ORIGINAL ARTICLE

Physical activity and cardiovascular function in 9-year-old schoolchildren: implications for health and well-being

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Abstract

Background and Study Aim: Sedentary lifestyles are major risk factors for cardiovascular diseases later in life. Identifying the potential benefits of physical activity for the cardiovascular health of children is crucial for developing effective strategies to promote healthy habits and prevent future health problems. Purpose of the article is to investigate the relationship between physical activity and cardiovascular function in 9-year-old schoolchildren, taking into account the gender.

Material and Methods: The study participants were 27 students of the 3rd grade (10 boys, 17 girls) of secondary school № 58 in Kharkiv, Ukraine. All children were healthy and were under the supervision of a medical worker. Consent was obtained from both the school administration and the parents of the children. The functional state of the cardiovascular system of children was determined by the indices of the Robinson index and the Ruffier index. To calculate these indicators, we measured heart rate (HR) and blood pressure (BP) at rest and after exercise (30 squats in 45 seconds).

Results: There were no significant differences between boys and girls in heart rate, systolic and diastolic blood pressure, heart rate at rest and recovery after exercise. The average level of reserves and efficiency of the cardiovascular system was revealed. A higher than average level of the response of the cardiovascular system to standard physical activity was revealed.

Conclusions: The results of this study suggest that the functional capabilities of the cardiovascular system of 9-year-old students are generally at an average level and that there are no significant differences between boys and girls in terms of heart rate, blood pressure, and diastolic blood pressure. These findings could be useful for developing physical education programs for children and for identifying children who may require additional cardiovascular health monitoring or interventions.

Keywords: cardiovascular, heart rate, blood pressure, schoolchildren, gender

Introduction

The issue of physical inactivity among children and its impact on cardiovascular health has become a growing concern worldwide. Recognizing the crucial role of physical activity in promoting cardiovascular well-being in children, it is imperative to comprehend the connection between physical activity and cardiovascular function within this population.

Extensive research has established that physical activity not only enhances cardiovascular function but also reduces the risk of cardiovascular diseases later in life [1, 2, 3]. Studies have demonstrated that regular physical activity can improve cardiovascular function, mitigate the risk of cardiovascular disease, and contribute to overall health and well-being in children [4, 5].

Numerous investigations have explored the correlation between physical activity and cardiovascular function in children [6, 7]. Some notable findings include significant differences in systolic and diastolic blood pressure among physically inactive schoolchildren [8, 9, 10], as well as differences in physical activity based on gender and body fat among schoolchildren [11, 12, 13, 14].

Other studies have yielded important insights, such as the positive impact of moderate to vigorous intensity interval exercise programs on isometric strength in schoolchildren [15, 16]. Additionally, research has shown that boys tend to accumulate more cardio-healthy physical activity than girls during recess [17], and primary schoolchildren spend an average time equivalent to 21.3% of the scheduled weekly Physical Education [18, 19].

The collective findings from these studies suggest that physical activity not only influences cardiovascular function but also correlates with academic performance and executive function in children. Furthermore, to comprehensively understand potential disparities in health outcomes and design effective interventions, it is crucial to examine gender differences in physical activity.

Numerous studies have explored gender differences between boys and girls concerning various aspects of physical activity [12, 20, 21, 22]. For instance, Rosa Guillamon et al. [23] revealed

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that boys exhibited superior motor performance in precision throwing, precision hitting, and ball jump compared to girls. Similarly, Torres-Luque et al. [24] found that boys displayed better vertical jump values, whereas girls demonstrated higher flexibility values. Furthermore, regarding physical activity levels, other authors [25, 26, 27, 28] discovered that boys had significantly higher physical activity indices than girls.

Collectively, these studies indicate the presence of gender differences in motor coordination, physical activity levels, and enjoyment of physical activity among schoolchildren. Boys generally exhibit better motor performance and higher rates of physical activity compared to girls. However, it is important to consider other factors, such as age and body composition, as they may also influence physical activity levels and motor coordination among schoolchildren.

Research Hypothesis. The level of physical activity in 9-year-old schoolchildren is positively associated with cardiovascular function, and higher levels of physical activity will result in better cardiovascular function in this age group.

Purpose of the article: The goal of our article is to investigate the relationship between physical activity and cardiovascular function in 9-year-old schoolchildren, taking into account the gender.

Materials and Methods

Participants

The participants of this study were 27 third-grade students (10 boys, 17 girls) from Secondary School № 58 in Kharkiv, Ukraine. The students who participated in the study were in good health and were supervised by a medical worker. Consent was obtained from both the school administration and parents of the children.

Research Design

This study aimed to determine the functional state of the cardiovascular system of the schoolchildren using the Robinson and Ruffier indices. The Robinson index measures the reserves and economy of the cardiovascular system, while the Ruffier index characterizes the response of the cardiovascular system to standard physical exercise. Heart rate (HR) and blood pressure (BP) were measured at rest and after exercise (30 squats in 45 seconds) to calculate the specified indices. The obtained average statistical results were compared with the rating scale proposed by Polyakov et al. [29].

