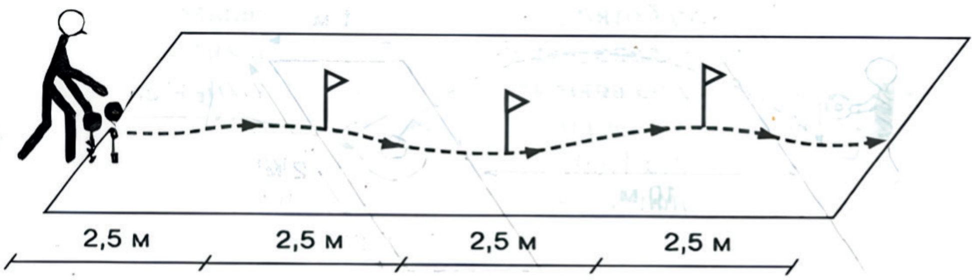

Figure 3. Slalom dribbling with two basketballs.

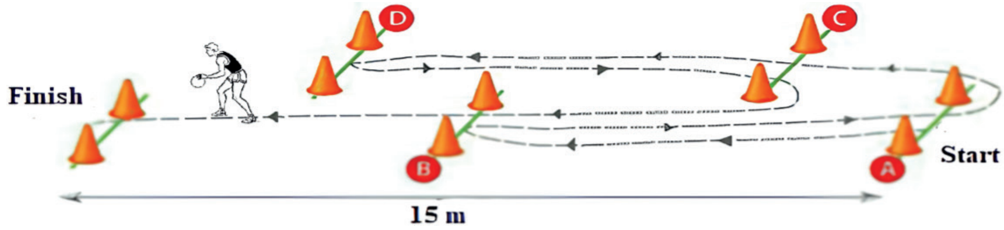

Figure 4. Balsom Agility Test with basketball dribbling.

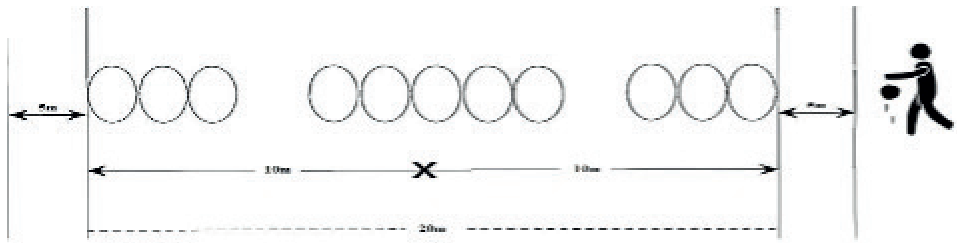

Figure 5. Sprint at the Given Rhythm Test with basketball dribbling.

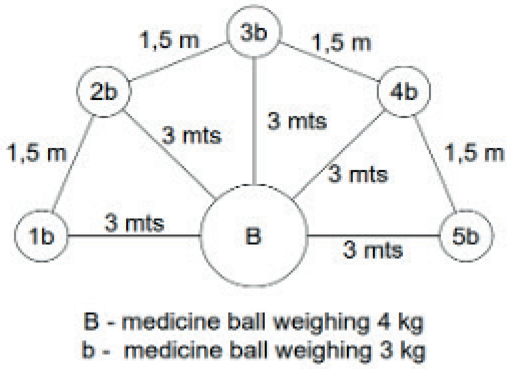

Figure 6. Numbered medicine ball run test

line, 150 cm from the lower edge of the benches, facing away from the ball (i.e., with their back to the rolling direction). At the examiner's audio signal, the ball is released to roll down the gap between the benches. The participant's task is to stop the ball with both hands as quickly as possible. There is one preparatory attempt and three measured attempts, with the best result being recorded.

Expert evaluation. Expert analysis of the technical and tactical preparedness of young basketball players was conducted by coaches with relevant experience. This allowed us to determine the level of mastery of technical elements. The following components of technical preparedness were considered [5]:

- Amount of technique: The total number of technical elements used by the player during training sessions and game activities.
- Mastery of technique: Characterized by consistency (performance of technical elements in training conditions) and stability (performance of technical elements in competitive conditions).

