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Original Article

The effect of two COVID-19 lockdowns on physical activity of school-age children

Olena Yelizarova [a,*], Tetiana Stankevych [a], Alla Parats [a], Nadiya Polka [a], Oksana Lynchak [a], Nataliya Diuba [b], Svitlana Hozak [a]

[a] State Institution "O.M. Marzieiev Institute for Public Health", National Academy of Medical Sciences of Ukraine, Kyiv, Ukraine
[b] Brovary School N9, Kyiv Oblast, Ukraine

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ABSTRACT

The introduction of strict quarantine restrictions in many countries initiated a direction in science to study the behavioral characteristics of children and adolescents during the social isolation at the population level. We present our observations during the two lockdowns in Ukraine. The objective of this study was to determine: a) the level of light (LPA) and moderate-to-vigorous (MVPA) physical activity among school-age children, and b) the impact of the external and internal factors on their physical activity during the lockdown. Global Physical Activity Questionnaire (GPAQ) as part of our questionnaire Q-RAPH was used. Parents of 1091 children 6–18 years old (54% boys) filled Q-RAPH at two measurement points in 2020 and 2021. After performing ANCOVA and logistic regression, we found a significant decrease in MVPA by 12.7% in 2021 compared to 2020 ($p < 0.001$) while LPA was about 1.5 h a day during both periods. The proportion of children who reach the recommended levels of MVPA also decreased by 13.7% in 2021 ($p < 0.001$). Factors negatively affecting the achievement of 60 min a day of MVPA were female gender, chronic diseases, overweight/obesity, non-participation in organized sports, and a decrease in the average air temperature. This study evidences the insufficient level of preventive measures and requires an intensification of health education among the Ukrainian population. When developing preventive measures, special attention should be paid to groups vulnerable to MVPA reduction as children who have chronic diseases and/or overweight/obesity as well as non-participation in sports.

Introduction

For the second straight year, humanity is living in the COVID-19 pandemic.[1,2] Pressure on the healthcare system, psychological pressure, increased morbidity and mortality, and the economic crisis – all these factors affect the health of the population in a negative way.[3–6] Studies show that the implementation of lockdowns has caused a decrease in physical activity (PA) and an increase in sedentary behavior among adults.[7–9] Studies regarding the physical activity of childhood and adolescents during the transition to distance learning also have shown negative behavioral changes in many countries.[10] However, some of the studies show an increase in the physical activity among certain groups of the population.[9,11] PA is a necessary component of childhood development and helps prevent non-communicable diseases in adulthood.[12–14] PA is also an important factor in reducing the anxiety and depression many are experiencing amid the COVID-19 pandemic.[15]

Since 2020, quarantine measures introduced throughout the world have resulted in the closing of educational institutions.[16,17] In connection with this, studies on PA of children and adolescents have been done since the start of the pandemic in many countries.[11,18–22] However, the issue of regular monitoring of the children's physical activity during the pandemic remains an open question. Although, monitoring the physical activity of the younger generation is necessary to improve the programs that increase their activity levels.[20]

The latest World Health Organization (WHO) guidelines recommend that students engage in moderate-to-vigorous physical activity (MVPA) of at least 60 min/day while under lockdown or learning remotely.[17] In terms of distance learning, recommended levels of MVPA can be achieved by both independent exercise and online physical education.

Most studies on the physical activity of children and adolescents during the lockdown were conducted using questionnaires[11,19–22] and only a few studies were completed using devices.[23,24] Pre-pandemic, the use of questionnaires also were common practice when studying PA habits because of the correlations with other research methods.[25] The study[26] has shown that parental reports are consistent with the objective

* Corresponding author. 50, Popudrenko str., Kyiv, 02094, Ukraine.
E-mail address: oelizarova1806@gmail.com (O. Yelizarova).

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Abbreviations

PA	Physical activity
LPA	Light physical activity
MVPA	Moderate-to-vigorous physical activity
WHO	World Health Organization
T_{avg}, ^0C	the daily average air temperature
T_{min}, ^0C	the minimum air temperature
T_{max}, ^0C	the maximum air temperature
N_h, %	the total amount of sky covered by cloud
P, millimetres	the weekly sum of precipitation
D_p, days	the number of days with precipitation
GPAQ	Global Physical Activity Questionnaire
Q-RAPH	The questionnaire 'Rapid assessment of school-age children's physical activity during the lockdown'
SD	Standard Deviation
BMI	Body Mass Index
ChD	Chronic diseases

measurements of children's PA using accelerometers. And thus, the results of this study have confirmed that the use of parents' reports is a reliable method to estimate students' behavioral factors. Therefore, the objective of this study was to determine: a) the level of PA among children and adolescents using a questionnaire, and b) the impact of the external and internal factors which could have affected PA among school-age children during the strict quarantine measures in Ukraine.

