



# Examining the Degree of Changes in Korean Elementary Schools' Physical Activity Promotion System Grades amidst the COVID-19 Pandemic

*\*Byung-Kweon Chang*

*Department of Physical Education, Korea National University of Education, Chungcheongbuk-do, Korea*

\*Correspondence: Email: jbg333@hanmail.net

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## Abstract

**Background:** The study aimed to provide basic data about the changes in the Korean elementary schools' Physical Activity Promotion System (PAPS) amidst the COVID-19 pandemic and to present future direction for school and physical education.

**Methods:** Data were collected for 2019–2021 from the PAPS, conducted by the Korea Ministry of Education. Participants were fifth and sixth level students from 1,214 Korean elementary schools, with 124,871, 126,396, and 117,953 participants in 2019, 2020, and 2021, respectively. Five physical fitness variables were evaluated—cardiopulmonary endurance, flexibility, muscle strength, power, and obesity—and graded from 1 (highest physical fitness level) to 5 (lowest physical fitness level). Data were analyzed using repeated measures analysis of variance and Bonferroni for multiple comparisons for computing confidence intervals.

**Results:** The findings indicated significant changes in the ratios of grades 1, 2, 4, and 5 according to the year ( $P<0.05$ ). Grades 1 and 5 decreased and increased in 2021 from 2019 and 2020, respectively ( $P<0.001$ ). Grades 2 and 4 continuously decreased and increased from 2019 to 2020 ( $P=0.001$ ,  $P<0.001$ , respectively) and further in 2021 ( $P<0.001$ ), respectively. Moreover, significant changes were identified in the grade ratio by year according to sex ( $P<0.05$ ). Male students reported higher grade 1 ratios than female students in 2019 ( $P=0.018$ ) and 2021 ( $P<0.001$ ). However, for all 3 years, female students reported higher grade 2 ratio ( $P<0.001$ ), while male students reported higher grade 4 and 5 ratios ( $P<0.001$ ). Lastly, male students reported higher grade 3 ratios than female students in 2019 ( $P=0.003$ ), but this finding was reversed in 2021 ( $P=0.004$ ).

**Conclusion:** The pandemic decreased students' physical activity and weakened their health, and this reduced fitness was greater pronounced in male students. In the future, physical educators should plan and present solutions to tackle reduced physical activity post the pandemic.

**Keywords:** COVID-19 pandemic; Elementary schools; Physical activity; Physical education

## Introduction

In March 2020, the coronavirus 2019 (COVID-19) was declared a pandemic; subsequently, as of January 30, 2022, the WHO has recorded over 370 million confirmed COVID-19 cases and over 5.6 million deaths (1). This pandemic has severely

affected and modified our ordinary daily lives. Particularly, measures such as lockdown, home quarantine or isolation, and social distancing, to prevent the spread of the virus, have in itself transformed human lifestyle (1). Accordingly,



educational and academic fields were also greatly impacted, as the face-to-face interaction between people was taken for granted. Currently, it is essential to diagnose the conditions of physical education based on physical activity (PA) for the future.

Recent studies have explored PA amidst the COVID-19 pandemic (2-8). These studies: a) aimed to explore the effect of the pandemic on PA (2-3), b) examined the impact of the pandemic on lifestyle through physical fitness, health, and other using a small sample quantitative analysis (4-6), c) employed a qualitative approach—to account for the constantly increasing pandemic period—to investigate psychological and physical health problems (7), and d) proposed PA as a means to recover from COVID-19.

Meanwhile, large-scale nationwide research has been steadily conducted to monitor and improve PA, physical fitness, and health (3, 9-10). However, no such large-scale research has been performed recently to explore the changes influenced by the COVID-19 pandemic. This study is novel as it employs a longitudinal design to explore the impact of the COVID-19 pandemic using three-year data collected from a nationwide elementary school population.

The study aimed to use large-scale survey data to examine the transforming effect of the COVID-19 pandemic on the changes of the Korean elementary schools' PAPS, and to provide basic data for future school and physical education system.

