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ORIGINAL ARTICLE

Effects of rhythmic-based exercise program in children

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Abstract

Physical fitness (PF) is an exceptional indicator of health in childhood and prevents chronic conditions in adulthood. Various exercise modalities have been studied for their impact on children's PF, but rhythmic-based exercises have received less attention. Hence, we structured the rhythmic-based exercise program to provide an approach to developing children's PF over ten months. The non-randomized pre-post-controlled 2x2 design included 154 children (REG, rhythmic-based exercise group, n=75, CG, control group, n=79). We assessed PF performance using the modified 20 m shuttle run test, the standing long jump, the 30-second sit-up test, and the sit-and-reach test before and after 10 months of rhythmic-based exercise program. The 2x2 mixed ANCOVA showed that all PF test performances improved significantly more in REG than in CG from a small (Standing long jump for 3%), across medium (Sit-ups for the 30s for 12%), to a large extent (Modified 20 m shuttle run test for 14% and Sit and reach for 23.1%). The rhythmic-based exercise program provoked extensive flexibility and overall muscular and cardiorespiratory fitness developments. Further randomized controlled trials should be conducted to support or contrast our results.

Keywords: children · exercise · rhytmic

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Introduction

Physical exercise has been widely recognized as a powerful instrument to improve cardiorespiratory health, muscle and bone strength, and weight management in children (Zhou et al., 2024). It also fosters social interaction and boosts self-esteem and confidence (Zamani Sani et al., 2016). Regular physical activity has been shown reduce the risk of heart disease later in life (García-Hermoso et al., 2020; Zhou et al., 2024). It also helps maintain a healthy weight by balancing calorie intake with energy expenditure, thereby reducing the risk of childhood obesity, a condition linked to various health issues like diabetes and hypertension (García-Hermoso et al., 2020). Physical activity supports brain development and improves cognitive functions, including better memory, attention, and problem-solving skills (Latino & Tafuri, 2024). Children engaged in regular physical activity tend to perform better academically, likely due to improved concentration, memory, and classroom behavior (Trudeau & Shephard, 2008).

One of the most significant benefits of regular physical activity in childhood is its role in preventing chronic conditions in adulthood. Research has consistently shown that active children are more likely to continue leading an active lifestyle into adulthood, contributing to long-term health and well-being (Moreno-Gonzalez et al., 2024; Ortega et al., 2008). By engaging in regular physical activity during childhood, individuals can significantly reduce their risk of developing chronic conditions such as type 2 diabetes, hypertension, and certain types of cancer in adulthood (Moreno-Gonzalez et al., 2024; Ortega et al., 2008). Hence, researchers showed that physical fitness (PF) is an exceptional indicator of health (Ortega et al., 2008). Exercise plays a critical role in developing and enhancing the various components of PF in children, such as flexibility, cardiorespiratory (CRF) (Zhou et al., 2024), and muscular fitness (Faigenbaum, 2000). The improvements contribute significantly to their physical health and overall growth and development, setting a solid foundation for a healthy and active lifestyle. This reassures us of the effectiveness of the exercise program in promoting children's health and well-being; hence, early childhood is considered an ideal age period for PF development.

Researchers have been widely investigating the effects of different exercise activities on PF components in children, such as ball games and multisport activities (Chen et al., 2018; García-Hermoso et al., 2020; Wang et al., 2023). Various authors found greater PF improvements in exercise groups compared to physically inactive control peers while inconsistently observing small to large effects (García-Hermoso et al., 2020; Wang et al., 2023; Zhou et al., 2024). Rhythm activities, however, have been less investigated, even though rhythm activities for children can be a fun and effective way to promote PF and motor skills. Studies show that rhythmic exercise programs promote PF, enhance coordination and motor skills, and, most importantly, encourage social interaction and boost self-esteem and confidence in children (Vazou et al., 2020). However, to the authors' knowledge, no study explored the 10-month effect of the rhythmic exercise program on PF components; hence, this study aimed to evaluate the impact of the rhythmic exercise program on PF components after ten months.

Method

Study design and protocol

The study is a non-randomized pre-post-controlled design (2 arms x 2 times). One arm was the experimental protocol, Rhythmic-based Exercise Program (REG, rhythmic exercise group); the other arm was control peers who had no participation in any organized exercise program (CG, control group). We obtained written informed consent from the parents' children who consented to participate in the study. Initial recruiting included the participants' eligibility to participate in the study pre-screening, and we conducted the initial testing afterward. The final testing followed the 10-month experiment.

