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THE RELATIONSHIP BETWEEN SPORTS PRACTICE AND COGNITIVE ASPECTS IN YOUNG SCHOOLCHILDREN: A CROSS-SECTIONAL STUDY

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ABSTRACT

Introduction: Children and adolescents have been targets of physical inactivity due to the convenience provided by the advancement of technology, thus leading to not only physical but also cognitive deficits. Thus, the practice of sport has been a strategy to reverse the situation and form a healthy citizen in its entirety, as it has shown benefits in physical, social and executive functions. Objective: The aim of this study was to compare cognitive performance between individuals who practiced sports and those who didn't in order to verify possible differences. Materials and Methods: A cross-sectional study with a sample of seventy-five (75) young people of both sexes aged between 10 and 14 years divided into two groups: Group I (Non-Sport) made up of students who only took part in Physical Education at school and Group II (Sport) made up of individuals who, in addition to Physical Education, practiced sports. Skeletal age was used to estimate the maturational stage of the subjects, and the "Go/No-Go" cognitive test was used to check the Inhibitory Control of the research participants. Results: Group II showed better cognitive performance by obtaining higher results in the Go/No-Go test, however there was no correlation between skeletal age and cognitive aspects. Conclusion: Young people who play sport do better in cognitive tests than those who don't, regardless of their stage of maturity. This suggests that practicing sport is beneficial for concentration, attention span and inhibition of stimuli in young people.

Key words: Sport. School Youth. Inhibitory Control. Development.

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RESUMO

Relação da prática esportiva e aspectos cognitivos em jovens escolares: um estudo transversal

Introdução: Crianças e adolescentes tem sido alvos da inatividade física devido ao comodismo proporcionado pelo avanço da tecnologia, levando assim a déficits não somente físicos como também cognitivos; Assim, a prática do esporte tem sido uma estratégia para reverter o quadro e formar um cidadão saudável integralmente, pois tem apresentado benefícios em aspectos físicos, sociais e nas funções executivas. Objetivo: A pesquisa teve como objetivo comparar o desempenho cognitivo entre indivíduos praticantes e não praticantes de esportes para verificar possíveis diferenças. Materiais e Métodos: Estudo transversal que contou com uma amostra de setenta e cinco (75) jovens de ambos os sexos com a faixa etária de 10 a 14 anos divididos em dois grupos: Grupo I (Não-Esporte) composto por escolares que realizavam apenas a Educação Física na escola e Grupo II (Esporte) formado por indivíduos que além da Educação Física eram praticantes de iniciação esportiva. Utilizou-se da idade esquelética para estimar o estágio maturacional dos sujeitos, e o teste cognitivo “Go/No-Go” para verificar o Controle Inibitório dos participantes da pesquisa. Resultados: O Grupo II apresentou melhor desempenho cognitivo ao obter resultados superiores no teste Go/No-Go, entretanto não houve correlação entre idade esquelética e os aspectos cognitivos. Conclusão: Jovens praticantes de esporte apresentam melhor resultado em teste cognitivo que os não praticantes, independente do estágio maturacional. Sugere-se assim que a prática do esporte é benéfica para a concentração, capacidade de atenção e inibição de estímulos de juvenis.

Palavras-chave: Esporte. Jovens Escolares. Controle Inibitório. Desenvolvimento.

INTRODUCTION

Over the years, society has become increasingly sedentary, due to factors such as the advance of technology, which provides human beings with convenience and thus a consequent decline in health (Cruz and Azevedo, 2018).

This phenomenon has reached the most diverse age groups, as statistics show that children and adolescents in the current century have decreased their levels of physical activity (Bacil et al., 2016; Katzmarzyk et al., 2016), which leads to deficits in the various domains of the human being, being physical, social and also psycho-cognitive (Wu et al., 2017; Flashner et al., 2020).

It is well established in the literature that physical inactivity has negative effects on individuals who are hostages to this phenomenon (Horacio et al., 2021) because individuals who are constantly at rest experience non-beneficial physiological changes such as reduced blood flow in the body and variation in glycemic control in both central and peripheral regions, less blood movement which results in lower cerebral oxygenation, atrophy of regions of the brain (decrease in white matter) such as the frontal cortex, parietal, medial temporal lobe, hippocampus which is configured as a smaller brain volume (Zavala-Crichton et al., 2020).

Thus, in cognitive aspects, the following results are obtained: insufficient storage and association of information, memory, attention span, concentration and filtering of distractors (Falck et al., 2017).

