Pehlivan,Y., Sonkaya, N., Bal, E., Güler, Ö., Güler, Y. E. & Yaşar, O. M. (2026). Comparison of health-related physical fitness (HRPF) levels of secondary school students before and after the covid-19 pandemic. Gümüşhane Üniversitesi Sosyal Bilimler Dergisi, 17(1), 01-09.

Comparison of Health-Related Physical Fitness (HRPF) Levels of Secondary School Students before and After the Covid-19 Pandemic

Ortaokul Öğrencilerinin Covid-19 Pandemisi Öncesi ve Sonrası Sağlıkla İlişkili Fiziksel Uygunluk (HRPF) Düzeylerinin Karşılaştırılması

Yeliz Pehlivan[1], Nihal Sonkaya[2], Erdal Bal[3], Özkan Güler[4], Yunus Emre Güler[5], Onur Mutlu Yaşar[6]

Abstract

The aim of this study was to compare some Health-Related Physical Fitness (HRFRS) levels of secondary school students before the pandemic period and post-pandemic measurements of the same students. The contribution of this study to the literature is the longitudinal comparison of pre- and post-pandemic measurements in the same student group, the multifaceted evaluation of health-related physical fitness parameters, and the revealing of gender-specific changes. A total of 41 students, 20 boys and 21 girls students, who continue their education in Kağıthane district of Istanbul, participated in the study. Participants' height, body weight, body mass index, flexibility, push-ups and crunches were measured. For statistical analysis, as a result of the Shapiro Wilk Normality test, the dependent variable was compared between the first and last test measurements by paired t-test. P<0.05 was accepted as the level of statistical significance. When the health-related physical fitness parameters of all participants were compared, statistically significant differences were found in body weight, height, body mass index, number of crunches and number of push-ups (p<0.05), while no statistically significant differences were found in right leg and left leg flexibility values (p>0.05). There was a significant increase in body weight, height, BMI and number of crunches in all participants after the pandemic. In the push-up parameter, an increase was found only in boy students. No pandemic-related change was found in the flexibility parameter in both genders.

Keywords: *Child, Covid-19, Inactivity, Pandemic.*

Öz

Bu çalışmada ortaokul öğrencilerinin pandemi dönemi öncesi bazı Sağlıkla İlgili Fiziksel Uygunluk Karnesi (SİFUK) ölçümleri ve aynı öğrencilere ait pandemi sonrası ölçümleri karşılaştırılması amaçlanmıştır. Bu çalışmanın literatüre katkısı, pandemi öncesi ve sonrasındaki ölçümlerin aynı öğrenci grubunda boylamsal olarak karşılaştırılması, sağlıkla ilişkili fiziksel uygunluk parametrelerinin çok yönlü değerlendirilmesi ve cinsiyete özgü değişimlerin ortaya konulmasıdır. Çalışmaya İstanbul ili Kağıthane ilçesinde öğrenime devam eden, 20 Erkek, 21 Kız öğrenci olmak üzere toplamda 41 öğrenci katılmıştır. Katılımcıların boy, vücut ağırlığı, vücut kütle indeksi, esneklik, şınav ve mekik değerleri ölçülmüştür. İstatistik analiz için Shapiro Wilk Normalite testi sonucunda, ilk test ile son test ölçümleri karşılaştırılması bağımlı değişken, eşleştirilmiş t testi ile yapılmıştır. İstatistiksel anlamlılık düzeyi olarak p<0.05 kabul edilmiştir. Tüm katılımcıların sağlıkla ilgili fiziksel uygunluk parametreleri karşılaştırıldığında, vücut ağırlığında, boy uzunluğunda, vücut kütle indeksinde, mekik sayısı ve şınav sayısında istatistiksel olarak anlamlı farklılık bulunurken (p<0.05), sağ bacak ve sol bacak esneklik değerlerinde istatistiksel olarak anlamlı farklılık bulunmadı (p>0.05). Tüm katılımcıların pandemi sonrası vücut ağırlığında, boylarında, VKİ' lerinde ve mekik sayılarında anlamlı bir artış bulundu. Şınav parametresinde ise sadece erkek öğrencilerde artış bulunmuştur. Esneklik parametresinde her iki cinsiyette de pandemiye bağlı bir değişiklik bulunmadı.

