

# Research Progress of Sports Improving Children's and Adolescents' Attention

Leqi Zhou<sup>1, a</sup>

<sup>1</sup>Shanghai Maritime University, Shanghai, 201306, China

<sup>a</sup>lqzhou@shmtu.edu.cn

## Abstract

**Objective:** To explore the mechanism and effect of acute and long-term exercise on children and adolescents' attention. **Methods:** the relevant research literature on the effects of acute exercise and long-term exercise on children's and adolescents' attention was searched, and the effects of different exercise variables such as exercise type, cycle, duration, frequency and intensity on children's and adolescents' attention were analyzed and compared. **Results:** many studies have proved that various forms of acute and long-term exercise with medium and high intensity can improve the attention of children and adolescents, and help to improve their learning performance. Some studies also show that acute and long-term exercise do not significantly improve the attention level of children and adolescents. **Conclusion:** acute and long-term exercise can positively improve the attention of children and adolescents as a whole.

## Keywords

Children; Teenagers; Attention; Exercise intervention.

## 1. Introduction

Sports can effectively promote the development of children's physical ability and brain nervous system, in which attention is the key element of children's cognitive ability and the basis of sensory information processing and cognitive thinking. By combing the relevant literature, it is found that the exercise prescription to promote the attention of children and adolescents is more reasonable and effective under what combination and matching conditions of exercise elements. At present, the research has not yet formed a unified exercise model. Therefore, based on the relevant literature, this study makes a systematic and comprehensive review on the effects of acute and long-term exercise intervention on children and adolescents' attention; In order to explore the reasonable and scientific sports in children and adolescents, so as to further enrich the theoretical system and practical reference of sports to improve the attention of children and adolescents.

## 2. Effect of Exercise on Children and Adolescents' Attention

Attention is the direction and concentration of people's psychological activities to a certain object, including the breadth, stability, distribution and transfer of attention, which is also an important standard for evaluating the level of attention. Attention is a multi-level integrated activity of the central nervous system. Everyone has an attention neuron physiological mechanism. A large amount of information is filtered by the attention mechanism for further processing by subsequent cognitive activities. Continuous attention creates a stable environment for cognitive activities. The level of attention not only determines the academic

performance of children and adolescents to a great extent, but also affects the shaping of good daily behavior. Zhang lingcong et al. pointed out that academic achievement is positively correlated with the development of attention related ability and attention process. Similarly, research shows that working memory ability is actually supported by potential attention ability, and attention acts as a filter to limit the amount of information entering the memory bank. The object of attention can be external objective things and their own actions. It is a necessary condition for people to adapt to the environment and master knowledge.

The effect of exercise on attention has short-term and long-term effects. Exercise has beneficial effects on neuron genesis and long-term enhancement and plasticity]. According to the research on the effect of exercise on children's and adolescents' attention, the implementation cycle can be divided into two categories: one is the experimental intervention of long-term exercise. Usually, subjects are randomly assigned to the exercise intervention group or control group lasting several weeks or longer to investigate the effect of long-term exercise intervention on children's and adolescents' attention; The second is the experimental intervention of acute exercise. Usually, researchers randomly assign children and adolescents to a 10-60min exercise intervention group or control group to investigate the immediate effect of short-term exercise on children and adolescents' attention. The exercise cycle, intensity, duration, test methods, intervention types and other measures adopted by exercise intervention attention are different, which will lead to different experimental results.

### **3. Effect of Acute Exercise on Attention of Children and Adolescents**

#### **3.1. Study on Acute Exercise Intervention to Improve the Attention of Children and Adolescents**

In the study of acute exercise intervention to improve the attention of children and adolescents, 7 comprehensive exercise interventions can improve the attention of children and adolescents. Reigal et al. showed in the study that the higher the physical quality of 210 adolescents aged 11-15, the higher the scores of attention selectivity and concentration in D2 attention test[1]. Kulinna et al. pointed out in the study that 192 children aged 9-10 years were intervened with a combination of 45min moderate intensity dance and aerobic exercise. The results showed that the comprehensive exercise intervention significantly improved children's selective attention performance[2]. Gallotta et al. found that through the attention intervention experiment of physical exercise and physical exercise + cognition group on 116 children aged 8-11, the results showed that the attention level was significantly improved after immediate and delayed (50min) compared with that before the intervention. Janssen et al. pointed out in the study that four groups of jogging, dribbling and jumping with different intensities for 15min significantly improved the selective attention of 123 children aged 10-11, and the medium intensity improved the most [3]. In the study, Gallotta et al. found that through comprehensive exercise intervention on 134 children aged 8-11 with heart rate greater than 139 times per minute, the results showed that the attention level was effectively improved [4]. Niederer et al. conducted 45-50min aerobic fitness, dynamic balance and agile exercise intervention on 245 children aged 5-6 years. The results show that exercise intervention can significantly improve children's attention level [5]. Graf et al. showed that 906 children with an average age of 6 years were randomly assigned to the coordination and endurance exercise group and the control group for 6 minutes. The results showed that the level of children's focused attention was effectively improved [6].