Considering that the human being must be seen as a whole, sport presents itself as a strategy for the development of a healthy individual in its entirety, because in addition to acting in the social sphere of leisure and providing improved health and physical fitness, sports training produces benefits in cognitive aspects by improving brain function, especially executive functions (Paiano et al., 2019; Ding et al., 2021) due to the constant movement producing the formation of new blood vessels (angiogenesis), an increase in neurotrophin and the formation of new neurons (Gunnell et al., 2019).

In support of this hypothesis, recent studies report that young individuals who practice systematic exercise have a better quality of life in all aspects due to better physiological functioning of the body, and consequently a higher level of concentration in their activities (Koble et al., 2022).

In addition, reviews of the literature show that in team sports, due to the diversity of stimuli, adverse circumstances and constant changes in activities, there is a positive psychophysiological imbalance (Paiano et al., 2019; Ding et al., 2021) which promotes improvement in executive functions, especially Inhibitory Control (Liu et al., 2020).

Given the above, the research hypothesis is that young people who practice sport will have better results in cognitive levels compared to those who do not practice sport.

The general aim of this study is to analyze the association between sports practice and cognitive aspects in schoolchildren aged 10 to 14. The problem of the study is centered on verifying whether there is a difference in cognitive aspects between individuals who practice sports and those who don't, and investigating the relationship between Biological Maturation and cognitive performance in young people who practice sports and those who don't.

MATHERIALS AND METHODS

This was an observational study with a quantitative cross-sectional design. The study sample consisted of 75 volunteers of both sexes; these individuals were public school students aged between 10 and 14 years old, all residents of the municipality of Natal.

From this sample, two groups were divided: Group I (Non-Sport) made up of 37 young people who only practiced school physical education, and Group II (Sport) made up of 38 young people who were active in sports initiation schools in addition to practicing school physical education.

The following terms were adopted as inclusion criteria: 1) present the informed consent form (ICF) and the assent form signed by the parents/guardians; 2) not present physical limitations that prevent practice or cognitive limitations that prevent the tests. All subjects who did not comply with all the required steps were excluded.

Ethical Considerations

The research was analyzed and approved by the Ethics and Research Committee - CEP of the Federal University of Rio Grande do Norte (CAEE:

98795318.3.0000.5537; Opinion: 3.390.644) in accordance with Resolution 466/12 of the National Health Council, on 12/12/2012, strictly respecting the international ethical principles in the Declaration of Helsinki (2000).

Protocols and Instruments

Bone Age

The bone age protocol described by Cabral et al., (2016) was used, where bone age is defined using the following equation:

(ii) Skeletal age = -11.620 + 7.004 × (Height $_{(m)}$) + 1.226 × (Dsex) + 0.749 × (chronological age $_{(years)}$) - 0.068 × (Triceps skinfold $_{(mm)}$) + 0.214 × (corrected biceps brachii circumference $_{(cm)}$) - 0.588 × (humerus diameter $_{(cm)}$) + 0.388 × (femoral diameter $_{(cm)}$)

Dsex: for males = 0; for women = 1. (m): meters. (mm): millimeters. (cm) centimeters.

To find the value of the corrected biceps brachii circumference we use the following equation:

(ii) Corrected biceps brachii circumference $_{(cm)}$ = Contracted biceps brachii circumference $_{(cm)}$ - (Triceps skinfold $_{(mm)}$ / 10)

(mm): millimeters. (cm) centimeters.

Chronological age

Chronological age in months was determined by adding up the individual's months of life, from the date of birth to the date of analysis in this study. In this way, the sum of the months of life was divided by 12, resulting in their chronological age in years (Malina and Bouchard, 2002).

For the anthropometric assessments: body mass was measured using a Filizola® digital scale with a capacity of up to 150 kg and a variation of 0.10 kg; height was measured using a Sanny® stadiometer with a precision of 0.1 mm; skinfolds using a Sanny® adipometer; perimeter using a Sanny® anthropometric tape; and a Sanny® pachymeter for bone diameters. The protocol followed the ISAK standard.

Determining the stage of maturity

Based on this, the maturational component classified individuals into a delayed, normal or accelerated maturational state. This classification is determined by subtracting the individual's bone age in months from their chronological age in months. Once the calculation has been made, when the individual is between +1 and -1 in relation to the sum of their chronological age months, they are considered normal, above +1 they are considered accelerated and below -1 they are considered delayed in relation to their chronological age.

Cognitive test protocols

Go/No Go Test - The test used was Go/No Go, which is characterized as follows: The child was shown an audio recording with 60 random numbers.

