Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

SCHOOL PHYSICAL EDUCATION PROGRAM IMPACT ON PSYCHOLOGICAL WELL-BEING AND COGNITIVE ABILITY OF PRIMARY SCHOOL CHILDREN

Irina Kliziene[1ABCD], Arunas Emeljanovas[2ABCD] and Mindaugas Dubosas[1ABCD]

[1]Kaunas University of Technology
[2]Lithuanian Sports University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Irina Kliziene, E-mail: irina.kliziene@ktu.lt
Accepted for Publication: April 3, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.19

Abstract

Study purpose. This study aimed to determine the impact of school Physical Education programs on well-being and cognitive ability (CA), as measured by mathematics achievements, in primary school children.

Materials and methods. The study participants selected from three schools were 100 girls and 102 boys aged 9–10 years. According to Kliziene et al. (2022), the CA diagnostic test for mathematics in Grade 4 is grounded in Feuerstein and Lewin-Benham's (2012) dynamic cognitive modality assessment theory, as well as the General Curriculum for Primary Education approved by the Minister of Education and Science of Lithuania (ISAK-2433, 2008). This test designed for learners in Grade 4 encompasses mathematics. The study aimed to assess the level of enthusiastic well-being by examining three primary dimensions: somatic anxiety, personal anxiety, and social anxiety. To measure anxiety, the Revised Children's Manifest Anxiety Scale (RCMAS) was used, which consists of 37 items, with 28 of them assessing anxiety and the other 9 measuring the child's defensiveness. In this study, a pre-/post-test experimental methodology was used to avoid any interruption of educational activities, due to the random selection of children in each group. The methodology depended on dynamic exercise, intense repetition of motor skills, differentiation, seating and parking reduction and physical activity distribution in the classroom model.

Results. The CA diagnostic test was analyzed in terms of the learners' levels of achievement (satisfactory, basic, advanced) and cognitive functions. The systematic exploration function was used to achieve systematic, non-impulsive, planned behavior when collecting data or checking information. There was a strong difference between students at the satisfactory and advanced levels in the ability to orient themselves in space and follow directions (score for boys, Post-test 2.53 (0.25) points; for girls, Post-test 2.91 (0.32) points out of a maximum 4 points; $p<0.05$). After the school PE program, the personality anxiety results decreased for both boys (2.68 ± 0.98 points) and girls (3.41 ± 0.55 points) ($F = 4.98$, $p < 0.05$, $P = 0.729$).

Conclusions. Overall, the physical education program implemented in this study was found to have a positive effect on the psychological well-being of 9–10-year-old children, specifically in reducing somatic anxiety, personality anxiety, and social anxiety. Additionally, it was observed that the program led to statistically significant improvements in the children's cognitive abilities across nine functions, including spatial orientation, sequencing, recognition of relationships and patterns, and information processing.

Keywords: school physical education program, well-being, cognitive ability, primary education.

Introduction

Despite being distinct skill sets in early school age, both motor competence and physical fitness may be important for children's overall physical well-being and academic achievement (Haapala, 2013; Robinson et al., 2015). Although physical education (PE) has been a curricular component in schools for many years, attention to the important role that schools play for physical activity and physical fitness surveillance has recently increased due to concern about childhood obesity and well-being. There are a number of psychological benefits for physical activity, including psychological well-being and improvements to self-confidence and self-esteem and reduced levels of stress, anxiety and depression (Lubans et al., 2016). Larsen et al. (2021) established that school-based 'health education

through sport', using the '11 for Health' model, was enjoyable for girls and boys aged 10–12 years old and improved health knowledge related to physical activity and well-being. It has been established that physical activity breaks with integrated mathematics content were effective in improving children's on-task behaviour and learning scores (Mavilidi et al., 2018).

Emerging research has also demonstrated the benefits of physical activity for children's cognition, meta-cognition, student engagement and academic performance (Alvarez-Bueno et al., 2017). According to the definition of Myers (2007), 'cognition is the mental activity of thinking, knowing, remembering and communicating'. Ashcraft (1989) defined the cognitive abilities used to acquire cognition as the ability to use the cognitive functions of attention, memory, logical and spatial reasoning, and well as concentration performance, memory, problem solving and decision-making (Lubans et al., 2016). Attention and concentration performance are key contributors to successful academic performance, adaptive behaviours and daily life functioning in youth and children (Janssen et al., 2014). These abilities are closely related to the learner's academic achievement (Gagne, 2005). In a conceptual model, Lubans et al. (2016) proposed that cognitive function provides the core foundation for developing and establishing psychological well-being. Cognitive function and psychological well-being are two variables related to mental health, and several studies have shown that these variables are sensitive to acute physical exercise, but it is not known what doses of exercise are the most adaptive. Including physical exercise prior to performing tasks that require high cognitive inhibition may be a useful strategy for improving cognitive performance (Pastor et al., 2021). Jäger et al. (2014) investigated the effects of an acute 20-min physical activity intervention on executive function in a sample of 52 young elementary school children, aged 6–8 years, compared to another 52 children assigned to a resting control condition. They found statistically significant cognitive effects induced by acute sports intervention.

This study sought to determine the impact of school PE programmes on well-being and cognitive ability (CA), as measured by mathematics achievements, in primary school.

Hypothesis 0: school PE programmes affect well-being and CA (as measured by mathematics achievements) in school students.

Hypothesis 1: school PE programmes do not affect well-being and CA (as measured by mathematics achievements) in school students.

