COMPARISON OF PERFORMANCE AND ANTHROPOMETRIC PARAMETERS IN PAEDIATRIC COMPETITIVE ATHLETES DURING COVID-19 PANDEMIC IN THE CZECH REPUBLIC

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SUMMARY

Objectives: In 2020, measures against the spread of COVID-19 were adopted, including nationwide school closures, restrictions on the free movement of persons and leisure time sports activities. The aim was to assess the impact of COVID-19-associated restrictions on the performance of paediatric and adolescent competitive athletes by comparing basic anthropometric and performance parameters.

Methods: The sample comprised 389 participants (115 girls, 274 boys). All participants were examined during regular preventive sports health checks from September to November 2019 and a year later. At the initial examination, the mean age of the entire sample was 12.2 ± 2.7 years (median 12.0, minimum 7.0; maximum 17.0). The examination consisted of a complete medical history and physical examination including maximal exercise testing on a leg cycle ergometer.

Results: In the entire sample, as well as in the boy and girl subgroups, body height, weight, body mass index (BMI), BMI percentile, and power output significantly increased according to a percentile graph for boys and girls in 2020. A reduction in power output (W/kg) was found. By 2020, W/kg dropped in 56.4% of the youngest participants (7–13 years), 75% of those aged 14–16 years and 64.9% of the oldest individuals (16–17 years). The percentage of the youngest children with power output reductions was statistically significantly lower than the percentages of the other age subgroups ($p = 0.007$). There were no significant differences in results between genders.

Conclusions: Performance and anthropometric parameters worsened especially among older children. This should be reflected when planning epidemic measures in case of any similar situation in the future.

Key words: athlete, COVID-19, sport, anti-epidemic measure, physical activity, cardiovascular performance

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https://doi.org/10.21101/cejph.a7484

INTRODUCTION

Physical activity is a basic biological manifestation and needs in human life. Globally, progressive technological development, urbanization, car-oriented urban and rural design have reduced common mobility habits and options. The overall amount of physical activity, in particular its habitual component, decreases even though the genetic makeup of individuals, and thus their need for movement, remain unchanged. The human genome is the result of millions of years of adaptation to the environment and changes occurred very slowly. Rapid, sharp and definitive changes to the conditions result in homeostatic imbalances due to a clash between the encoded properties and unusual conditions; the physiological possibilities of organism adaptation are exceeded, often grossly. In previous centuries, humans mainly faced a negative energy balance, resulting from food shortages. Therefore, most regulatory mechanisms that have evolved in the course of phylogenesis allow adaptation to reduced energy intake to ensure the survival of starving individuals. Although the need for movement has remained, the actual activity is inadequate; the resulting deficiency is associated with a lot of complications. Hypokinetic disease and a sedentary lifestyle are increasingly encountered in childhood. Physical activity is an important determinant of health in children and adults; for example, daily step count, a proxy for

physical activity, has been associated with all-cause mortality (1). Physical inactivity is described as one of the biggest public health problems of the 21st century (2–4).

In 2020, the global coronavirus disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2, produced major changes to social behaviour including restrictions on free movement, leisure activities and sports, both competitive and elite. Compared with adult COVID-19 patients, the number of paediatric patients was lower with milder symptoms and better prognosis (5, 6).

On 11 March 2020, the World Health Organization declared COVID-19 to be a global pandemic (7). On the same day, preventive measures to contain the spread of the disease were adopted in the Czech Republic, including nationwide school closures, restrictions on the free movement of persons, gathering restrictions, and closing of most shops and services where higher numbers of people were present. With schools and sports grounds being closed, children's leisure activities were significantly limited until 24 May 2020 when the ban was lifted. With regard to the worsening epidemiological situation, the measures were reintroduced; once again, schools, indoor and, later, outdoor sports grounds were closed. Thus, leisure, high competitive and school sports activities of Czech children were limited in 2020. Subsequently, the detraining effect may be expected, associated with reduced physical condition and specific performance (8) as well as other negative metabolic and morphological and functional changes (9).

The study aimed to assess the impact that temporary restrictions on leisure and organized sports activities had on paediatric and adolescent competitive athletes, by comparing baseline anthropometric and performance parameters measured from September to November 2019 with those obtained a year later.

