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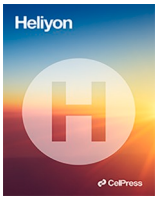

Research article

An empirical study of the flag rugby game programme to promote gross motor skills and physical fitness in 5–6 year old preschool children

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ABSTRACT

In order to investigate the effects of a flag rugby game programs on the development of gross motor skills and physical fitness in 5–6 year old preschool children. An overall random sampling method was adopted to select 56 preschoolers aged 5–6 years from class A and class B,class A was the ExG (28) implemented a flag rugby games intervention program,and class B was the ConG (28) implemented a regular physical education program,with a 12-week intervention period.The content and requirements of the experimental intervention program were determined through a systematic analysis method, and the subjects' gross motor skills level was tested using the TGMD-3, and their physical fitness level was measured using China's fifth national physical fitness monitoring of early childhood (3–6 years) component.Experimental data were statistically analyzed using independent samples *t*-test, paired samples *t*-test, and repeated measures ANOVA test.After 12 weeks of practice, 1) We found that the ExG outperformed the ConG in Skip,One hand stationary dribble, Overhand throw, Underhand throw, Forehand strike of self-bounced,Kick a stationary ball, Total object control subject score, Total gross motor score test results with significant differences ($p < 0.05$).The ExG differed significantly ($p < 0.01$) in Grip strength, Stand long jump,Sit forward bend, Continuous jump on both feet,15 m obstacle run,Walk the balance beam, while the ConG differed significantly ($p < 0.05$) only in Continuous jump on both feet,15 m obstacle run and Stand long jump.2) We also found gender differences in gross motor skills and Physical fitness test results, this difference is manifested in boys outperformed girls in Total object control subject Score, Grip strength and 15 m obstacle run with significant difference ($p < 0.05$), girls outperformed boys in Sit forward bend with significant difference ($p < 0.05$).The 12-week flag rugby game programs improved gross motor skills and physical fitness levels of 5–6 year old preschoolers more comprehensively than the regular program, and we recommend the purposeful and organized promotion of a flag rugby game programs in the physical activity curriculum for 5–6 year old preschoolers.

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1. Introduction

Preschool is a peak and sensitive period for motor development, and many gross motor skills develop with great variability up to the age of 8 [1].Focusing on the development of gross motor skills such as walking, running, jumping and throwing from preschool age to acquire and establish stable 'motor units' is very important for the acquisition of advanced motor skills in the future [2].Flag rugby follows the basic rules and techniques of rugby, with no holding or pushing allowed, and uses the basic movements of running, jumping, straddling, throwing, catching, passing, throwing and kicking to score by stealing, attacking, defending and scoring touchdowns.It is a non-physical contact, confrontational ball game in which the opponent is prevented from scoring by tearing off the flag of the offensive team's ball carrier.Some studies have concluded that it is a safe, competitive and non-violent sport [3,4].The sport that combines the benefits of different ball sports and has an impact on youth growth and development [5], suggesting that children under the age of 12 should participate more in flag rugby [6,7], which allows children and young people to develop physically in a holistic way [8].It can be seen that flag rugby is suitable for developing children's gross motor skills.Studies have shown that aerobic games have significantly improved the physical performance of preschool children in terms of horizontal jumping, sprinting and endurance [9], and significantly improved explosive power and sensitive response in the lower limbs [10], while specialized physical activities improve children's physical fitness even more [11], and strength qualities are significantly improved in preschool boys and flexibility qualities are significantly improved in girls aged 5–6 years [12].It is evident that play-based motor intervention programme have been widely used in the physical development of preschool children aged 5–6 years with gender differences.We agreed that flag rugby is safe, easy to learn, fun and has a high level of gross motor involvement and that it may have an important role in promoting gross motor and physical fitness development in 5–6 year old preschool children, but the programme has not been applied in a motor programme for 5–6 year old preschool children to discuss the relationship with gross motor and physical fitness development and no association between them has been reported.As 12 weeks meets the guidelines recommended by the American University of Sports Medicine (Title 2), we designed the motor skills of flag rugby as a 12-week instructional intervention in a game curriculum consistent with the physical and mental developmental characteristics of 5–6 year old preschool children to investigate the effects of a flag rugby programme on the development of gross motor skills and physical fitness in 5–6 year old preschool children.

2. Methods

2.1. Participants

A controlled study was conducted with 64 participants randomly selected from classes A and B of the HuaFu experimental kindergarten.Voluntary participants who had not previously trained in a rugby course and who did not participate in other physical education courses during the experimental period were included, those who had previously participated in a rugby course and who were not physically fit to participate at moderate to high intensity were excluded,not meeting inclusion criteria (n = 4),declined to participate (n = 2),other reasons (n = 2),and a total of 56 participants from class A (12 boys, 16 girls) and class B (12 boys, 16 girls) met the inclusion criteria.During the experiment lost to follow-up(n = 0),ExG analyzed (n = 28),ConG analyzed (n = 28),and 28 members of class A served as the experimental group (the ExG) implementing components of the flag rugby game intervention programme,

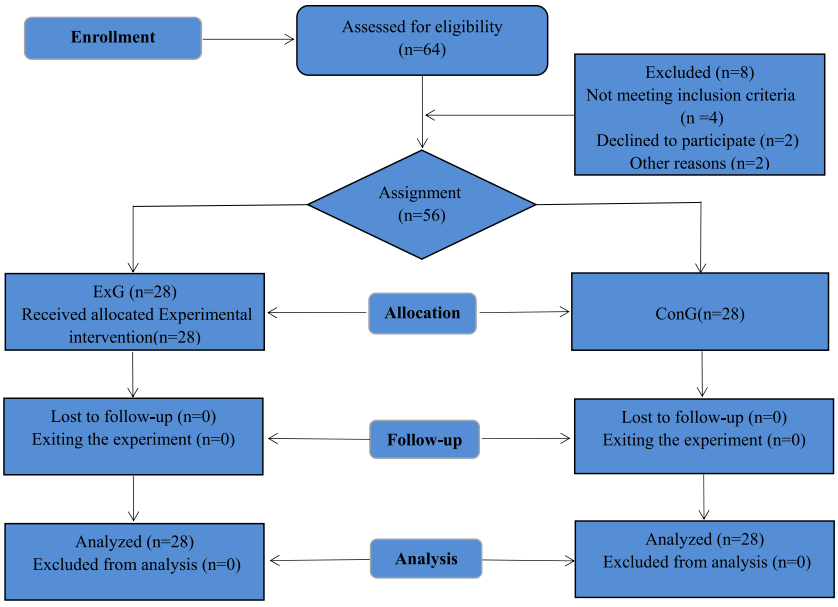

Fig. 1. Recruitment flow chart.

and 28 members of class B served as the control group(the ConG) implementing components of the regular programs, showed by Fig. 1. The differences in the basic characteristics of the subjects in the ExG and ConG were tested to be insignificant ($P > 0.05$).To avoid possible errors in the experimental results due to other factors, all subjects did not participate in any additional specialized physical activities during the experiment, and the same teacher was in charge of the teaching activities in class A and class B.

2.2. Experimental program

We conducted a 12-week, 3 times per week, 35-min experimental controlled study with all subjects.The ExG subjects implemented flag football game sessions,the ConG subjects implemented regular physical activity.Pre-intervention test work was implemented 24 h after all subjects were familiarized with the program testing procedures and environment, and post-intervention test work was implemented after 12 weeks of practice.To ensure that the ExG and ConG differed only in experimental content, we controlled the exercise load at 130–160 rpm for both the experimental and regular sessions, and Table 1 shows the content of the ExG and ConG sessions.Throughout the course design and teaching process, we paid particular attention to children's physical and mental health and developmental patterns, and used protective devices to prevent subjects from sustaining sports injuries to ensure that the experiments were not interrupted.Although the subjects were in a rapid growth phase, this experiment was not designed as an intermediate test because their normal growth would not be a major factor in the outcome of the experiment due to the relatively short duration of the instructional intervention.To avoid possible errors in the experimental results due to other factors, all subjects did not participate in any additional specialized physical activities during the experiment, and the same teacher was in charge of the teaching activities in class A and class B.

2.3. Measure

2.3.1. Gross motor skills

The Test of Gross Motor Development-Third Edition (TGMD-3) has been widely used in different regions of the world to investigate and assess the level of gross motor skills development in children aged 3–10 years [13–15] and has been shown to have good reliability in different regional cultural contexts and growth environments [16,17].Therefore, we used TGMD-3 as an assessment tool to evaluate the subjects' level of gross motor skills development, and each skill was assessed using 3 to 5 motor criteria.For example, the 'Run' action was assessed by bending the elbow and moving the arm towards the opposite thigh, this action was present during the assessment of the participant's running ability and a score of '1′ was recorded.A score of '0′ was recorded if the movement was not present, with a high score indicating a better level of gross motor skills and a low score indicating the absence or underdevelopment of a key movement, as shown in Table 2 [18].All subjects independently completed under the premise that test time, place and content were consistent, and performance was recorded on a TGMD-3 score sheet and organized using Microsoft Excel, then coded by 1 researcher who was unaware of the purpose of the study and evaluated by 2 non-testing staff members.

2.3.2. Physical fitness

The physical fitness of preschool children aged 5–6 years was measured using the "China's fifth national physical fitness monitoring of early childhood (3–6 years) component" [19].It can comprehensively reflect the upper limb strength, lower limb strength, agility, flexibility, coordination and balance ability of children aged 3–6 years, as shown in Table 3.Since the physical fitness test criteria are only graded and not scored, we only compared and analyzed the experimental results.