Materials and methods

Study participants

In this study, primary schools in Lithuania were selected randomly, with three schools chosen from different regions that represented the state education system. This system follows the primary, basic, and secondary education programmes approved by the Lithuanian Minister of Education and Science in 2015.

The study was conducted with the agreement of parents and school administration regarding the time and location. The research ethics committee of Kaunas University of Technology's Institute of Social Science and Humanity approved the study, identified by protocol no. V19-1253-03.

The participants selected from the three schools were 100 girls and 102 boys aged 9–10 years (fourth grade).

Rationale for the CA diagnostic test

According to Kliziene et al. (2022), the CA diagnostic test for mathematics in Grade 4 is grounded in Feuerstein and Lewin-Benham's (2012) dynamic cognitive modality assessment theory, as well as the General Curriculum for Primary Education approved by the Minister of Education and Science of Lithuania (ISAK-2433, 2008). This test designed for learners in Grade 4 encompasses mathematics. The assessment criteria in the test are specific and individualized, making it an objective tool for determining learners' strengths and weaknesses to plan appropriate teaching and learning methods. Kliziene et al. (2022) opine that the primary objective of the test is to measure changes in learners' knowledge, understanding, application of knowledge, and higher-order thinking skills. The test comprises tasks that reflect nine cognitive functions.

The CA test was aimed at testing and measuring alterations in the knowledge, understanding, and higher-order skills of learners. In the test, the tasks were distributed based on nine cognitive functions:

1. *Systematic exploration:* To achieve planned and systematic behaviour in data collection, learners use the function of systematic exploration, creating a sequential system (as a case in point, left to right, top to bottom) to complete tasks in a non-impulsive manner;
2. *Spatial orientation:* this refers to the ability to perceive and follow directions in words or signs to navigate a given path;
3. *Sequencing:* the function entails creating a rule for arranging objects in a specific order;
4. *Image recognition:* this involves evaluating changes in visual objects after an action has taken place.
5. *Recognising and understanding relationships:* recognizing and understanding relationships involves identifying associations between elements by observing periodic changes;
6. *Collecting and processing information:* the ability to collect complete, clear, and accurate information.
7. *Algorithm development:* this involves designing a logical rule tailored to solve a particular problem, regardless of the amount of data involved;
8. *Data management (classification):* the grouping of objects and events based on defined criteria.
9. *Construction of combinations:* this entails establishing sets according to given or self-created rules while recognizing the number of possibilities and variations in each combination.

The CA test categorizes tasks based on levels of achievement and cognitive abilities (CAs). This, in turn, paves the way for the evaluation of student achievement. The test aligns with the Grade 4 mathematics curriculum, and performance thresholds were established to ensure fair evaluation of students' CAs. The advanced level of achievement is a score of 22-29 points, basic is 15-21 points, satisfactory is 7-14 points, and low is 0-6 points. The CA clusters were used to identify levels of knowledge, understanding, application, and higher-order thinking skills. The assessment results

were used to evaluate how students organize and implement their learning process. The impact of the learning methods on students' CAs was analysed and interpreted based on the assessment of their achievement levels.

A level of achievement that is considered unsatisfactory indicates that the student does not exhibit the knowledge, comprehension, and abilities that are evaluated within the CA group of the CA test.

On the other hand, a satisfactory level of achievement indicates that the student can reproduce some knowledge, but lacks the ability to apply it in novel situations, resulting in errors in basic mathematical procedures. The student demonstrates an insufficient understanding of mathematical concepts and symbols and struggles to identify patterns and relationships. They can recognize familiar contexts and solve simple problems, typically with only one step involved, but their chosen problem-solving strategies are not always rational. While their reasoning may support their conclusions, they often fail to detect any errors in their reasoning, resulting in incorrect conclusions. They are unable to provide reasoning to support their answers.

A basic level of achievement suggests that the student can apply their existing knowledge to new and relatively simple situations in the CA test, and can perform standard mathematical procedures without making significant errors. Despite their ability to accurately read and comprehend the problem, they may lack consistency and precision in problem-solving. They can think productively in common or familiar situations and can identify basic features, relationships, or patterns of objects. Furthermore, they can solve problems correctly, but may not interpret the final answer in the context of the original condition.

Meanwhile, an advanced level of achievement is indicative of the fact that the student possesses a thorough understanding of the terms used in various problems, has learned and comprehends mathematical concepts, can perform standard mathematical procedures and can solve mathematical and practical problems in various contexts. The learner demonstrates creative thinking skills, can identify common and subordinate features of objects and their relationships, observes patterns, selects appropriate strategies to solve problems, and can test them effectively. The student can draw detailed and precise conclusions.

The Revised Children's Manifest Anxiety Scale

The study aimed to assess the level of enthusiastic well-being by examining three primary dimensions: somatic anxiety, personality anxiety, and social anxiety. To measure anxiety, the Revised Children's Manifest Anxiety Scale (RCMAS) was used, which consists of 37 items, with 28 of them assessing anxiety and the other 9 measuring the child's defensiveness. Only 28 items related to anxiety were used in the factor analysis. The RCMAS yielded three factors: (a) somatic anxiety, comprising 12 items; (b) personality anxiety, comprising 8 items; and (c) social anxiety, comprising 8 items (Dewaraja et al., 2006). The results were interpreted based on the following criteria: (a) somatic anxiety, with scores of ≥6.0 points indicating high somatic anxiety, scores of 5.9-4.5 points indicating typical somatic anxiety, and scores of 4.4-1.0 points indicating low somatic anxiety; (b) personality anxiety, with scores of 2.0-2.5 points indicating low personality anxiety, scores of 2.6-3.5 points indicating typical personality anxiety, and scores of 3.6-4.5 points indicating high personality anxiety; and (c) social anxiety, with scores of ≥5.5 points indicating high social anxiety, scores of 5.4-4.5 points indicating typical social anxiety, and scores of 4.4-3.3 points indicating low social anxiety. The Cronbach's alpha coefficient for the subscales ranged from 0.72 to 0.73.