## Methods

### Participants

The PAPS data were employed, which is a national student health fitness evaluation system for fifth and sixth level school students in Korean elementary schools. PAPS aims to improve students and parents' productivity, induce their motivation to participate in PAs, and promote students' health and physical fitness through "health-oriented comprehensive physical fitness evaluation and exercise prescription" (11). The annual PAPS evaluation measures are distributed online through the school notification portal (<https://www.schoolinfo.go.kr>), which is a notice distribution channel for Korean elementary schools. For this study, data was extracted from 1,214 Korean elementary schools between 2019 and 2021. From these schools, data on 124,871, 126,396, and 117,953 students were obtained in 2019, 2020, and 2021, respectively. Table 1 presents the characteristics of the study participants.

**Table 1:** The general characteristics of participants

Variables		n (%)				
2019	School year	Fifth		Sixth		
		65,337 (52.3%)		59,534 (47.7%)		
	Sex	Male		Female		
		64,552 (51.7%)		60,319 (48.3%)		
	PAPS grade	1	2	3	4	5
		7,362 (5.9%)	50,853 (40.7%)	58,295 (46.7%)	7,766 (6.2%)	595 (0.5%)
2020	School year	Fifth		Sixth		
		61,222 (48.4%)		65,174 (51.6%)		
	Sex	Male		Female		
		65,300 (51.7%)		61,096 (48.3%)		
	PAPS grade	1	2	3	4	5
		7,105 (5.6%)	49,742 (39.3%)	59,250 (46.9%)	9,572 (7.6%)	727 (0.6%)
2021	School year	Fifth		Sixth		
		57,371 (48.6%)		60,582 (51.4%)		
	Sex	Male		Female		
		61,255 (51.9%)		56,698 (48.1%)		
	PAPS grade	1	2	3	4	5
		5,246 (4.4%)	39,127 (33.2%)	57,082 (48.4%)	15,179 (12.9%)	1,319 (1.1%)

PAPS: Physical Activity Promotion System

**Data collection**

The PAPS is an annual evaluation performed from March to May to suit elementary school schedules. However, amidst the COVID-19 pandemic—in 2020 and 2021—the school administration decided whether and when to conduct this evaluation. The measurement items were categorized into: a) mandatory evaluation—includes

one evaluation item corresponding to each physical fitness element, and b) selective evaluation—autonomously evaluated items as per the principal’s decision. As shown in Table 2, this study only used the mandatory evaluation measurement items and the standard chart for elementary schools.

