

Methods for developing coordination abilities in 10–11-year-old basketball athletes

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Abstract

This study examines the effects of a specialized methodology for developing coordination abilities in 10–11-year-old female basketball players during a critical stage of development. Coordination—encompassing balance, rhythm, spatial orientation, and accuracy—is widely recognized as a basic component of motor learning and athletic performance. Basketball, in particular, requires a high degree of coordination owing to its fast-paced, dynamic nature and constantly shifting game situations. Previous research identifies ages 9–12 as a sensitive period for coordination development, when heightened motor learning capacity is supported by increased plasticity of the central nervous system. The experimental methodology lasted five months and involved 42 girls from two basketball clubs, evenly divided into experimental and control groups. Both groups trained with the same frequency and general structure. However, the experimental group followed a targeted approach that incorporated progressive coordination drills—primarily through ball-handling tasks—into each practice session. In contrast, the control group followed a standard basketball training program without additional emphasis on coordination development. To evaluate the effects, seven standardized motor tests were administered at the beginning and end of the experiment, assessing the following coordination components: accuracy (of arms and legs), rhythmic ability, balance (in two variations), and spatial orientation. Statistical analysis (t-test, $p < 0.05$) revealed significant improvements in the experimental group in six of the seven measured variables. Notable gains were observed in rhythmic ability (in both upper and lower limbs), balance, and spatial coordination. In contrast, the control group showed limited or inconsistent progress. These findings confirm the effectiveness of targeted coordination training during a sensitive developmental period and highlight the advantages of task-specific drills over general physical preparation alone. This study supports the structured integration of sport-specific coordination exercises—particularly in basketball—as a vital component of youth training programs. It emphasizes the importance of early, intentional motor skill development in enhancing overall athletic capacity. The findings have practical implications for coaches, physical education specialists, and sports scientists aiming to optimize training processes and promote long-term athlete development through evidence-based practices.

Keywords: coordination, motor development, basketball, sensitive periods, rhythm, balance, spatial orientation, youth athletes

Introduction

Coordination abilities allow humans to control and regulate movement activities. They are essential not only for high-performance actions but also for fine, highly accurate movements (Adolph & Hoch, 2019). Coordination abilities are defined as motor skills that characterize the complex organization of movements (Jovanovic & Jovanovic, 2003).

Because motor coordination is a function of the central nervous system, it is influenced by genetics but can be modified through training. Coordination is related to other abilities; for this reason, V. Starosta (1998) referred to it as a "super ability," while P. Hirtz (1986) called it a "phenomenal ability." V. Starosta (2000) further clarified the definition of coordination ability as "the capacity to perform high-performance movements that are accurate, fast, and adaptable to changing conditions."

Movement coordination is strongly associated with the development and enhancement of human motor activities (Coppens et al., 2021; Utesch et al., 2019). To perform movements in a specific order, the body's systems must coordinate individual muscles to follow exact spatial, temporal, and force parameters. Moreover, each sport requires specific abilities that allow athletes to achieve better performance. Movement abilities are fundamental for executing various muscle actions, and basketball is a sport that requires a high level of coordination. Basketball is often called a game of situations because the conditions on the court change rapidly, requiring athletes to be prepared at any moment to respond quickly and accurately to outplay their opponents. Various coordination abilities play a crucial role in effective game participation. For example, to execute a precise and accurate shot, athletes need strong balance and accuracy skills—both components of coordination

