

Study Protocol Cover Page

Official Study Title:

Effects of Velocity-based Training on Physical Fitness and Skills Performance
among Aerobic Gymnast Athletes in Henan, China

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Supervisory Committee: Prof. Dr. Soh Kim Geok; Dr. Roxana Dev Omar Dev



**Effects of Velocity-based training
on physical fitness and skills
performance among aerobic
gymnast athletes in Henan, China**

Expert Information	
Work Unit	
Full name	
Title	
Research Area	

Validation of Expert

Dear expert

My name is Ma Kui, a Ph.D. candidate at Universiti Putra Malaysia. My research title is: "Effects of Velocity-based training on physical fitness and skills performance among aerobic gymnast athletes in Henan, China." You have a wealth of theoretical knowledge and practical experience. I want to invite you to give me some comments about my study. All the information you have filled in will only be used for this study and not for any other purpose. All the information you fill in will be kept confidential. Therefore, please rest assured and fill in the details.

Thank you for your assistance and cooperation.

Universiti Putra Malaysia

Supervisor Committee: Prof. Dr. Soh Kim Geok

Dr. Roxana Dev Omar Dev

Expert Name: _____ Discipline:

Degree: _____ Work Unit:

1 Study Overview

1.1 Brief Summary

Since 1987, when Beijing held the first National Aerobic Gymnastics Competition, the National Aerobic Gymnastics Championship has been held every year. The technical level of aerobic gymnastics in Henan Province has always been at the middle and lower level in the country. The best ranking in the national competition was the seventh place in the 2000 Universiade. It is still a relatively backward province.

Aerobic gymnastics is a high-intensity sport that requires high strength, speed, flexibility, and explosive power from athletes. Velocity-based training (VBT) is a resistance training method by which training variables are manipulated based on kinematic outcomes, e.g., barbell velocity.

(2021Raphael Fritschi) The difficulty score of competitive aerobic gymnasts is crucial to competition performance. Developing the explosive power of aerobics athletes' lower limbs through VBT will help enrich aerobic gymnasts physical training methods and determine the optimal training load. Therefore, this study aimed to evaluate the effects of an 8-week VBT training program on the physical fitness and skill performance of aerobics athletes in Henan Province. The results were expected to provide a reference for developing training programs and promote the scientific development of aerobics in Henan Province.

1.2 Detailed Description

This study employed a cluster-randomized controlled trial (CRCT) design and involved aerobic gymnasts from universities in Henan Province. Participants were randomly assigned to an experimental group (VBT) or a control group (conventional training). Both groups received the same frequency and duration of aerobic gymnastics-specific skill training, but only the experimental group received the additional VBT protocol. The intervention lasted for 8 weeks, with three 90-minute sessions per week.

Dependent variables included physical fitness (strength, power, endurance, speed, balance, coordination, agility, and flexibility) and motor skill performance (group A 、 B 、 C difficulty and scoring routines). This comprehensive evaluation aimed to assess how VBT improves fundamental motor skills and specific motor skill performance in aerobic gymnasts.

2 Protocol Design

The following tables provide details of the study design: the velocity-based training intervention plan (Table 1), the overall intervention plan (Table 2), and the outcome measures (Table 4). We sincerely encourage experts to provide suggestions for improvement (Tables 1, 2, and 4) and scoring criteria (Tables 3 and 5).

Durati on (week)	Time (hour)	Frequency (times/ week)	Types (1RM%) Percent of 1 Repetition Maximum (1RM)	Sets	Velocity Zone; Velocity Loss	Rest (seconds)	Intensity	Improveme nt suggestion s
1-2	1	3	Barbell Bench Press (60%Rm)	3	0.55-0.65 m/s; ≤10%	30-60	Intermediate- threshold training (60%- 70%HRmax)	
			Seated Row (60%Rm)	3	0.55-0.65 m/s; ≤10%	30-60		
			Deadlift (60%Rm)	3	0.65-0.75 m/s; ≤10%	30-60		
			Seated Leg Extension (60%Rm)	3	0.80-0.90 m/s; ≤10%	30-60		
			Seated Leg Curl (60%Rm)	3	0.80-0.90 m/s; ≤10%	30-60		
3-4	1	3	Barbell bench press (70%Rm)	3	0.45-0.55 m/s; ≤10%	30-60	Intermediate- threshold training (65%- 75%HRmax)	
			Seated row (70%Rm)	3	0.45-0.55 m/s; ≤10%	30-60		
			Deadlift (70%Rm)	3	0.55-0.65 m/s; ≤10%	30-60		