**Table 2:** Essential evaluation and measurement items and standard chart for elementary school

Variables	Items	Male						Female				
		School year	Very bad (grade 5)	Bad (grade 4)	Normal (grade 3)	Good (grade 2)	Very good (grade 1)	Very bad (grade 5)	Bad (grade 4)	Normal (grade 3)	Good (grade 2)	Very good (grade 1)
Cardiopulmonary endurance	Shuttle run (reps)	Fifth	22~28	29~49	50~72	73~99	100~107	18~22	23~44	45~62	63~84	85~104
		Sixth	22~31	32~53	54~77	78~103	104~112	20~24	25~49	50~68	69~92	93~112
	Long run-walking (sec)	Fifth	480~640	410~479	325~409	282~324	268~281	502~640	442~501	360~441	300~359	268~299
		Sixth	450~587	380~449	315~379	251~314	243~250	480~587	430~479	354~429	300~353	243~299
Flexibility	Harvard step (physical efficiency index)	Fifth	44.0~46.9	47.0~51.9	52.0~61.9	62.0~75.9	76.0~95.0	44.0~46.9	47.0~51.9	52.0~61.9	62.0~75.9	76.0~95.0
		Sixth										
	Sit and reach (cm)	Fifth	-5.1~-4.1	-4.0~0.9	1.0~4.9	5.0~7.9	8.0~18.0	-0.1~0.9	1.0~4.9	5.0~6.9	7.0~9.9	10.0~22.0
		Sixth	~5.1~-4.1	-4.0~0.9	1.0~4.9	5.0~7.9	8.0~18.0	-0.1~1.9	2.0~4.9	5.0~9.9	10.0~13.9	14.0~26.0
Comprehensive flexibility (points)	Fifth	<4	5	6	7	8	<4	5	6	7	8	
	Sixth											
Muscle strength and endurance	Sit-up (reps)	Fifth	0~9	10~21	22~39	40~79	80~120	0~6	7~22	23~35	36~59	60~90
		Sixth	0~9	10~21	22~39	40~79	80~120	0~6	7~22	23~42	43~59	60~90
	Grip strength (kg)	Fifth	9.9~12.4	12.5~16.9	17.0~22.9	23.0~30.9	31.0~37.0	10.6~11.9	12.0~15.4	15.5~18.9	19.0~28.9	29.0~35.0
		Sixth	11.2~14.9	15.0~18.9	19.0~26.4	26.5~34.9	35.0~39.4	10.0~13.9	14.0~18.9	19.0~21.9	22.0~32.9	33.0~39.0
Power	Fifty-meter dash (sec)	Fifth	13.21~15.56	10.21~13.20	9.41~10.20	8.51~9.40	8.30~8.50	13.31~15.91	10.71~13.30	9.91~10.70	8.91~9.90	8.73~8.90
		Sixth	12.51~15.51	10.01~12.50	9.11~10.00	8.11~9.10	7.77~8.10	12.91~15.91	10.71~12.90	9.81~10.70	8.91~9.80	8.66~8.90
	Standing long jump (cm)	Fifth	105.6~111	111.1~114	141.1~159	159.1~180	180.1~187.4	89.3~100	100.1~112	123.1~139	139.1~170	170.1~175
		Sixth	112.0~122	122.1~148	148.1~167	167.1~200	200.1~204.7	89.9~100	100.1~112	127.1~144	144.1~175	175.1~178
Obesity	Body mass index (kg/m <sup>2</sup> )	Fifth	Under 14.5	14.6~21.6	21.7~24.4	24.5~29.9	Grade 1 obesity	Under 14.2	14.3~20.6	20.7~23.0	23.1~29.9	Grade 1 obesity
		Sixth	Under 14.8	14.9~22.5	22.6~24.9	25.0~29.9	Grade 2 obesity	Under 14.6	14.7~21.4	21.5~23.9	24.0~29.9	Grade 2 obesity
		Sixth	Under 14.8	14.9~22.5	22.6~24.9	25.0~29.9	Grade 2 obesity	Under 14.6	14.7~21.4	21.5~23.9	24.0~29.9	Grade 2 obesity

Five physical fitness variables were evaluated and scored at 20 points each, with a perfect sum score of 100 points. The summed scores were classified into grade 1 to 5 as follows: 1 (80 to

100 points), 2 (60 to 79), 3 (40 to 59), 4 (20 to 39), and 5 (0 to 19). The evaluation scores are automatically processed and computed by entering them into the National Education Information

System. The final evaluation outputs were distributed among parents and students through individual printouts.

### *Ethics approval*

The study was conducted in accordance with the Declaration of Helsinki principles and approved by the Korea Ministry of Education. Ethical approval was waived as the PAPS data did not include any private identifying information, such as name, age, home addresses, telephone numbers, and social security numbers.

### *Measurement of Physical Fitness Level*

#### *Cardiopulmonary endurance*

The cardiopulmonary endurance evaluation comprises three tests: 1) The shuttle run test evaluates the frequency of completing a 15-meter distance run within a predetermined time interval indicated by a buzzer. The test is terminated when the participant cannot complete the running distance, within the allotted time (buzzer ringing), twice in a row. 2) The long run-walking test records the time required to complete 1,000 meters walking/running/sprinting, irrespective of the sex, without departing from the set track. 3) The Harvard step test uses a 20.3 cm-high step box and evaluates the frequency of the repeated operation of going up and down on it with a set time interval of 3 minutes (indicated by a buzzer). It measures the resting heart rate thrice. This exercise is repeated 24 times per minute.