that can be developed through specialized exercises (Whittier et al., 2020; Fine et al., 2021). Similarly, successful dribbling requires well-developed rhythm abilities. To successfully pass the ball to a teammate or engage in any interaction with teammates, a basketball player must possess strong spatial and temporal orientation. Similarly, for a defender to effectively guard the basket, they need good balance, the ability to match the rhythm of the attacker, and accurate spatial and temporal coordination. These examples highlight the critical role of coordination abilities in basketball. Well-developed coordination not only improves performance quality and accuracy but also enables athletes to handle higher physical demands with greater power and efficiency, ultimately leading to improved results. This requires a thorough analysis of movement components and the effects they produce in the bodies of young athletes. Early childhood—the stage when children begin engaging in sports—is especially important for the development of both motor and coordination abilities (Draghi et al., 2021; Gallahue et al., 2012; De Niet et al., 2022). Numerous authors (Momchilova, 1998; Kaimakamis, 1992; Brestnichki, 2021) have identified the ages of 8–9 and 11–12 as sensitive periods for the development of coordination skills. It is recommended to develop a broad range of motor skills—especially for sports requiring complex coordination—not after the motor analyzer has fully matured (typically after the ages of 15–16), but during its most rapid phase of development, around the ages of 9 to 11–12 (Fomin, 1987; Balsevich & Zaporozhanov, 1987; Brestnichki, 2017).

Improved coordination skills also contribute to faster spatial orientation and help children learn order and discipline (Hristova, 1989). Therefore, it is important for children to begin developing these skills through sports from an early age.

According to P. Hirtz (1981) and D. Jovanovic and I. Jovanovic (2003), the development of coordination abilities should begin during preschool age, supporting fundamental movement skills such as running, throwing, kicking, hitting, walking, jumping, catching, and rolling (Coppens et al., 2021). Through small-sided games, the children improve their motor competence and develop movement skills (Eldiasty et al., 2023; Lopes et al., 2011; Wälti et al., 2022). They emphasize that the main goal of physical education and sports training for the younger generation is to fully develop coordination abilities during this critical age period (7–12 years), which is considered a sensitive phase for the development of such skills.

The goal of this study is to apply a specialized methodology tailored to basketball practice to improve athletes' coordination abilities, which are essential for success in the sport. Based on existing research, we have identified a sensitive period for the development of coordination skills and plan to leverage this window to achieve better results with children in this specific age range.

Additionally, our previous research (Brestnichki, 2008) established significant correlations between coordination and basketball technique. We will use these findings to develop a targeted methodology that improves coordination abilities through basketball practice, focusing particularly on specific ball-handling drills.

Methods:

Participants

According to a study by De Niet et al. (2022), boys and girls develop similarly during the school-age period (6–12 years). However, a more detailed analysis of specific variables shows that girls outperform boys in certain coordination abilities (Platvoet et al., 2018; De Niet et al., 2022), a finding also supported by Tsvetkov (2008). Based on these studies, we chose to perform our research with female participants aged 10–11 years. All participants and their legal guardians provided informed consent before the children's involvement in the study. The experiments and the publication of results were performed with the approval and consent of the National Sports Academy.

We selected 42 girls, all basketball players from two clubs, to participate in the study. The clubs were chosen based on discussions and agreement with the coaches to participate in the experiment. Each team contributed an equal number of players, all of whom had been practicing basketball for one year. The team whose coach agreed to implement our specialized methodology was designated as the experimental group, while the other team, whose coach followed a standard basketball training program, served as the control group. The experiment lasted for five months. During the five-month period, both groups completed approximately 35 practice sessions (± 3), training twice per week. All 42 participants were tested at the beginning and end of the study. After this experimental phase, we expected to observe changes in their overall sports abilities, with a particular focus on coordination skills.

The children were assessed using seven tests designed to evaluate key coordination components—rhythm, balance, accuracy, and spatial coordination. These tests, validated and described by Al. Naumovski et al. (2004), are reliable and consistent. The tests are categorized into four groups:

I group – Tests for evaluating arm and leg accuracy.

Test 1 – Target aiming with a short pole using one hand. The child stands at arm's length from a target while holding a 1-m pole in one hand. Using the pole, the child strikes the target 49 times. The target is marked with numbers ranging from 10 to 1.

Test 2 – Target aiming with a tennis ball using the inner part of the foot. For this test, the child tries to kick a tennis ball toward a target on the floor from a distance of 6 m. The child performs 7 consecutive kicks, with each kick aimed at the target, which is numbered from 6 to 1. The child has a total of 49 attempts

II group – Tests for evaluating body balance.