			Jump squats (70%Rm)	3	0.90-1.10 m/s; ≤10%	30-60		
			Squats (70%Rm)	3	0.55-0.65 m/s; ≤10%	30-60		

5-6	1	3	Barbell Bench Press (80%Rm)	3	0.35-0.45 m/s; ≤10%	30-60	High-threshold training (70%- 80%HRmax)	
			Seated Row (80%Rm)	3	0.35-0.45 m/s; ≤10%	30-60		
			Deadlift (80%Rm)	3	0.45-0.55 m/s; ≤10%	30-60		
			Seated Leg Extension (80%Rm)	3	0.50-0.60 m/s; ≤10%	30-60		
			Seated Leg Curl (80%Rm)	3	0.50-0.60 m/s; ≤10%	30-60		
7-8	1	3	Barbell bench press (90%Rm)	3	0.20-0.30 m/s; ≤10%	30-60	High-threshold training (75%- 85%HRmax)	
			Deadlift (90%Rm)	3	0.30-0.40 m/s; ≤10%	30-60		
			Seated row (90%Rm)	3	0.20-0.30 m/s; ≤10%	30-60		
			Push-ups (90%Rm)	3	0.30-0.40 m/s; ≤10%	30-60		

			Pull-ups (90%Rm)	3	0.25-0.35 m/s; $\leq 10\%$	30-60		
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Chart 1: Velocity-based Training Moves



Barbell Bench Press



Seated Row



Deadlift



Seated Leg Extension



Seated Leg Curl



Jump squats



Squats



Pull-ups



Images sourced from Google

Table 2: Overall Intervention Protocol for VG and SG

Duration (week)	Frequency (times/week)	Process & Time	VG (Velocity-based Training Group moves intervention)					SG (Standard training Group moves intervention)				
			Content of Physical training (1RM%)	Sets	Velocity Zone; Velocity Loss	Rest (s)	Intensity	Content of Physical training	Sets	Repetition	Rest (s)	Intensity
1-2	3	Warm up (15 min)	General warm-up activities use conventional warm-up exercises, and special warm-up activities use a complex combination of basic aerobics steps and hand position exercises.									
		Intervention (60 min)	Barbell Bench Press (60%Rm)	3	0.55-0.65 m/s; ≤10%	30-60	60%-70% HRmax	Barbell Bench Press (60%Rm)	3	8	30-60	60%-70% HRmax
			Seated Row (60%Rm)	3	0.55-0.65 m/s;	30-60		Seated Row (60%Rm)	3	8	30-60	

			)		≤10%			)				
			Deadlift (60%Rm)	3	0.65-0.75 m/s; ≤10%	30-60		Deadlift (60%Rm)	3	8	30-60	
			Seated Leg Extension (60%Rm)	3	0.80-0.90 m/s; ≤10%	30-60		Seated Leg Extension (60%Rm)	3	8	30-60	
			Seated Leg Curl (60%Rm)	3	0.80-0.90 m/s; ≤10%	30-60		Seated Leg Curl (60%Rm)	3	8	30-60	
		Cool down (15 min)	Static stretching, lower and upper body stretching									
3-4	3	Warm up (15 min)	General warm-up activities use conventional warm-up exercises, and special warm-up activities use a complex combination of basic aerobics steps and hand position exercises.									
Intervention (60 min)	Barbell bench press (70%Rm)	3	0.45-0.55 m/s; ≤10%	30-60	65%-75% HRmax	Barbell bench press (70%Rm)	3	6	30-60	65%-75% HRmax		
	Seated row (70%Rm)	3	0.45-0.55 m/s; ≤10%	30-60		Seated row (70%Rm)	3	6	30-60			
	Deadlift (70%Rm)	3	0.55-0.65 m/s; ≤10%	30-60		Deadlift (70%Rm)	3	6	30-60			
	Jump	3	0.90-1.10	30-60		Jump	3	6	30-			