Materials and methods

Design and participants

This study analyzed the type, duration and frequency of PA among school-age children aged 6–18 during the strict quarantine measures in Ukraine where 413,800 students lived at the time of the study. Data was collected from April 17 to May 11, 2020, and from April 12 to May 5, 2021. The exclusion criteria for participants were the acute form of COVID-19 or any other infectious disease, the period of rehabilitation after injury or surgery, and exacerbation of chronic diseases.

The survey was approved by the Bioethics Committee of the SI "O.M. Marzieiev Institute for Public Health" (protocol No 2, April 9, 2020). We used a specially designed questionnaire 'Rapid assessment of school-age children's physical activity during the lockdown' (Q-RAPH), the link to which was distributed via Facebook and parent groups in such networks as Viber, WhatsApp using a snowball sampling strategy. Residents of 79 localities in all regions of Ukraine took part in the survey. The population of these localities varied from 152 inhabitants to 3 million inhabitants.

Parents were asked to fill out the questionnaire. This approach in the study design is based on evidence of a close correlation between parental reports and objectively measured physical activity in their children.[26] At the beginning of the survey, participants received information about the objective of the survey the confidentiality and the conditions of the use of their data. All of the participants read and signed informed consent.

The structure of the Q-RAPH is presented in Table 1. The questionnaire consisted of 6 blocks that took into account the possible types of activity that school-age children could engage in during the lockdown. We also took into account indicators of daily routine such as sleep and diet. The questions in the last block of the questionnaire were aimed at studying the mental health of children and adolescents.

To assess the reliability of the questionnaire, we asked parents to refill the questionnaires at intervals of one week. The parents of 185 students in 2020 and 59 students in 2021 were filled out the Q-RAPH questionnaire twice. These test-retest measures allowed us to obtain acceptable intraclass correlation coefficients (*ICC*) (0.79–0.95 in 2020 and 0.68–0.99 in 2021) within each category and confirm the reliability of the Q-RAPH questionnaire (Table 1).

Physical activity

Global Physical Activity Questionnaire (GPAQ) as part of our questionnaire Q-RAPH was used to determine the type, frequency and duration of physical activity in a typical lockdown week. Since the study started one month after the start of the lockdown, the study participants already had well-established behavior patterns. This questionnaire was used by the WHO for NCD Risk Factor Surveillance (STEPS) in different countries, including Ukraine.[27] GPAQ is designed to quickly poll large numbers of people, which was the decisive factor in our choosing to use the questionnaire method.

We included light types of physical activity (LPA; 1.6–3.0 MET) such activities as slow walking, personal hygiene, playing musical instruments, sweeping, watering flowers, washing dishes and other chores, as well as participating in art and theatre. The moderate type of physical activity (3.0–7.0 MET) included any activities that cause a small increase in breathing or heart rate and which were maintained for at least 10 min continuously, such as brisk walking, dancing, slow running, aerobics, gymnastics, slow cycling, rollerblading, and gardening. The vigorous type of physical activity (7.0 and more MET) included any vigorous-intensity sports or fitness activities that cause large increases in breathing or heart rate and which were maintained for at least 10 min continuously, such as karate/martial arts, fast running, fast cycling, fast jumping or jumping rope. Sports or exercise, as well as gardening, were classified as moderate-to-vigorous types of physical activity (MVPA).

We defined the weekly duration of physical activity as the product to the frequency of type by a certain type of physical activity by its average duration. We also calculated the proportion of school-age children who have achieved the WHO guideline of more than 60 min per day of moderate-to-vigorous intensity physical activity.

Quarantine

In Ukraine, over the past two years, three variants of quarantine measures have been applied. There were strict quarantine restrictions, easier quarantine restrictions, and an adaptive quarantine.

This study analyzes the physical activity of school-age children during the period of strict quarantine restrictions. These restrictions included a prohibition on visiting educational institutions, walking in parks, squares, recreation areas, forest parks and coastal areas, playing on children's and sports grounds. During this period, fitness centers, sports clubs, gyms, and malls were closed. Children under 14 years of age were prohibited by the government from walking outside unaccompanied. However, school-age children had the opportunity to go to the store, pharmacy or walk near the house, along avenues and streets, and walk the pet. Children under 14 years old could walk accompanied by an adult, and children over 14 years old could walk on their own.