Test 3 – Standing on one foot next to a balance apparatus with eyes open. The children, barefoot, stand on a 5-cm-wide beam with their arms resting alongside their bodies and one leg bent at the knee. They must maintain this position for as long as possible. Each child has 6 attempts.

Test 4 – Parallel standing on one foot on the balance apparatus with eyes open.

This test uses the same setup as the previous balance test, but the children step parallel to the beam while performing rhythmic movements.

III group Rhythm

Test 5 – Rhythmless buffets with both hands. The child sits at a desk with both hands resting on it. They must perform a specific sequence of movements: starting with the left hand tapping the table twice, followed by the right hand crossing over the left hand and tapping the table twice. Then, the right hand touches the forehead before returning to the table. Upon the signal "begin," the child has 20 s to complete as many correct cycles as possible.

Test 6 – Buffets with legs and arms at the wall. The child stands in the corner where two walls meet. They perform the following movements in sequence: the left leg kicks the left wall, the right hand taps the right wall, the left hand taps the left wall twice, and the right leg kicks the right wall. The goal is to complete as many correct cycles as possible in 20 s.

IV group – Test for evaluation of body coordination

Test 7 – Running in the shape of an eight while bending (figure of eight). In this test, an elastic rope is stretched between two poles spaced 4 m apart. The rope is adjusted to the height of the child's hips. The child starts standing next to one of the poles. At the signal "start," the child runs, bending to pass under the rope without touching it, then runs around the opposite pole, returns under the rope, and circles back around the first pole. This sequence is repeated four times, and the total time is recorded.

All test results were analyzed using appropriate descriptive statistical methods. The main method for comparing the two groups was the Student's t-test, with a confidence level of at least 95%. All data analyses were performed using SPSS software.

The experimental method aimed to enhance the coordination abilities of the participating athletes, thereby increasing their overall movement and coordination potential.

Numerous pedagogical studies indicate that children aged 8–9 to 11–12 have substantial potential for developing their motive analyzer, highlighting an increased sensitivity in coordination abilities during this period (Momchilova, 1998). Based on this, we selected participants aged 10–11 years for our study.

The experiment lasted five months, from January to May. During this period, both groups participated in 2–3 basketball practices per week, with each session lasting 80 min. Over the entire experiment, the experimental group completed 38 practices, while the control group completed 35.

The main requirement for the experimental group is to increase the difficulty of the exercises every other practice. In the practice plan, special attention should always be given to the following aspects of the drills, in this order: 1) accurate execution; 2) increasing coordination difficulty by varying the rhythmic structure of the exercises or drills; 3) gradual increase in performance speed; 4) progressively more complex situations; 5) shortening the movements. Coordination exercises are quite demanding owing to their broad scope, engaging not only the muscles but also the mind and nervous system. For that reason, training sessions must be varied and engaging, especially during the preparation phase of practice.

In general, exercises should follow this sequence: first, emphasize accuracy in performance; next, focus on increasing speed; and finally, develop coordination between accuracy and speed.

Coordination development requires a long-term approach; therefore, each practice must include exercises targeting every component of coordination ability, such as balance, rhythm, spatial coordination, accuracy, and others.

The coordination exercises incorporated into the warm-up phase of training lasted between 12 and 18 min. These exercises included various drills for developing each component of coordination, presented in the following order: balance, coordination, and rhythm. From each category, 2–3 drills were selected, and in nearly every practice, these drills were varied while adhering to the five principles outlined earlier.

The control group participated in standard basketball practice, which included a few drills focused on technique and tactics, along with ample time for 5-on-5 gameplay.

Results

At the start of the experiment, after testing both teams, we established the following levels of coordination abilities (Table 1 and Figure 1).

Regarding accuracy with the arms and legs (tests 1 and 2), the experimental group demonstrated a slight advantage in arm accuracy, scoring 7.53 points compared to the control group's 7.45 points—a difference of 0.08 points. However, in leg accuracy, the control group performed better, scoring 0.94 points, which is 0.21 points higher than the experimental group.