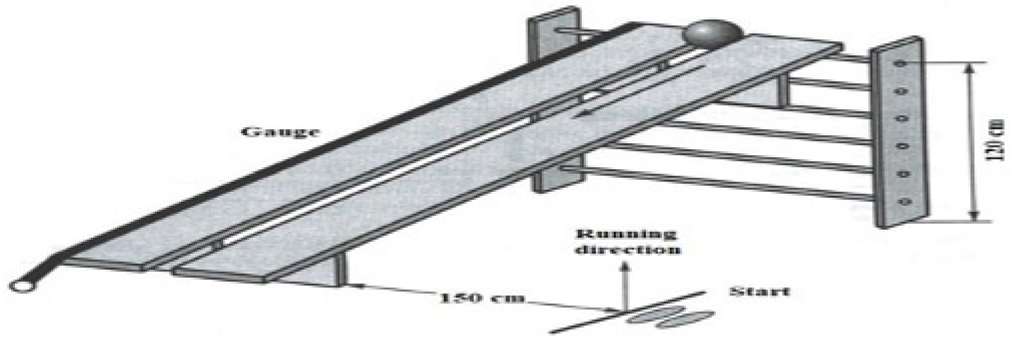

Figure 7. “Stopping the rolling ball”

- Efficiency of technique: Divided into absolute (the comparison of the basketball player’s technique with reference parameters), comparative (comparison of the technique between players of different ages), and implementation (the degree to which technical potential is realized under competitive conditions).

For an expert assessment of the technical skills of players, a 10-point scale was used, in which each indicator was evaluated from 1 to 10 points. The total number of points scored by the player made it possible to determine the rating of their technical and tactical preparedness in the team aspect. To determine the consistency of respondents’ opinions, the concordance coefficient was calculated.

Statistical analysis

Statistical data processing was carried out using Microsoft Excel and SPSS programs. The following parameters were determined for each indicator: arithmetic mean ($\bar{x}$), standard deviation (σ), error of arithmetic mean (m), coefficient of variation (V), correlation coefficient, χ^2– criterion.

Results

The tests selected were verified in accordance with the theory and methodology of motor quality testing [36]. A test was considered reliable when the results achieved by the athletes during repeated testing after a short period of time were similar. The reliability of 8 tests and 4 indicators for assessing different types of coordination abilities in young basketball players was examined (Table 1). A reliability coefficient of r = 0.5 is considered sufficient for group diagnostics, while a coefficient of r = 0.75 or higher is required for individual diagnostics.

The data presented in Table 1 show that all selected tests demonstrate reliability above r = 0.5. It is advisable to highlight tests that assess coordination abilities such as the ability to evaluate and measure the magnitude of muscle effort (2), coupling movements (3), rebuilding motor activity (5, 6), sense of rhythm (8), space orientation (10), and reaction speed (12). The reliability coefficients obtained for these tests are sufficient for both individual and group evaluations (r > 0.70). Slightly lower reliability coefficients are observed in the time differences for the execution of certain motor tasks.

The validity (diagnostic informativeness) of the selected coordination tests was determined using two criteria: rank assessments by coaches of the coordination and technical preparedness of young basketball players, and total rank assessments based on the battery of tests used. According to these criteria, most of the selected motor tests demonstrated a validity of no less than r = 0.3, with some exceeding r = 0.5 (Table 2).

An additional criterion for evaluating the diagnostic informativeness of the motor tests selected to assess coordination abilities was the correlation between the overall indicators of coordination preparedness of young basketball players and the subjective assessments of coaches. These assessments were based on the players’ level of technical coordination capabilities and effectiveness in the game. The correlation coefficient between the coaching grades and the total rank score from the battery of coordination tests ranged from r = 0.5 to 0.7.

To identify the values of expert assessments, the consistency of expert opinions was determined using Kendall’s concordance coefficient [37]. The statistical significance of the concordance coefficient was assessed using the χ^2 test [37].

According to N. Bailey’s table [37], the value of the χ^2 criterion was determined and compared with the calculated value of the χ^2 criterion to conclude the degree of consistency in the experts’ opinions. The tabular value of χ^2 is 16.92 with a probability of error $p < 0.05$ and V = 9. Since the calculated χ^2 (31.4) exceeds the tabular χ^2 (16.92), a high degree of consistency in the experts’ opinions can be confirmed.