Improvement suggestions	
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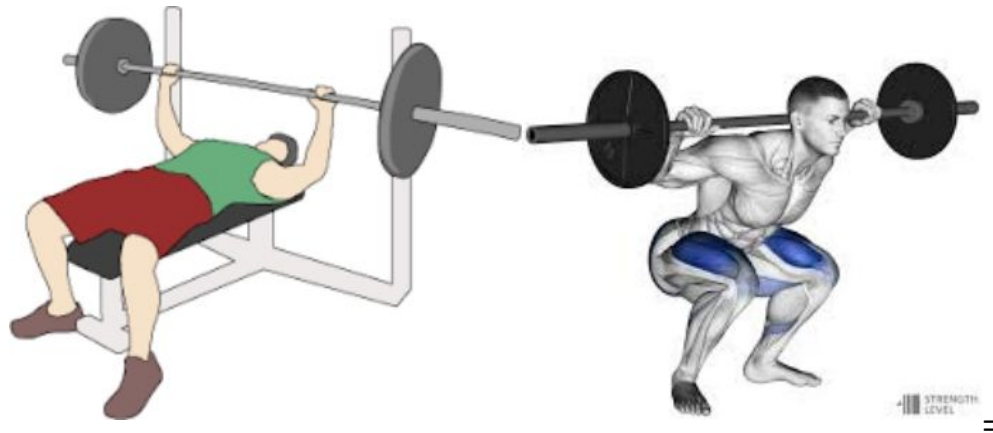
Repetitions									
Process & Time									
Rest/Recovery									
Intensity									
Content of Warm-up									
Content of Cool down									

Table 4: Protocol Outcome Evaluation Form by Experts

Test	Measure method	Instrument	Validity & Reliability	Unit	Improvement suggestions
Strength	Bench Press (1RM) Squat (1RM)	Barbell Squat Rack	0.97-0.98(Grgic, J. et al., 2020)	Kilogram (kg)	
Power	Standing long jump	Tape measure	0.98(Makhlouf et al., 2024)	Centimeters (cm)	
Speed	30m sprint	Stopwatch	0.93(McMahon, J et al., 2017)	Seconds	
Agility	Illinois Agility Test (IAT)	Stopwatch	0.96(Hachana, Y. et al., 2013)	Seconds	
Endurance	Trunk flexor test (TFT)	Stopwatch	0.93(McGill, S. M. et al., 1999)	Seconds	
Balance	Y Balance Test (YBT)	Y Balance test	0.99(Plisky, P. J. et al., 2009)	Centimeters (cm)	
Coordination	Wall-Toss Test	Stopwatch	0.957(Naru et al., 2025)	Seconds	
Flexibility	Sit-and-reach	Sit-and-reach box	0.92(Ayala et al., 2012)	Centimeters (cm)	
skill performance Groups (A、 B、 C)	skill difficulty score (Group A Families 1–3, Group B Families 4–6, Group C Family 7)	Scored against the FIG (2025) Aerobic Gymnastics Code of Points	0.88(León-Prados & Jemni, 2021)	points	
Scoring routine	Total Score = A-Score + E-Score + D-Score	Scored against the FIG (2025) Aerobic Gymnastics Code of Points	0.97(León-Prados & Jemni, 2021)	points	

3. Outcome measures detail

3.1 Strength



Bench Press (1RM) :

The maximum strength of the upper limbs was assessed using a one-repetition maximum weight (1RM) bench press test.

Squat (1RM):

Maximal lower limb strength was assessed using the 1-repetition maximum (1RM) deep squat test.

Participants performed progressive sets of barbells with increasing loads until they successfully completed one full-range repetition. (Makhlouf et al., 2022)

3.2 Power



Standing long jump:

Measure the distance of the standing long jump with a measuring tape.

Participants stand slightly apart in front of the jump line, bend their knees, and move their arms backwards, then swing their arms and jump as far as possible; Stand on both feet while maintaining an upright position; Conduct two tests. Record the best score from two tests with an accuracy of 1 centimeter (Ambroży et al., 2022).

