EFFECTIVENESS OF AN IMPROVED FLEXIBILITY TRAINING METHODOLOGY FOR 7-8-YEAR-OLD ARTISTIC GYMNASTS AT THE INITIAL TRAINING STAGE: EXPERIMENTAL EVIDENCE

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Received: 21.10.2026
Revised: 22.10.2026
Accepted: 23.10.2026

Keywords: artistic gymnastics; flexibility; initial training stage; 7-8-year-old athletes; stretching exercises; sensitive period; pedagogical experiment.

Abstract. The study evaluated an improved 12-week methodology for developing flexibility in 7-8-year-old artistic gymnasts of the initial training group. The pedagogical experiment was conducted with gymnasts of specialised sports schools of the Bukhara region (n = 30; control group n = 15, experimental group n = 15) as part of a wider study covering 90 children in the Bukhara, Navoi and Kashkadarya regions. Each training session of the methodology consisted of four parts - preparatory, main, partner and recovery - and the methodology rested on the principles of progression, purposefulness, continuity and repetition, safety and motivation. After the intervention, the experimental group outperformed the control group on all five flexibility-related tests, with moderate-to-large effect sizes (Cohen's d = 0.73-0.85). The relative improvement in the experimental group (30.8-69.6%) was 2.5-5.0 times greater than in the control group (7.9-24.6%). The between-group differences were statistically significant for the handstand hold (p = 0.045) and the L-sit hold (p = 0.027), reached the threshold of significance for the split and the forward bend (p = 0.050) and showed a trend for the bridge test (p = 0.056). Among general physical fitness indicators, the largest effect was found for the 30 m sprint (d = 1.26; p = 0.002). The results support the use of the methodology at the initial training stage and point to the need for individualised loading.

1. Introduction

Artistic gymnastics is one of the most technically complex sports, and success at the elite level depends largely on the foundation laid at the initial training stage

[10; 12]. Among the physical qualities developed at this stage, flexibility holds a special place: without a sufficient range of motion in the joints a young gymnast cannot master basic elements correctly, movement coordination is disturbed and the risk of injury increases.

The age of 7-8 years is regarded as a favourable period for developing flexibility. At this age joint mobility and the elasticity of muscles and ligaments are high, whereas in later childhood and adolescence the range of motion tends to decrease unless it is specifically trained [3; 7]. At the same time, methodological errors made at this age - poorly distributed loads, neglect of individual differences and of recovery - can have long-term negative consequences for the athlete.

The development of gymnastics is a state priority in Uzbekistan. Presidential Decree No. PF-5924 of 24 January 2020 set measures for the further improvement and popularisation of physical culture and sport [1]. Presidential Resolution No. PQ-449 of 23 December 2022 “On measures to further develop gymnastic sports” defined a new system for identifying, selecting and preparing talented gymnasts and introduced gymnastics programmes for preschool and primary-school children [2]. Effective methods of developing basic physical qualities in young gymnasts are therefore of direct practical importance.

The aim of the study was to evaluate experimentally the effectiveness of an improved methodology for developing flexibility in 7-8-year-old artistic gymnasts of the initial training group.

2. Literature review

The theoretical basis of technical and physical preparation in artistic gymnastics was developed by Yu. K. Gaverdovsky [10], and the general laws of long-term athlete preparation by V. N. Platonov [12]. E. A. Pirozhkova and V. G. Khustochkin described the means of developing flexibility at the initial training stage in artistic gymnastics [11]. In Uzbekistan, the methodology of teaching gymnastics has been presented in the textbook by A. K. Eshtayev and S. A. Eshtayev [6].

International studies have clarified how different stretching methods act. In competitive artistic gymnasts, G. Dallas and colleagues compared static stretching, proprioceptive neuromuscular facilitation (PNF) and stretching on a vibration platform; all three increased flexibility, PNF most of all, while vibration-assisted stretching preserved jumping performance [5]. A systematic review by D. G. Behm and colleagues showed that prolonged static stretching performed immediately before explosive efforts may slightly impair performance, which supports the use of dynamic exercises in the warm-up [4]. J. R. Rudd and colleagues demonstrated in 333 primary-school children that a 16-week gymnastics curriculum develops stability and object-control skills more effectively than standard physical education [8].