Procedure

The study employed a pre-/post-test experimental methodology to avoid disrupting educational activities. Children were randomly selected for each group, and the Grade 4 experimental group underwent an eight-month trial. A technique for the school PE programme was developed and a model of educational factors that encourage physical activity for children was created. Methodical material for the PE programme was also prepared based on the work of Coder et al. (2009) and Kliziene et al. (2020). As outlined in Kliziene et al. (2020) and Powell et al. (2016), the methodology involved dynamic exercise, intense repetition of motor skills, differentiation, reduction of sitting and parking time, and distribution of physical activity throughout the classroom.

The objective of the school's physical education programme was to promote physical activity, enhance skill development, and be enjoyable for the students. The recommended frequency for physical education classes was three times per week, with each Grade 4 session lasting 45 minutes and consisting of three sections: health fitness activities (20 minutes), skill fitness activities (20 minutes), and relaxation, focus, and reflection (5 minutes). The programme included activities that varied in intensity, duration, and complexity, with an emphasis on improving cardiovascular endurance. Short activities were also included to improve core strength and movement skills. To encourage motivation, students self-assessed and recorded their fitness levels monthly. The programme included four units of sports and games that developed skill-related fitness: basketball, football, gymnastics, and athletics. Information about healthy lifestyles and unconventional physical activities was also introduced. These sports and games had the potential to promote cardiovascular fitness and engagement in the community, while the relaxation, focus, and reflection activities promoted regular exercises and valuable meditation and relaxation techniques, such as children's yoga, concentration exercises, and conflict resolution (Table 1).

The study utilized physical schooling to teach school PE activities, with the aid of a textbook that had two parts: 1) the textbook itself; and 2) children's notes. The textbook included practical tasks, self-evaluation exercises, and activities that focused on spatial perception and self-improvement. Methodological devices were also provided to aid in using the textbook strategies. The PE programme aimed to integrate "natural" learning and dynamic learning to promote healthy lifestyles and awareness of nature. An advanced version of the programme was available to help teachers with planning and implementation. The material also incorporated intercultural mindfulness and sensitivity, with balanced gender representation. The intervention procedures were mixed, and a new methodology was used, which greatly impacted the participants, as found

Table 1. School Physical Education Programme (4 Grade)

Month	Lesson topic	Lesson areas of activity
Month 1	Working with textbook and notes	What helps you stay active throughout the day? What do you choose for your daily diet? Why is it important to exercise not only in the morning?
	Cohesive communication, communication to avoid conflict	Healthy lifestyle
	Throwing the small ball	Sport units (Athletics)
	Long jump test to test explosive power of children's leg muscles Activity games	Sport units (Athletics) Movement skills
Month 2	Working with textbook and notes	What exercises should you do in preparation for a long run? How can one overcome long distances? What are the square rules? How do you orient yourself in nature without a compass? Healthy lifestyle
	Lithuanian folk mobile games, dexterity training in special games	Movement skills
	Long-distance running	Sport units (Athletics)
	The square Orientation by maps Children's yoga Frisbee	Sport units (Football) Tourism, orienteering Unconventional physical activity
Month 3	Working with textbook and notes	What is important when you are doing the 5×10 m shuttle run test? How do you pass and kick the ball when playing mini football? How do you jump a long jump?
	Shuttle run: 5×10 m High jump Mini football game Orientation in nature Long jump-rope	Sport units (Athletics) Sport units (Athletics) Sport units (Football) Tourism, orienteering Sport units (Gymnastics)
Month 4	Working with textbook and notes	How do you exercise your eyes? How do you sit properly at the computer? What games do we play with a ball? What fun exercises improve coordination?
	Eye exercises Playing with balls	Unconventional physical activity
	Exercises to develop coordination, muscle stretching, maintaining balance Exercises to help calm down and concentrate	Movement skills Healthy lifestyle
Month 5	Working with textbook and notes	What foods are suitable for snacks? How do you throw a ball at a target? How do you pass and throw the ball?
	Food suitable for snacking	Healthy lifestyle
	Throwing the ball at target balls Basketball and passing after a two-step Gymnastics with hoop Project "Snow Castle"	Sport units (Basketball) Sport units (Gymnastics) Unconventional physical activity
Month 6	Working with textbook and notes	How do you get around an obstacle when sledding down a hill? Which mobile games develop aiming skills? How do you perform a correct handstand on the shoulder blades?
	Basics of gymnastics means, tools, correct posture; handstand on the shoulder blades Winter team game	Sport units (Gymnastics) Unconventional physical activity
	Sport games in pairs	Movement skills
	Mobile games to improve agility Time management	Sport units (Football) Healthy lifestyle
Month 7	Working with a textbook and notes	How does teamwork and a common goal help in relay races? What skills do you develop when you play mobile games? How can you learn to concentrate?
	Mobile relay races	Sport units (Athletics)
	Exercises for endurance and strength training	Movement skills
	Exercises to improve concentration	Healthy lifestyle