Six aerobic exercise interventions can improve the attention of children and adolescents. Altenburg et al. showed in the study that by comparing 62 adolescents aged 10-13 with 20 minutes of moderate intensity aerobic exercise intervention [7], the "sky search" subtest

showed that the selective attention score of the two groups was higher than that of the control group with and without aerobic exercise. In the study of Tine et al., 85 and 164 17-year-old adolescents were intervened with aerobic running with 12-minute exercise intensity (HRmax 70% - 80%) respectively. The results show that aerobic running significantly improves the selective attention of students from high and low-income families, and the attention level of students from low-income families is even higher[8]. Claudia et al. found that aerobic running intervention with 12 min exercise intensity (hr180-190bpm) was carried out for children aged 9-10 years. The results showed that aerobic running performed better in D2 attention test than sedentary children. In the study, Kubesch et al. intervened 81 13-14 adolescents with 5min and 30min aerobic exercise[9]. The results showed that 30min aerobic exercise improved attentional inhibition, but 5min did not. The research of Caterino et al. shows that 15min aerobic jogging has a significant effect on improving the attention level of students in grade 2, 3 and 4. Wood cook Johnson attention test shows that the effect of grade 4 is more significant than that of grade 2 and 3[10].

The intervention of three sports activities can improve the attention of children and adolescents. Ma et al. found that by conducting 4min high-intensity intermittent sports activities for 88 children aged 9-10, the results show that short-term high-intensity intermittent sports activities can effectively improve children's selective attention. The results of this study are inconsistent with those of Vera et al.. Therefore, whether short-term exercise intervention is effective still needs to be explored. In the study of Palmer et al., 16 6-year-old children were intervened with medium and high intensity sports activities. The results showed that children under the condition of medium and high intensity sports for 30 minutes could improve attention persistence more than children in the sedentary group[11].

Two coordinated exercise interventions can improve the attention of children and adolescents. Schmidt found in the study that 45 min acute coordinated exercise did not immediately improve the attention performance of 90 children aged 10-11, but 90 min after stopping. Budde et al. explained in the study that 99 15-year-old adolescents were intervened with 10 min coordinated exercise with moderate heart rate. The results showed that the coordinated exercise group was more effective than the non exercise group. The experiment was carried out in a professional performance school, so whether it is equally effective in ordinary schools remains to be studied.

One exercise intervention in the laboratory can improve the attention of children and adolescents. Chen Rong et al. pointed out in the study that 60 14-15-year-old children's sports school students and ordinary students were subjected to power bicycle test for three times (large, medium and small) load exercise intervention. The results showed that the attention level of children's sports school students was significantly improved after three times of load, while ordinary students improved after small and medium load, while large load had no immediate effect.

### **3.2. Acute Exercise Intervention Did Not Improve the Attention of Children and Adolescents**

Among the studies that acute exercise intervention did not improve children's and adolescents' attention, three studies showed that exercise intervention had no effect on children's and adolescents' attention. Vera et al. found in the study that students aged 10-13 years were subjected to 12 min low and medium intensity comprehensive exercise intervention in the classroom. The results showed that students' selective attention level had not been improved; The author said that the reason for the inconsistency with the results of other studies may be due to the difference in exercise intensity and exercise duration, in which the heart rate is maintained at 61% at low to medium intensity; Only 39% of the duration was maintained in the medium to severe intensity area. Pirrie et al. showed that 40 9-10-year-old children had 45

minutes of moderate (maximum heart rate 65-74%), intense (maximum heart rate 75-90%) and more intense (> 91%) sports activities. The results showed that children's attention level had not been improved[12]. Cooper et al. Based on the high-intensity intermittent activity intervention, the study pointed out that 90 children aged 9-10 were intervened in basketball games for 60 minutes, and the average heart rate was  $158 \pm 11$  beats / min and  $hr_{max} 197 \pm 9$  beats / min. The results showed that the basketball game intervention did not improve children's attention concentration; High intensity intermittent intervention has higher requirements for children's physical quality, and participants with better health or higher level of physical activity can adapt better[14]. Therefore, children need to often participate in sports to enhance their physique, so that they can get better results through high-intensity intermittent intervention.

