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# Influence of consequences of anti-pandemic measures in connection with the spread of coronavirus COVID-19 in the Czech Republic on selected body composition and performance parameters of children of younger school age

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**Abstract**

**Introduction. During the global COVID-19 pandemic, there has been a long-term and unprecedented reduction in physical activities. Aim of Study. The objective of the work was to describe specific changes in performance and body composition after long-term restrictions on mobility due to the COVID-19 pandemic in the group of young school children in the Czech Republic, which experienced one of the longest periods of closed schools and therefore restricted sports and leisure activities in the world. Material and Methods. This was a longitudinal study on an identical group of first-grade students (n = 52). The level of physical performance was repeatedly tested during the normal regime without any restrictions and after their return to school. The conducted test (standing long jump, shuttle run, sit and reach, sit-up test, endurance run) included also anthropometric measurements (weight, height, body fat content). Results. There was an increase in body fat by 64.23% (MD = 16.65 ± 2.73 cm; d = 0.85), increase in BMI values by 10.91% (MD = 1.77 ± 0.19 kg·m$^{-1}$; d = 1.29), as well as a significant decrease in endurance running by 14.6% (MD = 58.56 ± 9.32 s; d = 0.71) and in the flexibility test (sit and reach) by 250% (MD = 6.04 ± 0.75 cm; d = 1.12). For standing long jump and shuttle run the post-lockdown testing showed performance to improve in absolute terms, with children remaining in the given categories compared to the norms, usually around the population average of the given category. In the sit up test the performance scores did not change, an non-significant improvement of two exercises was recorded, but when comparing average performance results with the norms the performance deteriorated. Conclusions. The long-term restrictions on the normal exercise regime had a devastating effect on key components of performance and health-oriented fitness.**

**KEYWORDS: children, COVID-19, body composition, health related fitness.**

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## Introduction

During the global COVID-19 pandemic there was a long-term and unprecedented reduction in physical activities. Not only were organized leisure activities restricted or directly banned to a greater or lesser extent, but the normal movement regime also changed significantly due to the nature of the restrictions. Walking to work, to school, moving around the workplace or school buildings, to shops, trips, walks was limited.

In the Czech Republic, teaching at primary schools was transferred to the distance teaching regime for the first time on March 11, 2020. First grade children returned to school on February 25, 2021. The next school year began with standard full-time teaching on September 1, 2021. Due

to the deteriorating epidemiological situation, various measures were gradually taken; a ban on physical education (as well as music lessons) was imposed in early October. From October 14, 2020 schools were completely closed and teaching was fully transferred to the online form. Since the end of November there was the so-called "rotational teaching" regime for some grades, when classes attended school in rotation. From the beginning of January, a widespread transition to online teaching was ordered again. Online teaching lasted until April 12, when some grades began to operate in the rotating teaching mode. All primary school pupils returned to school on May 24, 2021.

Anti-pandemic restrictions have affected the content and forms of physical education. Even in the weeks when pupils were allowed to stay in schools, it was accompanied by a number of measures and restrictions: wearing masks, restrictions on teaching (physical education and music education), movement only in fixed groups, etc. For a more detailed overview of school closures and types of teaching, see Table 1.

During online teaching, the issue of physical education was generally addressed only marginally. Due to the recommendation not to overburden students with excessive time spent at the computer monitors, music and physical education were often completely discontinued by the regulations of the school management, or the fulfillment of tasks in these subjects was only on a voluntary basis. During physical education lessons teachers most often included challenges or joint online exercises usually focused on the development of strength and flexibility ("workout", "stretching"), some schools or specific teachers did not teach physical education, or education in general at all [13].