Table 1 (continued). School Physical Education Programme (4 Grade)

Month 8	Working with a textbook and notes	How do you overcome easy obstacles on a run? What are the important rules to follow when playing mini football? Why do you need to do stretching exercises?
	Ways to overcome easy obstacles on a run	Sport units (Athletics)
	Mini football game	Sport units (Football)
	Muscle stretching exercises, European physical fitness test (Eurofit): sit-and-reach	Healthy lifestyle
Month 9	Working with a textbook and notes	What are the important rules to follow when playing mini basketball? How do you protect yourself from the effects of the sun? How do you choose a safe swimming place?
	Eurofit in the following test order: Flamingo balance, standing broad jump, sit-ups, 10×5 m speed shuttle run	Sport units (Athletics)
	Mini basketball game	Sport units (Basketball)
	Mini golf game	Unconventional physical activity
	Project: Sport event	Healthy lifestyle

by Vaquero-Solís et al. (2020). The standard methodology was applied once a month, during which the material in the textbook was reviewed and tasks for the month were presented.

Statistical analysis. Descriptive statistics were reported for all measured variables as mean ±SD. The effect size of the Mann–Whitney U test was calculated using the equation $r = Z/\sqrt{N}$, in which Z is the z-score and N is the total number of the sample (small: 0.1; medium: 0.3; large: 0.5). Statistical significance was defined as $p \leq 0.05$ for all analyses. Analyses were conducted using SPSS 23 software (SPSS inc., Chicago, IL, USA).

Results

Cognitive functions by level of achievement (Grade 4)

The CA diagnostic test was analysed in terms of the learners' levels of achievement (satisfactory, basic, advanced) and cognitive functions. The systematic exploration function was used to achieve systematic, non-impulsive, planned behaviour when collecting data or checking information. It should be noted that almost all of the primary school students, both boys and girls, at the advanced level (scores for boys, Post-test 3.81 (0.42); for girls, Post-test 3.95 (0.50) points out of a maximum pf 4 points; $p<0.05$) were able to use this cognitive function. There was a strong difference between students at the satisfactory and advanced levels in the ability to orient themselves in space and follow directions (score for boys, Post-test 2.53 (0.25) points; for girls, Post-test 2.91 (0.32) points out of a maximum 4 points; $p<0.05$). The distribution of scores for the item sequencing rule and finding missing items or extending the sequences was consistent with the achievement levels (satisfactory: boys, Post-test 3.38 (1.61) points, girls, 3.51 (1.67) points; basic: boys, Post-test 4.38 (1.56) points, girls, 4.50 (1.12) points; advanced: boys, Post-test 5.51 (0.92) points, girls, 5.59 (0.94) points out of a maximum 7 points; $p<0.05$ for all). There was very little difference in the scores for the collection and processing of information (advanced: boys, Post-test 1.93 (0.10) points, girls, 1.99 (0.15) points; satisfactory: boys, Post-test 1.71 (0.53) points, girls, 1.80 (0.67) points; basic: boys, Post-test 1.89 (0.25) points, girls, 1.95 (0.19) points; $p<0.05$ for all; see Table 2).

Anxiety of 9–10-year-old children (Grade 4)

The study performed at the beginning of the experiment showed that, in the pre-test, the levels of somatic anxiety among primary school children were average for both boys (4.97 ± 1.05 points) and girls (4.98 ± 1.13 points). When exploring the results for somatic anxiety, we established that, after the school PE programme, somatic anxiety fell, but remained average for both boys (4.63 ± 1.00 points) and girls (4.92 ± 1.00 points). These scores demonstrate lower levels of depression, seclusion, somatic complaints, aggression and delinquent behaviour ($F = 5.76$, $p < 0.05$, $P = 0.638$; Figure 1a).

When looking at the results for personality anxiety, we established that the levels of personality anxiety among primary school children were average for both boys (3.49 ± 1.15 points) and girls (3.71± 0.85 points). After the school PE programme, the personality anxiety results decreased for both boys (2.68 ± 0.98 points) and girls (3.41 ± 0.55 points) ($F = 4.98$, $p < 0.05$, $P = 0.729$; Figure 1b)

In the pre-test, the levels of social anxiety were high for both boys (6.28 ± 1.08 points) and girls (6.03 ± 1.32 points). The post-test results were statistically significantly lower, with boys reaching low levels of social anxiety (4.26 ± 1.41 points, $F = 5.61$, $p<0.05$, $P = 0.684$) and girls reaching normal levels (5.30± 1.25 points, $F = 5.27$, $p<0.05$, $P = 0.724$). When analysing the levels of the social anxiety, the pre-test and post-test results decreased after the school PE programme (Figure 1c).

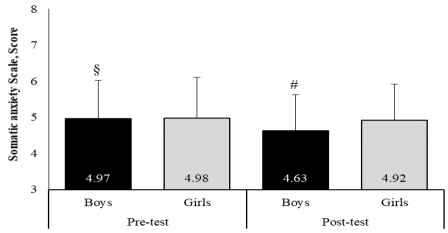
Discussion

Physical education is an essential component of school-based interventions aimed at promoting physical activity among children. PE has been shown to have positive effects on children's health, including improving their physical fitness, reducing the risk of chronic diseases, and enhancing mental health (Andermo et al., 2020; Kliziene et al., 2020).