## 4. Effects of Long-term Exercise on Attention of Children and Adolescents

### 4.1. Study on the Significant Effect of Long-term Exercise Intervention on Children and Adolescents' Attention

In the study of long-term exercise intervention to improve the attention of children and adolescents, 8 single exercise interventions can improve the attention of children and adolescents. In the study of Jarraya et al., 45 6-year-old children were treated for 12 weeks (30 min) × The results show that Yoga improves the attention level of normal children and reduces the inattentive behavior of ADHD children. In the study of Alesi et al., 44 children underwent 24 weeks (75 min) × The results showed that football significantly improved the level of attention and stimulated simple technical elements in training[15]. Marianna et al. tested 46 8-year-old children for 24 weeks (75 min) × 2 times / week) football intervention, the results show that children's selective attention has been significantly improved[16], which is consistent with the intervention results of Alesi et al.. In the study of Telles et al., 98 children were treated for 12 weeks (45 min) × 5 times / week) yoga practice, the results show that yoga practice significantly improves children's attention level[17]. Spitzer et al. pointed out that 44 children were treated for 16 weeks (30 min) × The results showed that the attention level of children in dance practice was significantly higher than that in the control group[18]. Chaya et al. showed that 200 children aged 7-9 passed 12 weeks (45 min) × 6 times / week) yoga practice, it was found that the children in the yoga group scored higher in the attention test than those in the non exercise control group, and the attention scores of children with low-income families were significantly higher[19]. Adsiz et al. intervened in volleyball for 12 weeks (3 times / week) for 60 adolescents aged 11-12[20]. Through Boden attention test, volleyball significantly improved children's attention. Yin Xia showed that 59 children aged 5-6 years were treated for 12 weeks (60min) × The results showed that the attention stability of 6-year-old children was significantly higher than that of 5-year-old children, and the attention level of girls was significantly higher than that of boys at the same age.

Seven comprehensive sports interventions can improve the attention of children and adolescents. Reigal et al. conducted comprehensive exercise intervention (jumping and 20m running) for 1-3min and more than 3min on 119 10-year-old children. The results showed that exercise intervention for more than 3min was more effective in improving children's attention selectivity and concentration than exercise intervention for less than 3min. At the same time, there was a significant correlation between attention and physical quality. Xiong qiongpeng et al. pointed out that 129 10-year-old children were randomly assigned to three experimental groups of table tennis, badminton and martial arts for 24 weeks (90 min) × The results showed that the attention level of the three experimental groups was significantly higher than that of the control group. The research of Zach et al. showed that 123 6-year-old children conducted

9-week (once / week) directional cross-country and dance intervention experiments[21]. The results showed that children's attention level was significantly improved. Kong Jiuchun pointed out in the study that table tennis, children's fitness boxing and rope skipping with exercise intensity maintained at  $hr_{max}65\% - 75\%$  have significantly improved the attention stability of 120 children aged 6-11, of which the table tennis group has the most obvious improvement. Wu Guanghong et al. showed in the study that 143 children were randomly assigned to table tennis and football groups for exercise intervention with low intensity ( $hr_{105-130bpm}$ ) and medium intensity ( $130-150bpm$ ). The results showed that medium and low intensity table tennis significantly improved attention persistence and concentration, and the effect of medium intensity was better than that of low intensity; Football has a significant improvement on attention span. The influence of table tennis on attention stability increases gradually, while the influence of football on the contrary, decreases gradually.

A coordinated exercise intervention can improve the attention of children and adolescents. Heidi et al. pointed out in the study that 116 students had a 4-week recess ( $6min$ )  $\times$  5 times / week) coordinated exercise, the results show that the fifth grade students' level of focused attention has been significantly improved[22].

