

IMPACTS OF SOCCER ON EXECUTIVE FUNCTION IN BOYS WITH ADHD



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IMPACTOS DO FUTEBOL NA FUNÇÃO EXECUTIVA DE MENINOS COM TDAH

IMPACTOS DEL FÚTBOL EN LA FUNCIÓN EJECUTIVA DE LOS NIÑOS CON TDAH

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ABSTRACT

Introduction: Attention Deficit Hyperactivity Disorder (ADHD) is a neurobiological disorder of genetic causes that appears in childhood. The main manifestations are inattention, hyperactivity, and emotional impulsivity. It is often accompanied by cognitive impairments and learning disabilities that seriously affect children's life, academic and social functions. **Objective:** Explore the impacts of soccer practice on executive function in boys with ADHD. **Methods:** Boys were selected from first and second graders in a public elementary school. They were randomly divided into an experimental group and a control group, and 8 boys in the control group were recruited according to the age difference of less than half a year. All children participated in various school sports activities, and the experimental group was added to soccer practice for 6 weeks. **Results:** There was no significant difference in cognitive subfunction between the soccer activity group, the conventional physical education teaching activity group, and the control group; however, the interaction between time and group factors proved to be significant $P(4142) = 6.296, F < 0.01$, it can be understood that the effect of the time factor on cognitive flexibility varies with different groups. **Conclusion:** The six-week soccer practice intervention can improve the executive function of 6-8-year-old boys with ADHD, especially inhibition control and cognitive flexibility, but does not represent a significant effect on memory. **Level of evidence II; Therapeutic studies - investigating treatment outcomes.**

Keywords: Soccer; Attention Deficit Disorder with Hyperactivity; Executive Function.

RESUMO

Introdução: O Transtorno de Déficit de Atenção com Hiperatividade (TDAH) é um transtorno neurobiológico de causas genéticas que aparece na infância. As principais manifestações são desatenção, hiperatividade e impulso emocional. Muitas vezes é acompanhado por deficiências cognitivas e dificuldades de aprendizagem que afetam seriamente a vida, as funções acadêmicas e sociais das crianças. **Objetivo:** Explorar os impactos da prática do futebol sobre a função executiva em meninos com TDAH. **Métodos:** Os meninos foram selecionados entre os alunos da primeira e segunda séries de uma escola primária pública. Eles foram divididos aleatoriamente em grupo experimental e grupo de controle, e 8 meninos do grupo de controle foram recrutados de acordo com a diferença de idade inferior a meio ano. Todas as crianças participavam de várias atividades esportivas escolares, e ao grupo experimental foi somada a prática do futebol durante 6 semanas. **Resultados:** Não houve diferença significativa na subfunção cognitiva entre o grupo de atividade futebolística, o grupo de atividade de ensino de educação física convencional e o grupo de controle; porém a interação entre os fatores de tempo e fatores de grupo revelou-se significativa $P(4142) = 6,296, F < 0,01$, pode-se entender que o efeito do fator tempo sobre a flexibilidade cognitiva varia com os diferentes grupos. **Conclusão:** a intervenção de seis semanas de prática de futebol pode melhorar a função executiva dos meninos de 6-8 anos de idade com TDAH, especialmente o controle da inibição e a flexibilidade cognitiva, mas não representa efeito significativo sobre a memória. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Futebol; Transtorno do Déficit de Atenção com Hiperatividade; Função Executiva.

RESUMEN

Introducción: El Trastorno por Déficit de Atención e Hiperactividad (TDAH) es un trastorno neurobiológico de causa genética que aparece en la infancia. Las principales manifestaciones son la falta de atención, la hiperactividad y la impulsividad emocional. Suele ir acompañada de deficiencias cognitivas y problemas de aprendizaje que afectan gravemente a la vida de los niños y a sus funciones académicas y sociales. **Objetivo:** Explorar los impactos de la práctica del fútbol en la función ejecutiva en niños con TDAH. **Métodos:** Se seleccionaron niños entre los alumnos de primer y segundo grado de una escuela primaria pública. Se dividieron aleatoriamente en grupo experimental y grupo de control, y se reclutaron 8 chicos del grupo de control según la diferencia de edad de menos de medio año. Todos los niños participaron en diversas actividades deportivas escolares, y al grupo experimental se le añadió la práctica del fútbol durante 6 semanas. **Resultados:** No hubo diferencias significativas en la subfunción cognitiva entre el grupo de actividad de fútbol, el grupo de actividad de enseñanza de la educación física convencional y el grupo de control; sin embargo, la interacción entre los factores tiempo y grupo resultó ser significativa $P(4142) = 6,296, F < 0,01$, puede entenderse que el efecto del factor tiempo sobre la flexibilidad cognitiva varía con los diferentes



grupos. **Conclusión:** La intervención de seis semanas de práctica de fútbol puede mejorar la función ejecutiva de los niños de 6 a 8 años con TDAH, especialmente el control de la inhibición y la flexibilidad cognitiva, pero no representa un efecto significativo en la memoria. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

Descriptores: Fútbol; Trastorno por Déficit de Atención con Hiperactividad; Función Ejecutiva.

