The impact of gymnastics on the body posture of preschool children

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Abstract

Background: Preschool age is crucial for developing proper body posture. Regular physical activity, particularly gymnastics, may significantly influence postural alignment, potentially preventing future musculoskeletal issues. However, specific evidence on how structured gymnastics programs impact posture in preschool children remains limited.

Aims: The aim of the study was to determine the impact of the gymnastics program on the posture of preschool children.

Materials and Methods: Thirteen children, with an average age of 4.49 ± 0.50 years who attended gymnastics classes were included in the study. The gymnastics intervention lasted 24 weeks, with sessions lasting 45 minutes twice a week. A digital posture assessment tool (2016 Postureco™ Posture Screen Mobile) was used for monitoring purposes. The collected data were compared and statistically evaluated using the Wilcoxon test.

Results: Research findings have shown improvements in posture. Statistically significant improvement was observed in the assessment of hips/pelvis ($z = 2.41$, $p<0.01$) and overall posture ($z = 1.71$, $p<0.05$). Additionally, notable improvements were documented in the positions of the head and shoulders, though these were not statistically significant. The greatest magnitude of improvement occurred in pelvic alignment, highlighting the targeted benefits of the gymnastics intervention for this region.

Conclusions: The results indicate that the application of the gymnastics program had a positive effect on the posture of the children involved in the study.

Key words

gymnastics, posture body, Posture Screen mobile, preschool age.

Introduction

Physical activity is widely recognized as a crucial factor influencing proper posture. A randomized trial was conducted to investigate the effects of holistic gymnastics and Pilates on posture among prepubertal girls. The study concluded that these body movement exercises resulted in notable improvements in head tilt, pelvic anteversion, and correct methods of carrying school bags [1]. Another study [2] examined how an elite, 22-year-old aerobic gymnast adapted performance over a two-year training period leading up to the European Aerobics Championships. Using the Y-Balance test, researchers noted improvements in postural coordination, stability, and flexibility, indicated by increased reach distances in the anterior (by 6.3%), posteromedial (by 2%), and posterolateral (by 4.8%) directions. These findings suggest that general aerobic gymnastics, even without targeted interventions, can enhance abilities closely related to competitive routines.

Further research [3] assessed how training regimens in children's fitness sports influence body posture and the incidence of flatfoot. Results revealed frequent posture deficiencies, particularly affecting the hips and shoulders (78%), spinal curvature (61%), and positioning of shoulder blades (55.6%). Statistically significant correlations were found between flat feet and postural deficiencies in hip and shoulder alignment, as well as spinal curvature.

Additionally, evidence suggests that core stability and plyometric training (CPT) positively impact postural control among female gymnasts. One study specifically evaluated the effects of an integrated functional training program on postural performance in young rhythmic gymnasts. After an eight-week intervention, participants demonstrated significant improvements in postural control measures [4].

Gymnastics practice has been demonstrated to enhance postural control. A previous study [5] aimed to evaluate changes in children's postural control following gymnastics participation. The gymnastics-trained group exhibited superior unipedal balancing abilities compared to a control group participating in general physical and sports education classes. Additionally, female participants performed better than their male counterparts. Introducing educational gymnastics at critical developmental stages, therefore, seems to promote significant improvements in both postural performance and control.

Medical research has utilized the Posture Screen Mobile device to evaluate static posture in patients during the first two months following orthognathic surgery. This innovative technology facilitates rapid posture analysis and assessment, and is increasingly adopted in clinical settings [6]. Furthermore, a recent study sought to quantify and compare the force production of the biceps femoris and semimembranosus muscles during closed-chain lower limb strengthening exercises performed in a supine position. Muscle activity was assessed via wireless electromyography (EMG) using the DELSYS Trigno™ sensor system (2016), and exercise performance was concurrently monitored using the Postureco™ Posture Screen Mobile digital postural assessment tool (2016) [7].

Aims

The aim of this study was to evaluate the impact of a gymnastics program on the posture of preschool-aged children. The research hypothesis was that participation in the gymnastics program would lead to significant improvements in body posture.