Anahtar Kelimler: *Covid-19, Çocuk, Hareketsizlik, Pandemi.*

Araştırma Makalesi [Research Paper]

Research and Publication Ethics Statement: The research part of this study was conducted in accordance with the permission granted by the Ethics Committee at Nişantaşı University, with the decision dated 30.01.2023 and numbered 2023/7.

Submitted: 14 / 02 / 2025
Accepted: 29 / 01 / 2026

[1]Doç. Dr., İstanbul Sağlık Bilimleri Üniversitesi, Yaşam Bilimleri Fakültesi, Egzersiz ve Spor Bilimleri Bölümü, İstanbul, Türkiye, yeliz.yol@sbu.edu.tr, ORCID: https://orcid.org/0000-0002-0859-6238.

[2] Öğretmen, Cemil Meriç Ortaokulu, Milli Eğitim Bakanlığı, İstanbul, Türkiye, nihalsonkaya@yahoo.com.tr, ORCID: https://orcid.org/0009-0009-8069-9723.

[3]Doç. Dr., İstanbul Sağlık Bilimleri Üniversitesi, Yaşam Bilimleri Fakültesi, Egzersiz ve Spor Bilimleri Bölümü, İstanbul, Türkiye, erdal.bal@sbu.edu.tr, ORCID: https://orcid.org/0000-0002-4927-3945.

[4]Doç. Dr., Ankara Üniversitesi, Spor Bilimleri Fakültesi, Antrenörlük Eğitimi Bölümü, Ankara, Türkiye, oguler@ankara.edu.tr, ORCID: https://orcid.org/0000-0002-5713-3395.

[5] Dr. Öğr. Üyesi, İstanbul Esenyurt Üniversitesi, Spor Bilimleri Fakültesi, Spor Yöneticiliği Bölümü, İstanbul, yunusemreguler@esenyurt.edu.tr, ORCID: https://orcid.org/:0000-0002-0270-7494.

[6] Doç. Dr., İzmir Demokrasi Üniversitesi, Sağlık Bilimleri Fakültesi, Egzersiz ve Spor Bilimleri Bölümü, İzmir, Türkiye, onurmutlu.yasar@idu.edu.tr, ORCID: https://orcid.org/0000-0001-7598-3927.

Introduction

COVID-19, a unique global infectious disease in modern world history caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), first emerged in the city of Wuhan, China, in December 2019 (Lake, 2022; Pan, 2020). Due to COVID-19, dozens of people have been hospitalized, and millions of individuals have been forced to stay in a confined area. This dramatic change in lifestyle, resulting from immobilization (hospitalization and bed rest), quarantine, and physical inactivity, has had a negative impact not only on the general population but especially on school-age children (Woods et al., 2020). It has been reported that the psychosocial aspects of quarantine, including new and unusual stress factors for children, could exacerbate the childhood obesity epidemic (Storz, 2020).

Multiple systematic reviews and large-scale studies show a significant decrease in children's physical activity and physical fitness during the COVID-19 pandemic, primarily due to school closures, cancellation of sports, and restrictions on outdoor activities. The average reduction in total daily physical activity was about 20%, with moderate-to-vigorous activity dropping by up to 32%—equivalent to a 17-minute daily decrease (Neville et al., 2022; Zaccagni & Gualdi-Russo, 2025). Sedentary behaviors, especially screen time, increased substantially and were strongly linked to reduced physical activity (Neville et al., 2024; Liu et al., 2024; Friel, Diaz & Rupp, 2023). Physical fitness, including endurance and muscle strength, also declined during the pandemic. Studies from Japan and Europe found significant drops in endurance (e.g., shuttle run performance) and muscle endurance (e.g., sit-ups), with only partial improvement after restrictions were lifted—fitness levels remained below pre-pandemic baselines, especially in boys (Ito et al., 2025; Ludwig-Walz et al., 2024; Kidokoro et al., 2022; Artymiak, Żegleń, & Kryst, 2024). Increased sedentary time and reduced activity contributed to higher rates of overweight and obesity, particularly among boys and children aged 8–11 (Zaccagni & Gualdi-Russo, 2025). Some regions with less restrictive policies (e.g., Sweden) saw more stable activity levels, though screen time still increased (Berggren et al., 2023). Children with access to outdoor spaces or who remained in sports clubs were more likely to maintain activity (Berggren et al., 2023; Okely et al., 2020). However, most studies agree that post-pandemic recovery in physical activity and fitness has been incomplete, with many children not returning to pre-pandemic levels (Friel, Diaz & Rupp, 2023; Ito et al., 2025; Ludwig-Walz et al., 2024).