2.4. Statistical analysis

The data were analyzed using SPSS 25.0, and the results of each test were normally distributed and expressed as mean ± standard deviation (M±SD). Independent and paired samples t-tests, 2 × 2 repeated measures ANOVA and three-factor repeated measures ANOVA tests were performed on the subjects' gross motor and physical fitness, and effect sizes were considered.The test results were

Table 1
Content of the intervention courses in ExG and the regular courses in ConG.

Number of weeks of experiment	Number of experiments	Course objectives	The ExG intervention course content	The ConG regular course content	Exercise intensity
12W	36Times	Development of speed, Agility, Upper limb strength, Lower limb strength, Flexibility, Balance and Motor integration skills in 5–6 year old preschool children.	1.10 m run around an obstacle game; 2.10 m lateral slide move game; 3.10 m Z-route sprint run game; 4.Toss and catch ball game; 5.Cross pass game; 6.Kick fix game; 7.Straddle jump game; 8.Fish forward roll game; 9.2v1 surrounded defence game; 10.3v1 surrounded defence game; 11.7v7 game; 12.14v14 game	1.20 m run around obstacles; 2.30 m face-to-face relay; 3.Rope skipping; 4.One-handed dribbling; 5.Two-handed breast passing and catching; 6.Two-handed breast throwing; 7.Foot dribbling; 8.Standing long jump; 9.Goat jumping; 10.Crossing a low fence; 11.Walking a one-way bridge; 12.Throwing a ball over the shoulder to hit a fixed object	130–160 rpm

Table 2
Test indicators and scores of TGMD-3.

Locomotor subjects			Object control subjects		
Skills	Score	Performance criteria	Skills	Score	Performance criteria
Run	8	1.Arms move in opposite direction to legs with elbows flexed. 2. Short period where both feet are off the surface. 3.Narrow foot placement landing on heel or toes (not flat footed). 4.Non-supporting leg bent about 90° so that the foot is close to the buttocks.	Two-hand Strike of a stationary ball	10	1.Child's preferred hand grips bat above non-preferred hand. 2.Child's non-preferred hip/shoulder faces in direction of straight ahead. 3.Hip and shoulder rotate and derogate during swing. 4.Steps toward ball with non-preferred foot. 5. Hits ball sending it straight ahead.
Gallop	8	1.Arms are bent and lifted to about waist level at takeoff. 2.A step forward with lead foot followed with the trailing foot landing beside or a little behind the lead foot (not in front of the lead foot). 3.Brief period where both feet come off the surface. 4.Maintains a rhythmic pattern for 4 consecutive gallops.	Forehand strike of self-bounced ball	8	1.Child takes a backswing with the paddle when ball is bounced. 2.Steps toward the ball with non-preferred foot. 3.Strikes ball forward toward wall. 4.Paddle follows through toward non-preferred shoulder.
Hop	8	1.Non-hopping leg swings forward in peninsular fashion to produce force. 2.Foot on non-hopping leg remains behind hopping leg (does not cross in front of). 3.Arms flex and swing forward to produce force. 4.Hops four consecutive hops on the preferred foot before stopping.	One hand stationary dribble	6	1.Contacts ball with one hand at about waist level. 2.Pushes ball with fingertips (not slapping at ball). 3.Maintains control of the ball for 4 bounces without moving their feet to retrieve the ball.
Skip	6	1.A step forward followed by a hop on the same foot. 2. Arms are flexed and move in opposition to legs to produce force. 3. Completes 4 continuous rhythmical alternating skips.	Two hand catch	6	1.Child's hands are positioned in front of the body with the elbows flexed. 2.Arms extend reaching for the ball as it arrives. 3.Ball is caught by hands only.
Horizontal jump	8	1.Prior to take off both knees are flexed and arms are extended behind the back. 2.Arms extend forcefully forward and upward reaching above the head. 3.Both feet come off the floor together and land together. 4.Both arms are forced downward during landing.	Kick a stationary ball	8	1. Rapid continuous approach to the ball. 2. Child takes an elongated stride or leap just prior to ball contact. 3. Non kicking foot placed close to the ball. 4. Kicks ball with instep of preferred foot, (not the toes).
Slide	8	1.Body is turned sideways so shoulders remain aligned with the line on the floor. 2.A step sideways with the lead foot followed by a slide with the trailing foot where both feet come off the surface briefly. 3.Four continuous slides to the preferred side. 4.Four continuous slides to the non-preferred side.	Overhand throw	8	1.Windup is initiated with a downward movement of hand and arm. 2.Rotates hip and shoulder to a point where the non-throwing side faces the wall. 3.Steps with the foot opposite the throwing hand toward the wall. 4.Throwing hand follows through after ball Release across the body toward the hip on The non-throwing side.
			Underhand throw	8	1.Preferred hand swings down and back reaching behind the trunk. 2.Steps forward with the foot opposite the throwing hand. 3.Ball is tossed forward hitting the wall without a bounce. 4. Hand follows through after ball release to chest level.

tested using "*" to indicate significant differences within the groups ($p < 0.05$),"#" indicates a significant difference between groups ($P < 0.05$), no significant differences ($P > 0.05$).

3. Results

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3.1. Comparative analysis of subjects' gross motor skills test results

Table 4:To ensure the pre-test level of gross motor skills in subjects in the ExG and ConG, we performed an independent samples *t*-test and found no significant difference between the ExG and ConG ($p > 0.05$).After 12 weeks of training, we conducted paired samples

Table 3
China's fifth national early childhood (3–6 years) physical fitness monitoring component.

Test projects	Test method	Test significance
Grip strength	A grip strength tester was used. The subject held the grip of the tester with one hand, stood with both feet naturally apart and shoulder width apart, both arms hanging diagonally, palms facing inwards, and grasped the grip of the tester with one hand at maximum strength.Two consecutive tests were performed and the maximum value was recorded in kilograms.	Reflects the strength of the subject's upper body.
Stand long jump	A standing long jump tester was used. The subject's feet were naturally separated, he stood behind the starting line, then swung his arms, jumped forward with his feet on the ground and measured the straight line distance between the starting line and the nearest heel.The test was performed twice and the maximum value was recorded in centimeters.	Reflects the subject's level of strength in the lower extremities.
Sitting forward bend	A seated forward flexion tester was used. The subject sits barefoot in front of the machine with legs straight, heels together, toes naturally apart and the whole foot in the tester plate, palms down, arms together and flat, upper body bent forward, using the fingertips of the middle fingers of both hands to push the cursor forward smoothly until it stops moving.Two consecutive tests were performed and the maximum value recorded in centimeters.	Reflects the flexibility of the subject's body.
Continuous jump on both feet	A two-legged continuous jump tester was used. Ten soft square bags were placed in a straight line on a flat surface at 50 cm intervals, a start line was drawn 20 cm from the first soft square bag and a finish line was drawn 20 cm from the last soft square bag, and the start time sensors were placed at both ends.Two consecutive tests are performed and the maximum value is recorded in seconds.	Reflects the subject's physical coordination and lower limb strength.
15 m obstacle run	Use a 15 m running tester around the obstacles. Mark a straight line of 15 m on a flat surface, draw a horizontal line of about 1.5 m wide at the start of the line as the start line, draw a horizontal line of 1.5 m wide at the end of the line as the finish line, place column sensors on either side of the start and finish lines, place the first conical barrel on the line at 3 m from the start, then place a conical barrel every 1.5 m, a total of 7, the last conical barrel at 3 m from the finish line. The distance between a conical cylinder and the finish line is 3 m. Two consecutive tests are carried out and the maximum value is recorded in seconds.	Reflects the physical agility of the subject.
Walk the balance beam	A balance beam tester was used. The subject stands on a balance beam 3 m long, 10 cm wide and 30 cm high, facing the beam with arms raised to the side and both feet moving alternately towards the target line.The timing stops when the subject steps on either foot to the target line.Two consecutive tests are performed and the maximum value in seconds is recorded.	Reflects the balance of the subject's body.

t-tests on the pre- and post-test scores for the ExG and ConG subjects.It was found that the ExG differed significantly ($p < 0.01$) in Run, Gallop,Hop,Skip, Horizontal jump, Slide,Total locomotor score,Two hand catch,One hand stationary dribble, Overhand throw, Underhand throw,Two hand strike of stationary ball, Forehand strike of self-bounced,Kick of stationary ball, Total object control score,

Table 4
Comparative analysis of subjects' gross motor skills test results.