Nevertheless, a holistic methodology for 7-8-year-old gymnasts of the initial training group, combining the structure of the session, the content of exercises, the order of stretching methods and the recovery regime into one system, has not been sufficiently developed and tested experimentally. This gap defines the novelty of the present study.

3. Materials and methods

Participants and design. The pedagogical experiment was conducted in the initial training groups of specialised gymnastics sports schools of the Bukhara, Navoi and Kashkadarya regions with a total of 90 gymnasts aged 7-8 years. This paper reports the data of the Bukhara region: control group (CG, n = 15) and experimental group (EG, n = 15). The groups were equalised by age, sex, level of physical development and the time they had started training. The CG trained according to the standard programme; the EG trained according to the improved 12-week programme, with sessions held at least 3-4 times a week. At baseline there were no significant differences between the groups in any flexibility test ($t = 0.02$-0.64; $p = 0.53$-0.99).

Intervention. Each session of the improved methodology consisted of four parts (Table 1).

Table 1

Structure of a training session in the improved methodology

Part	Content	Purpose
Preparatory	Walking, light running, jumps in place and in motion, circular movements in the neck, shoulder, knee and hip joints, mobile games	Warming up; preparing muscles and ligaments for the main load
Main	Forward and side bends, forward and backward rolls, bridge exercises, walking along parallel bars, leg raises, jumps	Increasing flexibility through a combination of static, dynamic and game-based exercises
Partner	Partner-assisted stretching, assisted arm-pulling exercises	Extending the range of stretching; building cooperation and trust
Recovery	Relaxation movements, breathing exercises, light stretching	Relieving tension; reducing the risk of injury

The methodology was based on five principles: progression (each new exercise builds on a previously mastered skill), purposefulness (each session is aimed at a clear, measurable result), continuity and repetition (at least 3-4 sessions a week), safety (exercises performed after a full warm-up and under the coach's supervision) and motivation (mobile games, in-group contests and regular feedback on each child's progress). Technical elements were introduced in a progressive order: backward roll, handstand, cartwheel, round-off and front handspring.

Measures. Flexibility was assessed with five tests: bridge (cm; a smaller value indicates a better result), split (cm; smaller is better), forward bend from a gymnastic bench (cm; larger is better), handstand hold (s) and L-sit hold at 90° (s). General physical fitness was assessed with the 30 m sprint (s), push-ups in 30 s (repetitions),

standing long jump (cm) and one-leg hops in 1 min (repetitions). Pulse rate and respiratory rate were recorded as functional indicators.

Statistical analysis. Means (M) and standard deviations (SD) were calculated. Between-group differences were assessed with Student's t-test for independent samples (df = 28), and effect sizes with Cohen's d based on the pooled standard deviation (0.5 - medium, 0.8 - large effect). The significance level was set at $p < 0.05$.

4. Results

At the end of the experiment the EG achieved better results than the CG in all five flexibility tests (Table 2). The effect sizes were moderate to large (d = 0.73-0.85).

Table 2

Flexibility indicators at the end of the experiment (M ± SD)

Test	CG (n = 15)	EG (n = 15)	t	p	d
Bridge, cm ↓	61.93 ± 21.26	46.27 ± 21.81	1.99	0.056	0.73
Split, cm ↓	20.60 ± 6.95	15.73 ± 6.05	2.05	0.050	0.75
Forward bend, cm ↑	13.87 ± 4.36	18.10 ± 6.70	2.05	0.050	0.75
Handstand hold, s ↑	4.15 ± 0.98	5.72 ± 2.72	2.10	0.045	0.77
L-sit hold (90°), s ↑	15.90 ± 4.24	22.40 ± 9.93	2.33	0.027	0.85

Note: ↓ - a smaller value indicates a better result; ↑ - a larger value indicates a better result.

The relative gains show the difference even more clearly (Table 3). In the EG the improvement ranged from 30.8% to 69.6%, in the CG from 7.9% to 24.6%; the rate of improvement under the improved methodology was 2.5-5.0 times higher.