#### *Flexibility*

Flexibility was evaluated using two tests. First, the sit and reach test was performed, where participants were instructed to lie down and bend their feet in front of their upper body, then sit with their knees stretched out, to enable the soles of their feet to completely touch the front of the measuring instrument, and simultaneously bend their upper body forward to measure the point where the fingertips of both hands stop in cm to which the participant can bend. Second, the comprehensive flexibility test is divided into an evaluation of four body parts: shoulder, torso, side, and lower body, where 2 points are allotted

if both right and left side of the body part are successful, 1 point for only one functional side, and 0 points for no function.

#### *Muscle strength and endurance*

Participants' muscle strength and endurance were evaluated using two exercises. First, the sit-up exercise measured the frequency of rolling the upper body into a bent position with 90-degree angle of the knee on the mat. This frequency was measured according to the buzzer that rang once every 3 seconds. Second, the grip strength was evaluated with minimal risk using a Smedley-type dynamometer (ITK-5401, Takei Scientific Instruments Co., Ltd., Tokyo, Japan). Participants were instructed to hold the dynamometer by wrapping it around the second node of the finger, while keeping their torso and arms at 15 degrees to avoid the dynamometer from touching the body or the bent elbows. This exercise was performed twice alternately from side to side and the highest weight was recorded.

#### *Power*

Power was evaluated using two components. First, the fifty-meter dash—a speed evaluation index that records the time taken to run a distance of 50 m as fast as possible—was employed. The start and end time were recorded when the participants' were in the standing position and when they touched the finish line, respectively. Second, in the standing long jump, participants were instructed to stand in a comfortable position with their feet on the takeoff board and jump as far as possible by bouncing their body to avoid crossing the takeoff board. For this test, the distance of the nearest landing point from the takeoff board was estimated and the longest jump distance after performing the exercise twice was recorded.

#### *Obesity*

Obesity was defined using body mass index criteria. It was measured using height and weight values ( $\text{kg}/\text{m}^2$ ).

Further details regarding the measurement procedure of physical fitness variables and the safety

of the participants for all physical fitness tests have been described in “*Advanced Fitness Assessment and Exercise Prescription*” (12).

### Statistical Analysis

Data were analyzed using repeated measures analysis of variance on SPSS/WIN 24.0 (IBM Corp., Armonk, NY, USA), to explore the changes in the PAPS grade ratio of Korean elementary schools amidst the COVID-19 pandemic. Statistical significance was set at  $P<0.05$ , and the confidence interval was computed using Bonferroni test for multiple comparisons. To adjust for the non-normal distribution of changes in grades 1, 4, and 5, variable values were converted into roots values according to West, Finch, and Curran's criteria (skewness $<3$ , kurtosis $<8$ ) (13).

## Results

Table 3 and Fig. 1 present the grade ratio according to year and sex. The current study results reported a significant main effect of year on the grade 1 and grade 5 ratios ( $P<0.001$ ); however, the interaction effect between year and sex for these grade ratios was not significant. For the grade 2 and grade 4 ratios, a significant main effect of year ( $P<0.001$ ), as well as a significant interaction effect between the year and sex ( $P<0.05$ ) were identified. The grade 3 ratio reported a significant interaction effect between the year and sex ( $P<0.001$ ), with no significant main effects. Table 4 presents the results of the changes in the grade ratio according to the year. The analysis findings indicated significant main effects of the year for the ratios of grades 1, 2, 4, and 5 ( $P<0.05$ ). Table 5 presents the results of the changes in the grade ratio according to sex. Following were the grade ratios according to sex by the year.

**Table 3:** The grade ratio according to year and sex

Grade	Source	Sum of squares	Degree	Mean square	F
1	Year	186.371	1.995	93.409	30.640***
	Year X Sex	12.974	1.995	6.502	2.133
	Error	29500.620	9676.771	3.049	
2	Year	84478.631	1.994	42362.592	98.116***
	Year X Sex	2640.368	1.994	1324.037	3.067*
	Error	4175906.981	9671.773	431.762	
3	Year	2465.557	1.990	1239.018	2.728
	Year X Sex	9667.696	1.990	4858.316	10.697***
	Error	4383309.300	9651.148	454.175	
4	Year	2234.911	1.963	1138.657	320.407***
	Year X Sex	28.632	1.963	14.588	4.105*
	Error	33829.889	9519.391	3.554	
5	Year	72.110	1.941	37.155	54.557***
	Year X Sex	3.965	1.941	2.043	3.000
	Error	6410.459	9412.719	0.681	