Test Projects	ExG				ConG			
	0W	12W	t	p	0W	12W	t	p
Run	6.79 ± 0.12	7.29 ± 0.11[b]	−2.867	0.008	6.71 ± 0.14	6.89 ± 0.17	−1.154	0.259
Gallop	5.00 ± 0.17	6.11 ± 0.14[c]	−5.325	0.000	5.50 ± 0.26	5.61 ± 0.23	−1.140	0.264
Hop	5.21 ± 0.15	6.04 ± 0.10[c]	−4.804	0.000	5.46 ± 0.12	5.86 ± 0.21	−1.834	0.078
Skip	4.11 ± 0.23	5.39 ± 0.18[ce]	−4.361	0.000	3.79 ± 0.23	4.11 ± 0.20	−1.880	0.071
Horizontal jump	5.29 ± 0.17	6.39 ± 0.11[c]	−5.684	0.000	5.61 ± 0.31	5.82 ± 0.30	−1.996	0.056
slide	5.71 ± 0.14	6.43 ± 0.11[b]	−3.873	0.001	5.79 ± 0.14	6.07 ± 0.27	−0.955	0.348
Total locomotor subject score	32.11 ± 0.40	37.64 ± 0.35[c]	−11.315	0.000	32.75 ± 0.66	34.29 ± 0.72[b]	−3.635	0.001
Two hand catch	4.25 ± 0.25	5.36 ± 0.15[c]	−4.456	0.000	4.32 ± 0.23	4.39 ± 0.19	−0.465	0.646
One hand stationary dribble	5.21 ± 0.19	6.57 ± 0.17[c,e]	−5.058	0.000	5.25 ± 0.15	5.39 ± 0.19	−0.812	0.424
Overhand throw	4.25 ± 0.11	5.82 ± 0.16[c,f]	−10.524	0.000	4.00 ± 0.24	4.32 ± 0.17	−1.730	0.095
Underhand throw	4.11 ± 0.17	6.07 ± 0.13[c,d]	−10.035	0.000	4.46 ± 0.27	4.75 ± 0.20	−1.137	0.265
Two hand strike of a stationary ball	4.50 ± 0.13	5.29 ± 0.12[c]	−4.747	0.000	4.32 ± 0.31	4.39 ± 0.27	−0.465	0.646
Forehand strike of self-bounced	3.43 ± 0.18	5.29 ± 0.30[c,f]	−6.218	0.000	3.32 ± 0.14	3.61 ± 0.20	−1.315	0.200
Kick a stationary ball	3.82 ± 0.20	6.43 ± 0.11[c,f]	−12.942	0.000	3.71 ± 0.18	4.04 ± 0.15	−1.432	0.164
Total object control subject score	29.57 ± 0.53	40.82 ± 0.45[c,f]	−20.430	0.000	29.39 ± 0.60	30.86 ± 0.56[a]	−2.772	0.010
Total gross motor score	61.68 ± 0.69	78.46 ± 0.52[c,f]	−21.935	0.000	62.14 ± 0.99	65.14 ± 0.93[c]	−4.731	0.000

Note : Within-group differences.
Differences between groups.
[a] $p < 0.05$.
[b] $p < 0.01$.
[c] $p < 0.001$.
[d] $p < 0.05$.
[e] $p < 0.01$.
[f] $p < 0.001$.

Total gross motor score.whereas ConG differed significantly ($p < 0.05$) only in Total Locomotor score, Total object control score and Total gross motor score between pre-test and post-test. We also found that ExG in Skip,One hand stationary dribble, Overhand throw, Underhand throw, Forehand strike of self-bounced, Kick a stationary ball, Total object control subject score, and Total gross motor score were significantly ($p < 0.05$) better than ConG.This indicates that the flag rugby game courses played a more effective role in improving subjects' gross motor skills in ExG.

Table 5: We performed a 2 (Group: ExG, ConG) × 2 (Time: 0w, 12w) repeated measures ANOVA on the subjects' gross motor skills test scores.The results showed that there was a non-significant main effect of group for the Run ($F = 2.129$, $p = 0.150$, $ES = 0.719$), a significant main effect of time ($F = 8.468$, $p = 0.005$, $ES = -0.865$) and a non-significant interaction effect of time and group ($F = 1.900$, $p = 0.174$, $ES = 0.034$).The main effect of the Gallop was not significant ($F = 0.000$, $p = 1.000$, $ES = 0.000$), the main effect of time was significant ($F = 28.323$, $p = 0.000$, $ES = -0.903$), and the Gallop interaction effect of time and group was significant ($F = 19.209$, $p = 0.000$, $ES = 0.262$).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (5.00) and ConG (5.50) at 0W was not significant, and at 12W the ExG (6.11) was significantly higher than ConG (5.61). The main effect of the Hop was not significant ($F = 0.049$,$p = 0.826$, $ES = -0.155$), the main effect of time was significant ($F = 19.630$, $p = 0.000$, $ES = -0.944$), and the interaction effect of time and group was not significant ($F = 2.445$, $p = 0.124$, $ES = 0.043$).There was a significant main effect of group ($F = 10.748$, $p = 0.002$, $ES = 0.919$), a significant main effect of time ($F = 22.235$, $p = 0.000$, $ES = -0.938$), and a significant interaction effect of time and group ($F = 8.004$, $p = 0.007$, $ES = 0.129$) for the Skip.Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (4.11) and ConG (3.79) at 0W was not significant, and at 12W the ExG (5.39) was significantly higher than ConG (4.11), ExG was significantly higher than 0W at 12W.The

Table 5
Subjects' gross motor 2 × 2 repeated measures ANOVA test.

Test Projects	ExG		ConG		Group		Time		Interaction	
	0W	12W	0W	12W	Main effect F-value (ES)	p	Main effect F-value (ES)	p	Interaction F-value (ES)	p
Run	6.79 ± 0.12	7.29 ± 0.11[b]	6.71 ± 0.14	6.89 ± 0.17	2.129 (0.719)	0.150	8.468 (-0.865)	0.005	1.900 (0.034)	0.174
Gallop	5.00 ± 0.17	6.11 ± 0.14[c]	5.50 ± 0.26	5.61 ± 0.23	0.000 (0.000)	1.000	28.323 (-0.903)	0.000	19.209 (0.262)	0.000
Hop	5.21 ± 0.15	6.04 ± 0.10[c]	5.46 ± 0.12	5.86 ± 0.21	0.049 (-0.155)	0.826	19.630 (-0.944)	0.000	2.445 (0.043)	0.124
Skip	4.11 ± 0.23	5.39 ± 0.18[c,e]	3.79 ± 0.23	4.11 ± 0.20	10.748 (0.919)	0.002	22.235 (-0.938)	0.000	8.004 (0.129)	0.007
Horizontal jump	5.29 ± 0.17	6.39 ± 0.11[c]	5.61 ± 0.31	5.82 ± 0.30	0.155 (0.268)	0.695	35.304 (-0.891)	0.000	16.117 (0.230)	0.000
slide	5.71 ± 0.14	6.43 ± 0.11[b]	5.79 ± 0.14	6.07 ± 0.27	0.637 (-0.891)	0.428	8.092 (-0.894)	0.006	1.486 (0.027)	0.228
Total locomotor subject score	32.11 ± 0.40	37.64 ± 0.35[c]	32.75 ± 0.66	34.29 ± 0.72[b]	3.588 (0.801)	0.064	119.660 (-0.976)	0.000	38.287 (0.415)	0.000
Two hand catch	4.25 ± 0.25	5.36 ± 0.15[c]	4.32 ± 0.23	4.39 ± 0.19	3.069 (0.779)	0.085	16.272 (-0.895)	0.000	12.566 (0.189)	0.001
One hand stationary dribble	5.21 ± 0.19	6.57 ± 0.17[c,e]	5.25 ± 0.15	5.39 ± 0.19	9.047 (0.906)	0.004	21.848 (-0.949)	0.000	14.317 (0.210)	0.000
Overhand throw	4.25 ± 0.11	5.82 ± 0.16[c,f]	4.00 ± 0.24	4.32 ± 0.17	16.082 (0.943)	0.000	63.045 (-0.967)	0.000	27.494 (0.337)	0.000
Underhand throw	4.11 ± 0.17	6.07 ± 0.13[c,d]	4.46 ± 0.27	4.75 ± 0.20	4.371 (0.828)	0.041	49.913 (-0.970)	0.000	27.780 (0.340)	0.000
Two hand strike of a stationary ball	4.50 ± 0.13	5.29 ± 0.12[c]	4.32 ± 0.31	4.39 ± 0.27	3.186 (0.784)	0.080	14.400 (-0.800)	0.000	10.000 (0.156)	0.003
Forehand strike of self-bounced	3.43 ± 0.18	5.29 ± 0.30[c,f]	3.32 ± 0.14	3.61 ± 0.20	14.386 (0.937)	0.000	33.657 (-0.963)	0.000	18.100 (0.251)	0.000
Kick a stationary ball	3.82 ± 0.20	6.43 ± 0.11[c,f]	3.71 ± 0.18	4.04 ± 0.15	52.210 (0.981)	0.000	94.262 (-0.988)	0.000	57.421 (0.515)	0.000
Total object control subject score	29.57 ± 0.53	40.82 ± 0.45[c,f]	29.39 ± 0.60	30.86 ± 0.56[a]	59.739 (0.984)	0.000	277.614 (-0.993)	0.000	164.453 (0.753)	0.000
Total gross motor score	61.68 ± 0.69	78.46 ± 0.52[c,f]	62.14 ± 0.99	65.14 ± 0.93[c]	39.434 (-0.976)	0.000	396.343 (-0.993)	0.000	192.409 (0.781)	0.000

Note : Within-group differences.
Differences between groups.
[a] $p < 0.05$.
[b] $p < 0.01$.
[c] $p < 0.001$.
[d] $p < 0.05$.
[e] $p < 0.01$.
[f] $p < 0.001$.