Material and methods

Study participants

The study involved 13 preschool children with a mean age of 4.49 ± 0.50 years at the beginning of the study. The research included assessment of basic somatic parameters including body height, body weight and BMI. The mean parameters of

the group were: body height 104.56 ± 6.07 cm, body weight 16.56 ± 1.94 kg and BMI 15.13 ± 1.11 $kg.^{m-1}$ (**Table 1**).

Outcome measures

Body height was measured using a Soehnle Professional stadiometer, and body weight was determined using the InBody 120 diagnostic device (Biospace Co., Ltd.). Posture was assessed using the PostureScreen Mobile digital assessment tool (PostureCo, Inc.). The children first stood facing the examiner in an upright, relaxed position with a forward gaze (**Fig. 1**).

Next, participants adopted a sideways upright stance, again with a forward gaze (**Fig. 2**). The examiner stabilized the mobile device, and the application indicated the correct positioning before photographs were taken from both frontal and lateral views. For accurate posture analysis, 17 anatomical landmarks were manually marked and digitized using the PostureScreen Mobile app—a process that was relatively time-consuming. The app subsequently generated angular values representing deviations from correct posture. These initial and final angle measurements were analyzed to identify improvements or deteriorations in posture. This assessment was conducted once per participant.

Study procedure

The study was designed as a single-group, simultaneous time-course quasi-experiment. Participants completed a structured 24-week gymnastics program comprising tailored exercises aimed specifically at enhancing posture through basic and conditioning gymnastics. Each weekly microcycle consisted of two sessions lasting 45 minutes each.

Each session was structured into three distinct parts: preparatory, main, and concluding segments. The preparatory segment lasted 15 minutes and consisted of general and gymnastics-specific warm-up activities. These included trotting, basic locomotor movements, and gymnastic locomotion exercises performed in various postures, culminating in engaging motivational movement games (**Table 2**). Dynamic and static stretching exercises using resistance bands (expanders), short bars, and overballs followed this warm-up period.

The main segment, lasting approximately 25 minutes, included a carefully structured series of gymnastic exercises designed specifically to improve posture. Exercises progressed gradually in intensity and complexity over the duration of the program. Participants engaged in both simple and acrobatic movements, including forward rolls, scapular handstands, handstands with di-

Table 1. Characteristics of the dataset.

Statistics	Age [years]	Body height [cm]	Body weight [kg]	BMI index [kg/m^{-2}]
Mean	4.49	104.56	16.56	15.13
SD	0.50	6.07	1.94	1.11
Min	4	93	13	13.72
Max	5.3	114.9	19.7	17.19

Abbreviations: *[cm] – centimeters, [kg] – kilograms,* SD *– standard deviation, Max – maximum, Min – minimum,* BMI *– body mass index.*

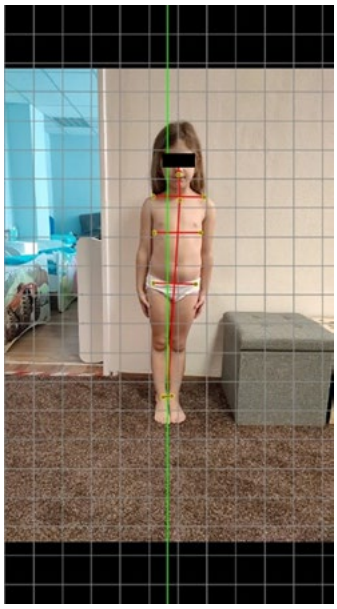

Figure 1. Posture from the front view.

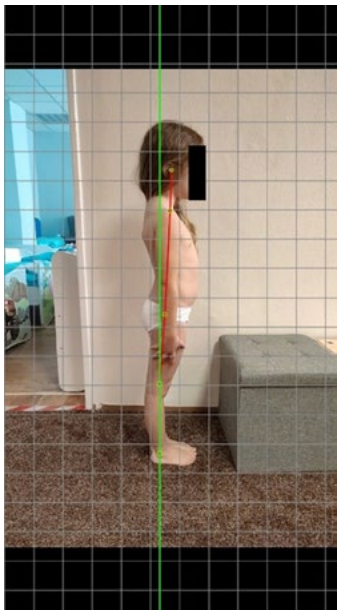

Figure 2. Posture from the right side.

