

## **Abstract**

Physical activity is one of the main factors determining physical fitness and health, including cardiometabolic health (blood pressure, dyslipidaemia, insulin resistance), bone health, mental health (e.g., depression symptoms, lack of self-confidence), as well as the correct development of cognitive functions.

The presented set of articles comprising the doctoral thesis is an attempt to investigate the cognitive functioning of young athletes in the period of late childhood, including the indicators of the brain's bioelectrical activity.

The articles comprising the doctoral thesis present two phases of scientific exploration: first of all, a review of the up-to-date scientific literature on the analysed topic was prepared (Articles 1-2). Next, the obtained knowledge allowed to formulate empirical goals, research questions, and hypotheses (Articles 3-4).

Article 1 presents the current knowledge on physical activity in terms of the cognitive functioning of children in the late childhood period. The data obtained indicate a potentially positive impact of physical activity on attentional processes, executive functions, language functions, working memory, and visual-spatial memory.

The conclusions drawn from the review of studies indicate that efficient cognitive functioning of preadolescents requires not only an adequate intelligence quotient, but also highly developed executive functions (such as motivation, goal setting, and self-control), which is supported by doing sports. The review of studies also revealed weaknesses of the research conducted so far, including in particular: 1) The scarcity of studies in the world literature that take into account the entirety of cognitive functioning, encompassing indicators of brain's bioelectrical activity in young athletes (not to mention simultaneous consideration of open-skill exercises and closed-skill exercises), because the studies conducted so far have been usually focused on the assessment of executive functions or attentional processes; 2) The group of 10-12-year-old children is rarely examined, researchers focus mainly on adults and children in the period of early childhood; 3) Few studies include as a comparison group individuals who are physically active, only to a lesser extent; usually a comparison group comprises individuals with a sedentary lifestyle.

Some discrepancies regarding the terminology used to classify sports depending on the discipline practiced were revealed during the development of this article. Many of Polish researchers use the English terminology. Some translate the concepts in a way they find suitable.

Therefore, the motivation to write another research paper comprising the doctoral thesis (Article 2) was to standardize the Polish terminology referring to the qualification of sports in accordance with the concept of Poulton (1957) and Knapp (1963), concerning two key concepts: 'open-skill exercise' (OSE) and 'closed-skill exercise' (CSE). The term 'sport interakcyjny' (interactive sport) was suggested for the 'open-skill exercise' and 'sport nieinterakcyjny' (non-interactive sport) was proposed for the 'closed-skill exercise'. The main objective of the undertaken research is to assess whether young athletes function better in cognitive terms than their peers who do not practice sports competitively and whether there are differences in cognitive functioning and in the brain's bioelectrical activity of pre-adolescent children involved in open-skill exercise (snooker) and closed-skill exercise (gymnastic).

The following specific objectives were also formulated:

- (1) Verifying the impact of sports activity on cognitive functioning of children (Article 3 and 4);
- (2) Verifying the assumption that differences in the brain's bioelectrical activity will be revealed (Article 3 and 4);
- (3) Investigating the distinct impact of different sports disciplines, classified as open-skill or closed-skill exercises, on cognitive functioning of children (Article 4).

The study group consisted of children in late childhood period (10-12 years of age),

invited to take part in the study with their parents. This period involves highly dynamic brain development, including executive functions.

The study participants were qualified to one from two criteria groups based on the sports discipline they practiced. The comparison group consisted of 58 children who were physically active, but to a much lower extent than children included in the study groups. 176 children were examined (88 boys and 88 girls). Both the first criteria group (gymnasts) and the second criteria group (soccer players) consisted of 59 children each. The comparison group included 58 children.

The International Physical Activity Questionnaire (IPAQ), in a version modified for children (Biernat et al., 2007) was used, as well as the 'sports activity' own survey - analysis of a child's sports experience (Bidzan-Bluma, 2020), the Cattell Culture Fair Intelligence Test – version 2 revised (CFT-20-R) (Stańczak, et al., 2013), the PU1 battery to diagnose cognitive functions (Borkowska, et al., 2015), the Diagnosis of Brain Damage (Weidlich et al., 1997; Dajek, 1999), the EAS-C Temperament Questionnaire - version for children, developed by A.H. Buss and R. Plomin, Polish adaptation by W. Oniszczenko (2015). The research also included EEG biofeedback examination with a centrally-placed electrode (Cz).

Parents of the examined children filled in a sociodemographic survey and the International Physical Activity Questionnaire (IPAQ) (version for children).

The research has shown that children doing both open-skill and closed-skill exercises function better in cognitive terms than children not doing sports professionally (Article 3 and 4). Cognitive profiles of children doing open-skill exercises (soccer) and closed-skill exercises (artistic gymnastics) differ from each other. Soccer players achieved better results regarding attention selectivity than gymnasts. Children doing closed-skill exercises (artistic gymnastics) were featured by the lowest level of attention selectivity compared to other study groups. However, they are featured by the best level of short-term memory for verbal information (Article 4).

Both criteria groups obtained higher scores on the phonological loop and spontaneous visual recall compared to the comparison group. However, considering the indicators of the brain's bioelectrical activity measured at point Cz, differences were only observed comparing gymnasts with the control group. Children who engaged in physical activity more than 5 times a week had a higher Theta/SMR ratio, which may be related to elevated experience of calmness and relaxation (Article 3 and 4).

Temperament was also included in the research as a moderating variable. The obtained results indicate that in terms of activity understood as the expenditure of physical energy during motor activities, the average results of children practising artistic gymnastics and soccer differ significantly from those of children from the control group. Both artistic gymnasts and soccer players are characterized by a faster pace, as well as vigour (intensity of reaction). In addition, there were also differences regarding sociability understood as seeking contact with other people, between children playing soccer and children from the comparison group in favour of the soccer players (Article 4).

The presented series of studies may draw attention to the great impact of physical activity of children in late childhood period on cognitive functioning.

The obtained results may also translate into practical actions and be used in the psychoeducation of parents, teachers, and children, as well as in the prevention and rehabilitation of children in late childhood. They can also be used to develop therapeutic plans that involve not only typical neuropsychological methods, but also elements of artistic gymnastics and soccer adapted to the deficits of a given person. This knowledge can be important for parents of children, as well as in the work of various specialists supporting children's health.