Measures affecting leisure activities always copied the situation in schools being imposed with a slight advance or delay. Gradual reduction or release was always accompanied by various restrictions concerning the place (only outside, in a specified area), the number of people or the organization of exercises (spacing, not using equipment, the trainer or coach wearing a mask, etc.). These regulations changed very often and quickly,

**Table 1.** Detailed overview of types of teaching in individual phases of pandemic in the Czech Republic

| 1st wave | 11.3.–11.5.20 | 11.5.–25.5.20 | 25.5.–1.6.20 | 1.6.–8.6.20 | 8.6.–26.6.20 |
|---|---|---|---|---|---|
| 1st – 2nd grade | distance | distance | full-time | full-time | full-time |
| 3rd – 5th grade | distance | distance | full-time | full-time | full-time |
| 6th – 8th grade | distance | distance | distance | distance | distance |
| 9th grade | distance | rotating | rotating | rotating | distance |
| Special classes | distance | distance | distance | full-time | full-time |
| 2nd wave | 14.10.–18.11.20 | 18.11.–30.11.20 | 30.11.20–4.1.21 | | |
| 1st – 2nd grade | online | full-time | full-time | | |
| 3rd – 5th grade | online | online | rotating | | |
| 6th – 8th grade | online | online | rotating | | |
| 9th grade | online | online | rotating | | |
| Special classes | online | full-time | full-time | | |
| 3rd wave | 4.1.–1.3.21 | 1.3.–12.4.21 | 12.4.–24.5.21 | | |
| 1st – 2nd grade | full-time | online | rotating | | |
| 3rd – 5th grade | online | online | rotating | | |
| 6th – 8th grade | online | online | online | | |
| 9th grade | online | online | online | | |
| Special classes | full-time | online | full-time | | |

Note: distance – partly online, partly fulfillment of submitted tasks; full-time – according to timetable (except PE, ME, Art); online – only online classes according to adjusted timetable (without PE, ME, Art); rotating – half of the class at school according to timetable, the second half online

with a number of exceptions, and they were difficult to follow and observe by all those involved. At the time of the strictest lockdown travel between districts and movement between individual municipalities was also restricted; these measures also interfered with seemingly permitted leisure activities, such as hiking, skiing, or cycling. The period of time, during which schools in the Czech Republic were restricted in their operation was the longest in comparison with other countries in the world.

A vast majority of research conducted to date on the impact of a pandemic situation on physical activity, performance and physical parameters have used online self-reporting questionnaires as a research method [5, 10, 14, 16, 19], a smaller number of studies applied a revolving panel design [1, 2, 4, 17] and to a lesser extent – in the order of units, researches with a longitudinal panel design are represented [6, 8, 17, 21]. Some studies also used data mining using wearables (watches, fitness bracelets, applications in mobile phones) [11].

The parameters that were monitored and evaluated in these studies include body composition in terms of assessing the increase in obesity, specifically BMI. This phenomenon has been observed worldwide. Jarnig et al. [6], found that in the observed group of Austrian children aged 7-10 years there was an increase in the number of overweight or obese children by 4% during the year, overall there was a more significant deterioration in boys. Wahl-Alexander et al. (USA) [21] recorded an increase in BMI in children by 10.6%. A meta-analysis by Chang et al. [3] showed significant increases in body weight gain (mean difference, MD = 2.67, 95% CI = = 2.12–3.23; $p < 0.00001$) and BMI (MD = 0.94, 95% CI = 0.32–1.56; $p = 0.003$) during lockdown among school-age children and adolescents. The prevalence of obesity and overweight also increased. The results presenting the conclusions of the research on this topic are summarized in Table 2.

The decrease in the level of health and performance-oriented fitness parameters is certainly due to the reduced level of physical activity during lockdown. As presented by Štveráková et al. [16], even countries with a much shorter school leaving period than the Czech Republic, such as France (lockdown for 11 weeks), Portugal (24 weeks) or Spain (15 weeks), confirmed the reduced level of physical activity in children during the COVID-19 pandemic and called for the development of effective national measures. For example, in Slovenia during the pandemic there was the most substantial decline in physical fitness in the course of 30 years. The deterioration occurred despite the efforts of the state authorities and aggressive campaigns to support physical activity at the time of the ordered social isolation [7]. Based on the results of questionnaires and data from accelerometers, a significant decrease in physical activity against the norm was also recorded in Czech children. Decreased physical activity is certainly one of the reasons for the increase in the number of overweight or obese people. However, not only a significant restriction of exercise, but for example a change in the diet had