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INTRODUCTION

According to the data of the national physical health survey of primary and middle school students, the physical quality development situation of young students in China is grim and worrying.¹ The rate of reaching the standard in the physical fitness test of young students is low, and the detection rate of poor eyesight test of students is constantly high. ADHD is mainly manifested by the age-related easy distraction of attention, reduced attention span, excessive activity without distinction, emotional impulsivity, cognitive impairment and learning difficulties, and normal or nearly normal intelligence.² The disease starts before school and presents a chronic process. It not only affects children's school, family and life outside school, but also easily leads to children's persistent learning difficulties, behavioral problems and low self-esteem. Cross cultural studies have found that ADHD occurs in almost all countries and cultural backgrounds.³ At present, the research on executive function is mostly from the perspective of neuropsychology. If there is an obstacle in executive function, it will inevitably lead to obvious defects in neuropsychology, such as planning, concept formation, abstract thinking, decision-making, cognitive flexibility, use of feedback, sequencing of events according to time sequence, and monitoring of one's own actions.⁴ Domestic researchers have observed that football can promote the development of executive function among preschool and school-age children^{5,6}, and it has not been reported whether football can also improve the executive function of ADHD children^{7,8}. Therefore, this study selects ADHD boys as the research object to explore the influence of football on the executive function of ADHD boys, and provide objective basis for finding appropriate exercise intervention programs for ADHD children.⁹

A theoretical review of attention deficit hyperactivity disorder

Study on executive function of children with attention deficit hyperactivity disorder

968 students in grade one and grade two of a public primary school in Jingmen were selected as screening objects. First, they were screened by Conners child behavior scale and ADHD symptom rating scale (Swanson, Nolan, and Pelham scale, Forth Edition, SNAP-IV) (parent questionnaire). During the experimental intervention period, the ADHD waiting group and the normal control group only participated in the daily physical activities of the school, mainly including 20 minutes / time, 2 times / day of recess exercises, and 40 minutes / time, 4 times / week of physical education. The main content of physical education is to let students run, jump, jump rope and other physical exercises. The ADHD experimental group not only participated in the daily sports activities of the school, but also carried out a 6-week football intervention. Task switching means that M can be switched flexibly when completing tasks according to different problems and task requirements. Specifically, it includes changing existing views, flexibly adapting to the changed environment, admitting mistakes, and seizing unexpected opportunities. In this experiment, E-Prime 2.0 executive function test software was used for psychological measurement. E-Prime 2.0 software can present text,

images, sounds and other stimuli, and provide detailed time information and event details. It is specially designed for psychological experimental research, and the time accuracy of psychological experiments is optimized. Arrange students to enter the test environment before and after the exercise. Before the test, the instructor will explain the instructions and arrange a pre-test. If any students are slow to master, the teacher will give individual guidance. After all the philosophy students are familiar with the testing software, they will test it uniformly. Each test is conducted in a unified environment. After the test, the tester copies the data and processes it centrally.

Experimental method

In childhood, the body and mind are in the stage of rapid development, and it is also one of the key periods of executive function development. Incomplete executive function development will affect the work, study and life of the whole life. The children of this age group have mastered basic scientific and cultural knowledge. Under the guidance of the tester, they have a relatively good understanding of the executive function test program, and can independently complete the psychological test tasks of this experiment. Moreover, the students of this grade can persist in completing certain load sports projects with the help and guidance of the researcher. The independent variables are the groups and the measurement time, wherein the groups include the football activity group, the regular physical education teaching activity group and the control group, and the measurement time includes the pre-test, the middle test and the post test; The dependent variable is the score of each sub function of the executive function. The test place is in a spacious, bright and quiet room with compartments.

