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Research on exercises to develop flexibility and motor coordination in female artistic gymnasts aged 9–10 in Ho Chi Minh City, Vietnam

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Abstract
Flexibility and motor coordination are crucial attributes for artistic gymnasts, particularly during the early stages of training. Selecting exercises that align with age-specific characteristics and technical requirements is essential for enhancing training effectiveness and establishing a foundation for skill development. This study aims to select and evaluate the effectiveness of specific exercises designed to develop flexibility and motor coordination in female artistic gymnasts aged 9–10 in Ho Chi Minh City. The study employed methods such as literature analysis and synthesis, expert interviews, pedagogical testing, pedagogical experiments, and statistical analysis to address its objectives. Twenty experts including referees, lecturers, and coaches experienced in rhythmic gymnastics were interviewed, while the experiment was conducted with female rhythmic gymnasts aged 9–10 in Ho Chi Minh City. The study selected 15 exercises designed to develop flexibility and motor coordination, comprising specialized flexibility, balance, and rotation exercises, as well as coordination drills using apparatus such as ropes, hoops, and balls. The results demonstrate that this set of 15 exercises is effective in simultaneously developing flexibility, balance, body control, and apparatus-based motor coordination among female rhythmic gymnasts aged 9–10 in Ho Chi Minh City.

Keywords: Rhythmic gymnastics, flexibility, motor coordination, exercises, female athletes, 9–10 years old, Ho Chi Minh City, Vietnam

Introduction

Rhythmic gymnastics is a sport characterized by complex techniques that combine body movements, apparatus handling, music, and artistic expression. During competition, athletes must continuously execute jumps, turns, balances, and poses requiring a wide range of motion, while simultaneously manipulating a hoop, ball, clubs, or ribbon in accordance with spatial, temporal, and rhythmic requirements. Consequently, rhythmic gymnasts require a comprehensive foundation of specialized physical fitness; specifically, flexibility, strength, balance, motor coordination, a sense of rhythm, and spatial orientation play crucial roles in the development and refinement of technique (Batista *et al*., 2017[1]; Fédération Internationale de Gymnastique [FIG], 2025) [7].

According to the *Rhythmic Gymnastics Code of Points 2025–2028*, fundamental body movement groups such as leaps, balances, and rotations must be executed with clear shapes, appropriate amplitude, body control, and precise coordination with the apparatus (FIG, 2025). This indicates that performance in rhythmic gymnastics depends not only on technical proficiency but is also inextricably linked to the development of physical attributes and coordination capabilities from the early stages of training.

Flexibility is a defining attribute of rhythmic gymnastics, enabling athletes to execute movements with a wide range of motion, maintain balance, perform jumps and turns, and enhance the quality and aesthetic appeal of their technique. Batista *et al*. (2019) [2] demonstrated the significance of flexibility for the performance capabilities of rhythmic gymnasts while also highlighting the phenomenon of functional asymmetry between the two sides of the body. Consequently, flexibility training must aim not only to increase the range of motion but also to integrate control, balance, and specific technical requirements.

For young athletes, the development of flexibility must align with age-related characteristics and the level of biological maturity. Bordalo *et al*. (2015) [3] demonstrated that training methods can significantly improve flexibility in 8- to 9-year-old children, though the degree of response is linked to biological maturity. Similarly, a study by Parfina and Anfilatova (2019) on 9- to 10-year-old female rhythmic gymnasts showed that the purposeful selection and application of appropriate exercises can yield positive changes in flexibility. These findings underscore the necessity of selecting training tools, exercises, and exercise loads that are suited to the developmental characteristics of young athletes.

Alongside flexibility, motor coordination is a crucial prerequisite for Rhythmic Gymnastics techniques. According to Lyakh (2006), coordination encompasses various components such as spatial orientation, balance, reaction time, a sense of rhythm, the differentiation of movement parameters, and the ability to adjust movements. This attribute is particularly relevant to Rhythmic Gymnastics, as athletes must simultaneously control the movements of their bodies and the apparatus amidst constantly changing conditions regarding direction, speed, amplitude, and rhythm.