Study size

Parents of 1091 children 6–18 years old (54% boys) filled Q-RAPH at two measurement points 2020 and 2021 during the COVID-19 lockdown in Ukraine. The Q-RAPH was completed by the parents of 421 primary school students (248 boys, 173 girls), 521 secondary school students (264 boys, 257 girls), and 149 high school students (74 boys, 75 girls). All of the participants provided informed consent. The age groups ratio of primary, secondary and high students was 38.7%:47.7%:13.6%. Therefore, this sample is representative of the general population of Ukrainian school-age children. The study's margin of error was 3% in 2020 and 6% in 2021 taking into account the population size and 95% confidence interval.

The margin error was computed using the formula:

Table 1
Categories of the Q-RAPH questionnaire.

Categories	Explanation	*ICC*	
		2020	2021
General information	Informed consent, email, parental education, place of residence in quarantine	0.95	0.99
Information about the child	Date of birth, gender, grade, height, weight, chronic diseases and disabilities, COVID-19, conditions of quarantine, duration of quarantine, sleep, personal hygiene, diet	0.87–0.91	0.95–0.98
Distance Learning	Form of lessons, duration of the learning, activity between lessons, duration of homework, parents' attitude to distance learning	0.79–0.89	0.68–0.84
Physical activity (GPAQ)	Duration and frequency of physical activity of moderate and vigorous intensity, morning gymnastics, walks	0.80–0.91	0.77–0.87
Other activities of the child	Participation in household chores, gardening, reading, drawing, communicating with friends, playing musical instruments, screen time.	0.85–0.92	0.74–0.91
Anxiety and depression scale	25 questions about the child's mental health	0.93–0.94	0.89–0.90

Note: Q-RAPH – the questionnaire 'Rapid assessment of school-age children's physical activity during the lockdown'; GPAQ – Global Physical Activity Questionnaire; *ICC* – Quantifying test-retest reliability the Q-RAPH questionnaire using the intraclass correlation coefficient.

$$\Delta_{2020} = Z\sqrt{\frac{pq}{n}} = 1.96\sqrt{\frac{0.519 \times 0.481}{807}} = 3.4$$

$$\Delta_{2021} = Z\sqrt{\frac{pq}{n}} = 1.96\sqrt{\frac{0.519 \times 0.481}{284}} = 5.8$$

Δ = the margin of error.
Z = the confidence level at 95% (z-score standard value is 1.96).
p = the boys' proportion = 0.519.
q = the girls' proportion = 0.481.
n = the Sample Size.

Statistical methods

Statistical processing was performed using STATISTICA 8.0. The significance level was set at 0.05. We calculated the mean and standard deviation of duration and frequency of LPA and MVPA using ANCOVA with values of physical activity as the dependent variable and the year of lockdown, gender and school-age as predictors. To assess the gradations of the MVPA, we used crosstabulations analysis.

Also, we studied the main effect of the external and internal factors that could affect the physical activity of school-age children during the strict quarantine measures in Ukraine: a) we added them as covariates to the model of ANCOVA to study their main effect which was adjusted for the year of the study, gender and age of the participants; b) we assessed the odds ratio (*OR*) in children with different duration of MVPA using the model of logistic regression. These factors included socio-demographic (age, gender, place of residence, parental education) and anthropometric (body mass index) values, chronic diseases as well as whether or not the children played sports pre-quarantine.[9,12,18,28,29] In addition, we assessed the impact of weather conditions.[30] For the study of weather conditions, the unit of measurement was seven days before the questionnaire was completed. We estimated the average value of the average daily temperature (T_{avg}), maximum (T_{max}) and minimum (T_{min}) temperatures for this period. The number of days with precipitation (D_p), the sum of weekly precipitation (P) and the average value of the sky coverage by clouds (N_h) were also taken into account. Only the T_{avg} and D_p levels were included in the analyzed models due to the phenomenon of multicollinearity.

Results

Participants

The characteristics of the physical development of the study participants by gender and age group are presented in Table 2.

The Q-RAPH was completed by the parents of 807 Ukrainian children and adolescents aged 6–18 years, including 307 individuals of primary school (181 boys, 126 girls), 384 students aged of secondary school (198 boys, 186 girls), and 116 students of high school (57 boys, 59 girls) in 2020. The 2021 study sample consisted of 284 school-age children, including 114 individuals of primary school (67 boys, 47 girls), 137 students of secondary school (66 boys, 71 girls), and 33 students of high school (17 boys, 16 girls).

As expected, statistical differences were found between BMI levels of students in primary, secondary and high school ($p < 0.001$), but there were no significant differences between surveys 2020 and 2021 ($p > 0.3$). The proportions of children with overweight or obesity also were no significant differences by sex, age and 2020/2021 groups ($p > 0.4$). 20.4% ($n = 222$) of the Ukrainian school-age children in the general study group had overweight or obese.

