

## Use of exercises with increased coordination complexity in the training process of young female volleyball players aged 13-14 years

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### Abstract

**Background and Study Aim** In the context of training young female volleyball players, understanding the criteria, extent, and impact of exercises with heightened coordination complexity becomes crucial. This study aims to determine the evaluation criteria, scope, and effects of incorporating exercises with elevated coordination demands on the specific athletic readiness of young female volleyball players aged 13–14 years.

**Material and Methods** The study involved female volleyball players aged 13–14 years (n=24) with an average of 4 years of professional experience. Participants were divided into a control group (n=12) and an experimental group (n=12). Prior to the study, both children and their parents were thoroughly informed about the research procedures, and parental consent was obtained for participation. The coordination exercises were categorized into five groups, each assigned a complexity rating from 1 to 5. The assessment utilized a battery of tests.

**Results** The findings reveal that coordination training yielded a more pronounced advancement in the development of various coordination abilities among female volleyball players in the experimental group, as compared to those in the control group. A statistically significant enhancement ( $p < 0.05$ ) was evident across all indices of coordination readiness within the experimental group. In contrast, the control group demonstrated notable progress only in 3 out of 10 instances ( $p < 0.05$ ). In the control group, noteworthy increases ( $p < 0.05$ ) were observed in spatial orientation, motor activity restructuring, and response indicators. Female volleyball players in the experimental group exhibited substantial improvement ( $p < 0.05$ – $0.001$ ) across all indicators of technical readiness, including reception, attack hit, serve, and ball pass. Conversely, the control group players showed comparatively less remarkable changes in this aspect of readiness, with significant enhancement ( $p < 0.05$ ) identified in three parameters.

**Conclusions** The strategic incorporation of exercises with progressively heightened coordination demands emerges as a valuable approach in substantially enhancing the range of coordination abilities among young female volleyball players. Recognizing this factor provides the means to expedite and optimize the mastery of motor skills more effectively.

**Keywords:** female volleyball players, abilities, coordination, complexity, method, training.

### Introduction

Sports training constitutes an intricate system encompassing a multitude of phenomena,

interrelationships, and behavioral components. In striving to attain the ultimate objective of sports training — that is, cultivating a top-tier athlete capable of optimal performance across diverse conditions — our endeavor rests on a comprehensive comprehension of the young athlete's individuality. Additionally, it hinges on an

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understanding of the nuanced influences of age and gender on players. This collective insight serves as the foundation for crafting a well-founded blueprint for a coherent, multi-year sports training regimen. This strategic framework should encompass the utilization of pertinent and efficacious training tools, methodologies, and instructional formats, as well as an adept calibration of training intensities, frequencies, and the sequential arrangement of training cycles [1, 2].

Verkhoshanski [3], Koryahin et al. [4] propose that the term “training load” encompasses the magnitude of alterations within the athlete’s internal physiological milieu brought about by the impact of physical exercises. It should be noted that physical exercises provoke a reaction from the functional systems of the body, which is reflected in the adaptive mechanisms of its adaptation to specific activities. In addition, the rate of adaptive changes in players’ bodies, their nature and the degree of adaptation achieved are determined by the type, magnitude and direction of the applied loads. Naturally, the experts divide the load into training and competition, specific and non-specific [5, 6]. According to this, the training load includes the amount of exercises that athletes carry out as part of the preparation for a competition. Competition loads are mainly characterized by quantitative and qualitative indicators of competition practice during a competition or multiple competitions that complete a given cycle of player training. In particular, Starosta [5] points out that specific and non-specific loads are typical for each type of motor activity, and the training effect depends on their combination. There is reason to believe that exercises with elements of competitive action create a specific load. Exercises for basic physical training characterize a non-specific load. For example, in the context of sports games, all exercises with the ball give specific loads, while exercises without the ball are non-specific. Specific training aids have a high training effect and are used as a means of special training. Their use ensures a direct and positive transfer of skills and motor qualities. As a rule, the use of training aids from this group results in a rapid increase in sporting and technical results. Specific effect of the training aids of the second group is insignificant and therefore they are used only as a means of basic training [7, 8, 9].

With any physical activity, first of all, that motor qualities develop and improve, on which the result depends. Obviously, the training effect of exercises is determined by the ratio of their components. In particular, in one combination of values of the impact components, this exercise can be aimed at the development of endurance, and in the other one it will develop speed and strength [2, 10]. Characteristically, a session’s training load should provide not only the required value and direction

of the urgent training effect, but also its interaction with the training effects of past and subsequent sessions. Finally, it is known that the interaction of exercises of different directions manifests itself in the fact that “the biochemical shifts caused by this exercise depend on whether the exercise is performed after a long break, whether it is preceded by another exercise, the aftereffect of which is reflected in the urgent training effect of the exercise performed [11].