Table 3 presents statistical indicators assessing various aspects of coordination preparedness in young basketball players. The data reveal consistent patterns in the players’ coordination readiness. Variations are noticeable in areas such as accuracy, agility, and time management across different test

Table 1. Reliability coefficients of tests and indicators used to measure the coordination abilities of young basketball players

Coordination ability	Test, indicator	N	Retest for 7–14 days
Kinesthetic differentiation ability	The accuracy of estimation of spatial parameters of movements	1	0.62
	The accuracy of estimation of power parameters of movements	2	0.79
Ability of coupling (changing) movements	Slalom dribbling with two basketballs	3	0.69
	The time difference between performing a slalom with dribbling two and one basketball	4	0.50
Ability to rebuild movements	Balsom Agility Test	5	0.71
	Balsom Agility Test with basketball dribbling	6	0.66
	The time difference between Balsom Agility Test with and without basketball dribbling	7	0.52
Rhythmic ability	Given Rhythm Test with basketball dribbling	8	0.70
	The time difference between «Sprint at the Given Rhythm Test» and «Sprint at the Given Rhythm Test with basketball dribbling »	9	0.52
Space-orientation ability	Numbered medicine ball run test	10	0.80
	"Time difference between Numbered medicine ball run test and shuttle running (5× 3 m)"	11	0.57
Reaction speed	"Stopping the rolling ball"	12	0.82

Table 2. Diagnostic information of tests and indicators used to measure the coordination abilities of young basketball players

Coordination ability	Test, indicator	№	Criteria	
			1	2
Kinesthetic differentiation ability	The accuracy of estimation of spatial parameters of movements	1	0.40	0.33
	The accuracy of estimation of power parameters of movements	2	0.42	0.63
Ability of coupling (changing) movements	Slalom dribbling with two basketballs	3	0.55	0.87
	The time difference between performing a slalom with dribbling two and one basketball	4	0.42	0.68
Ability to rebuild movements	Balsom Agility Test	5	0.64	0.43
	Balsom Agility Test with basketball dribbling	6	0.92	0.79
	The time difference between Balsom Agility Test with and without basketball dribbling	7	0.52	0.63
Rhythmic ability	Given Rhythm Test with basketball dribbling	8	0.49	0.59
	The time difference between «Sprint at the Given Rhythm Test» and «Sprint at the Given Rhythm Test with basketball dribbling»	9	0.34	0.44
Space-orientation ability	Numbered medicine ball run test	10	0.31	0.85
	"Time difference between Numbered medicine ball run test and shuttle running (5× 3 m)"	11	0.40	0.36
Reaction speed	"Stopping the rolling ball"	12	0.62	0.80

parameters. Lower variability suggests that certain skills are more uniformly developed among the players. In contrast, higher variability indicates greater challenges with complex coordination tasks, like dual dribbling or rhythm-based activities.

Discussion

The aim of this study was to identify methods to improve the monitoring of coordination abilities in young basketball players aged 13–14 years. The results demonstrated that the selected tests reliably

Table 3. Statistical indicators of coordination preparedness of young basketball players

№	Indicator	X̄	σ	m	V(%)
1	The accuracy of estimation of spatial parameters of movements, (°)	12.3	1.59	0.29	12.9
2	The accuracy of estimation of power parameters of movements, (kg)	3.1	1.03	0.19	32.3
3	Slalom dribbling with two basketballs, (s)	3.13	0.4	0.13	12.8
4	The time difference between performing a slalom with dribbling two and one basketball, (s)	0,52	0.16	0.03	31
5	Balsom Agility Test, (s)	11.3	0.77	0.24	6.3
6	Balsom Agility Test with basketball dribbling, (s)	12.03	0.81	0.26	6.8
7	The time difference between Balsom Agility Test with and without basketball dribbling, (s)	0.76	0.14	0.03	18.4
8	Given Rhythm Test with basketball dribbling, (s)	6.83	0.55	0.17	7.9
9	The time difference between «Sprint at the Given Rhythm Test» and «Sprint at the Given Rhythm Test with basketball dribbling», (s)	1.15	0.22	0.07	19.1
10	Numbered medicine ball run test, (s)	13.2	1.06	0.36	8.03
11	"Time difference between Numbered medicine ball run test and shuttle running (5× 3 m)", (s)	2.1	0.48	0.09	22.9
12	"Stopping the rolling ball" , (cm)	89.3	5.5	1.01	5.7

assess various coordination abilities, with reliability coefficients exceeding r = 0.5 for all tests. Several tests, including those evaluating muscle effort estimation, movement coupling, motor activity adjustment, spatial orientation, and reaction speed, showed reliability sufficient for both group and individual diagnostics (r > 0.70). Additionally, the validity of the coordination tests was supported by significant correlations between test results and expert evaluations of the players' technical and tactical preparedness.