main effect of the Horizontal jump was not significant (F = 0.155, p = 0.695, ES = 0.268). The main effect of time was significant (F = 35.304, p = 0.000, ES = −0.891) and the Horizontal jump interaction effect between time and group was significant (F = 16.117, p = 0.000, ES = 0.230).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (5.29) and ConG (5.61) at 0W was not significant, and at 12W the ExG (6.39) was significantly higher than ConG (5.82).The main effect of the Slide was not significant (F = 0.637, p = 0.428, ES = −0.891), the main effect of time was significant (F = 8.092, p = 0.006, ES = −0.894) and the interaction effect between time and group was not significant (F = 1. 486, p = 0.228, ES = 0.027), the main effect of the Total locomotor subject score was not significant (F = 3.588, p = 0.064, ES = 0.801), the main effect of time was significant (F = 119.660, p = 0.000, ES = −0. 976), and the Total locomotor subject score interaction effect of time and group was significant (F = 38.287, p = 0.000, ES = 0.415).Due to the significant interaction effect, a further simple effect analysis was performed and the difference between ExG (32.11) and ConG (32. 75) at 0W was not significant, and at 12W the ExG (37.64) was significantly higher than ConG (34.29), the ExG and ConG were significantly higher than 0W at 12W.The main effect of the Two hand catch was not significant (F = 3.069, p = 0.085, ES = 0.779).The main effect of time was significant (F = 16.272, p = 0.000, ES = −0.895),and the Two hand catch interaction effect between time and group was significant (F = 12.566, p = 0.000, ES = 0.189). Due to the significant interaction effect, further single effect analysis was performed and the difference between ExG (4.25) and ConG (4.32) at 0W was not significant and at 12W the ExG (5.36) was significantly higher than ConG (4.39),the ExG was significantly higher than 0W at 12W.The main effect of the One hand stationary dribble was significant (F = 9.047, p = 0.004, ES = 0.906). The main effect of time was significant (F = 21.848, p = 0.000, ES = −0.949) and the One hand stationary dribble interaction effect between time and group was significant (F = 14.317, p = 0.000, ES = 0.210).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (5.21) and ConG (5.25) at 0W was not significant and at 12W the ExG (6.57) was significantly higher than ConG (5.39), the ExG was significantly higher than 0W at 12W.The main effect of overhand throw was significant (F = 16.082, p = 0.000, ES = 0.943). The main effect of time was significant (F = 63.045, p = 0.000, ES = −0.967) and the Overhand throw interaction effect between time and group was significant (F = 27.494, p = 0.000, ES = 0.337).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (4. 25) and ConG (4.00) at 0W was not significant, and at 12W the ExG (5.82) was significantly higher than ConG (4.32),the ExG was significantly higher than 0W at 12W.The main effect of the Underhand throw was significant (F = 4.371, p = 0.041, ES = 0.828). The main effect of time was significant (F = 49.913, p = 0.000, ES = −0.970) and the Underhand throw interaction effect between time and group was significant (F = 27.780, p = 0.000, ES = 0.340).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (4.11) and ConG (4.46) at 0W was not significant and at 12W the ExG (6.07) was significantly higher than the ConG (4.75),the ExG was significantly higher than 0W at 12W.The main effect of the Two hand striking of a stationary ball was not significant (F = 3.186, p = 0.080, ES = 0.784). The main effect of time was significant (F = 14.400, p = 0.000, ES = −0.800) and the Two hand striking of a stationary ball interaction effect between time and group was significant (F = 10.000, p = 0.003, ES = 0.156).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (4.50) and ConG (4.32) at 0W was not significant and at 12W the ExG (5.29) was significantly higher than the ConG (4.39),the ExG was significantly higher than 0W at 12W. The main effect of the Forehand strike of self-bounce was significant (F = 14.386, p = 0.000, ES = 0.937). The main effect of time was significant (F = 33.657, p = 0.000, ES = −0.963) and the Forehand strike of self-bounce interaction effect between time and group was significant (F = 18.10, p = 0.000, ES = 0.251).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (3. 43) and ConG (3.32) at 0W was not significant, and at 12W the ExG (5.29) was significantly higher than the ConG (3.61),the ExG was significantly higher than 0W at 12W.The main effect of the Kicking a stationary ball was significant (F = 52.210, p = 0.000, ES = 0.981).The main effect of time was significant (F = 94.262, p = 0.000, ES = −0.988) and the Kicking a stationary ball interaction effect between time and group was significant (F = 57.421, p = 0.000, ES = 0.515).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (3. 82) and ConG (3.71) at 0W was not significant, and at 12W the ExG (6.43) was significantly higher than the ConG (4.04), the ExG was significantly higher than 0W at 12W. The main effect of the Total object control subject score was significant (F = 59.739, p = 0.000, ES = 0.984). The main effect of time was significant (F = 277.614, p = 0.000, ES = −0.993) and the Total object control subject score interaction effect between time and group was significant (F = 164.453, p = 0.000, ES = 0.753). Due to the significant interaction effect, further single effect analysis was

Table 6
Comparative analysis of the subjects' physical fitness test results.

Test Projects	ExG				ConG			
	0W	12W	t	p	0W	12W	t	p
Grip strength(kg)	4.55 ± 0.34	5.96 ± 0.21[c]	−5.433	0.000	4.65 ± 0.42	5.10 ± 0.18	−1.303	0.204
Stand long jump(cm)	76.57 ± 2.73	82.18 ± 1.59[b]	−3.187	0.004	76.36 ± 2.26	78.43 ± 2.25[c]	−6.455	0.000
Sit forward bending(cm)	9.26 ± 0.88	12.15 ± 0.44[b]	−3.610	0.001	9.90 ± 0.46	10.43 ± 0.37	−1.361	0.185
Continuous jump on both feet(s)	9.41 ± 0.51	8.15 ± 0.29[b]	3.495	0.002	9.82 ± 0.61	8.91 ± 0.38[a]	2.414	0.023
15 m obstacle run(s)	6.88 ± 0.21	6.07 ± 0.14[c]	4.979	0.000	6.85 ± 0.17	6.50 ± 0.17[a]	2.144	0.041
Walk the balance beam(s)	13.64 ± 1.40	10.11 ± 0.40[b]	2.853	0.008	13.44 ± 0.61	13.31 ± 0.54	1.058	0.299

Note : Within-group differences.
[a] $p < 0.05$.
[b] $p < 0.01$.
[c] $p < 0.001$.

performed and the difference between ExG (29.57) and ConG (29.39) at 0W was not significant, and at 12W the ExG (40.82) was significantly higher than the ConG (30.86), the ExG and ConG were significantly higher at 12W than at 0W.The main effect of the Total gross motor score was significant (F = 39.434, p = 0.000, ES = −0.976). The main effect of time was significant (F = 396.343, p = 0.000, ES = −0.993) and the Total gross motor score interaction effect between time and group was significant (F = 192.409, p = 0.000, ES = 0.781). Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (61.68) and ConG (62.14) at 0W was not significant, and at 12W the ExG (78.46) was significantly higher than the ConG (65.14), the ExG and ConG were significantly higher at 12W than at 0W.

3.2. Comparative analysis of the subjects' physical fitness test results

Table 6:To ensure the pre-test levels of physical fitness in subjects in the ExG and ConG, we conducted an independent samples *t*-test and found no significant difference between the ExG and ConG (p > 0.05).After 12 weeks of exercise, we conducted paired samples t-tests on the pre-test and post-test results for the ExG and ConG subjects.It was found that the ExG differed significantly (p < 0. 01) in Grip strength, Stand long jump,Sit forward bend, Continuous jump on both feet,15 m obstacle run,Walk the balance beam.While the ConG differed significantly (p < 0.05) only in Continuous jump on both feet,15 m obstacle run and Stand long jump in pre-test and post-test.We found that the ExG subjects had more comprehensive physical fitness development than the ConG,but the difference between groups was not significant.This indicates that the flag rugby game courses played a more effective role in improving the physical fitness of subjects in the ExG.

Table 7: We performed 2 (Group: ExG,ConG) × 2 (Time: 0w,12w) repeated measures ANOVA on the subjects' physical fitness test results.The results showed that there was a non-significant main effect of group for the Grip strength (F = 1.034, p = 0.314, ES = 0.585), a significant main effect of time (F = 18.657, p = 0.000, ES = −0. 907), the results showed that the Grip strength interaction effect of time and group was significant(F = 5.030, p = 0.029, ES = 0.085).Due to the significant interaction effect, further simple effects analysis was performed and the difference between ExG (4.55) and ConG (4.65) at 0W was not significant, and at 12W the ExG (5.96) was significantly higher than ConG (5.10).The main effect of the Stand long jump was not significant (F = 0.423, p = 0.518, ES = 0.418), the main effect of time was significant (F = 18.430, p = 0.000, ES = −0.771) and the interaction effect between time and group was not significant (F = 3. 903, p = 0.053, ES = 0.067), the main effect of the Sit forward bend was not significant (F = 0.636, p = 0.429, ES = 0.492), the main effect of time was significant (F = 14.748, p = 0. 000, ES = −0.904) and the Sit forward bend interaction effect between time and group was significant (F = 6.957, p = 0.011, ES = 0.114).Due to the significant interaction effect, further simple effect analysis was performed and the difference between ExG (9.26) and ConG (9.90) at 0W was not significant, and at 12W the ExG (12.15) was significantly higher than ConG (10.43).The main effect of the Continuous jump on both feet was not significant (F = 0.960, p = 0.332, ES = −0.570), the main effect of time was significant (F = 17.318, p = 0.000, ES = 0.855) and the interaction effect between time and group was not significant (F = 0. 459, p = 0.501, ES = 0.008), the main effect of the 15 m obstacle run indicator group was not significant (F = 0.852, p = 0.360, ES = −0.546), the main effect of time was significant (F = 25. 535, p = 0.000, ES = −0.546) and the15 m obstacle run interaction effect between time and group was significant (F = 4.185, p = 0.046, ES = 0.072).Due to the significant interaction effect, further simple effect analysis was performed and the difference between the ExG (6.88) and ConG (6.85) at 0W was not significant and at 12W the ExG (6.07) was significantly higher than ConG (6.50),the ExG and ConG were significantly higher than 0W at 12W.The main effect of the Walk the balance beam was not significant (F = 2.224, p = 0.142, ES = −0.726), the main effect of time was significant (F = 8.651, p = 0.005, ES = 0.836) and the Walk the balance beam interaction effect between time and group was significant (F = 7.504, p = 0.008, ES = 0.122). Due to the significant interaction effect, further single

Table 7
Subjects' physical fitness 2 × 2 repeated measures ANOVA test.