\* $P<0.05$ , \*\*\* $P<0.001$ , tested by repeated measures analysis of variance

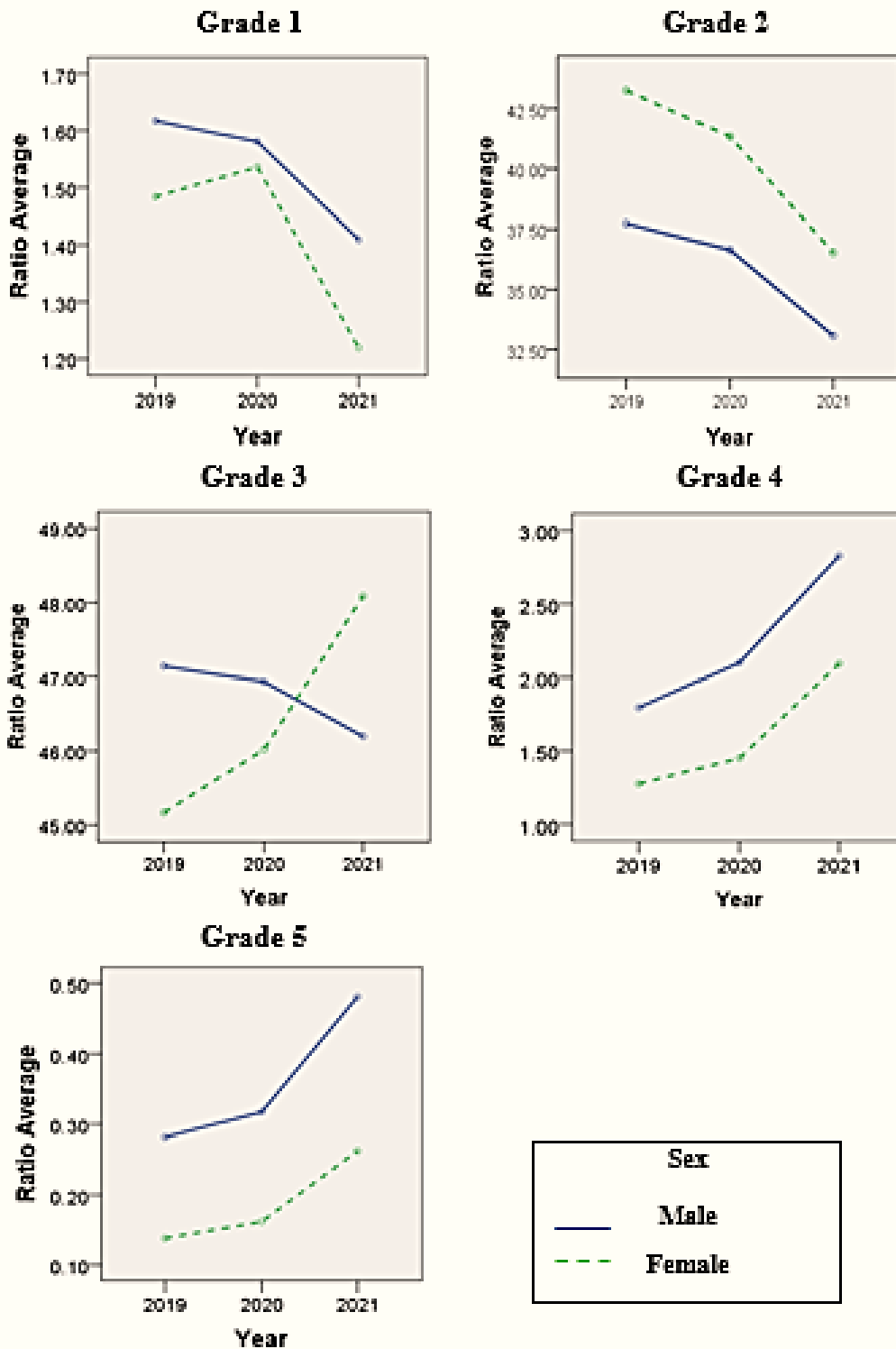


Fig. 1: Changes in grade ratio according to sex by year

**Table 4:** The results of the change in the grade ratio according to year

<i>Grade</i>	<i>Year</i>	<i>Mean</i>	<i>Standard error</i>
1	2019	1.550 <sup>b</sup>	0.028
	2020	1.558 <sup>b</sup>	0.028
	2021	1.314 <sup>a</sup>	0.026
2	2019	40.496 <sup>c</sup>	0.318
	2020	38.984 <sup>b</sup>	0.312
	2021	34.800 <sup>a</sup>	0.326
3	2019	46.153	0.332
	2020	46.477	0.324
	2021	47.142	0.329
4	2019	1.535 <sup>a</sup>	0.029
	2020	1.775 <sup>b</sup>	0.030
	2021	2.460 <sup>c</sup>	0.034
5	2019	0.210 <sup>a</sup>	0.011
	2020	0.239 <sup>a</sup>	0.012
	2021	0.372 <sup>b</sup>	0.014

Tested by Bonferroni: a&lt;b&lt;c

**Table 5:** The results of the change in the grade ratio according to sex

<i>Grade</i>	<i>Year</i>	<i>Sex</i>	<i>Mean</i>	<i>Standard error</i>
1	2019	Male	1.617 <sup>b</sup>	0.040
		Female	1.484 <sup>a</sup>	0.040
	2020	Male	1.581	0.040
		Female	1.536	0.040
	2021	Male	1.409 <sup>b</sup>	0.037
		Female	1.220 <sup>a</sup>	0.037
2	2019	Male	37.732 <sup>a</sup>	0.449
		Female	43.259 <sup>b</sup>	0.449
	2020	Male	36.632 <sup>a</sup>	0.442
		Female	41.335 <sup>b</sup>	0.442
	2021	Male	33.073 <sup>a</sup>	0.461
		Female	36.527 <sup>b</sup>	0.461
3	2019	Male	47.141 <sup>b</sup>	0.469
		Female	45.165 <sup>a</sup>	0.469
	2020	Male	46.934	0.458
		Female	46.020	0.458
	2021	Male	46.198 <sup>a</sup>	0.465
		Female	48.086 <sup>b</sup>	0.465
4	2019	Male	1.795 <sup>b</sup>	0.041
		Female	1.276 <sup>a</sup>	0.041
	2020	Male	2.099 <sup>b</sup>	0.042
