

## Changes in swimming performance of physically active young men over six years

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### Abstract:

In this study, we tracked changes in the swimming performance of physically active young men over six years, including the challenges posed by the COVID-19 pandemic. The cohort consisted of secondary school students in Slovakia, with an average age of  $18.5 \pm 0.5$  years. Testing was performed annually, with the following number of students assessed each year: 2017 (192), 2018 (184), 2019 (189), 2020 (0, owing to pandemic restrictions), 2021 (184), 2022 (160), 2023 (171). We monitored the students' performance in the 100 m freestyle swimming test from 2017 to 2023. The testing was always performed in the last week of April at the 25 m swimming pool of FTVŠ UK in Bratislava. We used the Kruskal- Wallis test to assess statistically significant differences among multiple groups of independent variables. Post hoc analysis was performed using multiple comparisons between all group combinations, applying Bonferroni correction. The Kruskal–Wallis H test indicated a significant difference between years ( $p = 0.004$ ). Post-hoc analysis using the Mann–Whitney U test with Bonferroni correction revealed differences between the following pairs of years: 2017 and 2021 ( $p = 0.000$ ), 2017 and 2022 ( $p = 0.011$ ), 2017 and 2023 ( $p = 0.038$ ), 2018 and 2021 ( $p = 0.006$ ), and 2019 and 2021 ( $p = 0.008$ ). The closure of swimming pools during the pandemic and the resulting inability to swim may have contributed to the observed differences in motor performance over the monitored years. We hypothesize that long-term involuntary inactivity may lead to a decline in motor performance both in the short and long term.

**Keywords:** monitoring, COVID-19, detraining

### Introduction

Over the last 50 years in the U.S. authors Church, et al. (2011) estimate that daily occupation-related energy expenditure has decreased by more than 100 calories, and this reduction in energy expenditure accounts for a significant portion of the increase in mean U.S. body weights for women and men.

Movement activity is characterized as any body movement that is provided by skeletal muscles and leads to an increase in energy expenditure. It accounts for 15-40% of the total energy expenditure. It is characterized by intensity, frequency, type and duration (Sigmund, et al. 2011).

For adolescents, the World Health Organization recommends one hour of moderate-intensity physical activity per day. Children's lack of physical activity may not only manifest itself acutely, but may have an impact on health later in life. In addition, the results of the Health Behaviour in School-aged Children (HBSC) survey showed that, in Europe, only 23.1% of boys and 14.0% of girls aged 13–15 years met the WHO recommendations for daily physical activity (Inchley, et al. 2016). Scientific works confirm that children with regular organized physical activity have a lower risk of cardiovascular diseases in later life.

The children that performed physical activity three times a week had a perfect posture. Results of Balkó, et al. (2017) shown a defective or even very bad posture was detected in almost 83% of children who did not do any sports or exercised only once a week.

The results of our study clearly demonstrated that schoolchildren who were less physically active during the week fell into the poor posture category ( $p = 0.0001$ ,  $\eta^2 = 0.09$ ). They achieve higher aerobic fitness and bone mineralization and have fewer injuries than children who do not participate in sports (Torres, et al. 2022; Seabra, et al. 2012; Larsen, et al. 2017; Faigenbaum, et al. 2017).

In the 2020-21 school year, according to data from the Retrospective survey of youth sports participation (Jin, et al. 2021), swimming is among the 10 most popular sports. In general, swimming is considered an endurance type of physical activity. On the physiological side, there are differences between disciplines in swimming.

Anaerobic energy production dominates on the 50 m track (ATP-CP 65%; LA 30%; O<sub>2</sub> 5%), on the 200m the ratio is approximately balanced (10% : 50% : 40%) and longer races are affected (2-5 % : 20% : 70-80%) mainly aerobic (Grasgruber & Cacek, 2008). Different types of sports training cause different adaptation

mechanisms in the body. In strength exercises, adaptation at the level of neuroregulatory mechanisms prevails (Santos, et al. 2023). During aerobic exercises, the adaptation of the cardiovascular and respiratory systems prevails (Dalamitros et al. 2016). A common indicator is that adaptation takes place over time. A minimum of 2 weeks of strength training is required to induce significant changes (Damas, et al. 2016). 8 to 12 weeks are required for endurance exercise (Folland & Williams, 2007).

After finishing or interrupting the training, the following changes occur: the size of the heart chambers and the wall thickness decrease by 4-30% within 21-60 days; heart functions - decrease by 0-30% within 10-28 days; maximum pulmonary ventilation decreases by 3-7% - after 3 days; blood volume and plasma decrease by 2-5% in the first 2 days, then decrease by 5-12% over 2-4 weeks; capillary density decreases by 0-6% within 15 days; the activity of oxidative enzymes decreases by 23-45% within 10 days; the activity of glycolytic enzymes decreases after 7 to 12 days; VO<sub>2</sub>max- decreases by 4-20% during the first 8 weeks (Mujika & Padilla, 2000; Simoneau, et al. 1987).