Table 1

Results at the beginning of the experiment								
		Experimental group		Control group		d	t	P(t)
		Average	STDEV	Average	STDEV			
accuracy	Short bar	7.53	1.01	7.45	1.19	0.08	0.24	15.60
	With ball	0.73	0.24	0.94	0.37	-0.21	-2.17	96.00
rhythmic	Non-rhythmic	8.11	1.77	7.49	1.89	0.62	1.09	71.60
	With legs and arms	6.86	1.58	5.83	2.12	1.03	1.79	91.30
balance	Alongside	1.44	0.35	0.82	0.28	0.62	6.37	99.99
	Crosswise	1.15	0.21	0.68	0.18	0.47	7.86	99.99
Coordination	Figure of eight	21.11	1.66	21.84	1.50	-0.73	-1.50	85.90

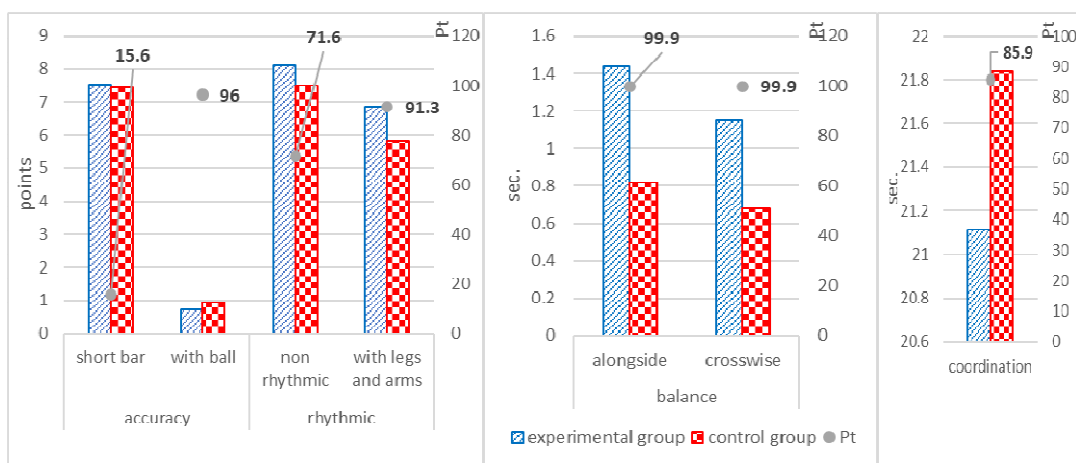


Fig. 1 Coordination abilities of the control and experimental groups at the beginning of the experiment

In rhythmic abilities, which include rhythmless buffets as well as buffets with the legs and arms, the experimental group achieved better results than the control group. For arm movements, children in the experimental group averaged 8.11 cycles, compared to 7.49 cycles in the control group. In the rhythmic test involving both legs and arms, the experimental group scored 6.86 cycles, while the control group scored 5.83 cycles.

Regarding balance abilities, we found that the experimental group showed a slight advantage over the control group. In the balance test with the apparatus, the experimental group outperformed the control group by 0.62 s, achieving 1.44 s compared to 0.82 s. In the parallel balance test on the apparatus, the experimental group's advantage was 0.47 s, with results of 1.15 s versus 0.68 s for the control group.

In spatial coordination, the experimental group achieved a result of 21.11 s, while the control group recorded 21.84 s, which is 0.73 s slower than the experimental group.

By the end of the experiment, significant differences were observed (Table 2 and Figure 2). Female basketball athletes in the experimental group outperformed those in the control group in 6 out of the 7 tested coordination abilities.

In the first two tests assessing arm accuracy, the experimental group achieved 8.05 cycles, compared to 7.99 cycles for the control group. For leg accuracy, the control group scored 0.85 points, which is 0.06 points higher than the experimental group's 0.79 points.

In rhythmic abilities with the arms, the experimental group achieved 11.03 cycles, while the control group scored 9.06 cycles. For rhythmic ability involving both arms and legs, the experimental group reached 8.61 cycles, which is 1.33 cycles higher than the control group's 7.27 cycles.