During a routine, athletes often perform movements such as traveling, jumping, turning, or balancing while simultaneously executing apparatus handling skills including throwing, catching, rolling, rotating, or passing the apparatus. Consequently, coordination in rhythmic gymnastics is demonstrated through the precise integration of the arms, legs, torso, and vision, alongside balance, rhythm perception, spatial orientation, and adaptability to movement situations. In a study involving girls aged 9–10 practicing rhythmic gymnastics, Safonenko et al. (2024) [14]

observed improvements in balance, spatial orientation, rhythm perception, and various other components of coordination following the experimental program. These findings indicate that coordination in this age group can be effectively developed through a system of exercises that are appropriately selected and organized.

In Vietnam, several studies have focused on developing sport-specific physical fitness for gymnastics athletes. Nguyen Trung Kien (2009) [9] investigated exercises to develop sport-specific physical fitness for young aerobic gymnastics athletes in Ho Chi Minh City; Nguyen Kim Lan (2009) [9] established standards for assessing the training proficiency of young rhythmic gymnastics athletes aged 8–10; Đinh Sang Giàu and Tran Minh Tuan (2019) [2] studied exercises to develop sport-specific physical fitness for a primary school female aerobic gymnastics team; and Nguyen Thi Thuy Trang *et al*. (2021) [11] selected and evaluated exercises to develop flexibility and agility for team aerobic athletes aged 9–10. These studies have provided important reference bases for organizing sport-specific physical training for young athletes.

However, there are differences in movement structure and technical requirements between Aerobic Gymnastics and Rhythmic Gymnastics. Rhythmic Gymnastics places particular emphasis on range of motion, balance, leaps, pivots, rhythm, and the coordination of body movements with apparatus techniques. Therefore, while research findings from Aerobic Gymnastics offer valuable reference points, they cannot replace the development of a specialized training regimen tailored to Rhythmic Gymnastics athletes.

For female rhythmic gymnasts aged 9–10, the development of flexibility and motor coordination is crucial for establishing a technical foundation. Flexibility must be translated into the ability to execute and maintain technical poses with the required range of motion, while coordination must be integrated with balance, rhythm, spatial orientation, and apparatus handling. These two attributes are closely interrelated and must be developed in tandem, in accordance with the specific demands of rhythmic gymnastics.

A review of domestic and international literature reveals studies addressing the assessment of training levels in young rhythmic gymnasts (Nguyen Kim Lan, 2009) [9], the development of sport-specific physical fitness in gymnastics disciplines (Nguyen Trung Kien, 2009[9]; Dinh Sang Giau & Tran Minh Tuan, 2019; Nguyen Thi Thuy Trang *et al*., 2021) [4, 11], flexibility development in young rhythmic gymnasts (Bordalo *et al*., 2015; Batista *et al*., 2019; Parfina & Anfilatova, 2019) [2, 3], and the development of coordination abilities in 9–10-year-old girls practicing rhythmic gymnastics (Safonenko *et al*., 2024) [14]. However, there is a scarcity of research that simultaneously selects and experimentally tests a system of exercises aimed at developing flexibility and motor coordination for 9–10-year-old female rhythmic gymnasts within the specific training context of Ho Chi Minh City.

Based on the professional requirements of artistic gymnastics, the specific characteristics of the age group, and the practical realities of young athlete training in Ho Chi Minh City, the study titled "Selection of exercises to develop flexibility and motor coordination for female artistic gymnasts aged 9–10 in Ho Chi Minh City, Vietnam" was conducted. Its aim was to select and evaluate suitable exercises that contribute to enhancing the quality of specialized physical conditioning and to establish a foundation for refining techniques and improving athletic performance in subsequent stages of development.