During the COVID-19 pandemic, there were significant restrictions on the movement of children and youth due to measures aimed at reducing the spread of the virus. In a comparison of European Union countries, Slovakia is among the countries where schools were completely or partially closed for the longest time - exactly 28 weeks. Schools were closed in the Czech Republic for one more week, and in Romania for two more. In Slovakia, swimming pools are mainly part of school facilities, so they were automatically closed together with the schools. For example, the city of Nitra (the 5th largest in Slovakia) has five swimming pools, and up to four of them are part of the school.

In Italy, adolescents (61 girls) recorded a statistically significant decrease in tests of general motor performance after 12 weeks of lockdown (Demarie, 2022). In Spain, they recorded a statistically significant decrease in VO<sub>2</sub>max in 12- to 14-year-old children after 12 weeks, while the sample consisted of 89 children (López-Bueno, et al. 2022). In Portugal, they tested 67 children (7 to 12 years old) during April 2018 and subsequently the same children in April 2022. From March to May 2020, the children underwent a 3-month lockdown.

Children were tested with a battery of tests focused on basic motor skills. As a result, the children achieved a statistically significant decrease in the tests of motor locomotion, manipulation and also achieved a statistically significant decrease in the total score (Carballo-Fazanes, et al. 2022).

This study aimed to track the changes in swimming performance of among physically active young men over six years encompassing the challenges posed by the Covid-19 pandemic.

## **Material & methods**

### *Participants*

The monitored group consisted of students in the last years of secondary schools in Slovakia, with an average age of 18.5 ± 0.5 years. In individual years, we tested the following number of students: 2017 (192); 2018 (184); 2019 (189); 2020 (0); 2021 (184); 2022 (160); 2023 (171)

### *Procedure*

We monitored the students' performance in the 100 m freestyle swimming test during the years 2017 to 2023. The testing always took place in the last week of April at the 25 m swimming pool of the FTVŠ UK in Bratislava.

### *Test protocol*

The test protocol consisted of a 15-minute warm-up. After it was finished, the 100 m freestyle swimming test followed. At the examiner's signal - a long whistle, the probands went to the starting block. At the command "Take your marks", the subjects immediately took the starting position, in which at least one foot was in the front part of the block. The position of the hands was irrelevant. The start of the test began with the sound signal of the examiner. If the proband started before the sound signal, the test was interrupted and then repeated according to the predicting pattern.

### *Data collection*

We recorded time accurate to the second. The swimming test for 100 m crawl was performed. The timer started on a sound signal. The end of the test was when the proband touched the pool wall with at least one hand.

### *Statistical analysis*

We used IBM SPSS 27 (IBM, Armonk, NY – USA) to process and evaluate the data we obtained. To determine whether a data set is modeled for normal distribution we used kurtosis, skewness and Shapiro–Wilk test. To determine if there are statistically significant differences between more groups of an independent variable we used Kruskal Wallis test. Post Hoc test was used to multiple comparisons between all combination of groups with Bonferroni correction.

The research was granted an ethical approval by The FPES CU Committee of Ethics in Bratislava (ref 9/2023) and was in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

**Results**

The results achieved in the individual years are shown in the tab. 1. After COVID – 19 pandemic we can see increase in time achieved in 100 m Crawl. While the average times achieved for the years 2017 to 2019 were 98.1 seconds, after COVID – 19 pandemic the average time for the years 2021 to 2023 increased to 105 seconds. The increase was 6.06 %. We can also see the difference in the average median values 96,6 before pandemic vs. 101 after pandemic. The increase was 4.55 %. The difference between years was: 2017 – 2018 (2.34 %), 2018 -2019 (1,09 %), 2019 – 2021 (6,23 %), 2021 – 2022 (0.38 %), 2022 – 2023 (2.18 %).

Years	2017	2018	2019	2021	2022	2023
Average score [s]	98.3	100.6	99.5	105.7	106.1	103.4
Median	96	96	98	103	99	101
Maximal score	204	210	170	196	223	205
Minimal score	55	54	56	57	59	52
Var	149	156	114	139	164	153
STDEV	22.5	24.6	20.3	22.6	28.5	27.3

The Kruskal–Wallis H test revealed a significant difference between years ( $p = 0.004$ ) Fig.1; Tab. 2. Post-hoc analysis through the Mann–Whitney U test with Bonferroni correction (Tab. 3) located the difference between 2017 and 2021 ( $p = 0.000$ ); 2017 and 2022 ( $p = 0.011$ ); 2017 and 2023 ( $p = 0.038$ ); 2018 and 2021 ( $p = 0.006$ ); 2019 and 2021 ( $p = 0.008$ ).