The size of the loads means the quantitative degree of the training impact [12]. The value of training and competition loads can be characterized from the “external” and “internal” sides. The “external” load is called a motor load and is determined by the duration and speed of the exercises performed, the number of repetitions, approaches, elements, weight lifted, etc. “Internal” or physiological load is a way of mobilizing the body’s functional capabilities while performing exercise and is taken into account in terms of indicators such as oxygen consumption, oxygen debt, heart rate, blood pressure, blood pH, blood lactate, etc. From the point of view of managing the process of physical education and sports training of young athletes, the “external” load is characterized by a direct connection directed from the controlling object (teacher) to the controlled object (student). This connection is visible and is determined by such load parameters as: the content of the exercises, duration of their execution, intensity, number of repetitions in a series, number of series, duration and type of rest intervals between exercises and series [7, 13].

It follows that the most developed and studied characteristics of the training load in child and youth sports include specialization, direction, and magnitude [12]. As for a load characteristic such as coordination complexity, despite its high scientific value and practical importance, this topic is still understudied. In addition, experts [14, 15] note that the importance of this factor for the mastery of technical and tactical techniques of volleyball by young athletes is very high and therefore it is not possible to classify the training loads taking into account, for example, the complexity of the coordination of the exercises can result in misjudgements in planning, since the influence of the coordination complexity significantly influences the extent of training effects.

Thus, a contradictory situation has developed between the need to classify training exercises according to the degree of coordination complexity of young female volleyball players and to determine their connection in the aspect of age, on the one hand, and the insufficient scientific development of methodological support for solving this pedagogical task, on the other hand. This determines the practical and scientific relevance of the study problem.

*Hypothesis:* We hypothesize that the establishment of methods for categorizing training modalities based on their levels of coordination complexity, coupled with the determination of optimal volumes for these modalities, will enable the fine-tuning of the educational and training processes for young female volleyball players aged 13-14 years. This, in turn, is anticipated to yield a measurable enhancement in specialized fitness indicators and substantial strides in the efficacy of their gameplay.

*Study Purpose:* The objective of this study is to ascertain the criteria for evaluation, the extent, and the impact of incorporating exercises of elevated coordination complexity on the specific athletic readiness indicators of young female volleyball players aged 13–14 years.

## Material and methods

### Participants

Female volleyball players aged 13–14 years participated in the experiment (n=24, training experience – 4 years). Female volleyball players were divided into a control group (n=12) and an experimental group (n=12). The groups formed were identical in terms of coordination readiness, physical qualities and technical and tactical skills. Prior to the study, both children and their parents were thoroughly informed about the research procedures, and parental consent was obtained for participation. The inclusion criteria for players were being at a stage of specialized basic training with no musculoskeletal or psychophysical disorder. A professional volleyball coach supervised and

regulated young athletes' training programs.

### Research Design

Pedagogical experiment lasted 8 months. Well-known motor tests were used to determine the level of coordination readiness of female volleyball players [16, 17, 18]. The tests were carried out at the beginning and at the end of the experiment. As part of the study, the level of kinesthetic differentiation, spatial orientation, reaction, restructuring and coordination of movements and balance skills was determined:

Test 1. Throwing a ball directed at a target standing with one's back to it (number of times);

Test 2. Ten eight figures (s);

Test 3. Stepping over a gymnastics stick (s);

Test 4. Running to the numbered balls (s);

Test 5. Time difference between running to the numbered balls and shuttle running (5x3 m), s;

Test 6. Static equilibrium evaluation by Bondarevsky's method (s);

Test 7. Turns on the gym bench (dynamic equilibrium), number of turns;

Test 8. Shuttle run with back forward (3x10 m) (s);

