Effects of developmental gymnastics exercise program on preschoolers' motor skills: a randomized controlled trial

March, 7, 2024

Study Overview

Brief Summary

Background: During childhood, physical activity (PA) is considered indispensable for developing motor skills through movement in the early stages of human development. Being active helps individuals develop fine and gross motor skills (GMS) by promoting an active lifestyle. Notably, this phase, characterized by regular PA and attaining motor competence, is associated with many health-related benefits. Early motor intervention programs have garnered attention for their positive influence on children's motor skills, as evidenced by various studies. A spectrum of more specialized methods is available alongside these general approaches, including programs designed to augment the time dedicated to general PA within school environments. Previous research has demonstrated the efficacy of incorporating experimental exercise interventions, grounded in enjoyable activities and game drills, into the curriculum, significantly improving children's basic motor skills. Many research articles have explored the impact of developmental gymnastics (DG) on children's fitness, indicating that gymnastics training can produce numerous beneficial outcomes for children's physical fitness.

Method and Materials: Three hundred preschool children were assigned to either a gender-balanced group participating in a DG exercise program (EG; n=99) or a control group (CG; n=121). While individuals in the CG followed three structured extracurricular physical activities per week in kindergarten, the EG participants received 60 minutes of the DG exercise program two days a week. We used the Test of Gross Motor Development-2 (TGMD-2) to assess GMS.

Aim: The study aimed to determine if participation in a structured DG program could improve GMS among preschool children compared to those in a group that attended extracurricular physical activities in a kindergarten.

Detailed Description

Study design

Developmental gymnastics (DG) presents a specialized form of gymnastics focusing on individuals' physical, cognitive, and motor development, typically children. The study aimed to determine the effects of DG, which lasts nine months, on preschoolers' gross motor skills (GMS). The study presents an Interventional study to improve motor abilities, and the main objective is prevention. The study model is parallel with two groups.

Participants

The initial sample of respondents (n=350) was recruited through an open project application lasting two months (from 1 July 2021 to 1 September 2021), from which 300 preschool children aged 4–7 were selected for this randomized, controlled interventional study. The recruitment process was completed after the selection process, and the optimal sample of subjects was filled out. The study sample underwent stratified randomization, resulting in the division into either EG (Experimental Group - 1) or CG (Control Group - 2). When stratifying, researchers used proportionate sampling to maintain the correct proportions of genders in every group. The intervention program started with a group of 150 children in EG, and at the same time, 150 children in CG started a kindergarten educational program in a Preschool Institution. Throughout the nine months of the experimental program, 51 children from the intervention group and 29 from the control group were excluded from the final analyses due to injury, flu, illness, or attendance at classes falling below 80%. Finally, 99 children (54 boys & 45 girls) who composed the EG and 121 children (64 boys & 57 girls) who composed the CG were analyzed for the effects of the DG. After nine months, a total of 220 participants were included in the final analysis. The parents or guardians of each child provided written informed consent, and the study received approval from the institutional ethics committee at the Faculty of Sport and Physical Education, University of Novi Sad (ethical approval number: 46-06-04/2020-1).