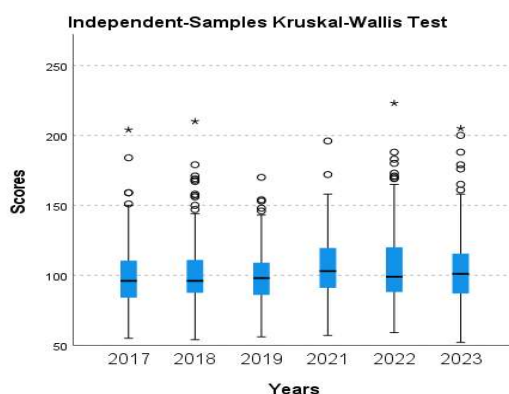


Figure 1 Results of Kruskal- Wallis Test

Table 2 Results of Kruskal- Wallis Test

Independent-Samples Kruskal-Wallis Test Summary	
Total N	1080
Test Statistic	17.433 <sup>a</sup>
Degree Of Freedom	5
Asymptotic Sig.(2-sided test)	.004

a. The test statistic is adjusted for ties.

Table 3 differences between years

Pairwise Comparisons of Years					
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig. <sup>a</sup>
2017-2018	-25,837	32,174	-,803	,422	1,000
2017-2019	-29,206	31,956	-,914	,361	1,000
2017-2023	-68,065	32,793	-2,076	,038	,569
2017-2022	-84,879	33,384	-2,543	,011	,165
2017-2021	-115,220	32,174	-3,581	,000	,005
2018-2019	-3,369	32,299	-,104	,917	1,000
2018-2023	-42,228	33,127	-1,275	,202	1,000
2018-2022	-59,042	33,712	-1,751	,080	1,000
2018-2021	-89,383	32,515	-2,749	,006	,090
2019-2023	-38,859	32,915	-1,181	,238	1,000
2019-2022	-55,673	33,504	-1,662	,097	1,000
2019-2021	-86,014	32,299	-2,663	,008	,116
2023-2022	16,814	34,303	,490	,624	1,000
2023-2021	47,155	33,127	1,423	,155	1,000
2022-2021	30,341	33,712	,900	,368	1,000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is ,050.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

## Discussion

From the results, we observe a statistically significant effect of restrictions during the Covid 19 pandemic on motor performance in the swimming test 100 m crawl. We did not notice the difference between 2017 and 2019. We also did not see a difference between 2021 and 2023. The difference between the years before the pandemic and after the pandemic was statistically significant in all monitored years. In long-term sports training, most coaches today start from the principle S.A.I.D. "Specific Adaptation to Imposed Demands" (Vanderka & Sedliak, 2011). The aquatic environment is specific to other types of sports, for example: the prone position; simultaneous use of arms and legs for propulsion; water immersion (i.e. hydrostatic pressure on thorax and controlled respiration); propulsive forces that are applied against a fluctuant element; and minimal influence of equipment on performance (Aspenes & Karlsen, 2012). We assume that closed swimming pools during the pandemic and the resulting impossibility of swimming could have caused differences in motor performance in the years we monitored. Also performance swimmers were affected by pandemic restrictions. For example coaches in Greece reported lower duration of the training and lower daily swimming distance during the 2019–2020 and 2020–2021 seasons, compared to the previous five seasons (Tsalis, & Mougios, 2022). In our case, it was high school students who could not use the swimming pool even with an exception. As of 2021, pandemic measures were lifted, still reduced motor performance persists. COVID-19-related lockdowns were detrimental to children and adolescents' movement behaviours, with stricter lockdowns tending to have a bigger impact. Children and adolescents under COVID-19 restrictions are likely to be less active, spend more time in front of the screen, and sleep longer hours than before the lockdown (Kharel, et al. 2022). In Slovakia Covid restrictions was one of longest in Europe. We assume in addition to the direct effects on motor performance, which could be manifested especially in 2021, the long-term effect of the lockdown was manifested in the following years. Based on our results, we assume that the effect of long-term involuntary inactivity could cause a decrease in motor performance both in the short term and in the long term.

## Conclusions

We assume, that lockdowns related to COVID-19 pandemic caused significant decrease in 100 m crawl performance in high school students in Slovakia. The average time before COVID pandemic observed in 100 m crawl test was 99 seconds vs. 105 seconds after COVID pandemic which is a decrease of 6,06 %. Based on our results, we assume that the effect of long-term involuntary inactivity could cause a decrease in motor performance both in the short term and in the long term. More studies from other motor tests and different age groups could provide a clearer picture of the effect of COVID – 19 pandemic on motor performance.

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**Conflicts of interest** - The authors declare no conflict of interest..

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