Regarding balance, children in the experimental group averaged 1.48 s alongside the beam and 1.32 s crossing the beam. In comparison, the control group's results were 0.95 s alongside the beam and 0.75 s crossing the beam.

In the final test, running the figure eight, the experimental group recorded an average time of 20.40 s, compared to 22.03 s for the control group.

Table 2

Results at the end of the experiment								
		Experimental group		Control group		d	t	P(t)
		Average	STDEV	Average	STDEV			
accuracy	Short bar	8.05	0.73	7.99	0.74	0.06	0.23	15.60
	With ball	0.79	0.25	0.85	0.27	-0.06	-0.73	50.80
rhythmic	Non-rhythmic	11.03	2.08	9.06	2.40	1.97	2.56	98.00
	With legs and arms	8.61	2.16	7.27	2.81	1.33	1.54	85.90
balance	Alongside	1.48	0.24	0.95	0.26	0.54	6.25	99.99
	Crosswise	1.32	0.24	0.75	0.20	0.57	7.82	99.99
Coordination	Figure of eight	20.40	1.71	22.03	1.31	-1.63	-3.26	99.60

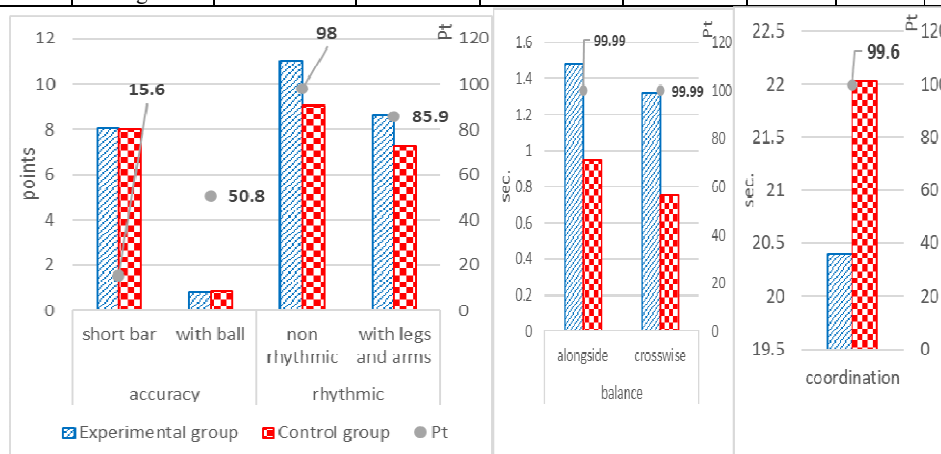


Fig. 2 Coordination abilities of the control and experimental groups at the end of the experiment

Figure 3 shows the differences between the results of the experimental and control groups at the beginning of the experiment and after five months, at the end of the experiment.

In the first test, measuring arm accuracy, the experimental group improved by 0.52 points, while the control group improved by 0.54 points.

In the second test, assessing leg accuracy, the experimental group improved by 0.06 points, whereas the control group's results declined by 0.09 points.

In the tests assessing rhythmic abilities, the experimental group improved by 2.92 cycles for arm movements and by 1.75 cycles for combined leg and arm movements. The control group also showed positive gains, improving by 1.57 cycles with the arms and 1.44 cycles with both legs and arms.

In the balance tests, both groups made progress. The experimental group improved by 0.04 s alongside the beam and 0.17 s crossing the beam. The control group improved by 0.13 s alongside the beam and 0.07 s crossing the beam. In the final test measuring spatial coordination, the experimental group improved by 0.71 s, while the control group's results declined by 0.19 s.