Sample of participants

The G*power 3.1 power analysis software a priori determined the minimum sample size ($n = 52$) per group given the critical $F = 4.04$, effect size = 0.21, $p = 0.05$, $1 - \beta = 0.8$, groups and time points = 2, and corr = 0.5. However, accounting for an attrition rate due to the long program duration, the study's final participants sample included 154 children (REG, n=75, CG, n=79). The flow of participants is presented in Figure 1.

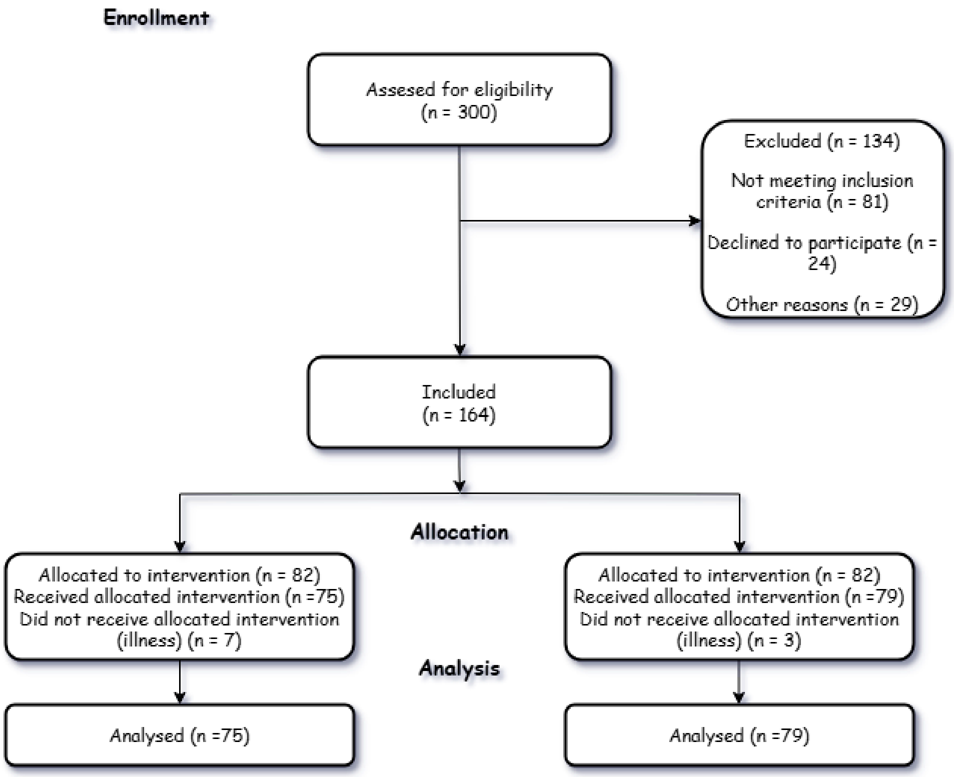

Figure 1. Participant flowchart

Eligibility criteria

The subject met the following inclusion criteria: (i) boys and girls aged 5-7 years; (ii) no musculoskeletal injuries or other medical conditions; (iii) finished at least 80% of all training sessions. The exclusion criteria were: (i) older or younger than 5-7 years; (ii) musculoskeletal injuries or other medical conditions. Basic sample characteristics are presented in Table 1.

Table 1. Basic descriptive characteristics

Variables	Rhythmic exercise group (n =75)					Control group (n =79)				
	Mean	SD	Range	MIN	MAX	Mean	SD	Range	MIN	MAX
Age (years)	5.66	0.76	2.95	3.98	6.93	5.60	0.62	2.14	4.51	6.65
Height (m)	1.18	6.8	33	1.03	1.36	1.17	6.8	32	1.03	1.35
Body Mass (kg)	22.14	3.37	16.8	16.8	33.6	22.08	3.85	16.5	16.0	32.5
BMI	15.81	1.46	8.9	13.2	22.2	16.08	1.60	8.5	12.5	21.0

Procedures

All procedures were performed in clean room, with a room temperature of 21-23°C, and free of obstacles to allow safe and unobstructed movement during exercises. Children wore appropriate athletic shoes and comfortable clothing, which allowed for a full range of motion. Before assessing PF test assessments, we gathered data on height and weight. Height was measured using a fixed anthropometer (GPM Anthropometer 100, DKSH Switzerland Ltd., ± 0.1 cm), and weight was measured using a digital scale (BC1000, Tanita, Japan; ± 0.1 kg) following the rigorous guidelines of the International Biological Program (IBP). The body mass index (BMI) was calculated using weight/height2 (kg/m^2).