**Table 2.** Overview of research related to the influence of a pandemic situation on motoric performance and physical parameters

| Authors<br>Dependent samples | n, age | Measured parameters and results | Country |
|---|---|---|---|
| Wahl-Alexander, 2021 [21] | 264, 9–14 | BMI +10.6%; PU –35.6%; SU –19.4%; SRT –26.7% | USA |
| López-Bueno, 2021 [8] | 89, 13.3 ± 0.9 | $VO_2$max from SRT –0.64 | ESP |
| Jarnig, 2021 [6] | 764, 8.3 ± 0.7 | BMI +2.2%; OO +3.8%; ER(6 m) –7.2% | AUT |
| Sunda, 2021 [17] | 66, 15.6 ± 0.51 | SU –21.4%; ER(600 m) –29.1% | CRO |
| Independent samples | | | |
| Dayton, 2021 [4] | 10, 14.5, 15.2 | $VO_2$max – direct –12.5% | USA |
| Chambonnière, 2021 [2] | 206, 9.9, 9.4 | SLJ –20%; MBT –17.1%; SRT –54.1% | FRA |
| Berisha, 2021 [1] | 41, 16.0 + 0.5 | SU –18.7%; PU –0.47%; MBT –7.31% | RKS |
| Sunda, 2021 [17] | 48, 15.3 + 0.3 | SU –8.3%; ER(600 m) –10.4% | CRO |
| Tsoukos, 2022 [18] | 293, 15.8 ± 0.3 | OO +22.1(M), +18.6(F); VJ –15.1, S –4.9% | GRE |

Note: PU – push-ups; SU – sit-ups; SRT – shuttle run test; OO – obesity overweight; ER – endurance; SLJ – standing long jump; MBT – medicine ball throw; VJ – vertical jump, S – sprint

an effect. The absence of a suitable and balanced diet, which is at least partially provided by school meals in the normal education regime, manifested itself [15].

The aim of this work was to quantify what specific changes occurred in the various components of motoric performance, and how the body composition changed, in terms of the amount of subcutaneous fat after a long-term absence of exercise regime in the monitored group of children of younger school age in the Czech Republic, which had one of the longest periods of closed schools and restricted sports leisure activities in the world. With these findings we want to contribute to the existing knowledge dealing with the impact of restrictions on the movement regime in connection with the global pandemic of COVID-19.

## Material and Methods

*Participants*

We performed testing on a group of younger school-age children, who were tested in another research shortly before the first wave of the COVID-19 pandemic [20]. As part of this survey we performed basic anthropometric measurements and performance testing. We used the obtained data as a basis for current research in the same group of children, in relation to some of them, where the situation allowed, we repeated these same measurements after the COVID pandemic subsided. The research group consisted of third graders at the elementary school in Brandýs nad Labem. A total of 52 children were included in the study, for whom it was possible to ensure complete results in both measurements. Of the total number, there were 20 girls and 32 boys.

*Procedures*

A series of tests based on the UNIFITTEST 6-60 test battery was used to evaluate the level of motor performance [9]. Tests used from this battery included standing long jump (feet closing), sit-downs repeatedly and shuttle run 4 × 10 meters. These tests were supplemented with a sit and reach test and 1000 m run. Somatic measurements of body height and weight were performed on probands and from the results the BMI was calculated. Body composition, in terms of the amount of subcutaneous fat was determined using calipers – measuring the thickness of 3 skin folds (tricipital, subscapular and suprailiac).