Test Projects	ExG		ConG		Group		Time		Interaction	
	0W	12W	0W	12W	Main effect F-value (ES)	p	Main effect F-value (ES)	p	Interaction F-value (ES)	p
Grip strength(kg)	4.55 ± 0.34	5.96 ± 0.21[c]	4.65 ± 0.42	5.10 ± 0.18	1.034 (0.585)	0.314	18.657 (-0.907)	0.000	5.030 (0.085)	0.029
Stand long jump (cm)	76.57 ± 2.73	82.18 ± 1.59[b]	76.36 ± 2.26	78.43 ± 2.25[c]	0.423 (0.418)	0.518	18.430 (-0.771)	0.000	3.903 (0.067)	0.053
Sit forward bend (cm)	9.26 ± 0.88	12.15 ± 0.44[b]	9.90 ± 0.46	10.43 ± 0.37	0.636 (0.492)	0.429	14.748 (-0.904)	0.000	6.957 (0.114)	0.011
Continuous jump on both feet(s)	9.41 ± 0.51	8.15 ± 0.29[b]	9.82 ± 0.61	8.91 ± 0.38[a]	0.960 (-0.570)	0.332	17.318 (0.855)	0.000	0.459 (0.008)	0.501
15 m obstacle run (s)	6.88 ± 0.21	6.07 ± 0.14[c]	6.85 ± 0.17	6.50 ± 0.17[a]	0.852 (-0.546)	0.360	25.535 (-0.546)	0.000	4.185 (0.072)	0.046
Walk the balance beam(s)	13.64 ± 1.40	10.11 ± 0.40[b]	13.44 ± 0.61	13.31 ± 0.54	2.224 (-0.726)	0.142	8.651 (0.836)	0.005	7.504 (0.122)	0.008

Note : Within-group differences.
[a] p < 0.05.
[b] p < 0.01.
[c] p < 0.001.

Table 8
Comparative analysis of gross motor skills test results between the ExG and ConG subjects of different sexes.

Test Projects	ExG				ConG				Group		Gender		Time		Group[a]Gender		Group[a]Time		Gender[a]Time		Group[a]Gender[a]Time	
	0W		12W		0W		12W		Main effect F-value (ES)	p	Main effect F-value (ES)	p	Main effect F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls														
Run	6.83 ± 0.14	6.75 ± 0.18	7.50 ± 0.22	7.13 ± 0.19	6.92 ± 0.20	6.56 ± 0.18	7.08 ± 0.22	6.75 ± 0.19	1.991 (0.707)	0.164	0.077 (0.787)	0.059	8.572 (-0.868)	0.005	0.130 (0.002)	0.720	2.080 (0.038)	0.155	0.323 (0.006)	0.572	0.430 (0.008)	0.515
Gallop	5.25 ± 0.33	4.81 ± 0.29	6.08 ± 0.29	6.13 ± 0.25	5.83 ± 0.33	5.25 ± 0.29	6.00 ± 0.29	5.31 ± 0.25	0.014 (-0.082)	0.907	2.461 (0.743)	0.123	26.669 (-0.899)	0.000	0.678 (0.013)	0.414	17.369 (0.250)	0.000	0.665 (0.013)	0.419	1.609 (0.030)	0.210
Hop	5.33 ± 0.21	5.13 ± 0.18	6.17 ± 0.25	5.94 ± 0.22	5.42 ± 0.21	5.50 ± 0.18	5.92 ± 0.25	5.81 ± 0.22	0.016 (-0.085)	0.900	0.480 (-0.439)	0.492	19.056 (-0.943)	0.000	0.397 (0.008)	0.532	2.190 (0.040)	0.145	0.137 (0.003)	0.713	0.088 (0.002)	0.768
Skip	3.67 ± 0.35	4.44 ± 0.30	5.25 ± 0.30	5.50 ± 0.26	3.92 ± 0.35	3.69 ± 0.30	4.17 ± 0.30	4.06 ± 0.26	9.363 (0.907)	0.003	0.485 (-0.441)	0.489	22.216 (-0.938)	0.000	1.881 (0.035)	0.176	8.480 (0.140)	0.005	0.325 (0.006)	0.571	0.866(0.016)	0.356
Horizontal jump	5.58 ± 0.39	5.06 ± 0.34	6.25 ± 0.35	6.50 ± 0.30	5.50 ± 0.39	5.69 ± 0.34	5.83 ± 0.35	5.81 ± 0.30	0.185 (0.292)	0.669	0.006 (0.056)	0.937	35.453 (-0.881)	0.000	0.112 (0.002)	0.739	14.625 (0.220)	0.000	1.708 (0.032)	0.197	5.177(0.091)	0.027
slide	5.67 ± 0.22	5.75 ± 0.19	6.33 ± 0.32	6.50 ± 0.28	5.58 ± 0.22	5.94 ± 0.19	6.08 ± 0.32	6.06 ± 0.28	0.634 (0.336)	0.429	0.634 (-0.492)	0.429	8.041 (-0.894)	0.006	0.013 (0.000)	0.910	1.209 (0.023)	0.277	0.164 (0.003)	0.687	0.405(0.008)	0.527
Total locomotor subject score	32.33 ± 0.85	31.94 ± 0.73	37.58 ± 0.87	37.69 ± 0.76	32.92 ± 0.85	32.63 ± 0.73	34.92 ± 0.87	33.81 ± 0.76	3.220 (0.785)	0.079	0.330 (0.376)	0.568	115.879 (-0.975)	0.000	0.141 (0.003)	0.709	35.138 (0.403)	0.000	0.056 (0.001)	0.814	0.992(0.019)	0.324
Two hand catch	4.33 ± 0.37[a]	4.19 ± 0.32	5.33 ± 0.26	5.38 ± 0.23	4.17 ± 0.37	4.44 ± 0.32	4.25 ± 0.26	4.50 ± 0.23	3.223 (0.784)	0.078	0.159 (-0.271)	0.692	15.098 (-0.889)	0.000	0.358 (0.007)	0.552	11.559 (0.182)	0.001	0.077 (0.001)	0.782	0.120(0.002)	0.730
One hand stationary dribble	5.50 ± 0.26	5.00 ± 0.23	6.75 ± 0.28[b]	6.44 ± 0.24	5.33 ± 0.26	5.19 ± 0.23	5.58 ± 0.28	5.25 ± 0.24	9.420 (0.909)	0.003	2.887 (0.769)	0.095	20.738 (-0.948)	0.000	0.192 (0.004)	0.663	12.997 (0.200)	0.001	0.000 (0.000)	1.000	0.324(0.006)	0.572
Overhand throw	4.08 ± 0.28	4.38 ± 0.25	5.92 ± 0.25	5.75 ± 0.22	4.33 ± 0.28	3.75 ± 0.25	4.58 ± 0.25	4.13 ± 0.22	14.521 (-0.948)	0.000	1.098 (0.596)	0.300	63.255 (-0.968)	0.000	1.779 (0.033)	0.188	28.728 (0.356)	0.000	0.478 (0.009)	0.492	1.465(0.027)	0.232
Underhand throw	4.33 ± 0.35	3.94 ± 0.30	6.25 ± 0.25	5.94 ± 0.22	4.25 ± 0.35	4.63 ± 0.30	4.92 ± 0.25	4.63 ± 0.22	4.724 (0.839)	0.034	0.443 (0.427)	0.509	50.898 (-0.971)	0.000	0.710 (0.013)	0.403	25.592 (0.330)	0.000	0.824 (0.016)	0.368	1.363(0.026)	0.248

(*continued on next page*)

Table 8 (*continued*)

Test Projects	ExG				ConG				Group		Gender		Time		Group*Gender		Group*Time		Gender*Time		Group*Gender*Time	
	0W		12W		0W		12W		Main effect F-value (ES)	p	Main effect F-value (ES)	p	Main effect F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls														
Two hand strike of a stationary ball	4.75 ± 0.37	4.31 ± 0.32	5.50 ± 0.32	5.13 ± 0.28	4.67 ± 0.37	4.06 ± 0.32	4.83 ± 0.32	4.06 ± 0.28	2.975 (0.774)	0.091	3.346 (0.791)	0.073	13.899 (-0.803)	0.000	0.244 (0.005)	0.623	9.057 (0.148)	0.004	0.050 (0.001)	0.823	0.244(0.005)	0.623
Forehand strike of self-bounced	3.42 ± 0.25	3.44 ± 0.22	5.42 ± 0.39	5.19 ± 0.34	3.50 ± 0.25	3.19 ± 0.22	3.83 ± 0.39	3.44 ± 0.34	13.331 (0.923)	0.001	0.914 (0.560)	0.343	32.609 (-0.963)	0.000	0.272 (0.005)	0.604	17.414 (0.251)	0.000	0.193 (0.004)	0.662	0.048 (0.001)	0.827
Kick a stationary ball	3.92 ± 0.29	3.75 ± 0.25	6.50 ± 0.20	6.38 ± 0.18	3.75 ± 0.29	3.69 ± 0.25	4.08 ± 0.20	4.00 ± 0.18	50.065 (0.981)	0.000	0.380 (0.402)	0.540	88.847 (-0.987)	0.000	0.042 (0.001)	0.838	53.966 (0.509)	0.000	0.001 (0.000)	0.973	0.010 (0.000)	0.920
Total object control subject score	30.33 ± 0.86	29.00 ± 0.75	41.67 ± 0.74[c]	40.19 ± 0.64[c]	30.00 ± 0.86	28.84 ± 0.75	32.00 ± 0.74	30.00 ± 0.64	61.779 (0.984)	0.000	5.200 (0.850)	0.027	268.84 (-0.993)	0.000	0.009 (0.000)	0.923	155.52 (0.749)	0.000	0.482 (0.009)	0.491	0.257 (0.005)	0.614
Total gross motor score	62.67 ± 1.31	60.94 ± 1.14	79.25 ± 1.11	77.88 ± 0.96	62.92 ± 1.31[a]	61.56 ± 1.14	66.92 ± 1.11[a]	63.81 ± 0.96	39.140 (0.975)	0.000	3.437 (0.795)	0.069	389.04 (-0.994)	0.000	0.110 (0.002)	0.741	182.92 (0.779)	0.000	0.479 (0.009)	0.492	1.089 (0.021)	0.302

Note：Within-group differences.
Differences between groups.
[a] $p < 0.05$.
[b] $p < 0.01$.
[c] $p < 0.05$.