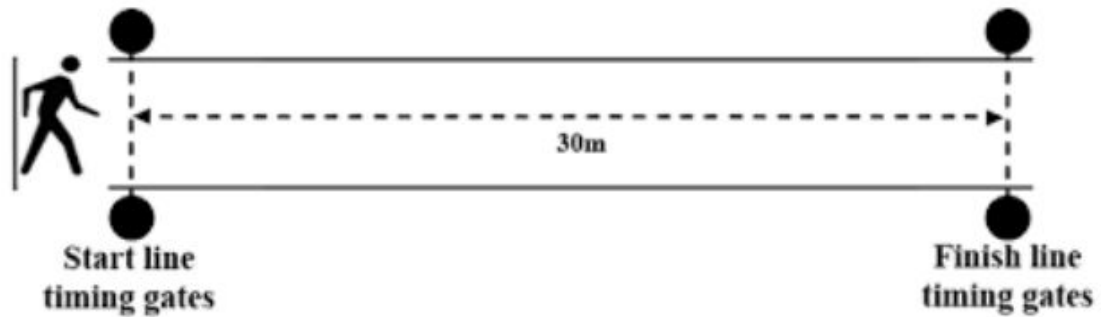
3.3 Endurance



Trunk flexor test (TFT) is used to assess the endurance of the anterior musculature of the core (rectus abdominis).

The flexor endurance test begins with the person in a sit-up position with the back resting against a jig angled at 60 degrees from the floor. Both knees and hips are flexed 90 degrees, the arms are folded across the chest with the hands placed on the opposite shoulder, and the feet are secured. To begin, the jig is pulled back 10 cm, and the person holds the isometric posture as long as possible. Failure is determined when any part of the person's back touches the jig. Record how long in seconds the client is able to maintain the position (Brumitt, 2010; Nesser et al., 2008).

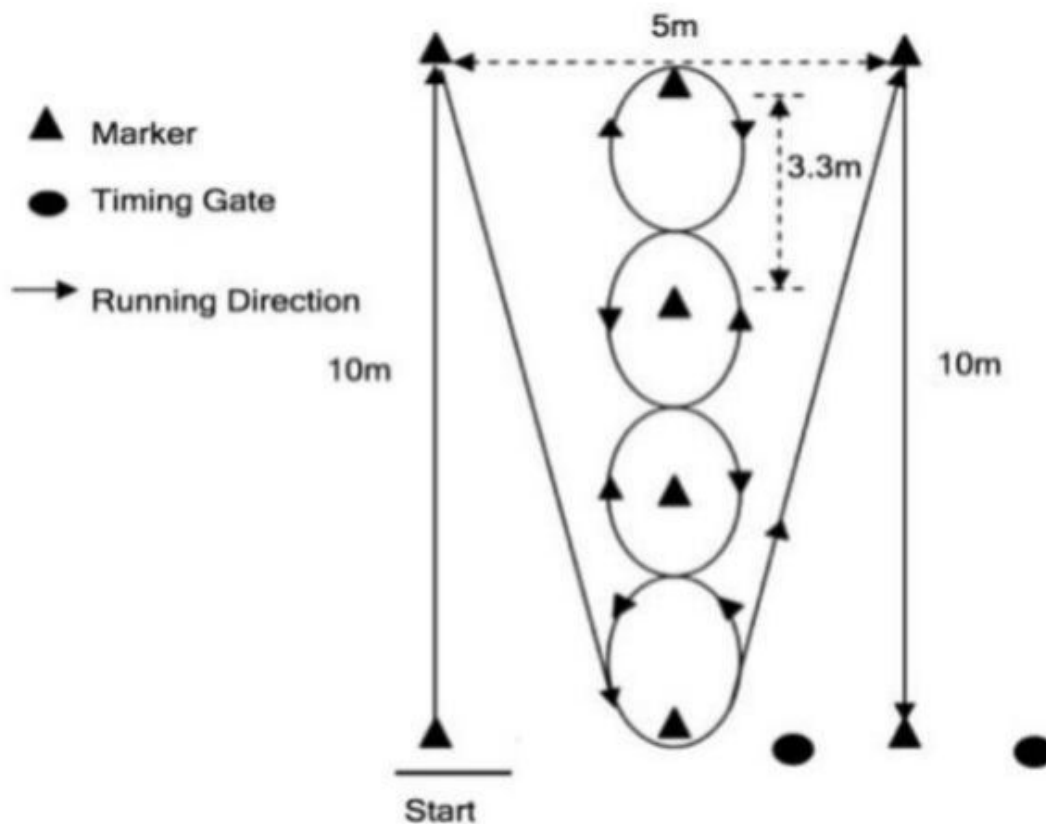
3.4 Speed



30m sprint: Use a stopwatch to record the duration of the participants' 30 m sprint.