There was a time interval of 19 months between the first and second measurements. The first measurement took place in the autumn of 2019, at that time the children were at the beginning of the 3rd grade and their average age was 8.38 ± 0.71 years. The second measurement took place in the spring of 2021, after the schools reopened. The observed group of children was at the end of the 4$^{th}$ grade, the average age of the children reached 9.98 ± 0.69 years. Extensive restrictions on full-time education were applied to children (Figure 1).

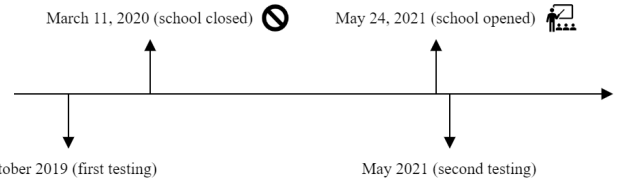


**Figure 1.** Study schedule

*Statistical analysis*

A prerequisite for further work with the data was the description of the research file in order to find the basic characteristics of the monitored variables both in the whole research group and in groups divided by gender, so that it was subsequently possible to make a comparison of performances with respect to the standards for a given age group. To determine intra-individual differences, both data sets were compared by a pairwise test (Student's t-test, a priori Shapiro–Wilk test). By comparing the results we determined the significance of differences in individual components of motor performance in the observed group of children. Given that this was an occasional non-random selection, the material significance of the difference was determined for all the parameters (Cohen's d). Data referring to averages were compared with the Unifittest [9] reference standards for a given age group and gender. We did not use the conversion to the standardized score, because a number of performances were in the range of the lowest points already during the first testing and a possible change in these cases could not be recorded at all.

## Results

Compared to the amount of subcutaneous fat (Table 3), there was an increase of 64.23%. The difference found corresponds to a large effect of material significance (d = 0.85). When compared to the standards for a given age category, the values of the amount of subcutaneous fat found in the first test averaged 3 points (from a 5-point scale). In the second testing, the values found were already above average, resp. very high (4 points). BMI increased by 1.77 ± 0.19 kg·m$^{-1}$. The difference found corresponds to a large material effect (d = 1.29). While BMI values in the first measurement were in both

genders at approximately the 60th percentile for a given age group, in the second measurement the values moved to 77th percentile (boys) and 75th percentile (girls). The percentage increase is 10.91%.

The results of the sit-downs test (Table 4) showed stagnation in absolute values, resp. there was an improvement of only 2 repetitions on average, but the difference found has only a low level of material significance (d = 0.27). When compared to the standards listed for a given age category, the performances of the entire study group remain in the average category (boys 5 points before and after, girls 6 points before and 5 points after).

In the jump test, the children improved by 24.40 cm on average (MD = 24.40 ± 2.57 cm; d = 1.32). There was an improvement not only in absolute values, but also when comparing the relative values of performances converted to standardized points for a given age category (boys 3 points before, 5 points after, girls 4 before and 5 after). The results of the sit and reach test indicate a worsening of flexibility in the observed group of probands. The observed difference in the performance of the first and second testing for sit and reach test was factually significant (MD = 6.04 ± 0.75; d = 1.12). Compared to the recommended standard [19], performances in the

**Table 3.** Basic anthropometric data and parameters of physical characteristics of boys (n = 32), girls (n = 20) and overall (n = 52)

| | Gender | Age [yrs] | | Height [cm] | | Weight [kg] | | Fat [mm] | | BMI [kg·m$^{-1}$] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| M | boys | 8.29 | 9.91 | 134.00 | 144.00 | 30.40 | 38.90 | 25.50 | 45.00 | 16.70 | 18.60 |
| SD | | 0.76 | 0.73 | 7.02 | 7.53 | 7.67 | 10.80 | 17.90 | 23.60 | 2.72 | 3.46 |
| ES(d) | | | | | | | | 1.02 | | 1.27 | |
| M | girls | 8.31 | 9.93 | 131.00 | 141.00 | 27.80 | 35.40 | 26.90 | 39.00 | 16.20 | 17.70 |
| SD | | 0.66 | 0.65 | 6.35 | 6.90 | 4.66 | 6.36 | 13.80 | 28.00 | 1.90 | 2.37 |
| ES(d) | | | | | | | | 0.60 | | 1.43 | |
| M | all | 8.30 | 9.92 | 133.00 | 143.00 | 29.40 | 37.60 | 26.00 | 42.70 | 16.50 | 18.30 |
| SD | | 0.71 | 0.69 | 6.94 | 7.35 | 6.75 | 9.43 | 16.30 | 25.30 | 2.43 | 3.09 |
| ES(d) | | | | | | | | 0.84 | | 1.29 | |