The majority of respondents were urban dwellers (84,1%), which corresponds to the structure of the population of Ukraine. Respondents from urban and rural regions did not differ statistically by age and gender ($p > 0.5$). However, in the 2020 sample, the number of urban residents among respondents was 15.8% higher ($p < 0.001$) than in 2021; therefore, this bias was taken into account as a covariate when analyzing the characteristics of physical activity of schoolchildren.

16.6% ($n = 70$) of primary school students, 27.6% ($n = 144$) of secondary school students, and 36.9% ($n = 55$) of high school students had chronic diseases ($p < 0.001$). The samples of 2020 and 2021 differed ($p < 0.05$) in the proportion of children with chronic diseases, which was also taken into account as a confounding factor.

Among participants of our study, 69.8% had parents with a high level of education (a bachelor's or higher degree) and 17.6% had parents with a low level of education (high school completion). Parents of 12.6% of the participants had specialized secondary education. During the second survey, the proportion of parents with a low level of education who completed the questionnaire was 10.4% lower than during the first survey ($p < 0.001$). The proportions of parents with high and secondary specialized education did not differ statistically ($p > 0.1$).

Main results

Physical activity

The average duration and frequency of physical activity among school-age children during the period of strict quarantine are presented in Tables 3 and 4, stratified by gender and age. Levene's test for homogeneity of LPA and MVPA variances was performed. The p-value of LPA Levene's test is more than 0.09 ($F = 2.9$; $p = 0.097$) and MVPA Levene's test is more than 0.9 ($F = 0.01$; $p = 0.923$). Based on this, we can conclude that the variances of the samples for 2020 and 2021 are homogeneous.

This study showed that the total MVPA time was 450.6 ($SD = 339.7$) minutes per week in 2020 and 393.2 ($SD = 342.8$) minutes per week in 2021 ($F = 10.9$; $p = 0.001$) while the total LPA time was 603.5 ($SD = 381.2$) minutes per week in 2020 and 606.1 ($SD = 355.0$) minutes per week in 2021 ($F = 13.4$; $p < 0.001$). That is, the introduction of the

lockdown in 2021 had an effect on the total MVPA level of school-age children ($F = 10.9$; $p = 0.001$) of −57.4 min per week, but did not change the total LPA level ($F = 0.2$; $p = 0.685$). In the girls' group, the total MVPA duration was lower than in the boy's group in both 2020 and 2021, by 60.5 and 143.9 min per week, respectively, ($F = 13.2$; $p < 0.001$) while the total LPA duration was higher by 152.2 min per week in 2020 and by 83.8 min per week in 2021 ($F = 13.4$; $p < 0.001$) in the girls' group. The frequency of MVPA in 2021 was significantly lower than in 2020 with the corresponding values of 3.8 ($SD = 1.5$) and 4.3 ($SD = 1.5$) times a week ($F = 25.4$; $p < 0.001$).

After covariate-adjustment in the model, we found that the MVPA during the period of strict quarantine decreased by 50.9 min per week in 2021 compared to 2020 ($F = 10.3$; $p < 0.001$). The female gender was responsible for the 60.1 min per week decrease in MVPA compared to the male gender during the period of strict quarantine restrictions. The chronic diseases caused a decrease in MVPA of 68.8 min per week ($F = 8.3$; $p < 0.01$). We also found a decrease in MVPA of 61.4 min per week for those with overweight or obese status ($F = 9.1$; $p < 0.01$). At the same time, the school-age children who played organized sports pre-lockdown duration of MVPA was higher by 111.4 min per week compared to children who are not involved in organized sports ($F = 28.3$; $p < 0.001$).

The significant main effects of such factors on chronic diseases, overweight/obesity status and organized sports were not detected for LPA ($p > 0.3$). However, it was found that in rural areas the average duration of primary and high students' LPA was lower than in cities by 134.1 min per week ($F = 5.1$; $p < 0.05$).

When the average duration of MVPA per day was calculated, we found that 47.0% ($n = 205$) of boys and 33.4% ($n = 124$) of girls of school age reached the recommended MVPA level in 2020 (Fig. 1). In 2021, these values were 35.3% ($n = 53$) and 17.9% ($n = 24$), respectively (Fig. 1). That is, the proportion of children who get at least 60 min/day of MVPA decreased both in the boys' group by 13.6% ($p < 0.05$) and in the girls' group by 17.4% ($p < 0.001$) during the 2021 lockdown compared to the 2020 lockdown. The chances of school-age children achieving the recommended level of MVPA in 2021 were almost halved compared to 2020 ($OR = 0.54$; 95%*CI* 0.40–0.73).