An important step in monitoring coordination abilities is the development of data collection methods that provide more accurate and regular measurements. Among these methods is the use of computer programs, which allow the transfer of existing test procedures into digital formats and enable the measurement of indicators that were previously inaccessible. Recently, there has been significant expansion in the ability to collect information on various aspects of the preparedness of young basketball players. The use of computer programs makes it possible to transfer the test procedures available to researchers into their computer version, as well as to use indicators that were previously unavailable for measurement. The computerization of data collection about the state of the human body enables researchers to address tasks quickly, fully, in detail, and with greater accuracy. However, the use of scientific and methodological support remains fragmented and does not provide regular control in connection with the training process [38, 39, 40, 41].

As a result, it can be concluded that there are few methods for collecting and obtaining reliable information about the condition of young basketball players that do not require significant expenses, yet still provide the necessary data. Therefore, a transition is needed to methods that minimize personnel and financial costs, while focusing on obtaining a carefully selected amount of reliable information [42, 43]. This transition can be achieved through the revision and modernization of existing approaches in youth basketball practice.

As shown in previous studies [44, 45], it is essential to identify weaknesses in the existing system of monitoring the coordination preparedness of young basketball players and update the normative evaluation criteria. It is also necessary to standardize these criteria as much as possible and harmonize them with the evaluation systems used in different countries. Moreover, having information about the coordination preparedness of young basketball players of various ages and the ability to compare this data with that of athletes from different countries allows for the identification of gaps in the training system. These insights enable necessary adjustments to increase the effectiveness of the training process.

One of the large-scale studies related to coordination preparedness in sports focused on football [46, 47, 48]. In these studies, the authors proposed nearly 20 tests to assess the level of development in areas such as rhythmic ability, balance, kinesthetic differentiation, movement adaptation, reaction speed, and spatial orientation. The researchers also recommended using these indicators as criteria for predicting the sports achievements of young football players.

A similar approach was applied in this study. In particular, each individual coordination ability was assessed using several homogeneous tests.

This approach provides a more reliable assessment of the development of each ability. Additionally, the positive correlations between homogeneous features indicate that these tests measure the same coordination ability. Moreover, care was taken to ensure that these tests were accessible to players of all ages and provided a differentiated assessment of the development of specific types of coordination abilities. It was also ensured that the tests did not involve complex motor actions that required extensive training or specialized equipment. The ability to perform control exercises with both the "dominant" and "non-dominant" limbs was considered to study the phenomenon of laterality (asymmetry) in relation to age and gender [49, 50].

In developing the criteria for assessing the coordination readiness of young basketball players, the focus was on evaluating the most significant types of coordination abilities for this sport. Similar views are expressed by other researchers [51, 52, 53, 54]. They note that when monitoring motor coordination at the stage of specialized basic training, the main emphasis should be placed on motor abilities critical for game performance. According to their findings, these include kinesthetic abilities (such as accuracy, timeliness, and adequacy of passes, throws, "feeling the ball," and "feeling the basket"), the ability to adjust movements, spatial orientation, and reaction speed.

In this study, both absolute and latent (relative, partial) indicators of coordination abilities were used. The relative indicators did not account for the individual's maximum speed, speed-power, and power qualities, but these were included in the absolute indicators.

Platonov and Nikitenko [55] offer a similar perspective on assessing the level of coordination preparedness of athletes. First, the authors recommend distinguishing between the concepts of "agility" and "coordination". By agility, they refer to the ability to efficiently and accurately solve motor tasks in unexpected and difficult-to-predict situations. The element of surprise and ingenuity is key to defining this quality and the method of its testing. As for effective motor actions performed in various, even the most complex, but well-known conditions that are not unexpected or unpredictable, the authors suggest using the term coordination. In such cases, the test results are determined by the technical proficiency of motor actions and speed-power capabilities. When it comes to agility, the effectiveness of testing depends not only on technical and speed-power potential but also on the perceptual-visual capabilities of a basketball player, situational knowledge and experience, the ability to counteract, and pattern recognition. Therefore, the authors recommend using both open and closed tests to assess agility and coordination. Open tests are based on stereotypical movements. They are conducted in a constant and stable environment with a familiar and proven program. These tests form the core of testing programs, as they have strict standards and regulations, ensuring measurement accuracy and the ability to compare results across different stages of testing. In contrast, tests built on a non-stereotypical (closed) program involve motor actions in a variable environment, with unexpected situations arising during the execution of test programs. Performing identical tests with both standard and variable structures allows for comparison of results and identification of factors that limit the effectiveness of motor skills and disrupt the training process for young basketball players. For instance, players with high movement speed but slow decision-making and delayed responses need to improve their perceptual abilities, while basketball players with quick responses and prompt decision-making but slower movement speeds should focus on speed and technical training [56].