Note: 1st – first (pre-lockdown) testing; 2nd – second (post-lockdown) testing; ES(d) – effect size (Cohen's d)

**Table 4.** Performances of boys (n = 32), girls (n = 20) and overall (n = 52) in single motoric tests, including an assessment of the materiality of the differences.

| | Gender | Sit-ups [rep] | | Jump [cm] | | Sit-reach [cm] | | Shuttle [s] | | 1000 m run [s] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| M | boys | 28.20 | 31.00 | 121.00 | 148.00 | 1.72 | –4.88 | 14.90 | 12.90 | 335.00 | 396.00 |
| SD | | 10.00 | 7.35 | 18.30 | 18.80 | 8.12 | 8.50 | 1.63 | 1.88 | 64.10 | 116.00 |
| ES(d) | | 0.36 | | 1.39 | | 1.18 | | 1.35 | | 0.92 | |
| M | girls | 29.80 | 30.40 | 127.00 | 148.00 | 6.55 | 1.40 | 14.60 | 12.90 | 356.00 | 410.00 |
| SD | | 7.87 | 8.99 | 21.10 | 19.60 | 7.58 | 9.84 | 1.21 | 1.34 | 66.30 | 108.00 |
| ES(d) | | 0.09 | | 1.24 | | 1.08 | | 1.12 | | 0.79 | |
| M | all | 28.80 | 30.80 | 123.00 | 148.00 | 3.58 | –2.46 | 14.80 | 12.90 | 342.92 | 401.48 |
| SD | | 9.19 | 7.94 | 19.50 | 18.90 | 8.20 | 9.46 | 1.47 | 1.68 | 65.20 | 112.00 |
| ES(d) | | 0.27 | | 1.32 | | 1.12 | | 1.26 | | 0.87 | |

Note: 1st – first (pre-lockdown) testing; 2nd – second (post-lockdown) testing; ES(d) – effect size (Cohen's d)

first test were just below the lower limit of the average, in the second they were significantly below average.
In the 4 × 10 m shuttle run test children on average accelerated (MD = 1.9 ± 0.21; d = 1.26). There was an improvement in absolute terms, even considering performance with respect to age. Compared to the standards, there was a shift from the category of significantly below average to the category of average (boys 1 resp. 5 points, girls 2 resp. 5 points).
There was a significant deterioration in aerobic endurance testing, which was tested using the 1000 m run test. The run time deteriorated by an average of 14.6% (MD = = 58.56 ± 9.32; d = 0.87). The materiality factor indicates a great effect.