The modified 20 m shuttle run test

We evaluated the CRF of children using the modified 20 m shuttle run test (Cadenas-Sanchez et al., 2016). In this test, the children were involved in running between two lines 20 m apart timed to an audio signal – beep, and the intervals between the beeps decreased each minute. Hence, the children run progressively progressively faster speeds, starting at 6.5 km/h. When the child either failed to reach the line in sync with the audio signal on two consecutive occasions or stopped due to exhaustion, the results were recorded and represented by the number of laps completed.

Muscular fitness tests

The standing long jump and 30-second sit-up test evaluated muscular fitness. The standing long jump estimated lower body explosive strength (Cadenas-Sanchez et al., 2016). We instructed the children to swing their arms and leap onto a metric mat while performing three consecutive jumps and recorded the longest jump in centimeters. We administrated the 30-second sit-up test to assess the trunk's muscular endurance (Cadenas-Sanchez et al., 2016). In the test, the child was positioned on their back with knees bent and hands placed behind their neck. They performed sit-ups by lifting their upper body to a seated position and returning to the starting position. The outcome was determined by the number of sit-ups correctly executed within 30 seconds.

Flexibility

The flexibility of the participants was evaluated using the sit-and-reach test (Cadenas-Sanchez et al., 2016). The participants sat on the floor barefoot, legs straight and together, and they were then instructed to lean forward gradually. They had to push a movable board as far as possible without bending their knees. The zero mark was 25 cm in front of the feet, and we took the measurement in centimeters of the best score directly from the meter on the device out of the two attempts.

Experimental program

The 10-month rhythmic-based exercise program, which consisted of sessions (outlined in Table 2), included various activities and exercises. Exercise science experts and trained physical education teachers designed and supervised, and led the program, respectively. The sessions took place indoors in a fully equipped gym three days per week for approximately 60 min (e.g., Monday: dance routine, slapping games, jump rope; Wednesday: Parachute games, balance exercises, coordination drills; and Friday: Dance routine, rhythmic relay races, strength activities). Participants were asked to rate their overall exertion for each session using the Borg Rate of perceived exertion (RPE) scale (1–10).

Table 2. An example of a rhythmic-based exercise session

Components	Activities
Warm-Up (5-10 minutes)	o Light jogging or marching in place. o Dynamic stretches (arm circles, leg swings, torso twists). o Simple rhythmic movements like clapping or tapping to a beat.
Rhythmic Activities (20-30 minutes)	o Dance Routines: Simple choreographed dances to children's songs or popular music. Focus on basic steps and repetitive patterns. o Clapping Games: Rhythmic clapping patterns that children can follow and create. o Jump Rope: Rhythmic jumping activities using a rope, individually or in groups. o Parachute Games: Rhythmic movements using a parachute, incorporating lifting, lowering, and shaking to a beat.
Skill Development (15-20 minutes)	o Balance Exercises: Standing on one foot, walking on a line, or using balance beams. o Coordination Drills: Activities like passing a ball in a rhythmic pattern, dribbling to music, or stepping through agility ladders. o Strength Activities: Bodyweight exercises like squats, lunges, push-ups, and planks incorporated into a rhythmic routine.
Cool-Down (5-10 minutes)	o Gentle stretching exercises targeting major muscle groups. o Slow, calming movements to relaxing music. o Deep breathing exercises and relaxation techniques.
Games and Group Activities (10-15 minutes)	o Rhythmic Relay Races: Teams compete in relays incorporating rhythmic movements. o Musical Chairs: Classic game with a focus on listening to the rhythm of the music. o Rhythmic Storytelling: Create stories with rhythmic movements and sounds.

Safety Considerations: Ensured a safe environment with enough space for movement.; Supervised children closely to prevent injuries.; Provided water breaks to keep children hydrated.

The structured rhythmic exercise program for children with progression over ten months gradually increased the complexity and intensity of activities while maintaining engagement and motivation. The detailed plan with monthly goals and activities is presented in Table 3.

The control group participated in standard kindergarten activities designed to support the holistic development of children. The program combined play-based learning, creative expression, and physical activities. The program aligns with Serbia's National Curriculum Framework for Early Childhood Education. These activities took place in a small kindergarten gymnasium and were led by kindergarten teachers.