They were instructed to say "yes" to each number they heard, with the exception of the number 8, when they were strategically asked to remain silent. Go/No Go is a model test that allows us to observe errors of omission (when the participant doesn't respond when expected to) and commission (when the participant responds when expected not to). Before starting the test for the researcher's analysis, a familiarization round was carried out for the young schoolchildren to understand. All the results were evaluated by a psychologist (Gonçalves et al., 2017).

Statistical analysis

Descriptive statistics were used to check the normality of the data using the Kolmogorov-Smirnov test. The data was analyzed using the Statistical Package for the Social Science - SPSS version 20.0. A significance level of $p<0.05$ was established. As for the correlation between the results of the Go-no-go Test and biological maturation, Spearman's test was used to analyze the magnitude (Hopkins, 2000): r<0.1 trivial; 0.1-0.3 small; 0.3-0.5 moderate; 0.5-0.7 strong; 0.7-0.9 very strong; 0.9-0.99 almost perfect; and 1.0 perfect. The Wilcoxon test was used to compare the groups (sports and non-sports). The size of the effect between the differences was analyzed by Cohen's d and interpreted by magnitude (Espírito Santo and Daniel, 2017): insignificant <0.19; small 0.20-0.49; medium 0.50-0.79; large 0.80-1.29; very large <1.30. Data were expressed as median and interquartile range. All analyses were carried out using the free R software (version 3.3.5; R Foundation for Computational Statistics®, Vienna, Austria). The level of significance considered was $p<0.05$ for all analyses.

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RESULTS

Table 1 below shows the characteristics of the sample. An analysis of the table shows that there were no significant differences when comparing chronological age between the sport and non-sport groups (Male: p=0.6. Female: p=0.53). In addition, the subjects in both groups (Sport and Non-Sport) were at a delayed maturational stage.

Table 1 - Characterization of the sample.

Variables	Sport		No Sport	
	Male	Female	Male	Female
N° (%)	16 (43%)	22(57%)	20 (54%)	17 (46%)
	Median (interquartile range)			
Chronological age	11.8 (1.8)	12.4 (2.0)	10.9 (0.6)	10.6 (0.5)
Bone age	8.8 (2.0)	11.1 (2.5)	7.9 (1.5)	8.6 (1.8)
Biological Maturation	-2.7 (1.9)	-1.5 (1.2)	-2.8 (1.0)	-2.3 (1.6)
Stature (cm)	149.7 (10.8)	155.5 (9.4)	144.0 (7.8)	145.6 (8.5)

Legend: N: absolute number. (%): Percentage. (cm): centimeters. Source: Data collected by the authors.

Table 1 shows that in the correlation analyses, biological maturity was not related to the results of the Go / no go test (Total sample: r=0.35; p=0.1. Female: r=0.30; p=0.3. Male: r=0.25; p=0.5).

Table 2 shows that in the total sample, those who practiced sport had better results than those who didn't practice sport in relation to the results of the Go / no go test (Effect size: 0.93; 95% CI: [0.45; 1.42]).

Table 2 - Go-no-go test score.

Variables	Sports Group		Non-Sport Group		p value
Total sample					
	MD	IIQ	MD	IIQ	
Score Go-no-go	58*	3	55	5	0,0001

Legend: MD = Median; IIQ = Interquartile Range. * = Statistically higher. Source: Data collected by the authors.

DISCUSSION

Analyzing the statistical data from the total sample, which contrasted male and female sports practitioners with male and female non-sports practitioners, confirmed the initial hypothesis, finding that the group of sports practitioners obtained better results in the Cognitive Test than the non-sports group. It was also found that there was no relationship between Biological Maturation and the cognitive performance of both groups, since both were classified as delayed and obtained different results.

It is therefore notable that the systematic practice of sport has a direct relationship with the cognitive aspects of young people of both sexes between the ages of 10 and 14, thus showing that it is an activity that not only brings benefits in physical, motor and social aspects, but has great influence and importance for society as it acts on the aspects of raising potential in the processes of mental faculties (Silva et al., 2021).

This influence of sport on cognitive aspects is justified because due to the diversity of stimuli, the continuous changing situations of the game, as well as the complexity of solving tasks, it produces physiological stress and a high demand on the Executive Functions of practitioners, which improves the attentional skills of children and adolescents (Paiano et al., 2019).

From this perspective, Liu et al., (2020) point out that sports, in addition to being occupations that promote engagement, because they are activities that use Open Motor Skills, are associated with a significant improvement in the 3 main Executive Functions which are inhibitory control, working memory

and cognitive flexibility in children and adolescents; In addition, in his review he presents data that the practice of exercise on a continuous basis presents exponential optimization of benefits for cognitive aspects in a cumulative way, which has already been accepted by international physical activity guidelines (Schmidt et al., 2015).