Table 9
Comparative analysis of physical fitness test results of subjects of different sexes in the ExG and ConG.

Test Projects	ExG				ConG				Group		Gender		Time		Group[a]Gender		Group[a]Time		Gender[a]Time		Group[a]Gender[a]Time	
	0W		12W		0W		12W		Main effect F-value (ES)	p	Main effect F-value (ES)	p	Main effect F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p	Interaction F-value (ES)	p
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls														
Grip strength	5.10 ± 0.58[c]	4.13 ± 0.51	6.59 ± 0.27[b, c]	5.48 ± 0.23	5.02 ± 0.58[c]	4.38 ± 0.51	5.57 ± 0.27[c]	4.74 ± 0.23	1.220 (0.616)	0.274	5.971 (0.866)	0.018	18.086 (-0.911)	0.000	0.180 (0.003)	0.673	4.729 (0.083)	0.034	0.133 (0.003)	0.716	0.002(0.000)	0.964
Stand long jump	79.33 ± 3.84	74.50 ± 3.32	86.08 ± 2.90	79.25 ± 2.51	79.00 ± 3.84	74.38 ± 3.32	81.42 ± 2.90	76.19 ± 2.51	0.451 (0.429)	0.505	3.119 (0.781)	0.083	18.466 (-0.777)	0.000	0.022 (0.000)	0.882	3.946 (0.071)	0.052	0.506 (0.010)	0.480	0.145(0.003)	0.704
Sit forward bend	8.25 ± 1.07	10.02 ± 0.93[c]	11.03 ± 0.57	12.99 ± 0.49[c]	9.43 ± 1.07	10.25 ± 0.93[c]	9.39 ± 0.57	11.21 ± 0.49[c]	0.557 (-0.777)	0.451	5.854 (-0.863)	0.019	13.387 (-0.901)	0.001	0.170 (0.003)	0.682	6.969 (0.118)	0.011	0.425 (0.008)	0.517	0.193(0.004)	0.662
Continuous jump on both feet	9.48 ± 0.88	9.36 ± 0.76	7.62 ± 0.52	8.54 ± 0.45	10.12 ± 0.88	9.60 ± 0.76	8.73 ± 0.52[a]	9.06 ± 0.45	1.022 (-0.581)	0.317	0.063 (-0.175)	0.803	19.623 (0.864)	0.000	0.161 (0.003)	0.690	0.498 (0.009)	0.483	3.311 (0.060)	0.075	0.037(0.001)	0.849
15 m obstacle run	6.60 ± 0.29	7.08 ± 0.25	5.97 ± 0.24[c]	6.14 ± 0.20[c]	6.51 ± 0.29	6.20 ± 0.24	7.10 ± 0.25	6.73 ± 0.20	0.737 (-0.519)	0.395	4.230 (-0.824)	0.045	23.403 (0.916)	0.000	0.286 (0.005)	0.595	3.720 (0.067)	0.059	0.616 (0.012)	0.436	0.276(0.005)	0.602
Walk the balance beam	13.73 ± 1.69	13.57 ± 1.46	10.63 ± 0.73	9.71 ± 0.64	13.49 ± 1.69	13.45 ± 0.73	13.40 ± 1.46	13.21 ± 0.64	2.029 (-0.710)	0.160	0.116 (0.234)	0.735	7.903 (0.828)	0.007	0.033 (0.001)	0.856	6.921 (0.117)	0.011	0.126 (0.002)	0.725	0.058(0.001)	0.810

Note：Within-group differences.
Differences between groups.
[a] $p < 0.05$.
[b] $p < 0.01$.
[c] $p < 0.05$.

effect analysis was performed and the difference between the ExG (13.64) and ConG (13.44) at 0W was not significant, and at 12W the ExG (10.11) was significantly higher than the ConG (13.31),the ExG was significantly higher than 0W at 12W.

3.3. Comparative analysis of gross motor skills test results between the ExG and ConG subjects of different sexes

Table 8:We performed a (Group: ExG, ConG) × (Gender: Boys, Girls) × (Time: 0w, 12w) repeated measures ANOVA on the gross motor skills test index scores.It was found that after 12 weeks of exercise, there were significant differences in the results of the Two hand catch, One hand stationary dribble, Total gross motor score and Total object control subject score tests between children of different genders($p < 0.05$).The group main effect of the Run was not significant($F = 1.991, p = 0.164, ES = 0.707$).The main effect of gender was not significant($F = 0.077, p = 0.059, ES = 0.787$),the time main effect was significant($F = 8.572, p = 0.005, ES = -0.868$). The group and gender interaction was not significant($F = 0.130, p = 0.720, ES = 0.002$),the group by time interaction was not significant($F = 2.080, p = 0.155, ES = 0.038$),the gender by time interaction was not significant($F = 0.323, p = 0.572, ES = 0.006$),the group*gender*time interaction was not significant($F = 0.430, p = 0.515, ES = 0.008$).The group main effect of the Gallop was not significant($F = 0.014, p = 0.907, ES = -0.082$),the main effect of gender was not significant($F = 2.461, p = 0.123, ES = 0.743$),the main effect of time was significant($F = 26.669, p = 0.000, ES = -0.899$),the interaction of group and gender was not significant($F = 0.678, p = 0.414, ES = 0.013$),the interaction of group and time was significant($F = 17.369, p = 0.000, ES = 0.250$),the interaction between gender and time was not significant($F = 0.665, p = 0.419, ES = 0.013$),the group*gender*time interaction was not significant($F = 1.609, p = 0.210, ES = 0.030$).The group main effect of the Hop was not significant($F = 0.016, p = 0.900, ES = -0.085$),the main effect of gender was not significant($F = 0.480, p = 0.492, ES = -0.439$),the time main effect was significant($F = 19.056, p = 0.000, ES = -0.943$),the interaction between group and gender was not significant($F = 0.397, p = 0.532, ES = 0.008$),the interaction between group and time was not significant($F = 2.190, p = 0.145, ES = 0.040$),the interaction between gender and time was not significant($F = 0.p137, p = 0.713, ES = 0.003$),the group*gender*time interaction was not significant($F = 0.088, p = 0.768, ES = 0.002$).The group main effect of the Skip was significant($F = 9.363, p = 0.003, ES = 0.907$),the main effect of gender was not significant($F = 0.485, p = 0.489, ES = -0.441$),the main effect of time was significant($F = 22.216, p = 0.000, ES = -0.938$),the interaction of group and gender was not significant($F = 1.881, p = 0.176, ES = 0.035$),the interaction of group and time was significant($F = 8.480, p = 0.005, ES = 0.140$),the gender and time interaction was not significant($F = 0.325, p = 0.571, ES = 0.006$),the group*gender*time interaction was not significant($F = 0.866, p = 0.356, ES = 0.016$).The group main effect of the Horizontal jump was not significant($F = 0.185, p = 0.669, ES = 0.292$),the main effect of gender was not significant($F = 0.006, p = 0.937, ES = 0.056$),the main effect of time was significant($F = 35.435, p = 0.000, ES = -0.881$),the interaction of group and gender was not significant($F = 0.112, p = 0.739, ES = 0.002$),the group and time interaction was significant($F = 14.625, p = 0.000, ES = 0.220$),the gender and time interaction was not significant($F = 1.708, p = 0.197, ES = 0.032$),he group*gender*time interaction was significant($F = 5.177, p = 0.027, ES = 0.091$).The main effect of group on the Slide was not significant($F = 0.634, p = 0.429, ES = 0.336$),the main effect of gender was not significant($F = 0.634, p = 0.429, ES = -0.492$),the main effect of time was significant($F = 8.041, p = 0.006, ES = -0.894$),the interactions of group and gender were not significant($F = 0.013, p = 0.910, ES = 0.000$),the interaction of group and time was not significant($F = 1.209, p = 0.277, ES = 0.023$), the gender and time interaction was not significant($F = 0.164, p = 0.678, ES = 0.003$),the group*gender*time interaction was not significant($F = 0.405, p = 0.527, ES = 0.008$). The group main effect of the Total locomotor score was not significant($F = 3.220, p = 0.079, ES = 0.785$),the main effect of gender was not significant($F = 0.330, p = 0.568, ES = 0.376$),the time main effect was significant ($F = 115.879, P = 0.000, ES = -0.975$),the group and gender interactions were not significant($F = 0.141, p = 0.709, ES = 0.003$),the group and time interaction was significant($F = 35.138, p = 0.000, ES = 0.403$),the gender and time interaction was not significant($F = 0.056, P = 0.814, ES = 0.001$),the group*gender*time interaction was not significant($F = 0.992, p = 0.324, ES = 0.019$).The group main effect of the Two hand catch was not significant($F = 3.223, p = 0.078, ES = 0.784$),the main effect of gender was not significant($F = 0.159, p = 0.692, ES = -0.271$),the main effect of time was significant($F = 15.089, p = 0.000, ES = -0.889$),the interaction of group and gender was not significant($F = 0.358, p = 0.552, ES = 0.007$),the interaction of group and time was significant($F = 11.559, p = 0.001, ES = 0.182$),the gender and time interaction was not significant($F = 0.077, p = 0.782, ES = 0.001$),the group*gender*time interaction was not significant($F = 0.120, p = 0.730, ES = 0.002$).The group main effect of the One handed stationary dribble was significant($F = 9.420, p = 0.003, ES = 0.909$),the main effect of gender was not significant($F = 2.887, p = 0.095, ES = 0.769$),the time main effect was significant($F = 20.738, P = 0.000, ES = -0.948$),the interaction between group and gender was not significant($F = 0.192, p = 0.663, ES = 0.004$),the interaction between group and time was significant($F = 12.997, p = 0.001, ES = 0.200$),the interaction between gender and time was not significant($F = 0.000, p = 1.000, ES = 0.000$),the group*gender*time interaction was not significant($F = 0.324, p = 0.572, ES = 0.006$).The group main effect of the Overhand throw was significant($F = 14.521, p = 0.000, ES = -0.948$),the main effect of gender was not significant($F = 1.098, p = 0.300, ES = 0.596$),the time main effect was significant($F = 63.255, p = 0.000, ES = -0.968$), the group and gender interaction was not significant($F = 1.779, p = 0.188, ES = 0.033$),the group and time interaction was significant ($F = 28.728, p = 0.000, ES = 0.356$),the gender and time interaction was not significant($F = 0.478, p = 0.492, ES = 0.009$),the group*gender*time interaction was not significant($F = 1.465, p = 0.232, ES = 0.027$).The group main effect of the Underhand throw was significant($F = 4.724, p = 0.034, ES = 0.839$),the main effect of gender was not significant($F = 0.443, p = 0.509, ES = 0.427$),the time main effect was significant($F = 50.898, p = 0.000, ES = -0.971$),the interaction between group and gender was not significant($F = 0.710, p = 0.403, ES = 0.013$),the interaction between group and time was significant($F = 25.592, p = 0.000, ES = 0.330$),the interaction between gender and time was not significant($F = 0.824, p = 0.368, ES = 0.016$),the group*gender*time interaction was not significant($F = 1.363, p = 0.248, ES = 0.026$).The group main effect of the Two hand striking of a stationary ball was not significant($F = 2.975, p = 0.091, ES = 0.774$),the main effect of gender was not significant($F = 3.346, P = 0.073, ES = 0.791$),the main effect of time was significant($F = 13.899, p = 0.000, ES = -0.803$),the interaction of group and gender was not significant($F = 0.244, p = 0.623, ES =$