Table 3. The monthly schedule of rhythmic exercise program

Months	Activities
Month 1: Introduction to Rhythmic Movement ● Focus: Basic rhythmic movements and coordination. ● Goal: Familiarize children with rhythm and fundamental movement patterns.	○ Simple dance routines with basic steps. ○ Clapping games with easy patterns. ○ Parachute games with lifting and lowering movements.
Month 2: Developing Coordination ● Focus: Enhancing coordination through varied activities. ● Goal: Improve coordination and introduce more complex rhythmic patterns.	○ Jump rope with basic jumps to a steady beat. ○ Balance exercises on one foot and walking on lines. ○ Ball-passing games with rhythmic patterns.
Month 3: Building Strength and Flexibility ● Focus: Incorporating strength and flexibility exercises into routines. ● Goal: Increase strength and flexibility while maintaining rhythmic movement.	○ Simple bodyweight exercises like squats and lunges in rhythmic sequences. ○ Dynamic stretches with rhythmic movements. ○ Dance routines with added strength elements.
Month 4: Introducing Group Activities ● Focus: Encouraging teamwork and cooperation. ● Goal: Foster social interaction and teamwork through rhythmic activities.	○ Rhythmic relay races in small groups. ○ Parachute games with group coordination tasks. ○ Group dance routines with synchronized movements.
Month 5: Exploring Different Music Genres ● Focus: Using various music genres to keep interest high. ● Goal: Expand children's musical horizons and adapt movements to different rhythms.	○ Dance routines to different types of music (pop, classical, hip-hop). ○ Rhythmic activities with culturally diverse music. ○ Musical chairs with varied music tempos.
Month 6: Enhancing Balance and Agility ● Focus: Advanced balance and agility exercises. ● Goal: Develop advanced balance and agility through rhythmic exercises.	○ Balance beam activities with rhythmic steps. ○ Agility ladder drills to music. ○ Complex jump rope patterns and sequences.
Month 7: Combining Skills ● Focus: Integrating learned skills into comprehensive routines. ● Goal: Reinforce and combine various skills learned over the previous months.	○ Dance routines incorporating balance, strength, and coordination elements. ○ Group games that combine different skills (e.g., rhythmic relay races with ball passing). ○ Rhythmic obstacle courses.

Table 3 (continued). The monthly schedule of rhythmic exercise program

Months	Activities
Month 8: Creative Expression ● Focus: Encouraging creativity and self-expression. ● Goal: Allow children to express themselves creatively through rhythmic movement.	o Create-your-own-dance routines where children design their steps. o Rhythmic storytelling with movements and sounds created by children. o Improvisational dance sessions to different music genres.
Month 9: Performance Preparation ● Focus: Preparing for a group performance. ● Goal: Build confidence and prepare for a group performance.	o Rehearsing a choreographed group dance routine. o Practicing group coordination games to be showcased. o Finalizing and refining movements and routines.
Month 10: Performance and Review ● Focus: Showcasing learned skills and reviewing progress. ● Goal: Celebrate achievements and reflect on progress over the ten months.	o Group performance for parents and peers. o Fun review sessions with favourite activities from the program. o Awards and recognition for participation and progress.

Progression: The complexity of movements and patterns gradually increased. New activities were introduced each month to keep children engaged. Activities were adapted to the children's pace and skill levels, ensuring inclusivity.

Statistical analysis

Data are presented as mean [95% CI, Confidence Interval] unless otherwise specified, and no outliers were identified during the boxplot analysis. When the Shapiro–Wilk test rejected normality, log-transformed data were analyzed; however, original data were reported for clarity. Both Levene's and Box's tests did not indicate a violation of the homogeneity of the variances and covariance matrices, respectively. A 2 (REG and CG) x 2 (pre- and post-test) mixed-model ANCOVA (mean age=5.63) evaluated the intervention effects on measured physical fitness. The primary tested hypothesis was the interaction effect between time and group. Moreover, we assessed the simple main effect of time to examine changes before and after in REG and CG. Partial eta squared (ŋ_p^2) was reported as measures of the effect size for the simple main effects and interaction effect, respectively, and defined as small (0.01), medium (0.06), and large (0.14). The Bonferroni corrected p values for multiple comparisons, and the significance level was set at $p \leq 0.05$. Data were analyzed using SPSS v. 26.0.

Results

Baseline values of mean PF test performances were similar across the groups, except the mean Standing long jump performance of REG which was significantly higher as compared to the CG (mean difference: 9.08cm [2.35, 15.82], $t(152)=2.67$, $p<0.01$).