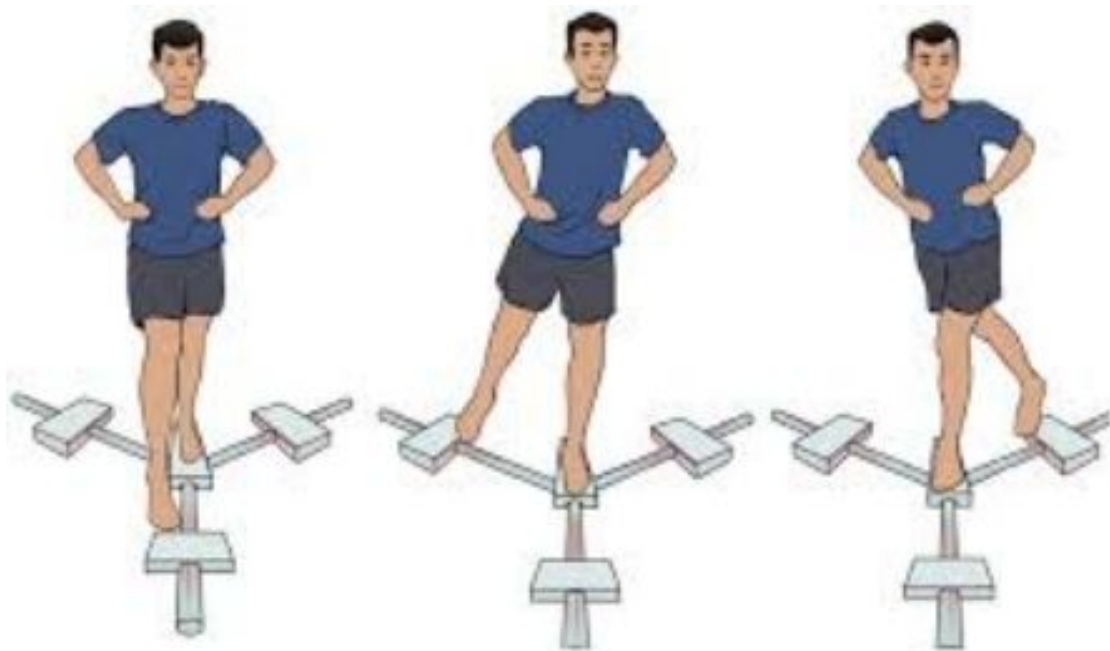
Set cones at 0 and 30 meters along a straight line. Participants place their toes on the starting line or behind the starting line, start from a stationary position, and sprint at maximum speed over the cone at 30 meters before safely slowing down (Meyers et al., 2015).

3.5 Agility



Illinois Agility Test (IAT): Use a stopwatch to record the total time required to complete the task. The Illinois Agility Test (IAT) assessed agility performance (Raya et al., 2013). When set up on a football field, the course measured 10 meters in length and 5 meters in width. Four cones indicated the start, finish line, and turning points. Four more cones were positioned at equal intervals down the center. The distance between the central cones was 3.3 meters. The subjects were told to run around the course in the designated direction (Makhlouf et al., 2022).

3.6 Balance



Y Balance Test (YBT): Use a meter stick to record the test distance.

Involves individuals positioning themselves at the centre of the YBT kit. They are then asked to extend their reach as far as possible, ensuring their feet remain on the reach indicators. After each stretch, they revert to the starting point. This process is repeated in anterior, posterolateral, and posteromedial directions. The test is conducted on both legs (Latifi et al., 2024).

3.7 coordination



Wall-Toss Test:

To perform the test, a person stands a set distance from a wall and repeatedly throws a ball against it, catching it with the opposite hand for a set amount of time, such as 30 seconds. The number of successful catches within that period is recorded to evaluate the individual's ability to coordinate their movements. (Bai et al., 2024)

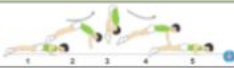
3.8 Flexibility



Sit-and-reach: Use the sit-and-reach box. The score is recorded as the point where their fingertips reach the measurement scale.

In the sitting position of the test, participants have their legs straight, their feet pressed against the sit and read box, and their arms extended forward as much as possible to push the sliding ruler on the surface of the box (Ambroży et al., 2022).