Table 2. Distribution of cognitive functions by level of achievement (Pre-test and Post-test)

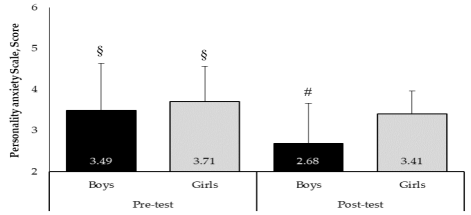
Cognitive functions	Achievement level					
	Satisfactory		Basic		Advanced	
	boys	girls	boys	girls	boys	girls
			Pre-test			
Systematic exploration	2.11 (1.12)	2.19 (1.53)	2.81 (1.02)	2.89 (1.20)	3.31 (0.98)	3.42 (0.91)
Spatial orientation	0.41 (0.92)	0.42 (0.98)	1.24 (0.95)	1.28 (0.93)	1.95 (0.38)	2.01 (0.36)
Sequencing	2.93 (1.50)	2.91 (1.49)	3.75 (1.60)	3.76 (1.41)	4.91 (0.93)	4.93 (0.89)
Image recognition	1.01 (0.91)	1.08 (0.83)	1.29 (0.48)	1.27 (0.46)	1.53 (0.72)	1.50 (0.69)
Recognising and understanding relationships	0.47 (0.20)	0.48 (0.18)	0.55 (0.14)	0.54 (0.18)	0.83 (0.10)	0.85 (0.08)
Collection and processing information	1.15 (0.84)	1.21 (0.86)	1.43 (0.51)	1.41 (0.52)	1.62 (0.31)	1.71 (0.38)
Algorithm development	0.51 (1.08)	0.51 (0.99)	1.83 (1.52)	1.89 (1.67)	2.49 (1.10)	2.50 (1.15)
Data management (classification)	0.21 (0.98)	0.19 (0.92)	0.75 (1.02)	0.78 (1.13)	1.50 (1.41)	1.49 (1.39)
Construction of combinations	0.32 (1.24)	0.68 (1.65)	1.15 (1.50)	1.21 (1.49)	1.98 (0.98)	2.07 (0.83)
			Post-test			
Systematic exploration	2.62* (1.51)	2.71* (1.42)	3.36 (0.72)	3.51* (0.51)	3.81 (0.42)	3.95 (0.50)
Spatial orientation	0.83* (0.94)	0.79* (0.99)	1.85* (0.92)	1.88* (0.95)	2.53* (0.25)	2.91* (0.32)
Sequencing	3.38 (1.61)	3.51 (1.67)	4.38 (1.56)	4.50 (1.12)	5.61 (0.92)	5.59 (0.94)
Image recognition	1.42* (0.80)	1.43* (0.65)	1.81* (0.25)	1.79* (0.73)	1.95* (0.53)	1.96* (0.61)
Recognising and understanding relationships	0.87* (0.15)	0.86* (0.13)	0.91* (0.10)	0.95* (0.09)	0.97 (0.08)	1.00 (0.00)
Collection and processing information	1.71* (0.53)	1.80* (0.67)	1.89* (0.25)	1.95* (0.19)	1.93 (0.10)	1.99 (0.15)
Algorithm development	0.85* (0.79)	0.72* (1.08)	2.38* (0.99)	2.31* (0.89)	2.95 (1.12)	2.89 (1.26)
Data management (classification)	0.25 (0.99)	0.28* (0.85)	1.15* (0.86)	1.23* (0.95)	1.92* (1.25)	1.98* (1.40)
Construction of combinations	0.45* (1.00)	0.85* (0.99)	1.92* (1.05)	2.01* (0.98)	2.57* (0.75)	2.86* (0.69)

* – p<0.05



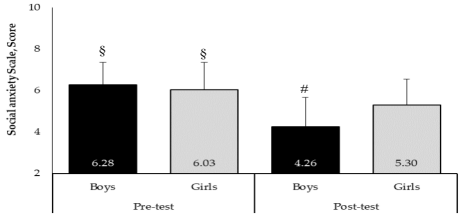
a

– p<0.05 between boys and girls; § – p<0.05 between pre-test and post-test



b

– p<0.05 between boys and girls; § – p<0.05 between pre-test and post-test



c

– p<0.05 between boys and girls; § – p<0.05 between pre-test and post-test

Fig. 1. The level of primary school children somatic anxiety (a), personality anxiety (b) and social anxiety (c) at pre-test and post-test

However, the effectiveness of PE programmes in reducing anxiety in children has received little attention.

Anxiety is a common problem among children, and it can affect their academic achievement, social development, and overall well-being (Ginsburg & Schlossberg, 2002). Anxiety can manifest in various forms, including somatic anxiety, personality anxiety, and social anxiety. Somatic anxiety is characterized by physical symptoms such as sweating, trembling, and rapid heartbeat, while personality anxiety refers to feelings of inadequacy and incompetence. Social anxiety is a fear of negative evaluation or judgment from others.

Given the importance of promoting physical activity and reducing anxiety among school children, this study aimed to identify a recommended approach for a school PE programme that could reduce anxiety in children aged 9-10 years in Lithuania.

According to the findings of this study, the recommended approach for a school PE programme had an impact on three key dimensions – a) somatic anxiety, b) personality anxiety, and c) social anxiety – in children aged 9-10 years. The approach involved dynamic exercise, repetition of motor skills, differentiation, reducing seating and parking, and spreading physical activity in the classroom. The study found a decrease in anxiety in children after nine months of implementing this school PE programme. Therefore, schools seem to be feasible in terms of promoting physical activity among children.