0.005),the interaction of group and time was significant(F = 9.057,P = 0.004,ES = 0.148),the interaction of gender and time was not significant(F = 0.050,p = 0.823,ES = 0.001),the group*gender*time interaction was not significant(F = 0.244,p = 0.623,ES = 0.005). The group main effect of the Forehand stroke of self-bounce was significant(F = 13. 331,p = 0.001,ES = 0.923),the main effect of gender was not significant(F = 0.914,p = 0.343,ES = 0.560),the main effect of time was significant(F = 32.609,p = 0.000,ES = −0.963),the interactions between group and gender were not significant(F = 0.272,p = 0.604,ES = 0.005),the interaction between group and time was significant(F = 17.414,p = 0.000,ES = 0.251),the interaction between gender and time was not significant(F = 0. 193,p = 0.662,ES = 0.004),the group*gender*time interaction was not significant(F = 0.048,p = 0.827,ES = 0.001).The group main effect of the Kicking a stationary ball was significant(F = 50.065,p = 0.000,ES = 0.981),the main effect of gender was not significant(F = 0.380,p = 0.540,ES = 0.402),the main effect of time was significant(F = 88.847,p = 0.000,ES = −0.987),the group and gender interactions were not significant(F = 0.042,p = 0.838,ES = 0. 001),the Group and time interaction was significant(F = 53.966,p = 0.000,ES = 0.509),the gender and time interaction was not significant(F = 0.001,p = 0.973,ES = 0.000),the group*gender*time interaction was not significant(F = 0. 010,p = 0.920,ES = 0.000).The group main effect of the Total object control subject score was significant(F = 61.779,p = 0.000,ES = 0.984),the main effect of gender was significant(F = 5.200,p = 0.027,ES = 0.850),the main effect of time was significant(F = 268.84,p = 0.000,ES = −0.993),the interactions of group and gender were not significant(F = 0.009, p = 0.923,ES = 0.000),the interaction of group and time was significant(F = 155.52,p = 0.000,ES = 0.749),the gender and time interaction was not significant(F = 0.482,p = 0.491,ES = 0.009),the group*gender*time interaction was not significant(F = 0.257,p = 0.614,ES = 0.005).The group main effect of the Total gross motor score was significant(F = 39.140,p = 0.000,ES = 0.975),the main effect of gender was not significant(F = 3.437,p = 0.069,ES = 0.795),the time main effect was significant(F = 389. 04,p = 0.000,ES = −0.994),the interaction between group and gender was not significant(F = 0.110,p = 0.741,ES = 0.002),the interaction between group and time was significant(F = 182.92,p = 0.000,ES = 0.779),the interaction between gender and time was not significant(F = 0.479,p = 0.492,ES = 0.009),the group*gender*time interaction was not significant(F = 1.089,p = 0.302,ES = 0.021).We observed that boys in the 0W the ExG outperformed girls in the Two hand catch test results, boys in the 12W the ExG outperformed girls in the One hand stationary dribble test results, and boys and girls in the 12W the ExG outperformed in the Total object control subject score test results.Boys in the 0W and 12W the ConG significantly outperformed girls in Total gross motor score test results, confirming the existence of gender differences in Total object control stills.

3.4. Comparative analysis of physical fitness test results of subjects of different sexes in the ExG and ConG

Table 9 : We performed a (Group: ExG, ConG) × (Gender: Boys, Girls) × (Time: 0w, 12w) repeated measures ANOVA on physical fitness test index.It was found that after 12 weeks of exercise, children of different gender was significant(P < 0.05) in the results of the Grip strength, Sit forward bending, and 15 m obstacle run tests.The group main effect of the Grip strength was not significant(F = 1.220,p = 0.274,ES = 0. 616),the main effect of grip strength gender was significant(F = 5.971,p = 0.018,ES = 0.866),the main effect of time was significant(F = 18.086,p = 0.000,ES = −0.911),the group and gender interactions were not significant(F = 0.180,p = 0.673,ES = 0. 003),the group and time interaction was significant(F = 4.729,p = 0.034,ES = 0.083),the gender and time interaction was not significant(F = 0.133,p = 0.716,ES = 0.003),the group*gender*time interaction was not significant(F = 0.002,p = 0. 964,ES = 0.000).The group main effect of the Stand long jump was not significant(F = 0.451,p = 0.505,ES = 0.429),the main effect of gender was not significant(F = 3.119,p = 0.083,ES = 0.781),the time main effect was significant(F = 18.466,p = 0. 000,ES = −0.777),the interaction between group and gender was not significant(F = 0.022,p = 0.882,ES = 0.000),the interaction between group and time was not significant(F = 3.946,p = 0.052,ES = 0.071),the interaction between gender and time was not significant(F = 0. 506,p = 0.480,ES = 0.010),the group*gender*time interaction was not significant(F = 0.145,p = 0.704,ES = 0.003).The group main effect of the Sit forward bend was not significant(F = 0.557,p = 0.451,ES = −0.777),the main effect of sit forward bend gender was significant (F = 5.854,p = 0.019,ES = −0.863),the main effect of time was significant(F = 13.387,p = 0.001,ES = −0.901),the interactions of group and gender were not significant(F = 0.170,p = 0.682,ES = 0.003),the interaction of group and time was significant(F = 6.969,p = 0.011,ES = 0.118),the interaction of gender and time was not significant(F = 0.425,p = 0.517,ES = 0.008),the group*gender*time interaction was not significant(F = 0.193,p = 0.662,ES = 0.004).The main effect of group of the Continuous jump on both feet was not significant(F = 1.022,p = 0.317,ES = −0.581),the main effect of gender was not significant(F = 0.063,p = 0.803,ES = −0.175),the main effect of time was significant(F = 19.623,p = 0.000,ES = 0.864),the interactions of group and gender were not significant(F = 0.161,p = 0.690,ES = 0.003),the group and time interaction was not significant(F = 0.498,P = 0.483,ES = 0.009),the gender and time interaction was not significant(F = 3.311,p = 0.075,ES = 0.060),the group*gender*time interaction was not significant(F = 0.037,p = 0.849,ES = 0.001).The group main effect of the 15 m obstacle run was not significant(F = 0.737,p = 0.395,ES = −0.519),the main effect of 15 m obstacle running gender was significant(F = 4.230,P = 0.045,ES = −0.824),the time main effect was significant(F = 23.403,p = 0.000,ES = 0.916),the group and gender interactions were not significant(F = 0. 286,p = 0.595,ES = 0.005),the group and time interaction was not significant(F = 3.720,p = 0.059,ES = 0.067),the gender and time interaction was not significant(F = 0.616,p = 0.436,ES = 0. 012),the group*gender*time interaction was not significant(F = 0.276,p = 0.602,ES = 0.005).The group main effect of the Walk balance beam was not significant(F = 2.029,p = 0.160,ES = −0.710),the main effect of gender was not significant(F = 0.116, p = 0.735,ES = 0.234),the main effect of time was significant(F = 7.905,p = 0.007,ES = 0.828),the interactions of group and gender were not significant(F = 0.033,P = 0.856,ES = 0.001),the group and time interaction was significant(F = 6.921,p = 0.011,ES = 0.117), the gender and time interaction was not significant(F = 0.126,p = 0.725,ES = 0.002),the group*gender*time interaction was not significant(F = 0.058,p = 0.810,ES = 0.001).Both 0W and 12W the ExG and ConG boys outperformed girls in Grip strength test results, 12W the ExG outperformed the ConG in 15 m obstacle run test results, and both 0W and 12W the ExG and ConG girls outperformed boys in Sit forward bend test results.