The external and internal factors that affect the physical activity of school-age children during the strict quarantine measures in Ukraine

Table 5 presents the odds ratios for the above impact indicators. The adjusted logistic model by age ($\chi^2 = 94.3$; $p < 0.001$) showed that performing more than 60 min per day of MVPA was associated with significantly increased odds for pre-lockdown organized sports ($OR = 2.68$; 95%*CI* 1.99–3.61). The chronic diseases ($OR = 0.67$; 95%*CI* 0.48–0.92), female gender ($OR = 0.52$; 95%*CI* 0.40–0.68) and increasing BMI > +1 *SD* ($OR = 0.60$; 95%*CI* 0.46–0.79) were associated with levels of moderate-to-vigorous physical activity < 60 min/day. Whereas covariates such as place of residence and parental education during the lockdown had not a significant influence on moderate-to-vigorous physical activity ($p > 0.4$).

Weather conditions during the 2020 and 2021 surveys were comparable and generally satisfactory for physical activity. During the observation periods, the average daily temperature for the last 7 days before filling the questionnaire was 12.0 °C ($SD = 2.3$) in 2020 and 11.7 °C ($SD = 3.6$) in 2021 (Table 6). Also, there were no statistically significant differences in the values of the maximum temperature, minimum temperature, percentage of cloudiness and the number of days with precipitation ($p > 0.1$).

When the T_{avg} and D_p variables were included in the ANCOVA model as additional covariates with the LPA or MVPA variables as dependent variables, no statistically significant effect of weather factors was found for MVPA ($p > 0.1$). However, it was found that the weekly duration of LPA increases by 25.7 ($SD = 14.0$) minutes with an increase in the average daily temperature by 1 °C ($F = 13.0$; $p < 0.001$) in the temperature range from 6 to 15 °C.

The logistic regression model was adjusted for values of average temperature and the number of days with precipitation (Table 5). The data analyses showed a significant effect of the daily average temperature ($OR = 1.08$; 95%*CI* 1.01–1.16) to achieving 60 min of MVPA per day. At the same time, the influence of other factors remained practically unchanged. That is, we can assert that weather conditions are a significant factor for achieving the recommended values of the MVPA, but not a determining one.

Discussion

This study presents the specific features of school-age children's physical activity in the spring of 2020 and 2021 during the period of strict quarantine measures. The sample sizes in the 2020 and 2021 studies were unequal. Confirmation of the null hypothesis by the Levene's test and the chi-square test allows us to be confident that there is no bias and the interpretation of the results obtained is correct.

We elected to employ questionnaire methodology online in this study because questionnaires have the advantage of being able to be deployed in large-scale population studies. The initiation of epidemical safety measures in Ukraine, as well as in other countries, made field experimentation unfeasible. Therefore, online surveys were the only opportunity to study the physical activity of school-age children. However, we acknowledge this limitation to our survey. The gold standard for the study of physical activity is objective measurement using devices[31,32] as well as a combination of objective measurements and questionnaire methods.[31-34] Even though the frequency of use of individual devices for monitoring physical activity will increase in the near future by more than five times,[35,36] today we do not have the opportunity to obtain such voluminous and significant information during the lockdown.

Table 2
Characteristics of the participants.

School age/Year	BOYS					GIRLS					Overweight/Obese status, %	ChD, %	Urban dwellers, %
	n	Age, years		BMI, kg/m^2		*n*	Age, years		BMI, kg/m^2				
		M	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*			
Primary	248	8.6	1.4	16.5	2.9	173	8.4	1.2	16.4	2.9	22.3	16.6	84.6
2020	181	8.6	1.4	16.4	2.9	126	8.5	1.3	16.2	2.7			
2021	67	8.5	1.3	16.9	2.9	47	8.4	1.0	16.9	3.3			
Secondary	264	13.0	1.5	19.7	3.6	257	12.9	1.5	19.0	2.9	20.7	27.6	85.0
2020	198	13.2	1.5	19.8	3.7	186	13.1	1.4	18.9	2.9			
2021	66	12.4	1.2	19.5	3.4	71	12.5	1.5	19.2	2.9			
High	74	16.3	0.7	20.9	3.1	75	16.3	1.1	20.2	2.7	13.4	36.9	79.9
2020	57	16.3	0.5	20.8	3.0	59	16.3	1.2	20.2	2.8			
2021	17	16.2	1.1	21.2	3.4	16	16.4	0.9	20.1	2.4			
Total	586	11.5	3.0	18.5	3.7	505	11.9	3.1	18.3	3.2	20.4	24.7	84.1
2020	436	11.7	3.1	18.5	3.7	371	12.0	3.1	18.2	3.2	18.6	25.9	85.2
2021	150	11.1	2.9	18.5	3.5	134	11.6	2.9	18.5	3.2	22.4	36.6	69.4

Note: *M* is sample mean; *SD* is standard deviation; BMI is body mass index; ChD is a chronic disease.