Our hypothesis 0, which proposed that a school PE programme would positively impact student well-being and cognitive achievement, was supported by the results of this study. These findings align with previous research indicating that physical activity interventions in schools can reduce anxiety, increase resilience, and improve overall mental health in children and adolescents (Andermo et al., 2020; Kliziene et al., 2020). Furthermore, the positive effects of physical activity on general health lend further credence to school-based initiatives aimed at increasing physical activity (Andermo et al., 2020).

Research by Larun et al. (2006) suggests that exercise can have a significant effect on depression in children and young people, but not on anxiety. Hermoso et al. (2020) also reported that physical activity is related to positive feelings, life satisfaction, and lower anxiety in children. Meanwhile, according to Chen et al. (2022), cardiorespiratory fitness, concentration performance, attention span, and attention accuracy are all significant predictors of psychological well-being in children. They also found that Grade 4 students with higher levels of psychological well-being had better cardiorespiratory fitness compared to those with lower levels of psychological well-being.

Given the increase in psychological well-being issues among children and youth, which may be partially caused by increased school stress, there is a growing need for evidence-based initiatives to counteract this trend. The results of this study are encouraging, as they suggest that schools can implement initiatives to increase physical activity during the school day and potentially reverse this negative trend.

According to Diamond and Lee (2011), cognitive control is essential for academic achievement, physical health, and mental health. The present study showed a significant improvement in school children's cognitive functions, including systematic exploration, orientation in space, sequencing, image recognition, recognizing and understanding relationships, collection and processing of information, algorithm development, data processing (classification), and construction of combinations. Pastor et al. (2020) suggested that including physical exercise before performing tasks that require high cognitive inhibition could be an effective strategy for enhancing cognitive performance. Similarly, Schmidt et al. (2016) found positive effects of acute ten-minute physical activity breaks on children's cognitive functions. Chen et al. (2022) identified three cognitive functions, namely concentration performance, attention span, and attention accuracy, as significant collective predictors of children's psychological well-being. Attention accuracy, in particular, was found to be a significant individual predictor of psychological well-being.

Attention accuracy is a crucial component of cognitive control, which enables individuals to selectively focus on relevant information and ignore distractions. It has been associated with various aspects of cognitive and socio-emotional development in children, including academic achievement, social competence, and emotional regulation (Posner & Rothbart, 2016). As such, attention accuracy is a key factor in promoting positive psychological well-being in children.

In addition, research has shown that physical activity can enhance attention accuracy and cognitive control in children. A study by Hillman et al. (2014) found that acute physical activity was associated with improved cognitive performance, including attention accuracy, in preadolescent children. Similarly, a study by Kao et al. (2018) found that physical activity was positively associated with cognitive control in preschool children. These findings suggest that physical activity can be a promising strategy for promoting attention accuracy and cognitive control, which, in turn, can improve psychological well-being in children.

Moreover, attention accuracy and cognitive control have been shown to play a critical role in academic achievement, particularly in early childhood. For example, a longitudinal study by Blair and Razza (2007) found that children who exhibited better cognitive control in preschool had higher academic achievement in early elementary school. Similarly, a study by McClelland et al. (2007) found that children who exhibited better attention control and working memory in kindergarten had higher academic achievement in second grade.

Furthermore, Grade 4 students with better psychological well-being exhibited better concentration performance and attention accuracy, indicating their ability to focus on relevant stimuli while ignoring irrelevant ones. Conversely, children with lower psychological well-being had lower concentration performance and attention accuracy.

Conclusion

Overall, the physical education programme implemented in this study was found to have a positive effect on the psychological well-being of 9-10-year-old children, specifically in reducing somatic anxiety, personality anxiety, and social anxiety. Additionally, it was observed that the programme led to statistically significant improvements in the children's cognitive abilities across nine functions, including spatial orientation, sequencing, recognition of relationships and patterns, and information processing.

Conflict of interest

If the authors have any conflicts of interest to declare.

References

Haapala, E. A. (2013). Cardiorespiratory fitness and motor skills in relation to cognition and academic performance in children: A Review. *Journal of Human Kinetics, 36*(1), 55-68. https://doi.org/10.2478/hukin-2013-0006

Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan,S. W., Rodrigues, L. P., & D'Hondt, P. (2015). Motor competence and its effect on positive developmental trajectories of health. *Sports Medicine, 45*(9), 1273-1284. https://doi.org/10.1007/s40279-015-0351-6

Lubans, D. R., Richards, J., Hillman, C. H., Faulkner, G., Beauchamp, M.R., Nilsson, M., et al. (2016). Physical activity for cognitive and mental health in youth: a systematic review of mechanisms. *Pediatrics, 138*(3), e20161642. https://doi.org/10.1542/peds.2016-1642

Larsen, M. N., Elbe, A. M., Madsen, M., Madsen, E. E., Ørntoft, C., Ryom, K., Dvorak, J., & Krustrup, P. (2022). An 11-week school-based 'health education through football programme' improves health knowledge related to hygiene, nutrition, physical activity and well-being—and it's fun! A scaled-up, cluster-RCT with over 3000 Danish school children aged 10–12 years old. *British Journal of sport medicine, 55*(16), 906-911. http://doi.org/10.1136/bjsports-2020-103097

Mavilidi, M. F., Drew, R., Morgan, P. J., Lubans, D. R., Schmidt, M., & Riley, N. (2019). Effects of different types of classroom physical activity breaks on children's on-task behaviour, academic achievement and cognition. *Acta Pediatrica,* 158-165. https://doi.org/10.1111/apa.14892

Alvarez-Bueno, C., Pesce, C., Cavero-Redondo, I., Sanchez-Lopez, M., Martınez-Hortelano, J. A., & Martınez-Vizcaino, V. (2017). The effect of physical activity interventions on children's cognition and metacognition: a systematic review and meta-analysis. *J Am Acad of Child Adolesc Psychiatry,* 56, 729-738. https://doi.org/10.1016/j.jaac.2017.06.012

Myers, D. D. (2007). *Psichologija.* Worth Publishers, ISBN 0-7167-2831-1.