Despite the positive outcomes of this study, there are several limitations that should be considered. First, the sample size was relatively small, which may affect the generalizability of the results to a broader population of young basketball players. Second, the study primarily relied on traditional testing methods, and while some computer-based assessments were suggested for future use, they were not integrated into the current research. Additionally, the study focused on specific coordination abilities, potentially overlooking other motor qualities that could influence performance.

Thus, theoretical analysis and experimental verification confirmed the possibility of using a wide range of tests to obtain sufficiently reliable assessments of the level of development of coordination abilities. The majority of this program should consist of control exercises that evaluate the most important types of coordination abilities in young basketball players. The use of relative indicators in assessing coordination abilities minimizes the influence of other motor qualities on test results. Additionally, further development of computer-based tests is needed to evaluate the coordination abilities of young basketball players. It seems that more attention should be given to assessing coordination abilities during gameplay, as the effectiveness of game actions is more than just the sum of isolated abilities and skills. The overall effectiveness of gaming activities should serve as the final criterion for evaluating the coordination preparedness of young basketball players.

Conclusions

1. The study highlighted the importance of developing and monitoring the coordination abilities of young basketball players during adolescence. This approach enables faster and more efficient mastery of new motor skills and

improves the technique and tactics of playing basketball. A high level of coordination ability development allows players to better handle tasks requiring psychophysiological functions in both the sensorimotor and intellectual domains.
2. Using multiple homogeneous tests to study each individual coordination ability allows for a more reliable assessment. The presence of positive correlations between homogeneous features indicates that this group of tests measures the same coordination ability.
3. When developing a testing program for assessing the coordination preparedness of young basketball players, it is advisable to use complex tests. It is also necessary to single out the types of coordination qualities that play a key role in the competitive activities of basketball players. When assessing the motor coordination of players aged 13–14 years, it is important to focus on evaluating these specific abilities.
4. The use of a latent indicator in assessing the coordination abilities of young basketball players will contribute to optimizing a differentiated approach in the training process. Performing identical tests with both standard and variable structures allows for a comparison of results and helps identify factors that limit the effectiveness of motor skill development.

Conflict of interests

The authors declare that there is no conflict of interests.