		Female	1.451 <sup>a</sup>	0.042
	2021	Male	2.828 <sup>b</sup>	0.048
		Female	2.092 <sup>a</sup>	0.048
5	2019	Male	0.282 <sup>b</sup>	0.015
		Female	0.138 <sup>a</sup>	0.015
	2020	Male	0.317 <sup>b</sup>	0.017
		Female	0.162 <sup>a</sup>	0.017
	2021	Male	0.481 <sup>b</sup>	0.020
		Female	0.262 <sup>a</sup>	0.020

Tested by Bonferroni: a&lt;b



## Discussion

This study explored the changes in Korean elementary schools' PAPS grade ratio amidst the COVID-19 pandemic. Accordingly, this study was conducted to provide basic data on the changes in school and physical education caused by the pandemic, and to anticipate future changes in the society.

The results indicated a difference in the change of the grade ratio according to the year. While the grade 1 ratio decreased in 2021 than 2019 and 2020, the grade 5 ratio increased in 2021 than 2019 and 2020. Similarly, the grade 2 ratio continued to decrease from 2019 to 2021, while the grade 4 ratio continued to increase from 2019 to 2021. However, grade 3 ratio did not report any changes. Therefore, the proportion of students in grades 1 and 2 (excellent health and physical fitness) decreased, while those in grades 4 and 5 (poor health and physical fitness) increased. Previous studies have reported decreasing PA owing to the COVID-19 pandemic. A study comparing the PA of 431 healthy adults before and after the pandemic in 45 states of the United States, revealed decreased PA after the COVID-19 due to lockdown (2). Additionally, an international survey on 1,047 individuals reported negative effects of the pandemic negatively on PA intensity and further on lifestyle, including binge-eating (3).