**Discussion**

The COVID-19 pandemic has had a significant impact on a number of areas, although it has been and still is a priority to reduce proliferation and prevent loss of life. The restrictions that the measures entail have a longer-term impact on children's health. Only through a completely lay assessment from the point of view of parents, coaches, and teachers the changes took place. With this work, we wanted to contribute to the transition from the level of assumptions to the level of facts. Although this is a relatively small sample, the results suggest a negative trend, the effects of which we will most likely face in the years to come. We followed the performance of a selected group of young school-age children, which we tested in the fall of 2019 and then in the spring of 2021, immediately after the release of the measures that had been taken due to the spread of COVID-19. Under normal circumstances, it would be expected to see improvement of physical test results in absolute terms and with increasing age. In the relative assessment of the results with respect to age, the results should not change significantly. The ratio of the fat component should remain practically the same at this age, the expected increase usually comes later with the coming puberty.
When measuring and comparing the results of our sample, we found out that after the COVID pandemic and the long-term closure of schools and restrictions on leisure activities, there were significant negative changes in body composition with a significant increase in fat and BMI. These findings are consistent with the results of similar researches [6, 21]. In this context, it is necessary to draw attention to the limits of the BMI value, the interpretation of which is especially problematic in the pediatric population, as it does not take into account growth specifics and biological age [12].
We noticed a significant deterioration in the results of flexibility and aerobic endurance tests. This can be attributed to the forced change of movement regime, when physical activity decreased significantly (natural walking, etc.) and the time spent at the computer increased (online teaching and online social contacts). The observed deterioration in aerobic fitness corresponds to the results of all other researches [6, 8, 17, 21] whereas the deterioration we detected is one of the most significant.
Surprisingly, the increase in the fat component did not result in a deterioration in speed or strength. The results of the jump tests and the shuttle run tests improved in absolute and relative terms. The sit up tests results are practically at the same level. It is possible that the teachers of the researched group of children motivated them to exercise at home, which included mainly exercises for strength development (skipping rope, small workout with their own weight and home aids). In these findings, we therefore differ from the results in the United States [17] in terms of strength and endurance tests. The reason may be partly another age cohort, partly different testing methodology or different cohorts studied (dependent versus independent samples) [2]. Physical abilities that are less trainable, resp. more affected by genetic predispositions were not so much affected by the failure of the exercise regime.
It would certainly be beneficial to monitor the interim results as well. The original plan was testing after the first wave and a relatively shorter closure in the autumn of 2020. Unfortunately, the schools were closed very quickly and unexpectedly, and this plan was unfortunately not possible to implement.
The teachers of our monitored classes also regularly gave children movement "tasks", they practiced online with their children, they mainly focused on small coordination exercises. They also focused on strength training exercises (weight training, skipping, etc.) and compensatory exercises. The school regularly published sports challenges and distance movement competition between classes. The school tried to support the children to move. Based on personal contacts and statements of children and parents, we know that many families have tried to replace the absence of physical education and sports activities by doing family walks or outdoor sports. However, the results suggest that the effect was not nearly as large as expected. It can be assumed that the restrictions adopted caused such a significant and fundamental change in the movement regime, which could not be sufficiently compensated despite considerable efforts. This subsequently led

to a significant change in body composition, i.e., an increase in both the fat component and BMI values and a deterioration in the aerobic part of physical fitness. We may trace the manifestation in the areas of motivation, attitudes, psyche later on.

## Conclusions

After evaluating the measured results, it was found that in the case of the amount of subcutaneous fat there was a significant increase in values, compared before and after the lockdown break (MD = 16.65 ± 2.73 mm; d = 0.85). We also detected higher values in BMI (MD = 1.77 ± 0.19 $m \cdot kg^{-1}$; d = 1.29). From the tests determining the parameters of health and performance-oriented fitness, there was a significant deterioration in the endurance run at 1000 m (MD = 58.56 ± 9.32 s; d = 0.87) and in the test, i.e., the sit and reach test, which determined flexibility (MD = 6.04 ± 0.75; d = 1.12). The improvement occurred in the jump test (MD = 24.40 ± ± 2.57 cm; d = 1.32) and shuttle run 4 × 10 m (MD = = 1.9 ± 0.21; d = 1.26) both in absolute terms and when comparing the results with the standards for a given age category.

There was only a slight improvement in the sit up test (MD = 2 ± 1.03; d = 0.27), performance stagnated in terms of age, in girls they were slightly worse compared to the results before the lockdown. The results of our study are comparable with similar research abroad. However, there are currently not enough primary studies to assess the hypothesis that the time of school closure in the Czech Republic, which was unprecedentedly the highest in the world, correlates with the rate of decline in the parameters of health and performance-oriented fitness.

## Conflict of Interest

The authors declare no conflict of interest.

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