Research materials and methods

Methods

Literature review method: This method enables the systematic study of knowledge relevant to the research field, the establishment of a theoretical framework, and the definition of research aims and objectives; it also facilitates the development of a literature overview and the processing and analysis of research findings. The method involves the selective recording, analysis, and synthesis of documents related to Rhythmic Gymnastics training and instruction, serving as a basis for constructing the theoretical framework and evaluating research results. The findings from the literature review help establish the theoretical foundation and assist in the selection of exercises designed to develop flexibility and motor coordination in Rhythmic Gymnastics.

Interview method: Used to consult experts, coaches, instructors, and referees experienced in artistic gymnastics training. The interview results aim to identify exercises for developing flexibility and motor coordination in female artistic gymnasts aged 9–10 in Ho Chi Minh City.

Statistical methods: Used to process and analyze data collected during the research process. The collected data were processed with the support of SPSS 22.0 software.

Participants

- Interview subjects: 20 coaches, instructors, experts, or referees experienced in artistic gymnastics training.
- Survey subjects: 10 female artistic gymnasts aged 9–10 from Ho Chi Minh City, Vietnam.

Results

To study exercises for developing flexibility and motor coordination in female artistic gymnasts aged 9–10 in Ho Chi Minh City, the research was conducted in two parts:

- Selecting exercises to develop flexibility and motor coordination for female artistic gymnasts aged 9–10 in Ho Chi Minh City.
- Evaluating the effectiveness of exercises for developing flexibility and motor coordination for female artistic gymnasts aged 9–10 in Ho Chi Minh City.

1. Selection of exercises to develop flexibility and motor coordination for female artistic gymnasts aged 9–10 in Ho Chi Minh City

The process involves two steps:

Step 1: Compile exercises designed to develop flexibility and motor coordination for artistic gymnasts, drawing from research by both domestic and international authors.

Step 2: Interview experts, judges, lecturers, and coaches with experience in the field of artistic gymnastics.

1.1 A compilation of exercises designed to develop flexibility and motor coordination in artistic gymnasts, based on research by domestic and international authors

Based on a review of textbooks, specialized literature, and domestic and international research regarding artistic gymnastics including works by authors such as Nguyen Kim Lan (2009), Nguyen Trung Kien (2009) [9], Dinh Sang Giau and Tran Minh Tuan (2019), Nguyen Thi Thuy Trang *et al*. (2021), Batista *et al*. (2019), Bordalo et al. (2015), Mironov

et al. (2020), Sabău *et al*. (2023), and Safonenko *et al*. (2024) [3, 4, 8, 11, 13, 14], as well as specialized documents from the International Gymnastics Federation (FIG, 2021; FIG, 2025), Special Olympics (2008), Palmer (2003), Karpenko (2003[5, 7, 12, 15]; 2007), Lyakh (2006), and Parfina and Anfilatova (2019) this study identifies flexibility and motor coordination as two specialized attributes of particular importance for artistic gymnasts aged 9–10.

Studies show that the development of flexibility helps improve the range of motion of joints, and the ability to perform splits, bends, jumps, and other highly difficult body techniques. At the same time, the ability to coordinate movements helps athletes improve body control, spatial orientation, balance, body coordination with equipment, and improve the efficiency of performing professional techniques in training and competition.

Based on a review of literature and training plans, practical observation of training sessions at the Hoa Lu Sports Center, and expert consultation, the study has compiled 34 exercises commonly used to develop flexibility and motor coordination in female rhythmic gymnasts aged 9–10 in Ho Chi Minh City.

The compiled exercises encompass categories designed to develop sport-specific flexibility, balance, and rotational ability, as well as exercises involving apparatus such as ropes, hoops, and balls. Based on this, the study involved consultations with experts, lecturers, and coaches to select the most suitable exercises for inclusion in the experimental program. Through practical training and coaching experience, a set of 32 commonly used exercises for developing flexibility and motor coordination was compiled.