#### **4.2. Study on Long-term Exercise Intervention Does Not Improve Children's and Adolescents' Attention**

In the study that long-term sports intervention did not improve children's and adolescents' attention, two sports intervention had no effect on children's and adolescents' attention. Schmidt et al. pointed out that 104 children aged 8-10 years passed 2 weeks ( $10min$ )  $\times$  The results showed that sports activities did not improve children's attention concentration level [23]; The author said that this may be due to the small exercise intensity of sports activities and the relatively short duration of intervention. The exercise intervention under the condition of sports activities failed to reach enough intensity to stimulate the change of attention improvement. Another theoretical explanation is that children's cognitive level can be linked with mental work, Because the multimodal information of the external learning environment during exercise requires children's greater attention and concentration, it leads to a large consumption of their attention resources. Other studies have obtained the same results. In the study of Andrew et al., 58 11 year old children were randomly assigned to recess sports group and rest (reading) group for 4 weeks ( $10min$ )  $\times$  The results showed that there was no difference in the attention level between the two groups[24].

## **5. Discussion**

### **Acute exercise**

Budde et al. said in the study that acute moderate intensity exercise during recess can improve the attention level and academic performance of children and adolescents. Exercise intervention in this environment needs to have the characteristics of time length and medium intensity in the implementation of measures. Wu Guanghong pointed out that in the change of exercise intensity from low to high, moderate intensity aerobic exercise has a better effect on improving the ability of attention concentration than low intensity and high intensity. Suggestions on acute exercise intervention in children's and adolescents' attention: the main type of exercise intervention is aerobic running, followed by jumping movement, basketball, and finally dance, lower limb strength, power bicycle and so on; The duration of exercise intervention was 4-50 min ( $25.56 \pm 16.91$  min); The exercise intensity is medium and above ( $hr_{max}70-80\%$ ,  $HR > 139bpm$ ).

### **Long term exercise**



in pre puberty (6-12 years old), long-term exercise can effectively improve various qualities of children and adolescents' attention and have a positive impact on academic performance. Altenburg et al. said that the relationship between exercise load and the change of attention level is as follows: within a certain range, the stimulation of load increases the attention level, and the increase is more significant with the increase of load. When the load exceeds this range, the attention level will decrease, resulting in "abnormal phase". Sports suggestions for long-term sports intervention in children's and adolescents' attention: football and table tennis are the best types of sports intervention, followed by dance, yoga and martial arts, and badminton, rope skipping, orienteering, volleyball and other sports are the least; The period of exercise intervention was 4-24 weeks ( $14 \pm 5.73$  weeks); The frequency of exercise intervention was 2-7 times / week ( $3.4 \pm 1.58$  times / week); The duration of single exercise intervention was 6-90 min ( $45.46 \pm 22.52$  min); The exercise intensity is medium (hrmax65% - 75%, hr105-130bpm; 130-150bpm).

## 6. Conclusions and Suggestions

Many studies have proved that various forms of acute and long-term exercise with medium and high intensity can positively improve children's and adolescents' attention as a whole, and help to improve children's and adolescents' learning performance. Some studies show that acute and long-term exercise do not significantly improve the attention level of children and adolescents. On the whole, both acute and long-term exercise can positively improve the attention of children and adolescents.

Based on systematic combing, different exercise schemes, intervention populations, measurement methods and other characteristics were used in the included literature studies, and the relevant exercise variables in some of the included studies were incomplete, which affected the scientificity and accuracy of the review results to a certain extent, and needed to be continuously supplemented and improved in the follow-up studies. Future research can further explore how sports intervention variables and their relationship can be combined and matched optimally to promote children's and adolescents' attention, further study the feasibility and effectiveness of implementation in the school environment, and finally integrate them into the academic curriculum to improve students' academic performance. At present, a reasonable and scientific attention prescription formulation paradigm for children and adolescents has not been formed, which needs more in-depth and systematic research to determine the most effective model for optimizing sports to improve children and adolescents' attention.

## References

- [1] Reigal RE , Moral-Campillo L , Rocío Juárez-Ruiz de Mier, et al. Physical Fitness Level Is Related to Attention and Concentration in Adolescents[J].Frontiers in Psychology,2020,11(2):110.
- [2] Kulinna PH , Stylianou M , Dyson B ,et al. The Effect of an Authentic Acute Physical Education Session of Dance on Elementary Students' Selective Attention[J].BioMed Research International,2018,(2-5):1-8.
- [3] Janssen M , Chinapaw M JM , Rauh SP ,et al. A short physical activity break from cognitive tasks increases selective attention in primary school children aged 10–11[J].Mental Health & Physical Activity,2014, 7(3):129-134.