Statistical Analysis

The value of X ± m (mean ± standard deviation) was calculated to describe the central tendency and variability of the data. To determine if there were any significant differences in cardiovascular function between boys and girls, an independent samples t-test was conducted. A p-value of < 0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

Results

Based on the analysis of individual indicators characterizing the functional state of the cardiovascular system of 9-year-old students in terms of gender (Table 1), it was observed that the indicators of girls are generally higher than those of boys, but these differences are not statistically significant ($p>0.05$).

Table 1 shows the comparison of indicators of the functioning of the cardiovascular system of 9-year-old students in the sexual aspect. The results indicate that there were no significant differences between boys and girls in terms of heart rate, blood pressure system, diastolic blood pressure, and heart rate during rest and recovery after exercise.

Comparison of the average statistical indicators of the Robinson index with the rating scale [29] revealed that the 9-year-old students had an average level of reserves and economy of the cardiovascular system (3 points). The distribution of scores according to the Robinson index shows that approximately 50.00% of boys and 52.94% of girls have a score of "3" (average), 20.00% of boys and 29.41% of girls have a score of "4" (higher than average), and 30.00% of boys and 17.65% of girls have a score of "5" (high) (Fig. 1).

Table 1. Comparison of cardiovascular system indicators between 9-year-old male and female students

Indicators	Boys (n=10)	Girls (n=17)	t-value	p-value
Heart rate (bpm-1)	78.00±1.95	81.47±1.69	1.38	>0.05
BP system (mmHg)	101.20±3.17	101.41±2.77	0.05	>0.05
Diast BP (mmHg)	73.60±2.24	71.00±2.04	0.88	>0.05
HR in 15 s (P_1)	15.20±0.47	16.11±0.36	1.60	>0.05
HR in 15 s (P_2)	30.80±1.88	32.88±0.66	1.09	>0.05
HR in 15 s (P_3)	17.60±0.53	18.53±0.33	1.54	>0.05

Note: P_1 - Heart rate for 15 s at rest, P_2 - Heart rate for the first 15 s of the recovery period after exercise, P_3 - Heart rate for the last 15 s of the first minute of recovery.

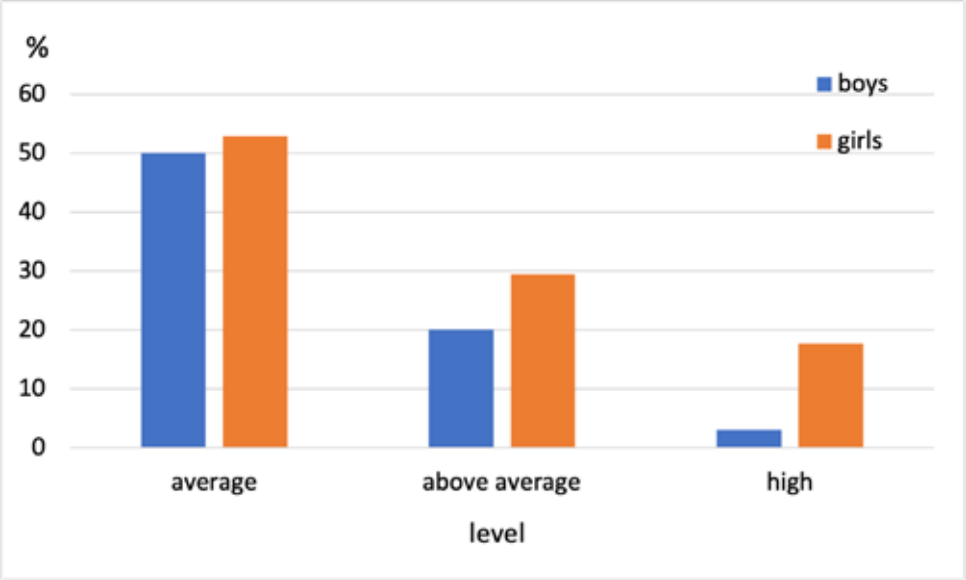

Figure 1. Robinson index rating distribution among 9-year-old students (%)