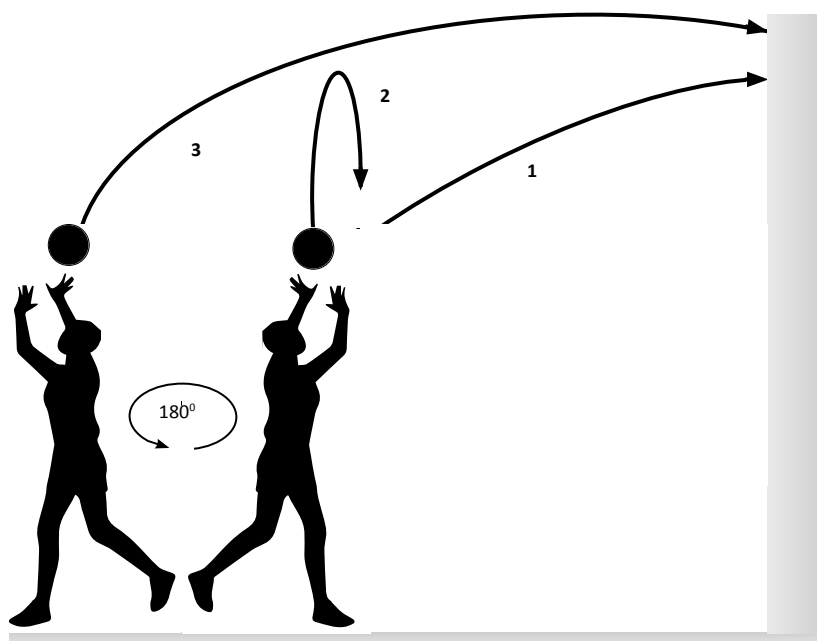
Test 9. Difference in time between running "Shuttle run (3x10 m)" and "Shuttle run with back forward (3x10 m)" (s);

Test 10. Measurement of the complex motor reaction (sm).

To determine the level of technical and tactical readiness of female volleyball players, the following tests were used [19]:

Test 11. Overhead Passing to Wall (fig. 1);

Test 12. Serving Accuracy (fig. 2);



**Figure 1.** Scheme of the test "Overhead Passing to Wall"

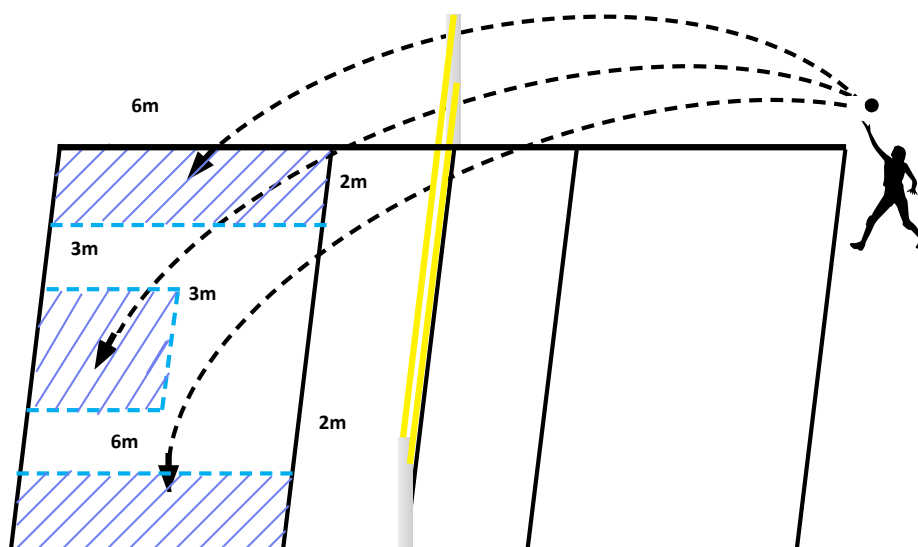


Figure 2. Scheme of the test "Serving Accuracy"

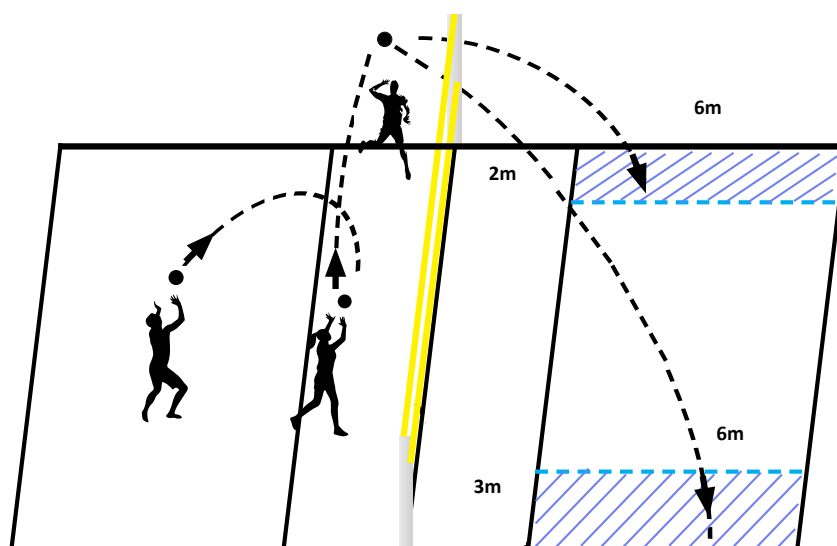


Figure 3. Scheme of the test "Accuracy of Spike"