2. Interviews with coaches, instructors, and experts

The study involved interviewing experts, judges, instructors, and coaches experienced in artistic gymnastics in Ho Chi Minh City. Two rounds of interviews were conducted using the same questionnaire and evaluation method, focusing on the same set of exercises. The questionnaire aimed to identify the exercises necessary for developing flexibility and motor coordination in artistic gymnastics athletes. Respondents selected one of two options: "Agree" or "Disagree." A chi-square test was used to assess the difference between the two interview rounds, with the results presented in Table 1.

Table 1: Results of interviews on the selection of exercises to develop flexibility and motor coordination in artistic gymnasts.

	Test	First interview (n = 20)		Second interview (n = 20)		Inspection	
		Agree	%	Agree	%		P
1	Lying leg kicks—forward, sideways, and backward (10 reps per leg)	18	90	20	100	2.11	>0.05
2	Floor front splits with forward folds and backward leans (10 reps per leg)	19	95	19	95	0.00	>0.05
3	Sit in a straddle position with knees bent, fold torso forward, and hold for 20 seconds	14	70	13	65	0.11	>0.05
4	Lying straddle split (knees bent) with backward leans (10 reps)	18	90	17	85	0.11	>0.05
5	Lying on back, sitting up into a front split, and rotating left and right (10 reps)	18	90	19	95	0.36	>0.05
6	Supported front and side splits (left and right) on a platform; hold the position (2 minutes per leg)	18	90	19	95	0.17	>0.05
7	Hold the band and rotate shoulders from front to back and vice versa 10 times.	17	85	15	75	1.03	>0.05
8	Forward, backward, and lateral body waves—5 times each	16	80	14	70	0.83	>0.05
9	Perform 10 low shoulder shrugs and hold	14	70	15	75	0.42	>0.05
10	Kneel with hands behind head; lean backward 10 times and hold the position for a count of 10.	16	80	17	85	0.42	>0.05
11	Perform a backbend, transitioning to place legs behind while lying down, and then reverse the movement; repeat 5 times.	15	75	12	60	1.76	>0.05
12	Bend body upwards to a 30cm platform 5 times and hold.	17	85	18	90	0.36	>0.05
13	Handstand hold: 1 minute / 2 sets	12	60	10	50	0.40	>0.05
14	Rise up onto toes and lower back down 20 times, then hold the position.	15	75	15	75	0.00	>0.05
15	Perform a *passé* with one leg, rise up and down on the supporting leg 10 times, and hold the position for 10 seconds	17	85	14	70	1.03	>0.05
16	Forward and backward flexibility rolls and balance holds.	18	90	17	85	0.17	>0.05
17	Perform 10 straight-leg side splits per leg.	12	60	15	75	1.90	>0.05
18	Perform a chainé turn and two forward rolls, then rise up onto the balls of the feet	18	90	17	85	0.17	>0.05
19	Alternate between single jumps and double unders for 30 seconds (2 sets)	16	80	18	90	0.83	>0.05
20	Throw and catch the rope continuously for 30 seconds	17	85	18	90	0.36	>0.05
21	Various jump rope styles combined with double unders	15	75	12	60	1.76	>0.05
22	Hold the hoop in one hand (or keep it in a single plane) and toss the small ball with the other hand	17	85	18	90	0.36	>0.05
23	Perform a forward roll over the arms	12	60	14	70	0.83	>0.05
24	Rotate the planes within the palm of the hand	17	85	19	95	0.42	>0.05
25	Rotating movement around an axis on the hand	18	90	19	95	0.17	>0.05
26	Throwing the hoop from behind while moving	15	75	14	70	0.11	>0.05
27	Dribble the ball in place with another athlete; the two athletes switch places.	10	50	11	55	0.11	>0.05
28	Dribble continuously while moving.	16	80	15	75	0.11	>0.05
29	Roll the ball forward over arms 10 times.	18	90	17	85	0.17	>0.05
30	Perform figure-eight rotations with the ball, 10 times per hand	8	40	11	55	1.10	>0.05
31	Toss and catch with crossed hands 10 times	15	75	15	75	0.00	>0.05
32	Toss, spin 360 degrees, and catch the ball 5 times	15	75	12	60	1.15	>0.05

The interview results in Table 1 show that all the exercises through 2 interviews had a chi-square test < chi-square table = 3.84; therefore, the difference between the two interview rounds was not statistically significant (P > 0.05). This indicates a high level of consensus in the responses provided by the experts and lecturers across both rounds. To be selected, exercises were required to achieve an agreement rate of 80% or higher (≥ 80%) in both interview rounds.