MATERIALS AND METHODS

Study Design and Sample

A retrospective, non-interventional, non-randomized, non-blinded, uncontrolled study was performed. The sample comprised 389 children and adolescents (274 boys, 70.4%). Outdoor (49.9%) and indoor athletes were equally represented in the study. Two-thirds (66.6%) of participants were involved in team sports, the others in individual sports. The mean age at the initial examination was 12.2 years (median 12.0, SD 2.7). All participants were examined during regular preventive sports health checks conforming to the Czech legislation (Decree No. 391/2013 Coll.) between September and November 2019 before the pandemic onset. Only athletes who were examined a year later, in 2020, who did not interrupt their training due to illness or injury between the two health checks were enrolled. The examination consisted of a complete medical history and physical examination, anthropometric measurements – height, weight and body mass index (BMI) calculations, and maximal exercise testing on a leg cycle ergometer (Ergoselect 100P, Ergoline, Bitz, Germany). Electrocardiography (ECG) recordings were made with BTL-08 LC ECG (BTL Industries Ltd., UK). The studied parameter was maximum power output (Wmax, or W per kg of body weight). To study relationships between variables and age, participants were divided into subgroups based on their age at the time of 2019 health checks ($\leq$ 13 years, 14–16 years, $\geq$17 years).

The study was approved by the Ethics Committee of the Faculty of Medicine, University of Ostrava (No. 18/2021). All participants (or their parents) signed informed consent forms.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 22 (Armonk, NY: IBM Corp.). Numerical variables were assessed with descriptive statistical methods (mean, median, SD). To determine the statistical significance of differences between the two years, genders and subgroups, the Wilcoxon test, Kruskal-Wallis test and Fisher's post hoc test with the Bonferroni correction were used. Forward stepwise logistic regression was applied to evaluate predictors for changes in power output per kilogram of body weight, as a dependent variable, and the other numerical, independent variables. All tests were performed at a significance level of 0.05.

RESULTS

Sample Characteristics

Basic characteristics of the entire sample, including the statistical significance of differences between data obtained at a one-year interval, are shown in Table 1. In the entire sample, as well as in the boy and girl subgroups, body height, weight, BMI, and power output significantly increased in 2020, with a significant reduction in power output per kilogram of body weight. Table 2 presents changes in the studied characteristics between the two years for the age subgroups created at the initial examination. The statistically significantly greatest changes to both their height and weight were observed in the youngest age group. However, the mean BMI change was not significant between the age groups.

Table 1. *Basic characteristics of the sample in both years of the study*

Characteristics	Year 2019		Year 2020		p-value (Wilcoxon test)
	Mean (SD)	Median	Mean (SD)	Median	
Height (cm)	155.3 (15.8)	155.0	160.6 (15.0)	161.0	< 0.001
Weight (kg)	47.3 (15.3)	44.7	53.0 (15.3)	51.1	< 0.001
BMI (kg/m^2)	19.0 (3.1)	18.6	20.1 (3.1)	19.7	< 0.001
Power output (W)	189.4 (76.7)	170	210.0 (77.1)	195.0	< 0.001
Power output per kg (W/kg)	4.01 (0.84)	3.97	3.95 (0.84)	3.93	< 0.001

SD – standard deviation; BMI – body mass index

Table 2. *Changes in mean values of variables between 2019 and 2020 for age subgroups (N = 389)*

Changes in the mean values	Age subgroups			p-value (Kruskal-Wallis test)
	≤ 13 years (n = 264) Mean (SD)	14–16 years (n = 88) Mean (SD)	≥ 17 years (n = 37) Mean (SD)	
Height (cm)	6.5 (3.7)	4.1 (3.6)	0.3 (0.5)	< 0.001
Weight (kg)	6.2 (3.5)	5.8 (4.3)	2.3 (3.8)	< 0.001
BMI (kg/m^2)	1.11 (1.30)	1.01 (1.00)	0.64 (1.24)	0.159
Power output (W)	23.6 (23.5)	18.7 (28.0)	3.2 (25.5)	< 0.001
Power output per kg (W/kg)	−0.02 (0.54)	−0.14 (0.47)	−0.13 (0.41)	0.221