3.8 Skills Performance Test

GROUP A - FLOOR ELEMENTS				
Family 1		Dynamic Strength	Base Name: A-FRAME	
No.	Value	EXPLOSIVE A-FRAME		
A 114	0.4	1. Front Support. 2. Pushing off the floor, the body is lifted upwards to allow it to pike while airborne. 3. Land in Push up.		
Family 2		Static Strength	Base Name: PLANCHE	
No.	Value	STRADDLE PLANCHE		
A 266	0.6	1. A support in which the body is supported on both hands with straight arms. 2. Hands may be turned out at the wrist or pointing towards the feet. 3. Legs are in straddle. 4. Hold for 2 seconds. 5. The body line must not exceed 20° above parallel.		
Family 3		Leg Circle	Base Name: HELICOPTER	
No.	Value	HELICOPTER		
A 334	0.4	1. Straddle Sit. 2. The leading leg crosses over the other leg to initiate the rotation, one arm on the floor at the beginning of the movement. As the leading leg circles over the body the hand is lifted and replaced by the upper back. Perform a 180° twist, both legs circle over the body while rotating. 3. Push up, facing the same direction as the starting seated.		
GROUP B - AIRBORNE ELEMENTS				
Family 4		Dynamic Jump / Leap	Base Name: SCALE	
No.	Value	SCALE 1/1 TWIST		
B 446	0.6	1. From a Sagittal Scale with body and lifted leg parallel to the floor. 2. Push off from the floor with the supporting leg to lift the body upwards to initiate a 360° twist airborne with legs together. 3. Hands and feet land at the same time in push up.		
Family 5		Form Jump	Base Name: COSSACK	
No.	Value	2/1 TURNS COSSACK JUMP		
B 537	0.7	1. A Vertical Jump from two feet take off with a 720° turn. 2. While airborne show a Cossack. 3. Landing on both feet, facing the same direction as the start		
Family 6		Split Jump / Leap	Base Name: SCISSORS LEAP	
No.	Value	SCISSORS LEAP 1/2 TURN		
B 626	0.6	1. A one-foot take-off with one straight leg forward, turning 180°. 2. Leading leg must show minimum 45° above the floor before switch. 3. While airborne the legs switch to show a Split. 4. Land on both feet, facing the opposite direction from the start.		
GROUP C - STANDING ELEMENTS				
Family 7		Turn	Base Name: ILLUSION	
No.	Value	DOUBLE ILLUSION		
C 726	0.6	1. From standing with both feet together, step forward and free leg is lifted upward to initiate vertical rotations. 2. Perform two illusions (720°) in a row. 3. The lifted leg comes down to the starting position of standing with both feet together.		

3.8.1 The Difficulty Element Pool: Group A, B, C and Families 1–7.

The Code of Points organises all recognised difficulty (skill) elements into

three Groups, which are further divided into Families of related base skills.

The study's skill-performance outcome draws on Group A, Group B, and Group C, as summarised below (FIG2025).

3.8.2 “Scoring Routines” score

The scoring routines is complete performance that is judged; also named total score. Total score in this study is scored exactly as it is scored in FIG-sanctioned competition, i.e., as the sum of three independently judged components: Difficulty (D-score), Execution (E-score), and Artistry (A-score), applied to the participant's complete competitive routine (FIG2025).

Difficulty Score (D-Score): Each recognised element in the Code of Points' Element Pool (Appendix 9, Difficulty Chart) is pre-assigned a point value on a 10-step scale, from 0.1 (simplest, Level A) to 1.0 (most complex, Level J), according to its technical difficulty.

Execution Score (E-Score): The E-Score evaluates how correctly the routine's movements are performed, independent of their difficulty or artistic value.

Judging starts from a maximum of 10.0 points, with points subtracted for each technical error observed across: Aerobic Movement Pattern (AMP) sequence technique, difficulty/acrobatic elements, transitions/links, collaboration and synchronisation.

Artistry Score (A-Score): The A-Score evaluates the choreographic and performance quality of the routine — how well the sport content is transformed into an artistic presentation. A panel of Artistry judges rates the routine on five criteria, each scored on a 1.0–2.0 scale (Poor → Excellent, in 0.1 increments), for a combined maximum of 10.0 points.

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