Based on the interview and research results, 15 exercises were selected each with an approval rate of 80% or higher deemed suitable for developing flexibility and motor coordination in the study subjects; these exercises are as follows:

Exercise 1: Lying leg kicks forward, sideways, and backward (10 reps per leg)

Exercise 2: Floor front splits with forward folds and backward leans (10 reps per leg)

Exercise 3: Lying straddle split (knees bent) with backward leans (10 reps)

Exercise 4: Lying on back, sitting up into a front split, and rotating left and right (10 reps)

Exercise 5: Supported front and side splits (left and right) on a platform; hold the position (2 minutes per leg)

Exercise 6: Kneeling with hands behind the head and leaning backward (10 reps, holding for a 10-count; 2 sets with a 30-second rest in between)

Exercise 7: Bend onto a 30 cm high platform (hold for 10 seconds x 5 sets)

Exercise 8: Front flip, back flip and balance (5 times/1 leg)

Exercise 9: Chainé rotation combined with upside down twice, stand up on tiptoes to maintain balance (5 times)

Exercise 10: Alternating single and double rope jumping (30 seconds × 2 groups, resting for 1 minute)

Exercise 11: Toss the rope and catch continuously (30 seconds x 2 groups, rest 1 minute in between)

Exercise 12: Hold the hoop in one hand in different planes, with the other hand toss the ball continuously (20 seconds/1 hand x 3 groups, rest for 30 seconds in between)

Exercise 13: Move and rotate in the flat surfaces of the palm (move 5 lines)

Exercise 14: Move and rotate around the axis on the hand (move 5 ways)

Exercise 15: Roll the ball forward through both arms (10 times x 2 sets)

3. Evaluating the effectiveness of exercises for developing flexibility and motor coordination in 9–10-year-old female artistic gymnasts in Ho Chi Minh City.

Table 2 presents the study's findings regarding performance improvements in tests assessing flexibility and motor coordination among 9–to–10-year-old female artistic gymnasts in Ho Chi Minh City.

Table 2: Improvement in performance on flexibility and motor coordination tests among female artistic gymnasts aged 9–10 in Ho Chi Minh City

TT	Test	Pre-experiment		Post-experiment		W%	t	P
		$\overline{X}$	S_x	$\overline{X}$	S_x			
1	Left and right front splits on a 30 cm platform (cm)	17.50	2.37	21.30	2.00	19,59	22,36	<0.05
2	Left and right side splits on a 30cm platform (cm)	17.75	2.10	20.95	1.98	16,54	14,99	<0.05
3	Bending movement (point)	4.30	0.95	5.40	0.70	22,68	6,13	<0.05
4	Trunk flexibility (cm)	2.95	0.55	4.50	0.75	41,61	8,19	<0.05
5	Forward roll with split-leg finish (left/right) (point)	4.65	0.82	5.95	0.60	24,53	5,75	<0.05
6	Backward roll (left and right legs) (point)	4.50	0.75	5.70	0.59	23,53	6,47	<0.05
7	Single-leg balance (s)	2.20	0.63	3.40	0.84	42,86	9,00	<0.05
8	Perform a 360° *passé* turn, a full seated turn, and finish (point).	4.50	0.85	6.10	0.99	30,19	7,24	<0.05
9	Dribble the ball with one hand under a raised leg (point)	1.90	0.57	2.70	0.67	34,78	6,00	<0.05
10	Toss the rope and jumping over it (point).	1.70	0.48	2.40	0.52	34,15	4,58	<0.05
11	Spinning around the axis on the hand (point)	2.00	0.67	2.90	0.57	36,73	5,01	<0.05
W̄						29.74		
Note: Df= 9; = 2.262								