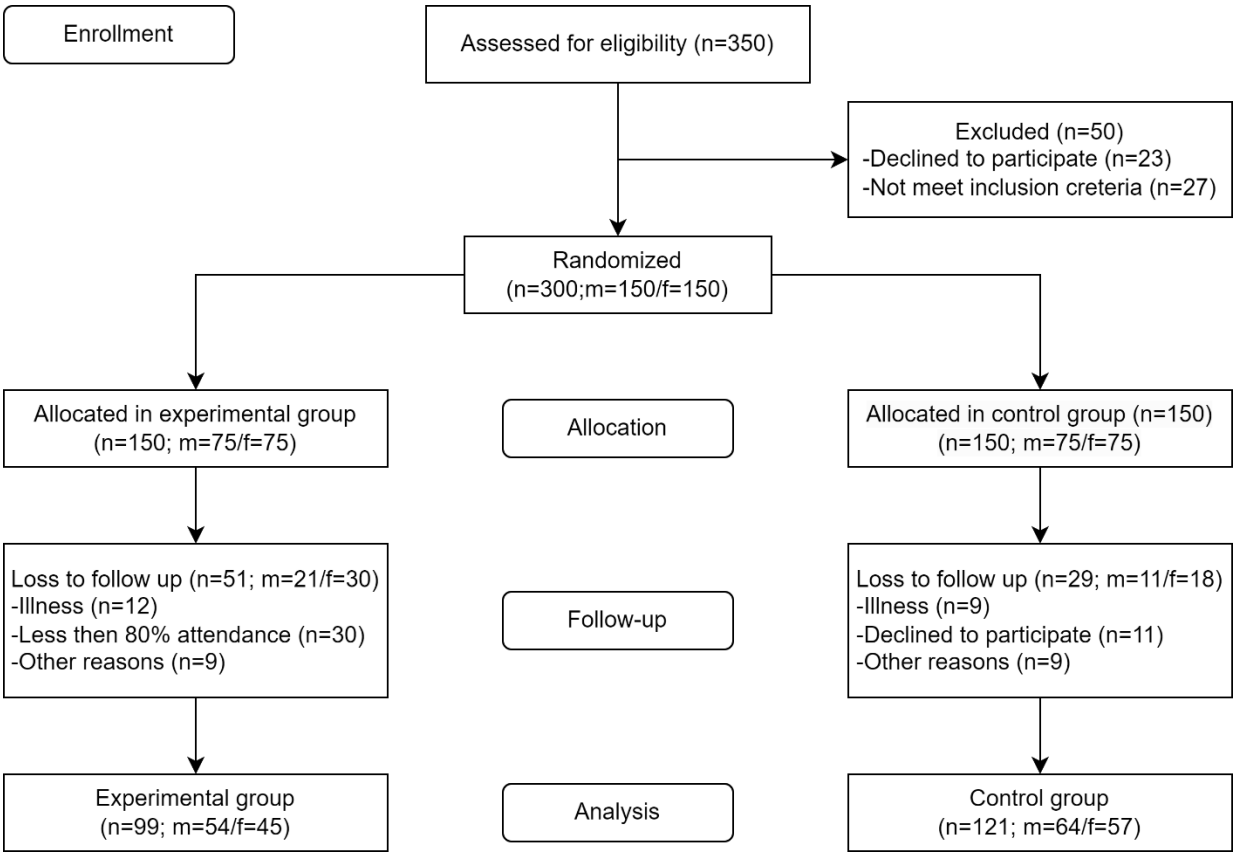
The exclusion criteria were:

- History of neurological or musculoskeletal disorders
- Clinical conditions that could affect balance, such as motor disorders, diabetes, heart disease, stroke, vision problems, thyroid issues, or issues with nerves or blood vessels.

The inclusion criteria for this study were:

- No injuries within the past six months
- No other medical conditions, including COVID-19
- No scheduled physical activity in the previous three months
- Considered valid for the experimental programs if participants completed at least 80% of all training sessions.

Figure 1 illustrates the flow of participants through the study.



Testing procedures

Secondary outcome – Anthropometric measures

Anthropometric data, including height and weight, were collected before the motor competence and physical fitness assessment. Following Martin's guidelines, body height was measured using a fixed anthropometer (GPM Anthropometer 100; DKSH Switzerland Ltd., Zurich, Switzerland; ± 0.1 cm). Body mass was measured with a digital balance (BC1000, Tanita, Japan; ± 0.1 kg), following the guidelines proposed by the International Biological Program (IBP). The body mass index (BMI) was calculated using the weight/height^2 (kg/m^2) formula based on the provided height and weight values.

Primary outcome - TGMD-2

The Test of Gross Motor Development – 2 (TGMD-2) is a standardized test to assess gross motor functioning in children aged 3 through 10. Researchers have previously utilized the TGMD-2, which demonstrates high reliability and minimal test error, instilling confidence in its application (Butler et al., 2023; Lopes et al., 2018; Nagy et al., 2023). The TGMD-2 measures 12 fundamental motor skills divided into two subcategories. The locomotor subtest consists of six skills: run, hop, gallop, leap, horizontal jump, and slide. The object control subtest includes six skills: hitting a stationary ball, dribbling while stationary, catching, kicking, throwing overhand, and rolling underhand. Motor competence was assessed with the TGMD-2 using the detailed instruction manual by examiners trained in physical education with prior experience in TGMD-2 measurements (Ulrich, 2000). Experienced researchers in test assessments coordinated and supervised the assessments. Each test took approximately 15-20 minutes and was performed indoors. The assessments were carried out, recorded, and coded at the Gymnastics Center, Faculty of Sport and Physical Education, University of Novi Sad, Serbia, from 1. September 2021 to 15. September 2021. Following a visual demonstration, each participant performed all 12 skills of the TGMD-2, receiving one practice attempt and two assessment trials for each skill. Each skill

consists of three to five performance criteria, with one score assigned if the criterion is present and zero if not. Total scores for each skill and subtest were calculated, ranging from 0 to 48.