Ashcraft, M. (1989). *Human Memory and Cognition.* Glenview, IL, Scott, Foresman, ISBN13: 9780673467898.

Janssen, M.; Toussaint, H. M.; van Mechelen, W.; & Verhagen, E. A. (2014). Effects of acute bouts of physical activity on children's attention: A systematic review of the literature. *SpringerPlus, 3*(410), 2-10.

Gagne, F. (2005). *From gifts to Talents: the DMGT as a Development Model: gifedness and talent*, Cambridge university press, 93-112, ISBN: 9780521547307.

Pastor, D., Cervelló, E., Peruyero, F., Biddle, S., & Montero, C. (2021). Acute physical exercise intensity, cognitive inhibition and psychological well-being in adolescent physical education students. *Current Psychology, 40*(10), 5030–5039. https://doi.org/10.1007/s12144-019-00454-z

Jäger, K., Schmidt, M., Conzelmann, A., & Roebers, C. M. (2014). Cognitive and physiological effects of an acute physical activity intervention in elementary school children. *Frontiers in Psychology, 1473*(5), 1-11. https://doi.org/10.3389/fpsyg.2014.01473

Kliziene, I., Paskovske, A., Čižauskas, G., Augustiniene, A., Simonaitiene, B., & Kubiliunas, R. (2022). The impact of achievements in mathematics on cognitive ability in primary school. *Brain sciences, 12*(6), 736, 1-17. https://doi.org/10.3390/brainsci12060736

Feuerstein, R. & Lewin-Benham, A. (2012). *What Learning Looks Like: Mediated Learning in Theory and Practice, K-6*. Teachers College Press: New York, NY, USA.

General Curricullum for Primary Education (approved by order no. ISAK-2433 of the Minister of Education and Science of the Republic of Lithuania, 26 August 2008. Official Gazette, 2008, Nr. 99-3848.

Dewaraja, R., Hideyuki, S., & Ogawa, T. (2006). Anxiety in tsunami-affected children in Sri Lanka measured by revised children's manifest anxiety scale and synthetic house-tree-person test. *International Congress Series,* 1287, 74–78. https://doi.org/10.1016/j.ics.2005.12.035

Corder, K., van Sluijs, E. M., Wright, A., Whincup, P., Wareham, N. J., & Ekelund, U. (2009). Is it possible to assess free-living physical activity and energy expenditure in young people by self-report? *American journal of clinical nutrition, 89*(3), 862-870. https://doi.org/10.3945/ajcn.2008.26739

Kliziene, I., Cizauskas, G., Augustiniene, A., Sipaviciene, S., & Aleksandraviciene, R. (2020). The relationship between school age children's ˙ academic performance and innovative physical education programs. *Sustainability, 12*(12), 4922, 1-13. https://doi.org/10.3390/su12124922

Powell, E., Woodfield, L. A., & Nevill, A. M. (2016). Increasing physical activity levels in primary school physical education: The SHARP Principles Model. *Preventive medicine reports,* 3, 7-13. https://doi.org/10.1016/j.pmedr.2015.11.007

Vaquero-Solís, M., Amado Alonso, D., Sánchez-Oliva, D., Sánchez-Migue, P.A., & Iglesias-Gallego, D. (2020). Emotional intelligence in adolescence: Motivation and physical activity. *Revista Internacional de Medicina y Ciencias de la Actividad Fisica y del Deporte, 77*(20), 119–131. https://doi.org/10.15366/rimcafd2020.77.008

Andermo, S., Hallgren,, M., Nguyen, T.T.D., Jonsson, S., Petersen, S., Friberg, M., Romqvist, A., Stubbs, B., & Elinder, L.S. (2020). School-related physical activity interventions and mental health among children: a systematic review and meta-analysis. *Sports Medicine – Open,* 2-27. https://doi.org/10.1186/s40798-020-00254-x

Ginsburg, G. S., & Schlossberg, M. C. (2002). Family-based treatment of childhood anxiety disorders. *International Review of Psychiatry, 14*(2), 143-154.

Larun, L., Nordheim, L.V., Ekeland, E., Hagen, K.B., & Heian, F. (2006). Exercise in prevention and treatment of anxiety and depression among children and young people. *Cochrane Database of Systematic Reviews,* 3, Cd004691. https://doi.org/10.1002/14651858.CD004691.pub2.

Hermoso, A.G., Aguayo, I.H., Vergara, O.F., Olivares, P.R., & Granado, X.O. (2020). Physical activity, screen time and subjective well-being among children. *International Journal of Clinical and Health Psychology,* 20, 126-134. https://doi.org/10.1016/j.ijchp.2020.03.001

Chen, W., Gu, X., Chen, J., & Wang, X. (2022). Association of cardiorespiratory fitness and cognitive function with psychological well-being in school-aged children. *International Journal of Environmental Research and Public Health,* 19, 1434. https://doi.org/10.3390/ijerph19031434

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science, 333*(6045), 959-964.