Table 3
The average duration of physical activity among school-age children during the period of strict quarantine.

School age/Year	Duration of physical activity, minutes a week															
	BOYS						GIRLS						Total			
	LPA			MVPA			LPA			MVPA			LPA			MVPA		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Primary	248	546.4	335.9	242	445.5	328.0	173	650.1	442.7	161	428.3	345.1	421	589.0	386.3	403	438.6	334.6
2020	181	544.3	350.1	177	452.8	321.1	126	663.8	422.3	118	455.3	341.8	307	593.4	385.3	295	453.8	329.0
2021	67	551.9	296.5	65	425.6	347.8	47	613.4	496.2	43	354.3	347.3	114	577.2	390.5	108	397.2	347.7
Secondary	264	525.3	321.4	244	486.9	369.3	257	685.1	392.3	237	358.4	284.9	521	604.1	366.6	481	423.6	336.3
2020	198	514.1	326.9	183	478.3	349.9	186	695.4	411.6	173	377.8	300.3	384	601.9	380.9	356	429.4	330.2
2021	66	559.2	304.2	61	512.8	424.2	71	658.0	337.6	64	305.9	232.2	137	610.4	324.6	125	406.8	353.9
High	74	586.8	326.0	71	522.4	382.7	75	707.1	395.3	71	417.7	340.5	149	647.3	366.3	142	470.1	364.7
2020	57	566.9	328.2	55	559.9	390.7	59	702.2	403.6	57	461.3	360.2	116	635.7	373.1	112	509.7	377.0
2021	17	653.2	318.9	16	393.4	333.5	16	725.3	375.0	14	240.4	152.5	33	688.2	343.7	30	322.0	272.0
Total	586	542.0	328.2	557	473.4	354.1	505	676.4	410.4	469	391.4	316.4	1091	604.2	374.4	1026	435.9	339.7
2020	436	533.5	336.7	415	478.2	344.6	371	685.8	413.2	348	417.7	326.5	807	603.5	381.2	763	450.6	337.6
2021	150	566.6	302.0	142	459.4	381.5	134	650.4	402.7	121	315.5	272.6	284	606.1	355.0	263	393.2	342.8

Note: *M* is sample mean; *SD* is standard deviation; MVPA is moderate-to-vigorous physical activity.

Table 4
The average frequency of moderate-to-vigorous physical activity among school-age children during the period of strict quarantine.

School age/Year	Frequency of MVPA, times a week								
	BOYS			GIRLS			Total		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Primary	242	4.1	1.5	161	4.3	1.4	403	4.2	1.5
2020	177	4.2	1.5	118	4.4	1.4	295	4.3	1.5
2021	65	3.7	1.4	43	4.0	1.5	108	3.9	1.4
Secondary	244	4.2	1.5	237	4.0	1.6	481	4.1	1.5
2020	183	4.3	1.5	173	4.1	1.6	356	4.2	1.5
2021	61	3.9	1.3	64	3.7	1.6	125	3.8	1.5
High	71	4.6	1.6	71	4.0	1.7	142	4.3	1.7
2020	55	4.9	1.5	57	4.3	1.6	112	4.6	1.6
2021	16	3.7	1.7	14	3.2	1.7	30	3.5	1.7
Total	557	4.2	1.5	469	4.1	1.5	1026	4.2	1.5
2020	415	4.4	1.5	348	4.2	1.5	763	4.4	1.5
2021	142	3.8	1.4	121	3.7	1.6	263	3.8	1.4

Note: *M* is sample mean; *SD* is standard deviation; MVPA is moderate-to-vigorous physical activity.