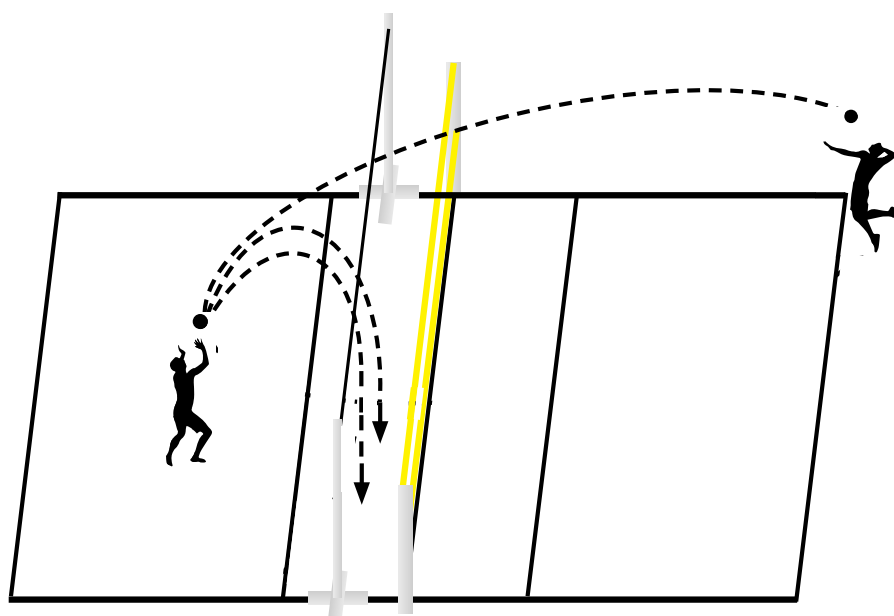


Figure 4. Scheme of the test "Serve Reception"

Test 13. Accuracy of Spike (fig. 3);

Test 14. Serve Reception (fig. 4).

The control and experimental groups trained five times a week for two hours. Lesson content and training loads were similar in both groups. The only exception was the method of using coordination exercises. The focus was on the targeted development of seven coordinative abilities in combination with elements of volleyball technique. Roughly the same amount of time was spent on training the individual coordinative skills. At one training session, specific coordination exercises lasting 8-12 minutes were performed, with no more than 2-3 types of coordination skills being improved. According to methodological recommendations [20], the approximate distribution of time for general and special coordination training to other types of training was as follows (Table 1).

**Table 1.** Approximate distribution of training types in the experimental training program [20]

Training type	Partial volumes, %
General coordination	10
Special coordination and technical	45
Conditional	25
Tactical	20

When developing the experimental program, there was a need to objectify the criteria for controlling the coordinative complexity of exercises used in the training process of young female volleyball players. The main study method was the analysis of training plans. In particular, the study materials were obtained based on the analysis of the yearly training cycle of young female volleyball players aged 13-14 years. The first step was to establish the observation scheme. Based on the recommendations of researchers [21, 22], the coordination exercises were divided into five groups and their complexity was rated from 1 to 5 (Table 2). In developing this rating scale, criteria such as accuracy, speed, punctuality, and economy that a volleyball player should demonstrate when performing appropriate motor actions were

taken into account. We also took into account the conditions under which these motor actions were performed, the number of players participating in the exercise, their skill level, performing exercises due to lack of time, in an uncomfortable direction, in a mirror image, with a non-conducting limb, in a state of fatigue etc.

When implementing the experimental program, the approximate proportions of exercises of different coordination complexity in the training process of athletes of all ages involved in sports games were taken into account (Table 3).

**Table 2.** Conditional evaluation of the complexity of coordination exercises

Coordination complexity of exercises	Evaluation of coordination complexity of exercises, points
Low	1
Medium	2
High	3
Submaximal	4
Maximum	5

According to the table we see that when training young athletes, with age it is necessary to reduce the volume of exercises of low and medium coordination complexity by 30-40%, and by 35-45% at the age of 8-12 up to 10-15 and 35 to 45% at the age of 17 to 18 years (if you reach the highest sporting levels). The proportion of exercises with high, submaximal and maximum coordinative complexity should be considered from 10-20% and 0-5% (8-12 years) to 30-40% and 10-15% (17-18 years).

A gradual increase in the volume of exercises of increased coordination complexity in the training process is of no small importance. In particular, an exercise only has a positive effect on improving the ability to control and regulate motor actions if it causes the player some coordination difficulties [13, 23]. An increase in the coordination complexity of the exercises was achieved through the following methodical techniques.