Corroborating the findings of the present study, which affirms the relationship between sports practice and cognitive aspects in young people, Gunnell et al, (2019) in a systematic review found that the vast majority of sports practices were directly related to the 3 main domains of cognitive control (Inhibitory Control, Working Memory and Cognitive Flexibility) in children and adolescents; he also stated that due to the complex, varied and dynamic movements, interventions based on sports training programs enhance the development of individuals' executive functions; He also reiterates that the greater the duration and frequency of sports practice, the greater the influence on improving the three executive functions, as it will produce a greater number of stimuli due to the amount of information provided for the choice process (Contreras-Osorio et al., 2021).

Silva et al., (2021) in their systematic review aimed to analyze the influence of a specific team sport on the psycho-cognitive aspects of children and adolescents. The results of their wide-ranging study are in line with our study, given that the results showed beneficial effects of practicing soccer on the executive functions and selective attention of children and adolescents.

Giordano et al., (2021) hypothesized in their research that there are some organized bodily practices that reflect greater benefits in cognitive aspects than others due to the movements and demands involved in the activity. In their study comparing 3 groups, one being the Martial Arts Fighters Group, the second group as Collective Sports practitioners and the third Group with Sedentary Individuals, the results showed that the Martial Arts practitioners obtained a better cognitive performance than the other two groups in the following executive function tasks: Inhibitory Control, Working Memory, verbal and auditory distributed attention, verbal fluency and decision making.

Since sport is a systematized practice, there are plausible pretexts in the physiological aspects for its relationship in the psycho-cognitive panorama.

Merege et al., (2014) in their study provides an update showing several explanations: Firstly, the practice of dynamic motor activities increases blood flow in the various regions of the body favoring a greater supply of oxygen and nutrients such as carbohydrate and creatine, as well as thus promoting a greater energy supply (ATP) to the Central Nervous System, specifically in the areas of the cortex that are responsible for cognitive tasks. Exercise is also capable of increasing the synthesis of synaptic neurotransmitters and activating brain catecholamines, which are responsible for managing nerve impulses. Contreras-Osorio et al., (2021) also point out that exercise acts on cognition by increasing monoaminergic transmission, greater neurotrophic signaling and connectivity in neuronal networks.

Not least, sport as a systematized practice has the power to adapt the brain structure and produce synaptic plasticity due to a higher level of brain activity, because through IGF-1 (somatomedin C) it modulates acetylcholine levels such that it induces neurogenesis (formation of new neurons), as well as mediated by the hormone VEGF (Vascular Endothelial Growth Factor) it stimulates the production of new blood vessels and consequently cerebral angiogenesis (Merege et al., 2014).

In this study, there was no significant relationship between Biological Maturation and cognitive aspects because both groups had a delayed level of maturation. However, if the scenario were different, where there was at least one group with an accelerated pattern, there would be the possibility of verifying differences, as researchers point out that biological maturation, being a physiological enhancement, helps the evolution of brain regions (development of the central nervous system and myelination), while also having power over the prefrontal cortex and executive functions such as working memory and inhibitory control (Carver et al., 2001; Chevalier et al., 2015).

Confirming this relationship between systematized aerobic exercise and improved psycho-cognitive aspects, Browne et al, (2016) agrees with the current research when they reveal in their results that children and adolescents who have a moderate to intense exercise routine have better performance in

executive functions (mainly inhibitory control) due to greater cerebral oxygenation, and as an effect of this intellectual improvement, they have a better ability to learn new knowledge due to having better logical and strategic reasoning and, above all, reliable control of their attention and behaviors (not constantly losing focus with distractors).

In addition, the author argues that the best academic results arise because school activities demand high levels of control of attentional functions, organization and planning, which are consequently provided by better Inhibitory Control.

CONCLUSION

The results of this study show that there was no correlation between Biological Maturation (verified by bone age) and cognitive performance in both groups (Practitioners and Non-Practitioners of Sports Initiation).

However, when comparing the Sports and Non-Sports Groups, it was found that young people who practiced initiation sports in addition to Physical Education had a better performance in the Inhibitory Control Test (Go/No-Go) than those who only practiced School Physical Education but did not practice initiation sports.

This reinforces the idea that sport is widely beneficial in various fields of human life, and in this particular study it was positive for cognitive aspects, especially Inhibitory Control, proposing that subjects who constantly practice sport have a greater capacity for attention, concentration, filtering out distractors and shorter reaction times.

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