The study is Purely observational studies which no need to registry ID of ICMJE, and all the participants were reviewed and approved by Ethics Committee of Jingchu University of Technology, China (NO. 2021033)

Three kindergarten teachers and three examinees are responsible for a task in pairs, and the tasks are not interfered with each other, and the subjects are measured one by one. First of all, 74 children who participated in this research were divided into football activity group (26 children), routine physical education activity group (24 children) and control group (24 children), and the level of each child's executive function was measured one week before the exercise. After that, different groups perform different tasks according to requirements. The routine physical education activity group arranges four kindergarten teachers, whose main goal is to develop and improve children's basic movement ability through teaching; The control group arranged two kindergarten teachers to lead the children to watch children's videos and other activities in the classroom in the same time period. The pre-test results of children's executive function in football activity group, routine physical education activity group and control group were analyzed by one-way ANOVA, in order to find out whether the three groups of children's executive function is at the same level. The results are shown in Table 1.

Before inhibition control, $F(2, 71) = 0.404, P = 0.669 > 0.05$; Working memory pretest $K(2, 71) = 0.095, P = 0.910 > 0.05$; Cognitive flexibility pretest $K(2, 71) = 0.185, F = 0.832 > 0.05$. This result can show that there is

no significant difference among the three groups of children in the three sub functions of executive function, that is, the executive functions of the three groups of children before the experiment are homogeneous.

RESULTS AND TESTS

Comparison of inhibition and control function of subjects in each group before and after football intervention

In the pre-test, there was no significant difference between the football activity group and the routine physical education activity group ($P = 0.752 > 0.05$). There was no significant difference between the football activity group and the control group ($P = 0.954 > 0.05$). There is no significant difference between the routine physical education activity group and the control group, $P = 0.965 > 0.05$. The above results can explain that the three groups are homogeneous in inhibitory control sub-function in pretest; In the post-test, there was a significant difference between the football activity group and the routine physical education activity group, with the score of the former being higher than that of the latter. There is a very significant difference between the football activity group and the control group, $P = 0.000 < 0.01$, and the score of the former is higher than that of the latter. There is no significant difference between the routine physical education activity group and the control group ($P = 0.149 > 0.05$). As shown in Figure 1, after multiple intra-group comparisons of the inhibition and control sub-functions of football activity group, routine physical education activity group and control group, it is found that:

For the football activity group, there was a significant difference between the post-test results of the inhibition control sub function and the middle test results ($P = 0.000 < 0.01$), and the post-test results were better than the middle test results; There was a significant difference between the post test results and the pre test results ($P = 0.000 < 0.01$), and the post test results were better than the pre test results; There is a very significant difference between the results of the intermediate test and the results of the previous test, and the results of the intermediate test are better than the results of the previous test. The above analysis mainly discusses the impact of football activities and regular sports teaching activities on children's executive function and the reasons for the difference between the two, that is, the actions, techniques and rules of football sports are more complex than those of regular

sports teaching activities, and require more cognitive participation of children, so the promotion effect is better. However, the author believes that in addition to the discussion from the aspects of movement and technology, the social connotation of the sports intervention program can not be ignored in its impact on children's executive function. The most prominent is the difference in the cooperative characteristics of the two sports intervention programs, and the promotion effect on children's peer communication ability is different, and the improvement effect of their executive function is also different. For the control group, there was no significant difference between the post test results and the intermediate test results of the inhibition of the control sub function ($P = 0.999 > 0.05$); There was no significant difference between the post test results and the front test results ($P = 0.791 > 0.05$); There was no significant difference between the results of the intermediate test and the results of the pre-test ($P = 0.67 > 0.05$).

Research results and analysis

The lower the score of time switching ability, the faster the average switching speed and the more flexible the switching. It can be seen from the figure that children's time switching scores are slightly lower than those of normal children, although the difference is not statistically significant. That is to say, children's switching ability is no worse than that of normal children, whether they are young or old. This is inconsistent with the results obtained by researchers using Wisconsin card task in the past. It shows that there are obvious obstacles in conflict resolution ability of patients with frontal lobe injury in Stroop color words test, Wisconsin card sorting test and other experiments. At the same time, some studies have found that executive dysfunction is positively correlated with the degree of frontal cortex injury, and some researchers even anatomically define executive process as a system located in frontal lobe. The results of the intra group test showed that the main effect of the time factor was very significant. $F(4142) = 6.296, P < 0.01$, which can explain that the effect of the time factor on cognitive flexibility varies with the groups. The results of the intra group test showed that the main effect of time factor was very significant, i.e. $F(2142) = 52.089, P < 0.01$, which could indicate that the child's cognitive flexibility subfunction changed with time; The main effect of group factors is not significant, i.e. $F(2, 70) = 1.562, P = 0.217 > 0.05$, which indicates that there is no significant difference in cognitive flexibility subfunction between the football activity group, the conventional physical education teaching activity group and the control group; the interaction between time factors and group factors is very significant. $P(4142) = 6.296, F < 0.01$, It can be explained that the effect of time factor on cognitive flexibility varies with different groups. As shown in Figure 2.