Table 4. Comparison of mean PF changes from initial to final testing between groups

Variable	Rhythmic exercise group (n =75)	Control group (n =79)	
	Mean change [95% CI]	Mean change [95% CI]	A Group-by-Time Interaction Effect
Modified 20 m shuttle run test (freq.)	10.76 [8.62, 12.53] ***	3.78 [1.88, 5.69] ***	$F_{(1, 151)} = 23.99$; $p < 0.001$; $\eta_p^2 = 0.14$
Standing long jump (cm)	8.38 [5.77, 10.99] ***	4.12 [1.58, 6.66] ***	$F_{(1, 151)} = 5.32$; $p = 0.02$; $\eta_p^2 = 0.03$
Sit-ups for the 30s (freq.)	3.08 [2.10, 4.07] ***	-0.13 [-1.09, 0.83]	$F_{(1, 151)} = 21.36$; $p < 0.001$; $\eta_p^2 = 0.12$
Sit and Reach (cm)	3.24 [2.52, 3.95] ***	-0.14 [-0.83, 0.56]	$F_{(1, 151)} = 44.62$; $p < 0.001$; $\eta_p^2 = 0.23$

*** significant at p < 0.001; F(df), F value with degrees of freedom; p, p-value; ŋ_p^2, partial eta squared.

Table 4 encompasses the 2x2 mixed ANCOVA results for each PF outcome and presents the mean PF changes from the initial to the final testing comparison between the REG and CG. The mean PF test performance changes were significant and extensive (ŋ_p^2 x 100%, 20 – 43%) in REG. In CG, small or no changes in all PF test performance (0 – 6%) occurred, except the mean change of the Modified 20 m shuttle run test, which was medium (9.3%). The time-by-group interaction effects confirmed that all PF test performances improved significantly more in REG than in CG from a small (3%) to a large extent (23.1%).

Discussion

One of the most significant benefits of regular physical activity in childhood is its role in preventing chronic conditions in adulthood. Hence, with this structured rhythmic-based exercise program, we aimed to provide an approach to developing children's PF over ten months. The study's findings indicated REG's more extensive PF improvements compared to CG's after ten months. The rhythmic-based exercise program provoked extensive enhancements in flexibility, overall muscular fitness and CRF. At the same time, children in CG only improved cardiorespiratory fitness and explosive lower body strength to a small to medium extent.

The two latest comprehensive reviews and analyses encompassing randomized controlled trials have demonstrated that physical exercise programs have a modest impact on the physical fitness of preschool-aged children (García-Hermoso et al., 2020; Zhou et al., 2024). These interventions promoted enhancements in cardiorespiratory fitness and muscular strength. Our current study aligns with these findings (García-Hermoso et al., 2020; Wang et al., 2023; Zhou et al., 2024) as it also indicates positive changes, particularly in muscular fitness, among the participants in the exercise program. This improvement in muscular strength can be attributed to including full-body strengthening exercises in the intervention. Furthermore, the program involved various activities such as jumping, and pulling, which collectively assisted to strengthening the entire body musculature of the children. Likewise, we observed large improvements in CRF following the rhythmic-based exercise program. The dance routines involving continuous, repetitive movements of large muscle groups could supported the CRF improvements. These findings validate the conclusions and recommendations of multiple researchers who underscore the substantial positive effects of regular physical exercise on all aspects of health-related fitness, particularly addressing the deficiency in muscle strength and endurance often observed in contemporary children (Cattuzzo et al., 2016; Ortega et al., 2008).

Only the latest review provided data on effect of physical exercise programs on flexibility in preschoolers and reported no effect (Zhou et al., 2024). We, however, found an extensive increment following the 10-month rhythmic-based exercise program. The rhythmic-based activities involved slow, controlled movements that emphasize stretching, bending, and reaching, which are essential for enhancing flexibility. Dance routines also included dynamic movements such as deep lunges, high kicks, and full-body stretches, all of which could have contributed to greater range of motion; hence, rhythmic activities are the most effective for directly improving flexibility.

This study has limitations. First, no randomization process was performed. Second, there has been no monitoring of habitual physical activity. Third, no exercise program comparisons. Fourth, the diet behaviors were not controlled or assessed. The strengths of this study are: 1) the novel- and specific- physical exercise program focused on improving overall PF; 2) the use of standardized measurements of PF performance with good psychometric properties in preschool children (Cadenas-Sanchez et al., 2016).

Conclusion

The rhythmic-based exercise program provoked extensive flexibility and overall muscular and cardiorespiratory fitness developments. Further randomized controlled trials should be conducted to support or contrast our results.

Disclosure of interest

The authors report no conflict of interest.

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