This decrease in PA can be assumed to have a negative effect on physical fitness. The social distancing and isolation imposed by the pandemic may have caused the lack of PA. Moreover, the lack of PA further influenced the level of physical fitness negatively (6). A study on 89 Spanish students, aged 12–14 years, reported a potential negative impact of the pandemic on cardiopulmonary fitness (5). Upon careful observation, the current findings suggest that the proportion of grade 1 students with excellent health and physical fitness did not decrease significantly between 2019 and 2020, but between 2020 and 2021. Conversely, the proportion of grade 5 students with poor health and physical fitness did not in-

crease significantly between 2019 and 2020, but between 2020 and 2021. Thus, it can be interpreted that the impact of the pandemic on students' health increases with the duration of reduced PA. Therefore, in accordance with the previous studies, it is essential to implement programs for increasing PA during the pandemic period (4,8). Moreover, physical education at school should play a role in overcoming the youth's deteriorated physical fitness.

The current study findings indicated differences in the grade ratio by year and sex. It should be particularly noted that a reversal was observed in the grade 3 ratio findings by sex. Thus, both male and female students reported a gradual decrease in grade 1 and 2 ratios and a gradual increase in grade 4 and 5 ratios from 2019 to 2021, but for grade 3 ratio, male students reported a gradual decrease, while female students reported a gradual increase. These findings reveal a relatively evident decrease in male students' health and physical fitness than in that of female students. Thus, it can be interpreted that among female students, those with better physical fitness levels gradually decline to the poorer levels, while male students' better physical fitness levels rapidly declined. Existing research reports that men are approximately 15–25% greater active than women, and during school age, men and women experienced reduced PA about 2.7% and 7.4% annually, respectively (14). This may indicate a higher impact of PA restrictions on men than on women. A study examining PA and sedentary time (ST) among 3,800 adults showed decreased PA and increased ST, with men reporting a higher amount of reductions in vigorous PA time and increases in ST than women (9). Furthermore, this study also reported similar findings in samples of young people, students, and highly active men. Therefore, the current study findings reveal that the COVID-19 pandemic reduced PA and deteriorated health and physical fitness in Korean elementary school students. Accordingly, an inverse relationship was observed in the PAPS grades, where the ratio of the number of high-grade students decreased, and that of low-grade students



increased. This change was rapid, especially in male students.

This study had several limitations. First, this study employed a large-scale research sample but only from Korea. Therefore, it is difficult to generalize these research findings to other populations. Future research must recruit research samples from various countries to enable comparison and generalization. Second, the data in this study were obtained from the Korean elementary schools' PAPS--a national survey of statistical significance conducted by the Korean government annually--for only 3 years (2019, 2020, 2021). Therefore, it is also required to explore the long-term changes after the pandemic. Third, this study analyzed data stratified only by the sex of the participants. In future studies, it is necessary to explore demographics other than sex, such as experience and region. Fourth, although this study aimed to derive predictions about the future of physical education, no in-depth conclusions have been derived regarding physical education since the pandemic. Further studies should explore physical and school education plans after the COVID-19 pandemic. Fifth, the current findings are limited in understanding the context of an individual due to the large-scale survey data used. Therefore, in future research, an in-depth analysis approach is needed through qualitative research methods.

## Conclusion

The COVID-19 pandemic caused a decrease in students' PA, thus deteriorating their health and fitness, which was especially pronounced in male students. In the future, various solutions within the field of physical education should be prepared and presented to mitigate the reduction of PA in schools post the COVID-19 pandemic. The pandemic is promoting changes in many areas and is demanding a re-establishment of the role of school and physical education. Considering the conditions imposed by the pandemic, it is important to devise non-face-to-face education strategies for the future.

## Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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## Conflict of interest

The author has no conflicts of interest to declare.

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