Table 2 shows:

The left and right front split tests performed on a 30 cm platform exhibited a growth rate of W = 19.59%. This shows that the vertical split performance after the experimental period improved well and was statistically significant because = 22,36 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The side split test on a 30 cm (cm) platform showed a growth rate of W = 16.54%. This indicates that the side split performance after the experimental period showed good and statistically significant development because = 14,99 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The bending test (score) showed a growth rate of W = 22.68%. This indicates that the ability to perform the bending movement has developed well and is statistically significant because = 6,13 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The trunk flexion test (cm) showed a growth rate of W = 41.61%. This indicates a significant improvement in human trunk flexibility after the experimental period and is statistically significant because = 8,19 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The left and right front flip test (points) showed a growth rate of W = 24.53%. This indicates an improved and statistically significant ability to perform the front flip because = 5,75 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The left and right posterior flip test (points) showed a growth rate of W = 23.53%. This indicates an improved and statistically significant ability to perform the posterior flip because = 6,47 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The one-legged balance test (s) showed a growth rate W = 42.86%. This indicates that the ability to maintain balance

improved significantly after the experimental period and is statistically significant because = 9,00 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The test of 360° passé rotation, one-round sitting rotation, and finishing (points) showed a growth rate of W = 30.19%. This indicates that motor coordination and body control in performing the technique were significantly improved and statistically meaningful because = 7,24 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The one-handed ball bounce test under the elevated foot (points) showed a growth rate of W = 34.78%. This indicates improved motor coordination with the equipment and is statistically significant because = 6,00 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The rope tossing and jumping test (points) showed a growth rate of W = 34.15%. This indicates that coordination with the rope was improved and is statistically significant because = 4,58 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

The hand rotation test (point) showed a growth rate of W = 36.73%. This indicates a significant and statistically significant improvement in tool control and motor coordination because = 5,01 > $t_{0.05}$ = 2,262 at the probability threshold P < 0,05.

Research results indicate an average growth rate of 29.74% across the 11 tests. All tests yielded calculated t-values greater than t0.05 = 2.262 with P < 0.05, demonstrating that the selected exercise regimen was effective in developing flexibility and motor coordination in 9 to 10-year-old female artistic gymnasts in Ho Chi Minh City.

Discussion

Research results indicate that the selected set of 15 exercises fostered relatively balanced improvements in flexibility and motor coordination among female rhythmic gymnasts aged 9–10 in Ho Chi Minh City. Following the intervention, all 11 assessment tests showed statistically significant improvements (P < 0.05), with an average growth rate of 29.74%. Notably, the tests showing the highest gains included single-leg balance (42.86%), trunk flexibility (41.61%), rotation around the body axis while balancing on the hands (36.73%), one-handed ball bouncing under a raised leg (34.78%), and a combined rope-tossing, catching, and jumping sequence (34.15%). These findings demonstrate that the program not only enhanced flexibility but also improved body control, balance, and apparatus coordination.

Regarding flexibility, tests for front splits, side splits, backbends, trunk flexion, and forward and backward flexibility rolls all showed improvements ranging from 16.54% to 41.61%. This aligns with the specific demands of rhythmic gymnastics, a sport requiring athletes to execute movements with a wide range of motion while maintaining body shape and postural control during activity. Batista et al. (2019) [2] argue that flexibility is a crucial component of specialized performance in rhythmic gymnastics and should be developed in conjunction with movement control and the minimization of functional asymmetries. Bordalo *et al*. (2015) [3] also demonstrated that targeted training methods can significantly improve flexibility in young rhythmic gymnasts, although the magnitude of the response may be influenced by the level of biological maturation.

A notable feature of the exercise regimen in this study is that it goes beyond simple stretching or static holds, incorporating movements structurally similar to Rhythmic Gymnastics techniques such as directional leg swings, splits combined with trunk flexion and extension, flexibility maneuvers, and forward and backward rolls. Consequently, flexibility is developed in a way that directly supports the range of motion required for specialized movements. These findings align with the work of Parfina and Anfilatova (2019), whose study on 9–10-year-old rhythmic gymnasts demonstrated that the use of purposefully selected exercises can yield positive improvements in flexibility.