Table 2. Preparatory part exercises.

Basic locomotion exercises	a) Walking lunges b) Low trot, high trot c) Canter sideways, d) Double-leg jumps, single-leg jumps e) Running across the frequency ladder, f) Double-leg and single-leg jumps across the frequency ladder, g) Climbing over the frequency ladder
Gymnastic locomotion exercises	Walking in a kneeling position, Walking in forward and backward support, Crawling Jumping over a small balance beam with arm support
Motion games	Molecules Red and black Into the water, out of the water Animals

rect assistance, and various hanging exercises on horizontal bars. Pair-based exercises designed to apply controlled pressure and tension to the brachial plexus were consistently incorporated into the sessions (**Table 3**).

Additionally, gymnastic games structured as obstacle courses, incorporating jumping, crawling, climbing, rolling, and balance-beam walking, provided engaging and varied physical challenges (**Fig. 3**). The concluding segment consisted of 5 minutes of static stretching exercises designed to facilitate recovery and flexibility.

Statistical analysis

Statistical methods were used to analyze the measurement results. Descriptive statistics, including arithmetic mean, standard deviation, minimum, and maximum values, were calculated to characterize the data set. The Wilcoxon test was utilized to evaluate statistical significance for within-group comparisons among participants. Statistical significance was set at the 5% level ($\alpha = 0.05$) and the 1% level ($\alpha = 0.01$).

Results

The initial measurement performed in the head position resulted in a mean angle of 39.23 ± 2.81°, while the output measurement recorded a value of 34.1 ± 2.35° (**Table 4**). The result was an improvement of 5.13 ± 0.47°. The average initial angle for shoulder position was 30.78 ± 2.27°. After the intervention, the mean angle was 15.8 ± 1.67°, indicating an improvement of 14.98 ± 0.59°. For hip/pelvis position, the mean input measurement was 33.57 ± 2.41°, which improved by 25.14 ± 1.15° during testing to a mean output value of 8.43 ± 1.26°.

Table 3. Pairs of gymnastic exercises for brachial plexus.

Handstand with feet on the balance beam	Horizontal bar hang
Oblique handstand against the wall	Elevated suspension hang
Handstand with direct assistance	Inverted hang

Table 4. Pre- and post-test data.

Measurement		Mean	SD	p-value
Head [°]	Pre-test	39.23	2.81	0.56
	Post-test	34.1	2.35	
Shoulder [°]	Pre-test	30.78	2.27	1.29
	Post-test	15.8	1.67	
Hips/pelvis [°]	Pre-test	33.57	2.41	2.41**
	Post-test	8.43	1.26	
Overall posture [°]	Pre-test	103.6	4.09	1.71*
	Post-test	58.32	3.63	

Abbreviations: SD – *standard deviation*; ° *degree.*

Notes: * $p < 0.05$; ** $p < 0.01$.