Schmidt, M., Benzing, V., & Kamer, M. (2016). Classroom-based physical activity breaks and children's attention: cognitive engagement works! *Frontiers Psychology,* 7, 1474, 1-13. https://doi.org/10.3389/fpsyg.2016.01474

ВПЛИВ ШКІЛЬНИХ ПРОГРАМ ІЗ ФІЗИЧНОГО ВИХОВАННЯ НА ГАРНЕ ПСИХОЛОГІЧНЕ САМОПОЧУТТЯ ТА КОГНІТИВНУ ЗДІБНІСТЬ ДІТЕЙ МОЛОДШОГО ШКІЛЬНОГО ВІКУ

Клізене Іріна[1ABCD], Емельяновас Арунас[2ABCD], Міндаугас Дубозас[1ABCD]

[1]Каунаський технологічний університет
[2]Литовський спортивний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 2 табл., 1 рис., 27 джерел.

Мета дослідження. Метою цього дослідження було визначення впливу шкільних програм із фізичного виховання на гарне самопочуття та когнітивну здібність (КЗ) дітей молодшого шкільного віку за рівнем їхньої успішності з математики.

Матеріали та методи. Учасниками дослідження, відібраними з трьох шкіл, стали 100 дівчат і 102 хлопчики віком 9–10 років. Згідно з даними дослідження Kliziene et al. (2022), діагностичний тест КЗ для математики в 4 класі ґрунтується на теорії динамічної оцінки когнітивної модальності Фойєрштайна та Левін-Бенхам, а також Загальній програмі початкової освіти, затвердженій міністром освіти та науки Литви (ISAK-2433, 2008). Цей тест, призначений для учнів 4-го класу, охоплює математику. Метою дослідження була оцінка рівня піднесеного гарного самопочуття шляхом вивчення трьох первинних аспектів: соматичної тривожності, особистісної тривожності та соціальної тривожності. Для вимірювання тривожності використовували Перероблену шкалу явної тривожності для дітей (RCMAS), яка складається з 37 пунктів, із яких 28 оцінюють тривожність, а решта 9 вимірюють захисну поведінку дитини. У цьому дослідженні використовували методологію експерименту з попереднім і підсумковим тестуванням, щоб уникнути перерви в освітній діяльності, з огляду на випадковий відбір дітей у кожній групі. Ця методологія ґрунтувалася на динамічних вправах, інтенсивному повторенні рухових навичок, диференціації, скороченні часу сидіння та стояння в очікуванні та розподілі фізичної активності в моделі шкільного класу.

Результати. Діагностичний тест КЗ аналізували за рівнями успішності (задовільний, середній, високий) та когнітивних функцій учнів. Функцію систематичного дослідження використовували для забезпечення систематичної, неімпульсивної, запланованої поведінки під час збору даних або перевірки інформації. Між учнями задовільного та середнього рівня спостерігалася сильна різниця у здатності орієнтуватися в просторі та рухатися в заданих напрямках (оцінка у хлопчиків: підсумкове тестування – 2,53 (0,25) бала; оцінка в дівчат: підсумкове тестування – 2,91 (0,32) бала з максимум 4 балів; $p<0,05$). Після проходження шкільної програми з ФВ результати особистісної тривожності знизилися і в хлопчиків (2,68 ± 0,98 бала), і в дівчат (3,41 ± 0,55 бала) ($F = 4,98$, $p < 0,05$, $P = 0,729$).

Висновки. Загалом було встановлено, що програма з фізичного виховання, реалізована в цьому дослідженні, позитивно впливає на гарне психологічне самопочуття дітей віком 9–10 років, зокрема на зниження соматичної тривожності, особистісної тривожності та соціальної тривожності. Крім того, за результатами спостережень, ця програма забезпечила статистично значущі покращення когнітивних здібностей дітей у дев'яти функціях, включаючи орієнтацію в просторі, упорядкування, розпізнавання взаємозв'язків та образів, а також обробку інформації.

Ключові слова: шкільна програма з фізичного виховання, гарне самопочуття, когнітивна здібність, початкова освіта.

Information about the authors:

Kliziene, Irina: irina.kliziene@ktu.lt; https://orcid.org/0000-0003-1914-7355; Educational Research Group, Institute of Social Science and Humanity, Kaunas University of Technology, K. Donelaičio g. 73, 44249 Kaunas, Lithuania.

Emeljanovas, Arunas: arunas.emeljanovas@lsu.lt; https://orcid.org/0000-0001-7762-0660; Department of Physical and Social Education, Lithuanian Sports University, Sporto g. 6, 44221 Kaunas, Lithuania.

Dubosas, Mindaugas: mindaugas.dubosas@ktu.lt; https://orcid.org/0009-0002-1164-6045; Educational Research Group, Institute of Social Science and Humanity, Kaunas University of Technology, Kaunas 44249 Lithuania.

Cite this article as: Kliziene, I., Emeljanovas, A., & Dubosas, M. (2023). School Physical Education Program Impact on Psychological Well-Being and Cognitive Ability of Primary School Children. *Physical Education Theory and Methodology, 23*(2), 290-298. https://doi.org/10.17309/tmfv.2023.2.19

Received: 06.03.2023. Accepted: 03.04.2023. Published: 28.04.2023