- [4] Gallotta MC , Emerenziani GP , Franciosi E , et al. Acute physical activity and delayed attention in primary school students[J].Scand J Med Sci Sports,2015,25(3):331-338.
- [5] Niederer I , Kriemler S , Gut J ,et al. Relationship of aerobic fitness and motor skills with memory and attention in preschoolers (Ballabeina): A cross-sectional and longitudinal study[J].Bmc Pediatrics,2011, 11(1):34-43.
- [6] Graf C , Koch B , Klippel S ,et al. Correlation between physical activities and concentration in children - Results of the CHILT project[J].Deutsche Zeitschrift für Sportmedizin,2003,54(9):242-246.
- [7] Altenburg TM , Chinapaw MJ , Singh AS. Effects of one versus two bouts of moderate intensity physical activity on selective attention during a school morning in Dutch primary schoolchildren: A randomized controlled trial[J].Journal of Science & Medicine in Sport,2016,19(10):820-824.
- [8] Tine, Michele. Acute aerobic exercise: an intervention for the selective visual attention and reading comprehension of low-income adolescents[J].Frontiers in Psychology,2014,5(8):575-594.
- [9] Kubesch S, Walk L, Spitzer M,et al. A 30-minute physical education program improves students' executive attention[J]. Mind, Brain, and Education,2009,3(4): 235-242.
- [10] Caterino, Maria, C,et al. Effects of two types of activity on the performance of second-, third-, and fourth-grade students. [J]. Perceptual & Motor Skills,1999,89(1):245-246.
- [11] Pirrie AM , Lodewyk KR. Investigating links between moderate-to-vigorous physical activity and cognitive performance in elementary school students[J]. Mental Health & Physical Activity, 2012, 5(1): 93-98.
- [12] Palmer KK, Miller MW, Robinson LE. Acute exercise enhances preschoolers' ability to sustain attention[J]. J Sport Exerc Psychol,2013,35(4):433-437.
- [13] Schmidt M , Egger F , Conzelmann A. Delayed positive effects of an acute bout of coordinative exercise on children's attention[J].Percept Mot Skills,2015,121(2):431-446.
- [14] Cooper SB, Dring KJ, Morris JG,et al. High intensity intermittent games-based activity and adolescents' cognition: moderating effect of physical fitness[J]. BMC Public Health, 2018,18(1):1-14.
- [15] Alesi M , Bianco A , Luppina G ,et al. Improving Children's Coordinative Skills and Executive Functions: The Effects of a Football Exercise Program[J].Perceptual & Motor Skills,2016,122(1):27-46.
- [16] Marianna A , Antonino B , Johnny P ,et al. Motor and cognitive growth following a Football Training Program[J]. Frontiers in Psychology,2015,6(10):1627-1634.
- [17] Telles S, Singh N, Bhardwaj AK,et al. Effect of yoga or physical exercise on physical, cognitive and emotional measures in children: a randomized controlled trial[J].Child and adolescent psychiatry and mental health,2013,7(1):1-16.
- [18] Spitzer US , Hollmann W. Experimental observations of the effects of physical exercise on attention, academic and prosocial performance in school settings[J]. Trends in neuroscience & Education, 2013,2(1):1-6.
- [19] Chaya MS , nagendra H , Selvam S ,et al. Effect of Yoga on Cognitive Abilities In Schoolchildren from a Socioeconomically Disadvantaged Background: A Randomized Controlled Study[J]. Journal of Alternative & Complementary Medicine,2012,18(12):1161-1167.
- [20] Adsiz E , Dorak F , Ozsaker M ,et al. The influence of physical activity on attention in Turkish children[J]. Healthmed,2012,6(4):1384-1389.
- [21] Zach S, Inglis V, Fox O,et al. The effect of physical activity on spatial perception and attention in early childhood[J].Cognitive Development,2015,36(8):31-39.

- [22] Heidi BH , Schnabel CK , Thomas T ,et al. Impact of Coordinated-Bilateral Physical Activities on Attention and Concentration in School-Aged Children[J]. Biomed Research International, 2018, 2018,4:1-7.
- [23] Schmidt M , Benzing V , Wallman-Jones A ,et al. Embodied learning in the classroom: Effects on primary school children's attention and foreign language vocabulary learning[J]. Psychology of Sport and Exercise, 2019, 43(9):45-54.
- [24] Andrew, N, Wilson,et al. The impact of 10-minute activity breaks outside the classroom on male students' on-task behaviour and sustained attention: a randomised crossover design[J]. Acta Paediatrica,2016, 105(4):181-188.