SD – standard deviation; BMI – body mass index

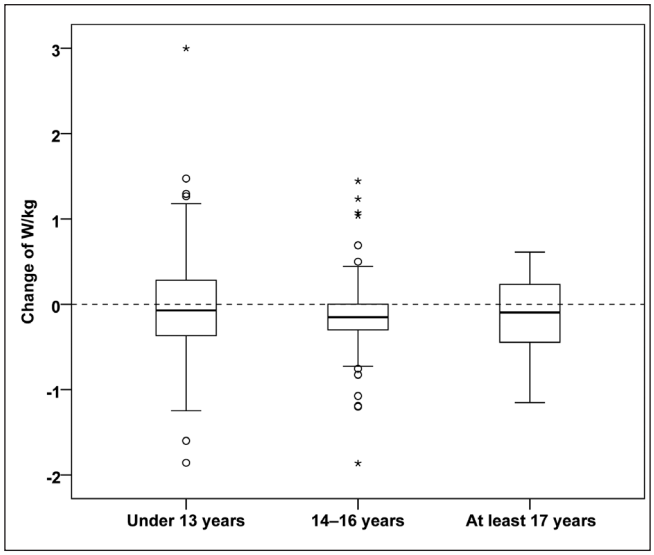

Fig. 1. *Comparing changes in power output per kilogram of body weight by age subgroups.*

While girls' BMI remained approximately at the 60th percentile level, boys' BMI showed a more prominent increase (within the physiological range). In 2019, their mean BMI was below the 75th percentile; it exceeded the 75th percentile by 2020. In the youngest participants, the increase in power output was statistically significantly greater, by an order of magnitude, compared to the oldest subgroup. By contrast, the least reduction of power output per kilogram was seen in the youngest participants (Fig. 1). Table 3 gives the numbers and percentages of individuals with improved, or worsened relative power output, with regard to their age. Between the two health checks, power output per kilogram of body weight dropped in 56.4% of the youngest participants, 75% of those aged 14–16 years and 64.9% of the oldest individuals. The percentage of the youngest children with power output reductions was statistically significantly lower than the percentages of the other age subgroups (p = 0.007). Once again, there were no significant differences in results between genders.

Predicting Changes in Power Output

Regression analysis identified age as the only statistically significant predictor of changes in power output per kilogram of body weight. A one-unit increase in age in the sample increased the odds of reduced relative power output by a factor of 1.116 (OR = 1.116, 95% CI: 1.033–1.206, p = 0.005). Inversely, a one-unit increase in age decreased the odds of increased power output by a factor of 0.896.

DISCUSSION

The results show that between two health checks, performed at a one-year interval, the participants increased their mean height, body weight, BMI and power output, but reduced their power output per kilogram of body weight, irrespective of gender. Reduced power output per kilogram of body weight was positively associated with age. The greatest reduction in power output was observed in children aged 14–16 years.

The body weight of the participants increased. No reduction in BMI percentiles was noted; conversely, BMI percentiles increased, mainly in boys. Nikolaidis and Karydis, who analysed the effect of age on body composition in competitive male adolescent soccer players (aged 12–21 years), showed a positive association between age and fat mass (r = 0.2, p < 0.001), fat-free mass (r = 0.68, p < 0.001), and a negative association with body fat (r = −0.12, p = 0.047) (10). Moreover, they found that a typical gain in the mean BMI value per year was 0.42 kg/m^2 within the age category 12–21 years. Botek et al. reported a mean BMI of 22.1 kg/m^2 with a mean maximum power output of 6.3 W/kg

Table 3. *Percentages of changes in power output per kilogram of body weight by age subgroups (N = 389)*

Change in power output per kilogram	Age subgroups			p-value (Fisher's post-hoc test)
	≤ 13 years (n = 264) n (%)	14–16 years (n = 88) n (%)	≥ 17 years (n = 37) n (%)	
Worsening	149 (56.4)	66 (75.0)	24 (64.9)	0.007
Improvement	115 (43.6)	22 (25.0)	13 (35.1)	