1. Introduction to the performance of motor actions that are complex in terms of coordination

**Table 3.** Approximate ratio of exercises of different coordination complexity when training athletes of all ages in team sports, % [20]

Age, years	Exercises of low coordination complexity (1 point)	Exercises of medium coordination complexity (2 points)	Exercises of high coordination complexity (3 points)	Exercises of submaximal and maximum coordination complexity (4-5 points)
8-12	30-40	35-45	10-20	0-5
13-14	20-30	45-55	15-25	0-5
15-16	15-20	40-50	25-35	5-10
17-18	10-15	35-45	30-40	10-15

- (e.g. performing an attack hit after performing defensive actions);
2. Increasing the requirements for the accuracy of performing motor actions, subsequently for accuracy and speed, and finally for accuracy, speed, stability and resourcefulness in performing motor actions in changing conditions;
  3. Limiting the time for performing motor tasks (e.g. trying to perform as many attack hits as possible in a given period of time);
  4. Changing the way of performing motor actions and individual movement parameters:
    - Performing technical elements with a non-conductive hand or in an uncomfortable direction;
    - Changing the direction and pace of movement;
    - Changing the magnitude of the force components (e.g. passing the ball to different distances);
    - Changing the starting and ending positions during the exercise (e.g. performing a reception after the movement);
    - Execution of controlled motor actions in various combinations (alternate execution of several elements that are complex in terms of coordination);
    - Change in technique when performing the same motor action (e.g. the way of receiving the ball after the serve);
  5. Changing conditions and situations when performing motor actions:
    - Introduction of active opposition on the part of the defenders;
    - Use of different forms of play – tasks (e.g. playing one or two touches of the ball);
    - Changing the spatial parameters, reducing the field of action (e.g. playing on a reduced area);
    - Limiting the action of individual motion analyzers (receptors) that provide the player with relevant information (e.g. limiting visual control, playing with a darkened net);
    - Performing actions on accuracy, accuracy and speed under psychological stress, for example, rivalry in the serve execution);
    - Carrying out coordination tasks during exercises to develop certain physical qualities (strength, speed, speed and endurance) or carrying out these exercises against the background of physical fatigue;
    - Complication of tasks with additional movements (for example, taking protective measures after a roll);
    - Performing technical elements with balls of different sizes and masses (e.g. passing or hitting a ball that is smaller and lighter in size than usual);
  - Execution of motor actions after “stimulation” of the vestibular analyzer (e.g. passing the ball after quick rollovers, turns, etc.);
  - Conducting exercises on an atypical surface (e.g. performing technical and tactical actions, on sand, an unstable surface, etc.) [17, 24, 25].

#### *Statistical analysis*

Statistical data processing was carried out using Microsoft Excel and SPSS programs. The following parameters were determined for each indicator: arithmetic mean (X), standard deviation (S), standard error (m), confidence interval ( $\Delta x$ ), significance of differences according to Student’s t-test with the corresponding significance level (p). Differences were considered significant at a significance level of  $p < 0.05$  [26].

#### **Results**

Before the start of the pedagogical experiment, there were no statistically significant differences between the indicators studied in the experimental and control groups. It was shown that the variant of coordination training used in female volleyball players in the experimental group contributed to a higher rate of increase in the level of development of most coordination skills compared to the control group. A significant improvement ( $p < 0.05$ ) in the experimental group was shown for all indicators that characterized the level of coordination readiness of young female volleyball players (Table 4). At the same time, as in the control group, there was a significant improvement in results in only 3 out of 10 cases ( $p < 0.05$ ) (Table 5).

The improvement in kinesthetic differentiation ability occurred by 11.9% in the experimental group and by 14.3% in the control group. Indicators of the ability to coordinate movements improved by 6.5–8.5% ( $p < 0.05$ – $0.001$ ) in the experimental group and by 1.2–2.4% ( $p > 0, 05$ ).

The comparison of indicators characterizing the subjects’ spatial orientation ability showed that the representatives of the experimental group were significantly ( $p < 0.05$ ) ahead of their peers from the control group. It should also be added that one of the indicators of this ability recorded a significant increase in the representatives of the control group, which, in our opinion, indicates the presence of an effective training process in this team. Thus, the indicators of running to the numbered balls and the difference between the 5x3 m shuttle run and the pre-test in the experimental group improved by 6–33%, while in the control group these indicators increased by 4.3–8.3 %, respectively. The indicator characterizing the trainees’ static balance ability in the experimental group improved by 83% ( $p < 0.05$ ), while the increase in the control group was 38%

**Table 4.** Changes in indicators of coordination readiness among female volleyball players of the experimental group (n=12)