References

1. Jerzy S, Pawel W, Janusz Z, Tomasz N, Mariusz B. Structure of coordination motor abilities in male basketball players at different levels of competition. *Polish Journal of Sport and Tourism,* 2015;21(4):234. https://doi.org/10.1515/pjst-2015-0004
2. Koryahin V, Iedynak G, Blavt O, Galamandjuk L, Zaverikin A, Grebinca G, et al. Study of the training system for young basketball players who are preparing for a competition. *Journal of Physical Education and Sport.* 2018;18(2):753–6. https://doi.org/10.7752/jpes.2018.02110
3. Koopmann T, Faber I, Baker J, Schorer J. Assessing technical skills in talented youth athletes: a systematic review. *Sports Medicine.* 2020;50(9):1593–611. https://doi.org/10.1007/s40279-020-01299-4
4. Issurin V. *Athletic Talent: Identification and Development.* Ultimate Athlete Concepts; 2017.
5. Bompa TO, Sarandan S. *Training and Conditioning Young Athletes.* Human Kinetics; 2022.
6. Alimovichn FU. The system of training young basketball players at the initial stage of training at school. Asian *Journal of Multidimensional Research (AJMR).* 2020;9(11):93–8. https://doi.org/10.5958/2278-4853.2020.00279.7
7. Zwierko T, Lesiakowski P, Florkiewicz B. Selected aspects of motor coordination in young basketball players. *Human Movement Science.* 2005;6:124–8.
8. Trunić N, Mladenović M. The importance of selection in basketball. *Sport–Science & Practice.* 2014;4(2):65–81.
9. Szabo DA, Neagu N, Sopa IS. Research regarding the development and evaluation of agility (balance, coordination and speed) in children aged 9-10 years. *Health, Sports & Rehabilitation Medicine.* 2020;21(2):33–40. https://doi.org/10.26659/pm3.2020.21.1.33
10. Suryadi D, Suganda MA, Samodra YTJ, Wati IDP, Rubiyatno R, Haïdara Y, et al. Eye-hand coordination and agility with basketball lay-up skills: A correlation study in students. *JUMORA: Jurnal Moderasi Olahraga.* 2023;3(1):60–71. https://doi.org/10.53863/mor.v3i1.681
11. Šimonek J, Horička P, Hianik J. Differences in pre-planned agility and reactive agility performance in sport games. *Acta Gymnica.* 2016;46(2):68–73. https://doi.org/10.5507/ag.2016.006
12. Paul DJ, Gabbett TJ, Nassis GP. Agility in team sports: Testing, training and factors affecting performance. *Sports Medicine.* 2016;46(3):421–42. https://doi.org/10.1007/s40279-015-0428-2
13. Hirtz P, Starosta W. Sensitive and critical periods of motor co-ordination development and its relation to motor learning. *Journal of Human Kinetics.* 2002;7:19–28.
14. Cazzola D, Pavei G, Preatoni E. Can coordination variability identify performance factors and skill level in competitive sport? The case of race walking. *Journal of Sport and Health Science.* 2016;5(1):35–43. https://doi.org/10.1016/j.jshs.2015.11.005
15. Waldziński T. Reaction time and special fitness of tennis players aged 10-12 years. *Arch Budo Sci Martial Arts Extreme Sports*, 2023; 19: 179–185.
16. Lyakh V. Differences in the level of development and proficiencyin coordination motor abilities among female and male athletes ofselected combat sports. *Journal of Kinesiology and Exercise Sciences*. 2021;31:11–23. https://doi.org/10.5604/01.3001.0015.7373
17. Kalina RM. Methodology of complementary research as the basis for integrating science in fulfilling its social mission in the future. *Arch Budo,* 2023; 19:77–82.
18. Borysiuk Z. Selected aspects of Nikolai Bernstein's theory assessed with modern motion analysis tools. *Arch Budo,* 2023; 19:95–102.
19. Šimonek J. *Coordination Abilities in Volleyball.* De Gruyter Open Poland; 2014. https://doi.org/10.2478/9783110370317
20. Rana MS, Rajpoot YS. Impact and role of selected coordinative abilities in racket sports. *IJSR İnternational Journal of Science and Research.* 2015;4(3):66–9.
21. Raczek J, Mynarski W, Ljach W. *Developing and diagnosing of coordination motor abilities*. Katowice:AWF; 2002.
22. Young W, Farrow D. The importance of a sport-specific stimulus for training agility. *Strength &*