From the above studies, it can be seen that the positive effects of these two exercise programs on the three sub functions of children's executive function increase with the increase of time. This result verifies hypothesis

Table 1. Executive function level of three groups of children in experiment.

Subfunction	Football team	General group	Control group	F	P
Control pretest	18.246±1.725	18.312±1.775	18.561±1.352	0.425	0.867
Working memory pretest	3.145±0.256	3.815±0.334	3.146±8.564	0.341	0.534
Cognitive flexibility pretest	8.2434±1.767	8.024±1.615	8.2434±1.443	0.278	0.834

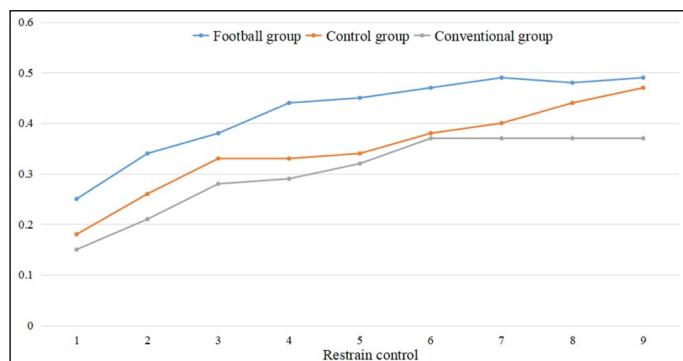


Figure 1. The trend chart of the effect of different exercise programs on children's inhibitory control sub-function changes with time.

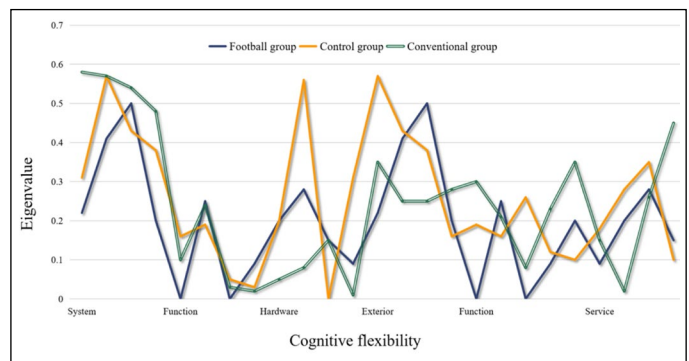


Figure 2. Trend chart of effect of different exercise schemes on children's cognitive flexibility subfunction over time.

1 of this study; There are differences in the promotion effect between the two sports programs. The specific performance is as follows: in the two sub functions of inhibition control and cognitive flexibility, the improvement effect of the football activity group is better than that of the conventional sports teaching group; However, in terms of working memory sub function, there is no significant difference between the football activity group and the conventional sports teaching activity group. This result is not completely consistent with hypothesis 2. In this study, after 6 weeks of football intervention, the experimental group's immediate memory ability improved, but it was still lower than that of normal boys, while the delayed memory ability did not change significantly. In addition, the study also suggests that only the training that requires a lot of attention and memory will have a positive impact on children's working memory. How to enrich football practice programs or combine them with other forms of sports to effectively stimulate and improve ADHD children's working memory ability needs further exploration.

CONCLUSION

We selected ADHD children as subjects, and applied neuropsychological methods to study ADHD children's executive dysfunction. The results of this study showed that ADHD children took longer time to complete card C than normal children compared with normal control

children. Therefore, this study attempts to further explore the influence of exercise intervention on children's executive function on the basis of previous studies, in order to provide reference for promoting the development of children's executive function. Future research can explore the effect of exercise intervention on ADHD children of different genders, ages and subtypes by increasing the sample size; In the process of exercise intervention, we can further compare the intervention effects of different exercise intensities through the use of heart rate monitoring equipment. And the damage characteristics of different subtypes are different. Consistent with the report of ganslerda et al. ADHD is mainly characterized by inattention, hyperactivity, impulsivity and willfulness, often accompanied by learning difficulties. According to the results of this study, it is suggested that kindergarten teachers and relevant leaders recognize the important value of children's physical and mental development, pay more attention to children's physical education, and invest in the training and introduction of relevant teachers, equipment and funds. It can promote the improvement of children's advanced cognitive function while cultivating children's basic motor ability.

The author declare no potential conflict of interest related to this article

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