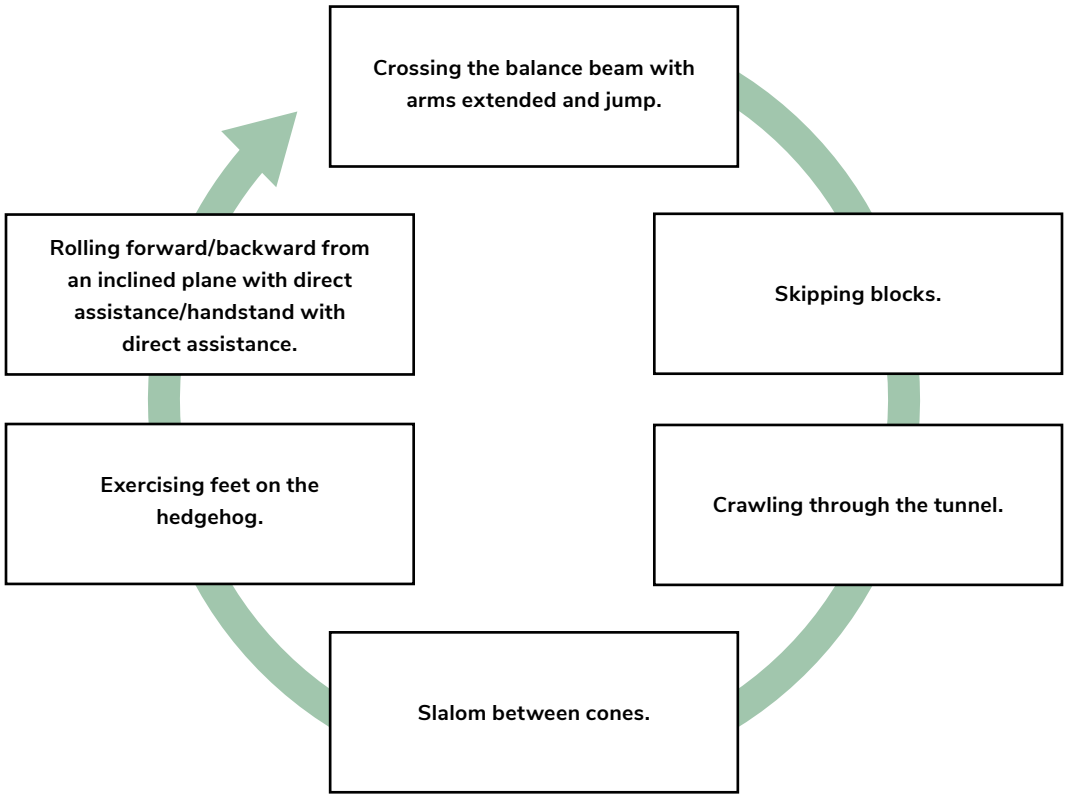

Figure 3. Example of an obstacle course.

Discussion

Within the study group, the mean baseline value for posture was 103.6 ± 4.09°. After completion of the gymnastics intervention, participants demonstrated an average improvement of 45.27 ± 0.45°, with a post-intervention mean posture score of 58.32 ± 3.63°. Specific areas of notable improvement included head posture (5.16 ± 0.47°), shoulder alignment (14.98 ± 0.59°), and hip/pelvis posture (25.14 ± 1.15°) (presented in **Table 4**). Statistically significant improvements were observed for hip/pelvis alignment ($z = 2.41$, $p<0.01$) and overall posture ($z = 1.71$, $p<0.05$) following the intervention (**Table 4**). By rejecting the null hypothesis (H0) in favor of the alternative hypothesis (H1), it can be concluded at a 5% significance level that the gymnastics program positively influenced overall body posture.

Fernanda's research explored the effects of holistic gymnastics and Pilates in a sample of girls aged 10–13 years (n=80). Participants completed ten weekly exercise sessions, each lasting one hour. Static posture was evaluated using SAPO posture analysis software, while dynamic posture was assessed using a modified LADy dynamic posture assessment method. Findings indicated significant improvements in specific postural parameters, notably head tilt in the frontal plane (1.49°) and pelvic anteversion on the right (1.9°) and left (2.09°) sides. Additionally, 25% of participants improved their habits related to carrying school bags, thereby contributing to overall posture enhancement [1].

The case study involving a 5.5-year-old individual diagnosed with torticollis due to shortening of the left sternocleidomastoid (SCM) muscle was conducted. The participant engaged in gymnastics training for a period of 10 months, with assessments of active range of motion (AROM) and cervical radiography conducted prior to and following the intervention. After the 10-month training period, improvements were noted in the limitation of left lateral flexion and left rotation of the active joint in the cervical region, leading to enhanced neck posture. These findings suggest that gymnastics training under the guidance of a skilled instructor may be beneficial for individuals presenting similar clinical manifestations [8].