Conditioning Journal. 2013;35(2):39–43. https://doi.org/10.1519/SSC.0b013e31828b6654
23. Starosta W. The concept of modern training in sport. *Studies in Physical Culture & Tourism.* 2006;13(2):9–23.
24. McNeil DG, Spittle M, Mesagno C. Imagery training for reactive agility: Performance improvements for decision time but not overall reactive agility. *International Journal of Sport and Exercise Psychology.* 2021;19(3):429–45. https://doi.org/10.1080/1612197X.2019.1696866
25. Dubey S, Choudhary P K. Comparative analysis on selected coordinative abilities among female team sports players. *Int J Phys Educ Sports Health*, 2023;10(1): 7–11. https://doi.org/10.22271/kheljournal.2023.v10.i1a.2745
26. Podrihalo O, Jagiello W, Xiaohong G, Podrigalo L, Yermakova T, Cieslicka M. Sensory integration research: priority scientific directions based on the analysis of Web of Science Core Collection resources. *Physical Education of Students*. 2023;27(6):358-77. https://doi.org/10.15561/20755279.2023.0608
27. DiCesare CA, Montalvo A, Foss KDB, Thomas SM, Hewett TE, Jayanthi NA, et al. Sport specialization and coordination differences in multisport adolescent female basketball, soccer, and volleyball athletes. *Journal of Athletic Training.* 2019;54(10):1105–14. https://doi.org/10.4085/1062-6050-407-18
28. Mańkowska M, Poliszczuk T, Poliszczuk D, Johne M. Visual perception and its effect on reaction time and time-movement anticipation in elite female basketball players. *Polish Journal of Sport and Tourism.* 2015;22(1):3–8. https://doi.org/10.1515/pjst-2015-0008
29. Jerzy S, Paweł W, Janusz Z, Tomasz N, Mariusz B. Structure of coordination motor abilities in male basketball players at different levels of competition. *Polish Journal of Sport and Tourism*. 2015;21(4):234–9. https://doi.org/10.1515/pjst-2015-0004
30. Epurem M, Badau D. Study on improving coordination skill in women's basketball game. *Discobolul-Physical Education, Sport & Kinetotherapy Journal.* 2021;60(2): 93–105. https://doi.org/10.35189/dpeskj.2021.60.2.2
31. Lyakh V. Differences in the level of development and proficiency in coordination motor abilities among female and male athletes of selected combat sports. *Journal of Kinesiology and Exercise Sciences*. 2021;31(96):11–23. https://doi.org/10.5604/01.3001.0015.7373
32. Sun H. Improving the Accuracy of Recognition and Evaluation of Technical Movements of Basketball Players Using Deep Learning Algorithms. *Journal of Electrical Systems.* 2024;20(6s):1959–69. https://doi.org/10.52783/jes.3111
33. Weerakkody N, De Noronha M, Wiseman P, Sleeth P, Jayalath L. The use of electromyography for the assessment of sense of muscular effort: a test–retest reliability study. *Somatosensory & Motor Research.* 2019;36(1):1–7. https://doi.org/10.1080/08990220.2018.1556629
34. Iseni A, Hiseini G, Bilali R.Effects of spesific motor skills agility with students aged 13. *Research in Kinesiology.* 2016;44(1):81–85.
35. Peker AT, Vural M. Comparison of Some Coordinative Abilities in Terms of Team and Individual Sports. *Journal of Education and Training Studies.* 2019;7(8):67–72. https://doi.org/10.11114/jets.v7i8.4333
36. Zatsiorsky VM, Kraemer WJ, Fry AC. Science and practice of strength training: Human Kinetics; 2020.
37. McCormick K, Salcedo J. *SPSSreg Statistics for Data Analysis and Visualization*. 1st ed. Wiley; 2017. https://doi.org/10.1002/9781119183426
38. Robertson SJ, Burnett AF, Cochrane J. Tests examining skill outcomes in sport: a systematic review of measurement properties and feasibility. *Sports Medicine.* 2014;44:501–18. https://doi.org/10.1007/s40279-013-0131-0
39. Rico-González M, Pino-Ortega J, Nakamura FY, Arruda Moura F, Rojas-Valverde D, Los Arcos A. Past, present, and future of the technological tracking methods to assess tactical variables in team sports: A systematic review. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 2020;234(4): 281–290. https://doi.org/10.1177/1754337120932023
40. Türkmen M, Genç H, Ciğerci AE. Investigation of Different Training Methods Integrated into Soccer Training on Body Composition and Athletic Performance. *Physical Education of Students*. 2022;26(6):288-95. https://doi.org/10.15561/20755279.2022.0603
41. Iermakov S, Yermakova T, Prusik K. Modeling the gameplay actions of elite volleyball players and teams based on statistical match reports. *Pedagogy of Health*. 2023;2(2):50-64. https://doi.org/10.15561/health.2023.0202
42. Delaney JA, Cummins CJ, Thornton HR, Duthie GM. Importance, reliability, and usefulness of acceleration measures in team sports. *The Journal of Strength & Conditioning Research*. 2018;32(12):3485–93. https://doi.org/10.1519/JSC.0000000000001849
43. Gómez-Carmona CD, Bastida-Castillo A, Ibáñez SJ, Pino-Ortega J. Accelerometry as a method for external workload monitoring in invasion team sports. A systematic review. *PloS One*. 2020;15(8):e0236643. https://doi.org/10.1371/journal.pone.0236643
44. Morral-Yepes M, Moras G, Bishop C, Gonzalo-Skok O. Assessing the reliability and validity of agility testing in team sports: a systematic review. *The Journal of Strength & Conditioning Research.* 2022;36(7):2035–49. https://doi.org/10.1519/JSC.0000000000003753
45. Mackala K, Vodičar J, Žvan M, Križaj J, Stodolka J, Rauter S, et al. Evaluation of the pre-planned and non-planed agility performance: Comparison between individual and team sports. *International journal of Environmental Research and Public Health.* 2020;17(3):975. https://doi.org/10.3390/ijerph17030975
46. Ljach W, Witkowski Z. Development and training of coordination skills in 11-to 19-year-old soccer

players. *Human Physiology*. 2010;36:64–71. https://doi.org/10.1134/S0362119710010081