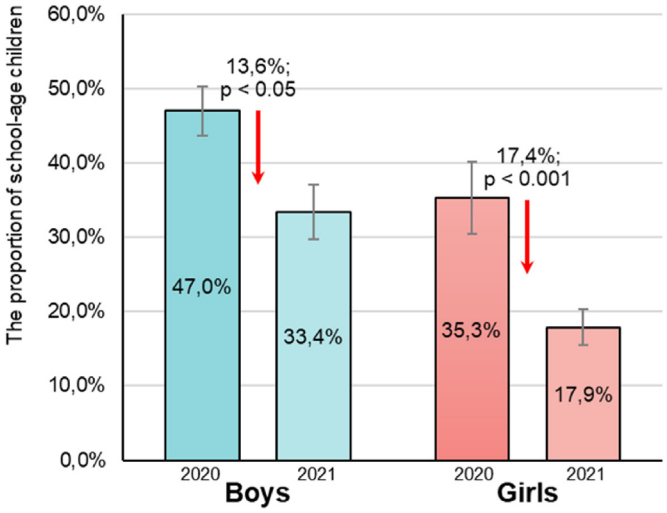

Fig. 1. The proportion of school-age children meeting the 60 min/day of moderate-to-vigorous physical activity during the 2021 lockdown compared to the 2020 lockdown.

Despite the differences in methods to measure physical activity, the authors[16,36] emphasize the need to maintain a sufficient level of physical activity to promote physical and mental health during the COVID-19 pandemic. Our pre-pandemic studies of the physical activity of urban adolescents showed that more than 70% of participants had a sedentary lifestyle.[37] During the introduction of quarantine measures in connection with the COVID-19 pandemic, schooling was periodically conducted in a distance format,[17,18] which likely caused an even greater reduction in the physical activity of children and adolescents.

This study showed that LPA levels, independent of the participant's age, were in the range of 577.2–688.2 min per week estimating about 1.5 h per day. However, our previous studies showed that school-age children need at least 1.5 h of walking per day,[38] to support cognitive abilities. Children should also engage in other types of LPA from 1.5 to 3 METs, aside from walking, to promote optimal health. According to the recommendations from the Canadian 24-Hour Movement Guidelines for Children and Youth, 14 the duration of LPA should be at least several hours a day to stay healthy. This study showed that school-age children had the opportunity to achieve the required duration of LPA during the

Table 5
Logistic regression of the factors affecting the achieving the recommended levels of moderate-to-vigorous physical activity of school-age children.

Factors	No weather conditions			With weather conditions		
	OR	95%*CI*	*p*	*OR*	95%*CI*	*p*
Parental education	1.02	0.86–1.22	0.812	0.99	0.82–1.20	0.929
Gender	0.52	0.40–0.67	0.001	0.51	0.39–0.67	0.001
Age	1.01	0.97–1.06	0.590	1.01	0.97–1.06	0.648
Body mass index z-score	0.60	0.46–0.79	0.001	0.61	0.47–0.80	0.001
Chronic diseases	0.67	0.48–0.92	0.015	0.70	0.50–0.96	0.029
Organized sports	2.68	1.99–3.61	0.001	2.75	2.04–3.71	0.001
Place of residence	1.14	0.80–1.62	0.468	1.16	0.81–1.66	0.421
Average temperature[a]	–	–	–	1.08	1.01–1.16	0.035
Number days with precipitation[b]	–	–	–	0.95	0.85–1.07	0.418
Model characteristics	$\chi^2 = 94.3; p < 0.001$			$\chi^2 = 99.1; p < 0.001$		

Note.
[a] – the average value for the previous week before completing the questionnaire.
[b] – the total number of days with precipitation.

Table 6
Weather conditions during observation in 2020 and 2021.

Weather conditions	2021		2020		*t*	*p*
	Mean	*SD*	*Mean*	*SD*		
T_{avg}, ^{0}C	11.7	3.6	12.0	2.3	0.3	0.776
T_{min}, ^{0}C	4.6	3.3	3.6	2.2	1.4	0.174
T_{max}, ^{0}C	20.4	3.2	21.5	3.6	1.2	0.244
N_h, %	53.3	10.4	47.4	16.8	1.6	0.126
P, millimetres	19.9	14.0	22.0	16.9	0.5	0.621
D_p, days	4.4	1.0	4.2	2.3	0.5	0.643

Note: The temperature degrees Celsius at 2-m height above the earth's surface during the last 7 days before filling the Q-RAPH. T_{avg} - the daily average air temperature; T_{min} - the minimum air temperature; T_{max} - the maximum air temperature; N_h - the total amount of sky covered by cloud; P - the weekly sum of precipitation; D_p - the number of days with precipitation; *SD* is standard deviation.

period of strict quarantine restrictions in Ukraine. However, a low level of LPA shows the insufficient quality of promoting a healthy lifestyle and requires improvement. Also, psychological pressure apparently is also a significant factor in reducing LPA during the lockdown period. As a result, the population needs additional education about the correct behavior during the lockdown period.