Table 3

Relative improvement of flexibility indicators during the experiment, %

Test	CG	EG	EG / CG ratio
Bridge	7.9	30.8	3.9
Split	14.2	35.3	2.5
Forward bend	24.6	69.6	2.8
Handstand hold	12.8	64.4	5.0
L-sit hold (90°)	11.4	56.6	5.0

The largest absolute change was observed in the bridge test: in the EG the result improved by 20.6 cm (from 66.87 to 46.27 cm), in the CG by only 5.34 cm. At the

same time, the coefficients of variation in the EG were high (bridge V = 47.1%, split V = 38.5%), which shows that the children responded to the methodology individually.

Among general physical fitness indicators (Table 4), the EG was markedly faster in the 30 m sprint (large effect, p = 0.002). For push-ups the difference was of moderate size and close to significance (p = 0.053); for the standing long jump and one-leg hops there were no significant differences.

Table 4

General physical fitness indicators at the end of the experiment (M ± SD)

Test	CG (n = 15)	EG (n = 15)	t	p	d
30 m sprint, s ↓	6.22 ± 0.66	5.46 ± 0.54	3.45	0.002	1.26
Push-ups in 30 s, reps ↑	12.90 ± 6.19	17.53 ± 6.37	2.02	0.053	0.74
Standing long jump, cm ↑	119.45 ± 11.61	126.07 ± 13.29	1.45	0.157	0.53
One-leg hops in 1 min, reps ↑	37.67 ± 9.82	36.53 ± 9.75	0.32	0.752	0.12

Functional indicators also improved in the EG: the pulse rate measured over 15 s decreased from 25.0 to 17.93 beats (CG: from 25.8 to 21.67), and the respiratory rate from 26.4 to 22.87 breaths per minute (CG: from 26.0 to 24.4); these changes were reported as significant in the primary analysis ($p < 0.05$) [9].

5. Discussion

The results show that the improved methodology produced a consistent advantage of the experimental group in every flexibility test, with moderate-to-large effect sizes. Several p-values lie at or near the 0.05 threshold. With 15 children per group and effects of $d \approx 0.75$, the statistical power of the comparison is limited; the effect sizes are therefore a more informative measure of the practical value of the methodology, and the full sample of 90 children will allow a more definitive test.

The inclusion of a partner part, in which stretching is assisted by a partner and goes beyond the active range of motion, agrees with the advantage of assisted and PNF techniques reported by Dallas et al. [5]. Placing dynamic exercises in the preparatory part and static stretching in the main and recovery parts follows the recommendation of Behm et al. to avoid prolonged static stretching immediately before explosive efforts [4]. The largest effects among flexibility-related tests were found for the handstand and L-sit holds, which require both mobility and static strength; this is consistent with the finding of Rudd et al. that gymnastics training accelerates the development of stability skills in children [8].

The large effect in the 30 m sprint may reflect a greater range of motion and better movement coordination, while the absence of a difference in one-leg hops

shows that the methodology does not target local muscular endurance. The high variability of results in the EG indicates that the load should be individualised according to each child's sex, initial preparation and rate of progress.

Limitations. The analysed sample was small (n = 30) and came from one region; the groups were equalised rather than randomised; and the long-term retention of the gains was not assessed.

6. Conclusions

1. The improved 12-week methodology, built on four session parts and five principles, increased flexibility in 7-8-year-old gymnasts more than the standard programme in all five tests, with moderate-to-large effects (d = 0.73-0.85) and a 2.5-5.0 times higher rate of improvement.
2. The most reliable effects were obtained for the handstand and L-sit holds ($p < 0.05$), which link flexibility with the quality of basic gymnastic elements.
3. The methodology also had a positive effect on speed (30 m sprint) and on functional indicators, but did not affect local endurance.
4. In practice, it is recommended to hold flexibility-oriented sessions at least 3-4 times a week in the sequence preparatory - main - partner - recovery, to make recovery stretching a compulsory part of each session, to combine static stretching with game-based and partner forms, and to set the load individually for each child.

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