47. Lyakh V, Sadowski J, Witkowski Z. Development of coordination motor abilities (CMA) in the system of long-term preparation of athletes. *Polish Journal of Sport and Tourism*. 2011;18(3):187–91. https://doi.org/10.2478/v10197-011-0014-6
48. Popovych J, Nesen O, Prusik K, Lutskyi V. Assessing the effects of targeted soccer exercises on the physical fitness of 15-16-year-old schoolchildren. *Physical Culture, Recreation and Rehabilitation*. 2024;3(1):4-9. https://doi.org/10.15561/physcult.2024.0101
49. Kozina ZL, Repko O, Safronov D, Kozin S, Evarnickii I, Grebniova I. System of development of coordination abilities of young climbers 6–7 years. *Health, Sport, Rehabilitation*. 2018;4(4):62–71. https://doi.org/10.34142/HSR.2018.04.04.07
50. Piatysotska S, Podrigalo L, Romanenko V, Zhernovnikova Y, Dolgopolova N, Yefremenko A. Comparative analysis of motor functional asymmetry indicators in athletes of cyclic sports, martial arts, and esports. *Physical Education of Students*. 2023;27(4):212-20. https://doi.org/10.15561/20755279.2023.0408
51. Raczek J, Mynarski W. *Coordination motor abilities of children and young people: internal structure and variability*. Katowice: AWF; 2012.
52. Šimonek J. The effect of intervention on the changes of coordination factors in the youth sports preparation. *Sport Science*. 2016;9(Suppl 2):77–81.
53. Nae CI, Pop CL. Improving university students' coordinating skills in physical education lessons with basketball focus. *Physical Education of Students*. 2022;26(1):41-7. https://doi.org/10.15561/20755279.2022.0106
54. Litwiniuk A. Conditioning and coordination motor abilities of combat sports athletes. *Arch Budo Sci Martial Arts Extreme Sports*, 2023; 19: 169–177.
55. Platonov V, Nikitenko A. Agility and coordination testing in hand-to-hand combat sports. *Polish Journal of Sport and Tourism*. 2019;26(2):7–13. https://doi.org/10.2478/pjst-2019-0008
56. El-Shafee A, Kapouh N. The relationship of developing coordination abili-ties with the level of performance of some basic skills of young female basketball. *International Journal of Sports Science and Arts*. 2016;301:253–76.

Information about the authors:

Roman Boichuk; (Corresponding author); https://orcid.org/0000-0001-7377-6211; roman-boychuk@ukr.net; Department of Physical Education and Sports, Ivano-Frankivsk National Technical University of Oil and Gas; Ivano-Frankivsk, Ukraine.

Mykola Nosko; http://orcid.org/0000-0001-9903-9164; mykola.nosko@gmail.com; Department of Pedagogy, Psychology and Methods of Physical Education; T.H. Shevchenko National University "Chernihiv Colehium"; Chernihiv, Ukraine.

Yuliya Nosko; http://orcid.org/0000-0003-1077-8206; ulianosko5@gmail.com; Department of Preschool and Primary Education, T.H. Shevchenko National University "Chernihiv Colehium"; Chernihiv, Ukraine.

Zhanna Grashchenkova; https://orcid.org/0000-0002-9372-9890; zhannet444margo@gmail.com; Department of Olimpic and Professional Sports; Kharkiv State Academy of Physical Culture; Kharkiv, Ukraine.

Iryna Petrenko; https://orcid.org/0000-0002-5658-9681; ivpetrenko18@ukr.net; Department of Physical Culture Management; Kharkiv State Academy of Physical Culture; Kharkiv, Ukraine.

Ivan Vaskan; https://orcid.org/0000-0002-1725-3595; i.vaskan@chnu.edu.ua; Department of Physical Culture and Health Basics; Yuriy Fedkovych Chernivtsi National University; Chernivtsi, Ukraine.

Andriy Shankovskyi; https://orcid.org/0000-0003-2904-662X; andrii.shankovskyi@nung.edu.ua; Department of Physical Education and Sports, Ivano-Frankivsk National Technical University of Oil and Gas; Ivano-Frankivsk, Ukraine.

Cite this article as:

Boichuk R, Nosko M, Nosko Y, Grashchenkova Z, Petrenko I, Vaskan I, Shankovskyi A. Ways to improve methods of monitoring the coordination abilities of young basketball players aged 13-14. *Pedagogy of Physical Culture and Sports,* 2024;28(6):489–500.
https://doi.org/10.15561/26649837.2024.0603

Received: 22.09.2024
Accepted: 07.11.2024; Published: 30.12.2024