The average weekly MVPA duration of Ukrainian school-age children during the lockdown 2021 was lower by 57.4 min/week compared to the 2020 study. Significant negative dynamics in MVPA weekly duration were observed in the group of girls, children with chronic diseases and/or with overweight/obesity, and also for those who did not do organized sports in the pre-pandemic. Studies conducted both by us and by other authors in the periods before and during the pandemic also assessed the female gender as a risk factor for a decrease in MVPA.[14,19,21,22,37] The results of our study are comparable with the results of other studies that indicate a reduced frequency and duration of physical activity among overweight and obese children during the pandemic.[20,29] Despite pediatric associations recommending physical activity as the main preventive measure of diseases and strengthened immunity in childhood and adulthood,[39–41] school-age children with chronic diseases often have both a decrease in overall physical activity and MVPA.[18] Our study confirms these trends.

This study showed that children who were involved in organized sports before the pandemic had the highest MVPA weekly duration in 2020 and 2021, and this is consistent with the results obtained in other studies.[28,42] At the same time, some studies have obtained data on the decrease in physical activity among participants in team sports during the lockdown period, but this issue has not been analyzed in this publication.

40.3% of Ukrainian school-age children reached the optimal MVPA level in 2020 and only 27.1% in 2021. The sufficiently high level of this activity in comparison with the results of other studies is due, to the observation period among other things. In Ukrainian families, involving children in gardening both in rural and urban areas is customary, especially in spring, and such activities correspond to MVPA.

Our study did not reveal a change in the level of physical activity depending on the place of residence of the respondents, although this factor has been included in the study, being guided, among other things, by the results indicating a decrease in physical activity among urban dwellers compared to rural areas during the lockdown period.[43]

We also found no effect of parental education on the physical activity level of their children. In previous studies, we did not find a significant effect of parental education on the level of MVPA either.[37] Additional interviews with parents showed that their awareness of the need for physical activity did not depend on the level of their education or family income.[37] And therefore health education of the Ukrainian population is one of the problems requiring solutions at the state level.

A meta-analysis[30] of data obtained in the period before the pandemic showed the associations between weather conditions and physical activity in children and adolescents. That study found that the duration of PA increased during favorable weather conditions. Our study during the lockdown period did not confirm this trend for MVPA. At the same time, the association of average daily temperature and LPA was revealed. Also, an average daily temperature increases statistically increased the chances of reaching 60 min a day of MVPA. These results indicate the need for further study of this issue.

As previously shown, a variety of approaches can lead to increased physical activity in people of all age groups.[44–47] Previous research provides a potential way to motivate children to engage in any type of physical activity during the quarantine period.[37] Using modern information technologies, in particular, the development of exercise information resources can be beneficial when taking into account the characteristics of school-age children's psychophysiological development.[48] Online physical education lessons are also a great method to increase the physical activity of children in this age group. This study once again emphasizes the importance of meeting recommended levels of physical activity during the quarantine and social restriction measures. The main strategy for a healthy lifestyle during this period is regular physical activity in a safe environment.[49,50] Since the risk groups for achieving the optimal MVPA level during quarantine include children with chronic diseases, overweight or obesity and children who did not play organized sports before quarantine, these children are the target groups to all possible promotional measures for healthy life.

Conclusions

We found a significant decrease in the level of school-age children's MVPA by 12.7% in 2021 compared to 2020 ($p < 0.001$). The proportion of children who reach the recommended levels of MVPA also decreased by 13.7% in 2021 ($p < 0.001$). This fact evidences the insufficient level of preventive measures and requires an intensification of health education among the Ukrainian population. When developing preventive measures, special attention should be paid to groups vulnerable to MVPA reduction as children who have chronic diseases and/or overweight/obesity as well as non-participation in sports.

Conflict of interest

The authors declare that there is no conflict of interest.

Submission statement

This article has not been published previously and it is not under

consideration for publication. This publication is approved by all authors and by the responsible authorities where the work was carried out. After accepted, this article will not be published elsewhere including electronically in the same form, in English or any other language, without the written consent of the copyright-holder.

Authors' contribution

This original study proposal was drafted by OY and SH. The data was collected by OY, AP, SH, NP, OL, ND. OY performed the statistical data analysis. This manuscript was written by OY and TS with the valued guidance of SH. All authors also contributed to the data analysis, formulation of the structure, and methods, as well as discussion.

Ethical approval statement

The survey was approved by the Bioethics Committee of the SI "O.M. Marzieiev Institute for Public Health" (protocol No 2, April 9, 2020). Participants received information about the objective of the survey, the confidentiality, the conditions of the use of data and the contact information of the principal investigator of the study. All of the participants read and signed informed consent.

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