Our findings showed that there was an overall improvement in posture after the application of the gymnastics program. In a research study involving 63 participants aged 7 years, posture was assessed at two time points: once at age 7 and again at age 13 using a modified assessment method. A second examination did not identify any significant postural defects. During the interval between assessments, most children with suboptimal posture participated in weekly gymnastics training at their educational institutions. The findings suggest that the results underscore the dynamic nature of posture, showing spontaneous improvements as well as deteriorations over time [9]. The study [10] was findings presence of alterations in body postures among children aged between 10 and 13 years. These alterations, identified as deviations in body posture, exhibited both improvements and deteriorations across various aspects of body posture. But comprehensive percentage analysis, an overall enhancement was observed in the body posture of children over a span of three years. Our research results demonstrated enhancements across all posture. Our analysis did not reveal any deteriorations in our findings.

The study [11] evaluated changes in body posture parameters in the frontal plane in the same children at 5 and then 9 years of age. In the examined children, there were statistically significant differences in the position of the lower corners of the shoulder blades (UL) between the first and second examination ($p = 0.005$). The difference in waist height improved and shoulder position worsened. In general, an improvement in posture was observed.

Two groups of children received 20 × 45 minutes of physical education (PE); one group ($n = 43$, age = 6.4 ± 0.7) participated in gymnastics classes at school under the guidance of a professional coach, while the other group received standard PE classes ($n = 18$; age = 6.5 ± 0.3). One-legged standing (Unipedal) performance was assessed by calculating the percentage of successful attempts performed. Fluctuation dynamics included measurements of entropy at the center of pressure, the fluctuation area of the 95% ellipse, and the fluctuation rate. The group that took the gymnastics classes showed significantly improved Unipedal abilities compared to the traditional group [5].

Forty-four young female gymnasts from a competitive team (age = 10.5 ± 1.8 years) participated in the study [4]. Postural control was assessed by single-leg stance tests and RG-specific balance tests on a power platform, with judges performing the assessments. After the 8-week intervention period, the experimental group showed significant improvements in specific parameters related to balance on the right support leg with eyes open and the left support leg with eyes open ($p < 0.01$). In addition, there were improvements in RG-specific balances such as Arabesque on the power platform ($p < 0.01$) and balance assessed by a group of judges ($p < 0.01$). In our case, the study also demonstrated an improvement in posture after applications of the gymnastics program.

Based on the findings, it is recommended that the featured exercises from the gymnastics program be introduced into preschool education to enhance early childhood posture development. Additionally, educators should be provided with adequate training to effectively implement these

structured programs. Regular incorporation of gymnastics activities at an early age could potentially prevent posture-related health issues and promote overall physical well-being.

Study limitations

The generalizability of the conclusions drawn from this research is limited due to the small number of participants and the absence of a control group. Therefore, further studies with larger sample sizes and inclusion of a control group are recommended to enhance the robustness and external validity of the findings. Additionally, future research should explore long-term retention of postural improvements and investigate other potentially influencing factors, such as varying exercise intensities, frequency of training sessions, and participant compliance, to provide a more comprehensive understanding of gymnastics interventions.

Conclusions

The final conclusion is that there was an improvement in all parameters in the final measurement (post-test) as well as in the overall posture assessment. There was a statistically significant improvement at the 1% level of significance between each hip/pelvis testing. After implementation of gymnastics, a significant improvement in overall posture was observed with statistical significance at the 5% level. The results also suggested that gymnastic stimuli play a key role in influencing posture. Regular participation in gymnastic training in early childhood might increase the ability to regulate posture.

Declarations

Ethical Consideration: The study was designed and conducted in accordance with the Declaration of Helsinki (1964) and Good Clinical Practice (GCP) guidelines.

Clinical Trials: This study was not registered as a clinical trial as it did not involve investigational products or interventions that would classify it under clinical trial regulations.

Conflict of Interest: The authors declare no conflict of interest. The study was conducted independently and without any influence from external organizations or entities.

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