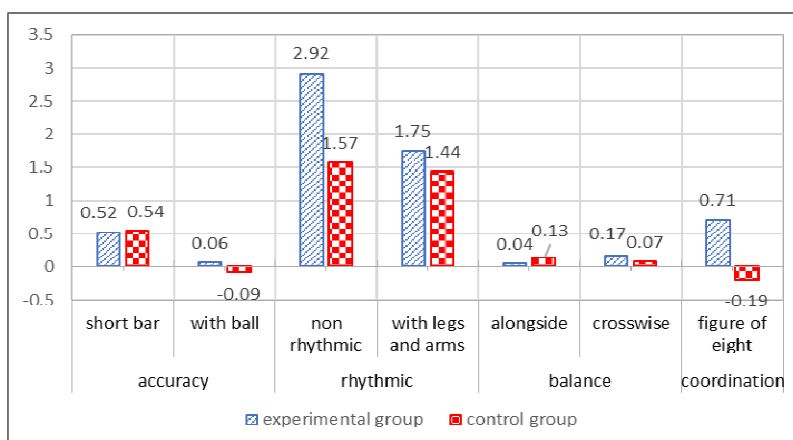


Fig. 3 Improvement in coordination abilities in both groups after the experimental period

Discussion

It has been confirmed that motor activity supports the development of children's motor skills, and that purposeful training accelerates this process—especially when performed during sensitive periods for specific abilities. Boichuk, R. (2020), as well as Ljach and Witkowski (2010), confirm that systematic coordination exercises focused on developing particular coordination skills in football and volleyball players are more effective than other "dexterity" exercises in these sports. Their research shows that this approach to coordination training leads to a greater improvement in coordination levels, technical skills, and other motor abilities. Incorporating coordination exercises into training programs positively influences the specific coordination abilities of volleyball players. These exercises improve the training process, aid in mastering technique, and add variety to the training routine. A similar effect was observed in boys practicing basketball by Smochevski (2001) and Iliev (2006), who used targeted exercises to develop coordination abilities. Recognizing the significant differences between male and female athletes, as well as between different sports, we focused our research on female athletes to demonstrate that they responded similarly to these training methods. At the start of the study, the experimental group showed a statistically significant advantage in balance abilities, while the control group had a superiority in accuracy with the lower limbs.

For the remaining indicators studied, no significant differences were found in the results, indicating that any variations were likely random and that statistics did not support the superiority of either group. This suggests that both groups started the experiment at nearly equal levels, which allowed us to fairly assess later whether our methods positively impacted the improvement of coordination abilities in female athletes. We selected girls in the sensitive age range for developing coordination skills because numerous studies identify ages 9–12 as the critical period for coordination development (Balsevich, Zaporozhyanov, 1987; Hirts, 1981; Starasta et al., 2000; Brestnitsky, 2017). Considering these sensitive periods, the results of our experiment are consistent because both groups showed improvements in the studied coordination abilities over the five-month experimental period (Figure 3). By the end of the experiment, statistically significant differences were observed between the experimental and control groups. The experimental group demonstrated significantly better results in rhythm, balance, and spatial orientation. These findings confirm that the applied methodology is effective and supports enhanced development of coordination abilities. The initial significant difference between the control and experimental groups in lower leg accuracy, which favored the control group, was reduced by the end of the experiment and lost statistical significance. This further confirms the effectiveness of the applied experimental methodology. As noted, the experimental group showed improvement across all measured indicators, while the control group improved in five but experienced declines in two coordination abilities.

These results confirm that our methods and ball-handling exercises lead to greater improvements in children's coordination compared to standard basketball training, which mainly improves technical skills. Understanding sensitive periods helps specialists accelerate the development of their athletes. Our study demonstrates that while general training improves coordination abilities, targeted training during sensitive periods yields even greater improvements. This is supported by our results: both groups started with minimal differences, indicating similar initial levels, but by the end of the study, a clear difference emerged. The time spent practicing specific ball-handling exercises produced positive effects on children's coordination development. In this study, we demonstrate that children's coordination improves significantly more—in 4 out of 7 indicators—when training includes coordination exercises through ball-handling, compared to children practicing basketball without targeted coordination work. Similar findings were reported by Lyakh and Vitkovsky (2010), who achieved comparable results through focused coordination training with volleyball players.

Conclusions:

Sensitive periods are essential in developing specific motor skills—in our case, coordination abilities. Targeted training during these sensitive periods amplifies the effectiveness of practice and significantly improves coordination. This study has demonstrated that incorporating additional ball-handling exercises positively impacts the coordination abilities of female athletes.

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