Regarding motor coordination, significant improvements in tests involving balance, rotation, ball bouncing, rope tossing and catching, and hoop rotation indicate that the program influenced various components of coordination. According to Lyakh (2006), coordination encompasses balance, spatial orientation, a sense of rhythm, reaction, and the ability to adjust movements. These capabilities are particularly significant for rhythmic gymnastics, as athletes must simultaneously control their bodies and manipulate apparatuses amidst constantly changing movement situations.

The study results align with the findings of Safonenko *et al*. (2024) [14], who demonstrated that a targeted training program could improve balance, spatial orientation, and a sense of rhythm in 9–10-year-old girls practicing rhythmic gymnastics. However, in the current study, the coordination exercises were designed to more closely reflect specialized technical structures such as combining chainé turns with forward rolls and balance poses, rope tosses and catches, movement combined with rotations, and maintaining a hoop pose while tossing or rolling a ball across the arms. This approach facilitates the transition from developing general coordination to specialized coordination associated with the apparatus.

Another significant finding is the simultaneous improvement of flexibility and motor coordination. In rhythmic gymnastics, these two attributes are closely linked: flexibility enables movements with a wide range of motion, while coordination allows the athlete to control that range during balances, rotations, leaps, and apparatus handling. Consequently, the program's effectiveness suggests that developing these two qualities in an integrated manner may be more suitable than treating them as entirely separate components.

In comparison to previous domestic studies such as those by Nguyen Trung Kien (2009) [9] and Nguyen Thi Thuy Trang *et al*. (2021) [11], which focused primarily on aerobic gymnastics athletes; Nguyen Kim Lan (2009) [9], who examined proficiency standards for young rhythmic gymnastics athletes; and Dinh Sang Giau and Tran Minh Tuan (2019) [4], who investigated specialized physical conditioning for primary school female rhythmic gymnastics teams the novelty of the current study lies not in the creation of entirely new exercises, but in the selection and systematization of 15 exercises designed to simultaneously develop flexibility and motor coordination in female rhythmic gymnastics athletes aged 9–10. Furthermore, the study validates the effectiveness of this program through specialized pre- and post-experimental tests. The exercise system is structured to integrate physical conditioning with balance, rotation, and apparatus techniques (rope, hoop, and ball), thereby enhancing specialization and practical applicability in training.

Although the results indicate positive outcomes, the study has certain limitations. The study population was restricted to a group of female athletes aged 9–10 in Ho Chi Minh City, and the design relied primarily on a pre-test/post-test comparison without a control group. Therefore, future research should expand the sample size, incorporate both experimental and control groups, and account for factors such as biological age, training level, and training duration. Additionally, further investigation is needed into the relationship between improvements in flexibility and motor coordination versus technical scores and competitive performance; optimal training loads for specific exercise categories should be determined, and the long-term sustainability of the effects should be monitored.

Overall, the research findings indicate that the set of 15 exercises is applicable to the training of female rhythmic gymnasts aged 9–10, contributing to the simultaneous development of flexibility, balance, body control, and apparatus coordination. This serves as a practical basis for further refining the training program by integrating sport-specific physical conditioning with rhythmic gymnastics techniques.

Conclusions

The study selected 15 exercises designed to develop flexibility and motor coordination for female artistic gymnasts aged 9–10 in Ho Chi Minh City. Experimental results showed statistically significant improvements ($P < 0.05$) across all 11 assessment tests, with an average growth rate of 29.74%. Notable gains were observed in single-leg balance, trunk flexibility, and apparatus-based coordination tests. These findings indicate that the selected exercise regimen is effective in simultaneously developing flexibility, balance, body control, and apparatus coordination skills for female artistic gymnasts aged 9–10 in Ho Chi Minh City.

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