From the results of the study, we found that the ExG of 5–6 year old preschoolers had significantly better gross motor skills than the ConG, whereas there was no significant group difference between the ExG and ConG in the results of the physical fitness test.In addition, we found gender differences in gross motor and physical fitness test results among 5–6 year old preschoolers, and these interesting findings warrant further analysis.

4. Discussion

A.Capelle.et al. [20]concluded that physical activity interventions improve basic motor skills in preschool children.Currently, intervention methods regarding gross motor skills in preschool children are contained four categories: ①Rhythmic activities (Aerobics, Cheer-leading, Rhythmic gymnastics, etc.); ②Sports games (Traditional sports games, Ball games, etc.); ③Sports programs (Mini-s-occer, Mini-basketball, Fun athletic, Soft volleyball, etc.); ④Functional exercises (Basic movement exercises, Physical fitness exercises) [21,22].Research on rugby has focused on the risk and probability of sports injuries in young children [4,23–25], physical fitness [26–28], physical and mental health [27], and tactical strategy execution rate [29], and there are no empirical studies on flag rugby and the development of gross motor skills in preschoolers for the time being.A.Fisher.et al. [30] concluded that motor-specific skill interventions are more effective in improving young children's gross motor than recreational free play.10 weeks of fun athletic can significantly improve Locomotor subject skills, but insignificant differences for One hand stationary dribble and Kick a stationary ball, fun athletic can effectively promote preschool children's gross motor skills, but showed uneven characteristics of motor gross skills [31].Mini-basketball activity improved One hand stationary dribble, Underhand throw and Forehand strike of self-bounced in both boys and girls, there was no significant difference in improving Kick a stationary ball [32].12 weeks of soccer game instruction to promote 5–6 year old in One-handed stationary dribble, Two-handed strike of a stationary ball, and Forehand strike of self-bounce were not significant [33].After 12 weeks of soft volleyball game instruction, there were significant differences in gross motor skills among 5–6 year old, but non-significant differences in kicking a stationary ball test items [34].A García.et al. [10] concluded that physical activity facilitates small improvements in lower limb strength and speed agility in preschoolers, and suggesting that physical activity should focus on high intensity on the development of gross motor skills in future.

After 12 weeks of exercise, we observe from Table 4: the ExG outperforms the ConG only in the Skip test results, because Locomotor subject skills mainly include basic mobility skills such as Run, Gallop, Slide, etc., which are also commonly found in the ConG curriculum and belong to the same content in both the ExG and ConG curricula, so the difference between the ExG and ConG in the Total locomotor subject score test results is not significant.We also found that the ExG in One hand stationary dribble, Overhand throw, Underhand throw, Forehand strike of self-bounced, Kick a stationary ball, Total object control subject score, and Total gross motor score were significantly ($p < 0.05$) better than the ConG.On the one hand, because Object control subject skills are composite motor skills that require hand-eye, foot-eye, spatial perception, and body control to work together , and the flag rugby games programme focuses on compound motor skills during snaps, offense, defense, and touchdowns, which enriches the preschooler's movement patterns with greater gross motor involvement compared to the regular program.On the other hand, we believe that the movement techniques of the flag rugby games programme in catching, passing, throwing, and kicking are compatible with the review form of Object control skills, and the movement techniques in running, dodging, changing direction, crossing, and jumping are compatible with the perception of body displacement and the balance control mechanism, which is a result of the combination of the internal mechanism of motor skills and the external form.

In comparison to previous studies , the comprehensive nature of the flag rugby games programme compensates for the under-developed motor skills of Kicking a stationary ball in basketball, One hand stationary dribble,Two hand hit a stationary ball and Forehand hit a self-bounced ball in soccer, and Kick a stationary ball and Two hand hit a stationary ball in volleyball, consistent with the idea that moderate and vigorous-intensity physical activity is significantly associated with total motor skill score in preschoolers [30], validating the idea of D.Jones.et al. [35] that there is a positive relationship between Total gross motor score, Object control subject skills, and moderate and vigorous-intensity physical activity in preschoolers.

While the flag rugby game programs does a good job of making up for the shortcomings of other sports intervention programs in promoting gross motor skills in preschoolers.However, we observe from Table 8: there is a gender difference in the test results of the Two hand catch, One hand stationary dribble, Total object control subject score, Total object control still, and Total gross motor score among the subjects.Because physical fitness levels are usually much lower in girls than in boys from preschool onwards [36], and the intervention effect of ball games was better in boys than in girls [37], in line with the view of gender differences shown during in-campus activities in preschoolers aged 5–6 years [38], which is similar to the results of the study by J.Piek.et al. [39], but differs from the view of L.Donath.et al. [40].

Studies have shown that physical fitness is the foundation and prerequisite for physical activity in children and adolescents [41], and children's physical fitness is influenced by age [42,43], gender [44], and growing environment [45].Currently, experimental intervention studies on children's physical fitness include fun athletic [46], sports games [9,12], dynamic and static balance [47], push-ups and pull-ups [48], and flag football [26,27].It can be determined that there are significant differences in physical fitness development of children between different motor intervention contents, intervention programs and frequency of interventions, and the game-based motor interventions are the most preferred and most effective.F.BÜRGI.et al. [49,50] concluded that rich motor skills contribute to children's physical development.

After 12 weeks of practice, we observed from Table 6 that the ExG subjects showed significant differences in physical fitness test results ($p < 0.01$), while the ConG subjects showed significant differences only in Stand long jump, Continuous jump on both feet, and 15 m obstacle run test results ($p < 0.05$). Because the flag rugby game programme integrates the characteristics of soccer, basketball, volleyball and other sports, integrating speed and skill, attacking through passing and receiving, running, dodging, jumping and other

actions, and defending using blocking, chasing, flag pulling and other actions, which have a greater impact on the muscles and bones [5].In addition, due to the flag rugby game curriculum for preschool children is a new thing, it has a strong fun, systematic and comprehensive characteristics, in the intense offense and defense process more than the conventional curriculum content to mobilize their participation in the enthusiasm, comprehensively improve the level of children's gross motor participation, thus effectively promoting the development of children's muscular endurance, speed qualities, in line with the views of J.Zhuang.et al. [26].The difference between the ExG and ConG in physical fitness test results was not significant ($p > 0.05$), which is consistent with the idea that there is a significant difference in the development of physical fitness in children across different exercise intervention components and programs.

Although the flag rugby games program promotes the development of children's physical fitness in a holistic manner.However, we observed from Table 9: the subjects had significant ($p < 0.05$) gender differences in Grip strength, 15 m obstacle run test results.This may be related to the irregular shape of rugby, high frequency of running with the ball, throwing and catching and crossing the ball, which requires gripping, passing and throwing during the attacking process in order to score points, whereas boys were more actively involved in the attacking process during the sessions such that they outperformed the girls in the Grip strength, 15 m obstacle run test results.Both 0W and 12W girls outperformed boys in Sitting forward bending test results ($p < 0.05$).Because this gender difference is influenced by the physical and physiological characteristics of children, which is in line with the conclusions of the characterization of the differences in physical fitness of children of different genders [12].It was demonstrated that there were innate gender differences between boys and girls in Grip strength, Sit forward bend, a finding that is consistent with that of grip strength and flexibility qualities in a study of physical fitness of children with different BMI in a 10-week flag football program intervention [27].

5. Conclusion

This study is the first to review and confirm that a 12-week the flag rugby game program has an overall facilitating effect on gross motor skills and physical fitness in preschoolers, and it is recommended that the flag rugby game programs be promoted in physical activity programs for preschoolers.Because the flag rugby game program shows some gender differences in the development of gross motor skills and physical fitness in preschoolers, it is recommended that teaching and learning activities be implemented in a targeted manner during the promotion process.In addition, since only one urban kindergarten was selected for this study, the sample size was small and did not involve younger children under 5 years of age, and no differentiation study was implemented to differentiate between children's growing environments (rural and urban), the present results may not be applicable to all preschool-age children.It is recommended that future in-depth research be conducted on flag rugby game programs from the perspectives of physical activity, motor skills, and exercise intensity, taking into account influences such as preschool children's growth environments, teaching resources, and age structure.

Data availability statement

The data will be available on request.

Ethics declarations

This study was reviewed and approved by the Ethics Review Committee of Chongqing Preschool Education College, with the approval number:CPEC[2022]255.All participants legal guardians provided informed consent to participate in the study.

CRediT authorship contribution statement

Zuozheng Shi: Writing – original draft, Funding acquisition. **Xulin Yang:** Project administration, Investigation. **Xinru Zhang:** Formal analysis, Data curation. **Weihua Zhu:** Writing – review & editing, Project administration. **Yuxin Dai:** Project administration, Investigation. **Jian Li:** Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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