Interventions

The Developmental Gymnastics Exercise Program

The nine-month DG exercise program (from 15 September 2021 to 15 May 2022) was conducted indoors in a well-equipped gymnasium. Trained physical education teachers and gymnastics experts led the training sessions twice weekly (on Tuesday and Thursday) without a break throughout the experimental period. Each session lasted for 60 minutes and covered a range of gymnastics activities and exercises, with each week focusing on specific categories of GMS, such as stability (trunk strength), locomotor skills (running, hopping, skipping), and manipulation (ball skills). The program also introduced children to fundamental elements of DG and was meticulously structured, incorporating frontal and group work, primarily circuit training (polygon) or repetitive (station) training. Obstacle courses were designed to incorporate various gymnastic apparatus and props, encouraging problem-solving through gymnastic and athletic exercises and elementary games. The number of repetitions, sets, and complexity of exercises and routines gradually increased in the central part of the session as children could perform them quickly, accompanied by external cues such as sweating, blushing, spontaneous breaks, and heart rates. The training structure consisted of three parts: I) A 15-minute warm-up with diverse movements, speed-varied exercises, activities for flat feet, stretching, corrective and preventive exercises for posture improvement, and a focus on proper performance awareness. II) The central part lasted 40 minutes and included reviewing and practising previous skills, introducing and practising new skills, engaging in competitive activities, and conditioning exercises. III) A 5-minute cool-down involving stretching, coaching feedback, and informal discussion about sports, exercise, and daily activities. A positive and friendly atmosphere was maintained throughout each training session, accompanied by suitable kids' music, especially during the

introduction and preparation phases. Basic principles and procedures were adapted from previous research (Bala, 1996; Radanovic, 2018).

In contrast, the CG adhered to their routine, engaging in three structured extracurricular physical activity sessions per week, each lasting approximately 45 minutes. A physical education specialist and a kindergarten teacher led these sessions. They were designed to enhance fundamental locomotor skills (e.g., hopping, skipping, jumping, crawling, and navigating obstacles) and manipulative skills involving balls, bricks, and toys. The primary objective was to create an environment where children could enjoy and have fun during exercise. According to the National Program for Kindergarten Physical Education Classes, the standardized program predominantly featured frontal and group activities, encompassing traditional games and dances, and included different training forms. The authors did not thoroughly provide detailed information about the intervention program.

Statistical analyses

Unless otherwise specified, we present data as mean and 95% confidence intervals [95% CIs]. We conducted an independent samples t-test to examine whether the baseline study outcomes varied among the groups. Normality was confirmed using the Kolmogorov-Smirnov test, and homogeneity of variances and covariance matrices were accepted through Levene's and Box's tests, respectively. We first modelled raw scores of each study outcome using a 2x (girls vs. boys), 2x (EG vs. CG), and 2 (initial vs. final testing) mixed ANCOVA (Model 1) to test confounding effects of gender, age, and BMI on intervention effects. We inspected the main effects of gender, age, and BMI to assess whether the study outcomes depended on these factors. This examination aimed to determine whether gender, age, and BMI could control the effects of the DG program on the study outcomes. Hence, respecting the significance of control variables effects ($p \leq 0.05$), we modelled each study outcome using either a 2x (girls vs boys) 2x (EG vs CG) 2 (initial vs final testing) mixed ANCOVA with age and BMI or only with age to find whether study outcome mean changes [95% CIs] from initial to final testing depended on whether subjects completed DG program or not (Model 2). We assessed potential gender confounding effects on changes in the study outcomes by

examining a time*group*gender interaction effect, followed by a time*group interaction effect for boys and girls, respectively. The time*group interaction effects allowed the evaluation of DG program effects followed by the simple main effects of time, which designated mean changes [95% CIs] from initial to final testing for each group. In addition, we estimated the parameters (beta coefficients, β and partial eta^2, η^2) of ANCOVA models. Games-Howel tests corrected multiple comparisons, and a p-value of ≤0.05 designated statistical significance. Partial eta squared (partial η^2) is reported as a measure of effect size and classified as small (0.01), medium (0.06), and large (0.14), according to Cohen. We conducted all analyses using SPSS (v.23, IBM Corporation, New York, USA).

References

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UNIVERSITY OF NOVI SAD

FACULTY OF SPORT AND PHYSICAL EDUCATION

ETHICS COMMITTEE – COMMISSION

DECISION No. **46-06-04/2020-1**

ETHICS COMMITTEE - COMMISSION FOR THE IMPLEMENTATION OF SCIENTIFIC PROJECT - RESEARCH

DESCRIPTION
After reviewing the submitted application (on June 17, 2020) for a scientific research project entitled: **Biomechanical parameters of athlete's postural stability** Ethics Committee - Commission - **APPROVES –** Borislav Obradović, PhD, Full Professor to continue with the realization of applied scientific research project.

SIGNATURES OF THE MEMBERS OF THE COMMISSION

Novi Sad,

17.06.2020.