No	Indicator	Before experiment		After experiment		$\Delta x$	t	p
		$\bar{X}$	s	$\bar{X}$	s			
1	Throwing a ball directed at a target, (number of times)	12.22	3.03	13.67	3.16	1.98	3.51	0.008
2	Ten eight figures, s	10.19	0.80	9.39	0.70	0.53	5.23	0.001
3	Stepping over a gymnastics stick, s	11.49	1.56	10.79	1.08	1.02	2.63	0.030
4	Running to the numbered balls, s	13.20	1,06	12.35	0.74	0.70	4,18	0.003
5	Time difference between running to the numbered balls and shuttle running (5x3 m), s	2.94	0.33	2.21	0.37	0.21	5,40	0.001
6	Static equilibrium evaluation, s	16.42	8.6	30.2	15,3	5.65	4.33	0.003
7	Turns on the gym bench, number of turns	6.32	0.87	7.22	0.46	0.51	4.08	0.004
8	Shuttle run with back forward (3x10 m)	11.91	0.46	11.7	0.44	0.30	1.66	0.002
9	Difference in time between running "Shuttle run (3x10 m)" and "Shuttle run with back forward (3x10 m)"	3.44	0.34	3.22	0.39	0.22	2.63	0.030
10	Complex motor reaction, cm	106.2	3.99	101.7	4.27	2.6	4.16	0.003

**Table 5.** Changes in indicators of coordination readiness among female volleyball players of the control group (n = 12)

No	Indicator	Before experiment		After experiment		$\Delta x$	t	p
		$\bar{X}$	s	$\bar{X}$	s			
1	Throwing a ball directed at a target, (number of times)	9.8	3.07	11.2	3.4	2.74	1.70	0.128
2	Ten eight figures, s	11.22	0.98	10.96	1.04	0.64	2.00	0.081
3	Stepping over a gymnastics stick, s	14.4	1.93	14.23	1.96	1.26	1.84	0.102
4	Running to the numbered balls, s	14.55	1	13.95	0.92	0.65	3.07	0.015
5	Time difference between running to the numbered balls and shuttle running (5x3 m), s	2.63	0.35	2,44	0.40	0.76	1.69	0.130
6	Static equilibrium evaluation, s	14.9	8,95	20.5	11.55	5.85	2.19	0.060
7	Turns on the gym bench, number of turns	5.77	1.39	6	1.58	0.91	0.595	0.569
8	Shuttle run with back forward (3x10 m)	12.49	1.05	11.76	0.66	0.69	3.54	0.008
9	Difference in time between running "Shuttle run (3x10 m)" and "Shuttle run with back forward (3x10 m)"	2.98	0.64	2.69	0.45	0.42	2.44	0.041
10	Complex motor reaction, cm	106.8	5.04	103.4	5.05	2.29	4.04	0.004

( $p > 0.05$ ). Somewhat similar results were obtained in the analysis of dynamic balance ability. In particular, an improvement of 14% ( $p < 0.05$ ) was observed among the representatives of the experimental group, while the control result improved by 4% ( $p > 0.05$ ).

When analyzing the changes in the indicators characterizing the ability of volleyball players to reorganize motor activity and complex reactions, significant improvement ( $p < 0.05$ ) was revealed in both groups. In the experimental group, these indicators improved by 2.6–6.8%, and in the control

**Table 6.** Changes in indicators of technical readiness among female volleyball players in the experimental group (n = 12)

No	Test	Before experiment		After experiment		Δx	t	p
		$\bar{X}$	s	$\bar{X}$	s			
1	Serve	3	0.60	4.1	0.70	0.46	5.5	0.001
2	Attack hit	3.2	0.66	4.1	0.60	0.44	4.4	0.002
3	Serve Reception	2.67	0.70	3.78	0.67	0.46	5.5	0.001
4	Passing	9.55	5.1	15.22	7.2	3.35	3.1	0.014

**Table 7.** Changes in indicators of technical readiness among female volleyball players of the control group (n = 12)

No	Test	Before experiment		After experiment		Δx	t	p
		$\bar{X}$	s	$\bar{X}$	s			
1	Serve	3.11	1.05	3,78	0.66	0.69	2.31	0.050
2	Attack hit	3.33	1.22	4	1	0.80	2.82	0.022
3	Serve Reception	3.33	0.88	3.88	1	0.57	2.29	0.051
4	Passing	9.11	3.17	9.89	2.67	2.07	1.50	0.174

group by 6.2–10.7% respectively. The complex reaction indicator, in turn, improved by 4.4% in the experimental group, while this indicator improved by 3.3% in the control group.