in 19-year-old competitive male soccer players (11). The Czech Republic's Report Card on physical activity for children and youth, part of the Active Healthy Kids Global Alliance global effort, shows that 62% of adolescents participate in organized sport and physical activity programmes, with participation in such leisure time activities being associated with better physical and mental health (12). It may be therefore assumed that the restrictions on these activities contributed to performance reduction. In childhood, apart from organized sports activities, leisure time, habitual activities including active transportation to school are of key importance. In Denmark, where nearly two-thirds of adults use cycling as a means of transport, bike riders were found to have an 8% higher level of fitness (13). The number of Czech children choosing active forms of transport to school (walking, cycling) has steadily decreased. In 2011, Czech adolescents were 2.7 less likely (OR = 0.365, $p < 0.001$) to use active transportation to a school than in 2001, as shown by Dygrýn et al. in a study of 6,236 participants. Between 2001 and 2011, the proportion of adolescents using active transportation to school decreased from 49.1% to 21% (14). In this age category, long-term restricted school attendance may result in failing to meet the recommended amount of walking. Boys and girls aged 6–12 years should take at least 15,000 and 12,000 steps a day, respectively (15). Previous studies indicate that healthy behaviours have complied more beneficially during structured days (e.g. school days) as compared to unstructured days (during vacations or on weekends). This is supported by data showing the importance of structured institutions and organizations (schools, sports clubs) for children's and adolescents' sports activities (16–20). A physical activity-friendly school environment is associated with a lower risk of obesity and a positive youth development-based sports mentorship programme improved healthy adolescents' mental well-being, psychological assets, physical fitness, and physical activity levels (21, 22). In their cross-sectional study determining the performance level of 200 elite youth hockey players aged 13–17 years, Leiter et al. found that aerobic fitness increased to a lesser extent at older ages with a significant increase in maximum power output between the ages of 13 and 14 years (280.3 ± 38.0 W vs. 323.7 ± 45.3 W, $p < 0.001$), as well as between 14 and 15 years (323.7 ± 45.3 W vs. 353.0 ± 33.1 W, $p < 0.001$), but an insignificant increase between the ages of 15 and 16 years (353.0 ± 33.1 W vs. 354.5 ± 36.2 W, $p = 1.0$) (23). This is consistent with the present study showing the greatest increase in absolute power output in children aged 13 years or younger (23.6 ± 23.5 W), a smaller increase in those aged 14 to 17 years (18.7 ± 28 W) and the smallest increase in adolescents aged 17 years and older (3.2 ± 25.5 W, $p < 0.001$).

Despite the undeniable importance of restrictive measures, such as movement limitations, social distancing or school closures, for containing the COVID-19 pandemic, epidemiological studies have demonstrated a negative impact of certain measures on health through the worsening of cardiometabolic parameters in various populations throughout the world. In Europe, an example may be a study of 2,447 Lithuanian adults by Kriaucioniene et al. showing that due to COVID-19, one-third of the participants gained weight, negatively changed their dietary patterns and reduced their physical activity (24). Similarly, Bhutani et al. reported increased mean weight (n = 727) resulting from only several months of lockdown in the United States (25). Studying a population of Greek children and adolescents (n = 397), Androutsos et al. showed that during the COVID-19 lockdown, children's/adolescents' BMI (in 35%), sleep duration and screen time increased, while their physical activity decreased (26). In a study of 41 Italian children aged 13 years with obesity, Pietrobelli et al. revealed that during the COVID-19 lockdown, time spent in sports activities decreased by 2.30 hours a week, sleep time increased by 0.65 hours a day, screen time increased by 4.85 hours a day, and the number of meals eaten per day increased by 1.15 (27).

Generally, the orders of social distancing and staying at home reduce the chances to participate in exercise and sports activities, especially for urban children with limited apartment space. Research demonstrates that the use of online games has been growing rapidly during the pandemic. Excessive screen time in childhood is associated with overweight/obesity, possibly due to both sedentary problems and the connection between screen time and snacking (28). All of these result in the worsening of cardiometabolic parameters and physical health, as demonstrated by our results concerning competitive athletes. However, the literature focusing on the impact of anti-epidemic measures on children is still scarce. We have not found other studies dealing with the effect of the measures on performance characteristics such as power output. From a public health perspective, it is therefore essential that during restricted school attendance, parents, with state support, provide their children with adequate physical activity adhering to current international recommendations (29).

CONCLUSIONS

After months of restrictive measures to prevent the spread of COVID-19, paediatric competitive athletes increased their body weight and BMI while their power output per kilogram of body weight dropped. This was mainly noted in older, adolescent, individuals. These findings should be reflected when planning further epidemic measures.

Conflict of Interests

None declared

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Received May 30, 2022
Accepted in revised form March 11, 2023