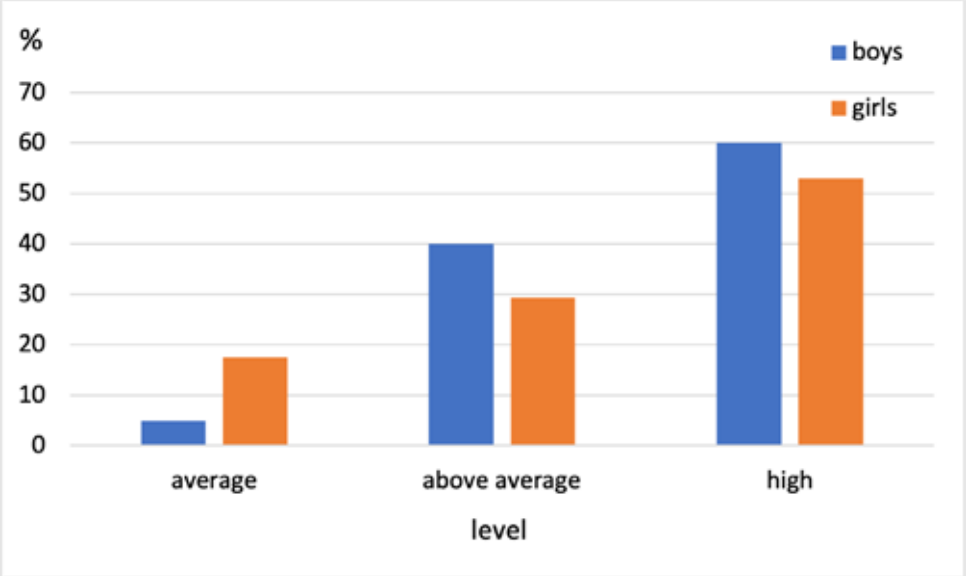

Figure 2. Ruffier index rating distribution among 9-year-old students (%)

The analysis of the Ruffier index with normative estimates [29] indicates a higher than average level of response of the cardiovascular system to standard physical exertion (4 points) of the studied contingent. The rating of grades according to the Ruffier index shows that 17.65% of girls had an average grade of "3", 40.00% of boys and 29.41% of girls had above-average grades of "4", and 60.00% of boys and 52.94% of girls had high grades of "5" (Fig. 2).

From the above results, it can be concluded that the functional capabilities of the cardiovascular system of 9-year-old students correspond to the average level (3 points).

Discussion

The analysis of individual indicators characterizing the functional state of the cardiovascular system of 9-year-old students in terms of gender showed that there were no significant differences between boys and girls in terms of heart rate, blood pressure, and diastolic blood pressure. Although the indicators of girls were higher than those of boys, these differences were not statistically significant ($p>0.05$). These findings suggest that the cardiovascular systems of 9-year-old boys and girls are generally functioning at similar levels.

The Robinson and Ruffier indices were used to evaluate the functional capabilities of the cardiovascular system of the students. The analysis of the Robinson index showed that the average level of reserves and economy of the cardiovascular system (3 points) was observed in both boys and girls. However, the rating of grades according to the Ruffier index indicated a higher than average

level of response of the cardiovascular system to standard physical exertion (4 points) of the studied contingent. The percentage of students with a rating of "4" and "5" according to the Ruffier index was higher than that according to the Robinson index. These findings suggest that the cardiovascular system of 9-year-old students responds well to physical exertion.

In general, the functional capabilities of the cardiovascular system of 9-year-old students correspond to the average level (3 points) according to both the Robinson and Ruffier indices. These results are consistent with the findings of previous studies [3, 8, 30, 31, 32] that have shown that the functional capabilities of the cardiovascular system of children are generally at an average level.

Our study found no significant difference in heart rate and blood pressure between boys and girls in the 9-year-old age group, which is consistent with the findings of Gelabert et al. [15], Alvarez [8, 9] and Navarro-Paton et al. [26]. However, some studies have reported higher blood pressure in boys compared to girls in this age group, such as Rosa-Guillamón et al. [23] and Moral Moreno et al. [18].

Regarding physical fitness, our study did not measure it directly, but Li et al. [33] reported a positive association between fetal imprinted gene RTL1 variants and birth weight, which could indicate higher physical fitness in children with these variants. In contrast, Kostrzewski et al. [34] found a negative association between body mass index and physical fitness in children aged 7-10 years old.

Previous research has consistently highlighted the significant impact of children's physical activity and fitness on their overall health and well-being [24, 25, 35, 36, 37, 38]. These studies underscore the crucial role that physical activity plays in promoting positive health outcomes for children. By engaging in regular physical activity and maintaining good fitness levels, children can experience various benefits that contribute to their overall well-being.

Overall, the comparison of our results with those of other studies highlights the complexity of the factors that influence cardiovascular function and physical fitness in children, including genetics, body composition, and gender differences. Further research is needed to better understand these factors and their implications for children's health and development.

In conclusion, the results of this study suggest that the functional capabilities of the cardiovascular system of 9-year-old students are generally at an average level and that there are no significant differences between boys and girls in terms of heart rate, blood pressure, and diastolic blood pressure. These findings could be useful for developing physical education programs for children and for identifying children who may require additional cardiovascular health monitoring or interventions.

Conclusions

Based on our study, we can draw the following conclusions:

Our results are consistent with previous studies that have shown that regular physical activity can positively impact cardiovascular health in children.

However, further research is needed to determine the long-term effects of physical activity on cardiovascular health in children and to investigate the potential differences between boys and girls.

Based on these conclusions, we recommend that children engage in regular physical activity to promote cardiovascular health. Additionally, we recommend that future studies investigate the potential differences between boys and girls in the long-term effects of physical activity on cardiovascular health.

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