The analysis of the results showed that the optimal use of exercises with increased coordination complexity resulted in an improvement in technical training in both groups. On four indicators of technical readiness (reception, attack hit, serving, passing), female volleyball players in the experimental group improved their scores significantly ( $p < 0.05 - 0.001$ ) (Table 6).

In female volleyball players of the control group, significant changes in this type of readiness were less noticeable. Significant improvement ( $p < 0.05$ ) was found in three parameters. There was no statistically significant improvement in the results of the test “Overhead Passing to Wall” among female volleyball players in the control group ( $p > 0.05$ ) (Table 7).

## Discussion

It is known that training and competition loads are the basis of sports training. The question of determining the size of the training load, taking into account the age and individual characteristics of young athletes, is one of the main issues in the modern system of long-term sports training. When developing this problem, the characteristics of the physical development of those involved should first be considered – age patterns, gender differences and individual characteristics [27, 28, 29].

Various studies [4, 30, 31] indicate that controlling the specialization of training loads is important as it is associated with an assessment of the quality of training work. Usually, a coach’s work is considered decent when his students perform large amounts

of loading with high results. However, such an assessment is biased until the ratio of specific work to non-specific work is determined. In fact, it is quite common, especially in sports games, for training exercises to be externally based on a game exercise in terms of their technical and tactical orientation and therefore apparently to be classified as specialized. However, determining the heart rate or any other physiological criterion shows that there is no connection between the intensity of the game and the intensity of these exercises. It is only possible to really specialize these exercises if the conditions for their implementation (movement speed of the players, active resistance of the opponent, etc.) are as close to the game ones as possible [32, 33].

Our study, in turn, confirmed the expediency of maintaining a rational ratio of general and special means of training young athletes in the process of age development. A similar opinion is held by other researchers [34, 35, 36], who point to the avoidance of significant amounts of specialized training loads at primary and secondary school age. After all, in their opinion, this will certainly result in an acceleration of training and a violation of the natural process of forming athleticism in the system of long-term improvement. The main tasks of the educational and training process at this age are the multifaceted development of the body’s motor skills, strengthening the health of those involved, eliminating deficits in their physical development and physical fitness, and creating motor potential that will help them to acquire diverse motor skills (including those that correspond to the specifics of the future sport specialization). In her opinion, special attention should be paid to the formation of a lasting interest in sports among students. Versatile training in this phase with a



few special exercises is more beneficial for further improvement than special training. Sports activities at these ages are characterized by an abundance of means and methods, the widespread use of material from various sports and outdoor games, and the introduction of a game method.

The results of the pedagogical experiment indicate the need to use a variety of general coordination exercises in the training process of young female volleyball players in the initial and preliminary training phase. This allows young athletes to create a broad coordinative basis, a pool of different movements in muscle memory. In addition, if this fund is accumulated for thousands of exercises, which are manifested in cyclic and acyclic locomotion, gymnastic and acrobatic exercises, throwing with an emphasis on range and accuracy, outdoor games, sports and game actions, when using training tools in a targeted manner at the improving the ability to link motor actions and to transform the forms of movement developed or to switch from one requirement to another according to changed conditions, exercises are also used systematically to develop general perceptions of movement in the form of a sense of space, time, dosing of muscular effort, sensorimotor reactions, development of speech and thought processes, motor memory and movement representation, then this is excellent material for the further successful technical and tactical improvement of those involved, even at the stage of subject-specific basic training. In this regard, Platonov [12] and Bompa [37] note that in the process of assimilation of technical material, in no case should one try to stabilize the technique of movement in order to achieve stable motor ability, which will allow one to practice certain sports exercise results. During this time, young athletes develop a versatile technical basis that enables them to master a wide variety of motor actions. This approach is the basis for further technical improvements. It is noteworthy that these experts stubbornly emphasize that the game method is best justified when working with primary and secondary school-age students in the context of their sporting activities, as it creates a positive emotional background in the classroom. Furthermore, after analyzing the biographies of leading athletes, these researchers concluded that the game orientation of initial training was mostly associated with a low overall workload. At the initial stage, they worked less intensively than their peers, who did not achieve high results in the future.

After the pedagogical experiment, the assumption about the possibility of developing coordination skills in combination with improving speed, speed and strength, strength, endurance and flexibility was confirmed. In particular, special physical training methods were used, which not only resemble the structure of the main motor skills, but also fully

correspond to the performance regime in the main movement phases. In order to improve special motor and technical readiness and increase the coordination skills of those involved, the possibility of using loads as a means of additional mobilization of analyzers was confirmed. Movements with weights, performed as part of a specific technique, contributed to an effective improvement in the coordination structure of motor action and the efforts that strengthen it. In this regard, Zatsiorsky [1] points out that when intensifying the work of muscles, movements with weights contribute to the development of intermuscular coordination, which is necessary for the rational organization of dynamic accents of the coordination structure of motor action. Weights contribute to additional excitement of the nerve centers and an increase in the number of motor units involved in muscular work. The optimal weighting of the movement reduces the variability in the structure of muscle work, bringing it closer to the most rational model. The weight of the weights should be such that some heaviness is felt during the exercise, but the structure of the movement is not distorted. In addition, Sadowski [38] states that the combined method is a variation of the holistic method. Its essence lies in the fact that the mastery of certain motor actions and their improvement occurs with significant muscular effort and a high level of coordinative complexity. With such motor actions, the athlete shows his/her maximum motor qualities, that means at the same time there is a kind of combined improvement in both movement technique and motor qualities. In particular, the researcher argues that this method should be used in the process of improving trained motor actions in order to improve the quality of their performance. When applying this approach, it is important that the technique of the movements under study does not deteriorate and their integral structure is not violated. This is one of the most effective ways to improve movement technique against the background of developing the motor qualities that are leading for these exercises.

After the pedagogical experiment, the assumption about the positive effect of special coordination exercises on the growth of technical readiness indicators was confirmed. The main aim is to use the trained techniques in a targeted manner in coordinatively more complex conditions that put forward increased requirements for such coordinative abilities of young players, such as the ability to adapt and restructure motor actions, kinaesthetic differentiation of movement parameters, a sense of rhythm, ability and balance. Similar results have previously been obtained by other researchers [39, 40, 41] working with young athletes. The authors came to similar conclusions and recommended extensive use of the combined influence method in the training process of young athletes in order

to simultaneously improve coordination, technical and tactical abilities and skills. In fact, as the researchers note, in practice there are cases where a young player possesses motor action technique under standard conditions, but is unable to use it optimally in changing situations. The qualitative education and improvement of the special readiness of young volleyball players largely depends on the rational use of forms, means and methods of sports training, which allow to simultaneously develop motor qualities and improve motor skills. Lyakh et al.[17] consider this fact as a result of a positive interference (transfer) of one more integral factor (abilities) to another less integral factor (game technique).

Coordination complexity is one of the most important characteristics of training load. The influence of this factor is particularly important in sports games and volleyball in particular. Accordingly, in order to avoid planning errors, trainers should not only control the scope, intensity and specialization of the load, but also take into account the coordinative complexity of the training means used. The conducted study resulted in the conclusion that the targeted use of exercises with a gradual increase in their coordination complexity can significantly improve the development level of various coordination abilities of young female volleyball players aged 13-14 years. Our data are fully consistent with the studies of other authors who have studied movement coordination in young athletes [22, 42, 43, 44, 45]. The researchers showed that the use of general and specific exercises with increased coordination complexity in training sessions with athletes of all ages and qualifications achieves a high training effect. The inclusion of such exercises in the training process in combination with a rational method of their application can significantly increase the level of development of motor coordination, indicators of technical and tactical mastery, as well as conditional qualities (speed, explosive strength and endurance) of volleyball athletes.

Thus, the results of the study show that it makes sense to use the optimal amount of exercises with increased coordination complexity in the training process of young female volleyball players aged 13-

14 years. The optimal combination of developing coordination abilities and improving the elements of volleyball playing technique will help improve the game activity of players. In addition, further study is needed to develop criteria for assessing the coordinative complexity of exercises used in the training process of young volleyball players of all ages. It seems that it is time to pay more attention to the experimental substantiation of different variants of coordination training in volleyball.

## Conclusions

By dividing the coordination training of young volleyball players into a separate training section, the tasks of this activity could be formulated. The range of specific and non-specific means for players of all ages was shown, and the optimal duration of this process was examined on a separate session. The need for an optimal combination of exercise to improve coordination abilities with other indicators of motor function was demonstrated, and the most important types of motor coordination for a successful volleyball game activity were identified.

Coordination complexity is one of the main characteristics of the training load. The targeted use of exercises with a gradual increase in coordination complexity can significantly improve the development of various coordination abilities in young female volleyball players aged 13 to 14. Taking this factor into account when choosing training means makes it possible to master motor actions much faster and more rationally, to master new ones at the highest level and quickly rebuild old training programs, to rise faster to sports excellence and to stay in sports longer.

Further study shall be conducted to improve criteria for assessing exercise coordination complexity and to test the effectiveness of different variants of coordination training for volleyball players at all stages of long-term sports improvement.

## Conflict of interests

The authors declare that there is no conflict of interests.

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