Prior to the pandemic, in collaboration with the Ministry of Health, the Ministry of National Education developed a program called Health-Related Physical Fitness Report (HRPF) within the physical education curriculum to help students improve their physical skills and incorporate physical activity into their lifestyle. This program was implemented twice a year by physical education teachers, measuring body weight, height, flexibility, sit-up, and push-up tests in September-October and April-May. (Guide to the Implementation of the Health-Related Physical Fitness Report Card for Physical Education and Sports Teachers, 2017). During the period of remote learning, when education was interrupted and occasional lockdown measures were implemented, HRPF assessments were not conducted, resulting in a period characterized by inactivity in terms of physical activity (Gülhan & Akpınar, 2021). Physical fitness levels can decline due to a sedentary lifestyle. Therefore, this study aims to determine the changes between the pre-pandemic (September 2019) HRPF values of students and the values measured after the pandemic (September 2021).

Therefore, this study aims to examine the changes in health-related physical fitness parameters of middle school students by comparing pre-pandemic (September 2019) and post-pandemic (September 2021) HRPF measurements, focusing on anthropometric measurements (height, body weight, BMI), muscular endurance (sit-ups, push-ups), and flexibility. Specifically, the study will investigate whether significant differences exist between pre- and post-pandemic measurements, whether the pandemic period negatively affected students' physical fitness, and whether these changes varied by gender. It was hypothesized that (H1) students' health-related physical fitness parameters would show significant differences between pre- and post-pandemic measurements, (H2) muscular strength and other fitness components would be negatively affected by the pandemic, and (H3) changes in physical fitness would differ according to gender, while the null hypothesis (H0) posited no significant differences between pre- and post-pandemic measurements. By longitudinally tracking the same students, this study will contribute to the literature by providing more reliable evidence of pandemic-related changes than most existing cross-sectional studies. In addition, analyzing the results by gender offers a new perspective, particularly in revealing differences in strength parameters, which will help inform school-based interventions and support strategies for promoting children's physical fitness.

This study contributes to the literature by longitudinally comparing the health-related physical fitness parameters of the same middle school students before and after the pandemic. While most existing research is conducted with a cross-sectional design during the pandemic, monitoring the same individuals in this study allows for more reliable identification of pandemic-related changes. Furthermore, the results obtained by gender separation offer a new perspective to the literature, particularly by revealing differences in strength parameters.

1. Materials and Methods

A total of 41 students studying in Kağıthane, Istanbul participated in the study. Based on the statistical analysis of power analysis (G*power) on a group of approximately 45 participants, the literature review yielded a 95% accuracy (p=0.95) and an effect size of d=0.5. Also in this study, the effect sizes of the analyses were calculated using Cohen's d value and its reference ranges. According to the effect size scale, d = 0.20 indicates a small effect, d = 0.50 a medium effect, and d = 0.80 and above a large effect (Cohen, 1988). The number of participants in the study was determined accordingly. Four participants were excluded because they did not take several of the final measurement tests. Therefore, the study was completed with 41 participants. The participants consisted of 20 boys and 21 girls. The study compared the HRPF measurements of the students in 5th grade with their measurements in 7th grade. The measurements used in the HRPF assessment were from the same students, and measurements of students who transferred out of the school or joined later were excluded from the analysis. Written and verbal consent was obtained from the parents of the students before the study. Student data whose parents did not give permission to use their measurement data and did not sign the consent form were excluded from the study. The study protocol was approved by the Graduate Education Institute Publication Ethics Committee, in accordance with the ethical principles outlined in the Declaration of Helsinki for research involving human participants. Informed written and verbal consent was obtained from all participants prior to their involvement in the study (date: 30.01.2023, no: 2023/7).

1.1. Body Mass Index (BMI)

The height and body weight of the participants were measured using an electronic device (Seca 767, USA) with standard methods. Body Mass Index (BMI) was calculated using the formula;

BMI = weight measurement (kg) / (height measurement (m^2).

1.2. Sit-and-Reach Flexibility Measurements (cm)

These measurements were conducted to determine the maximum flexibility that the participants could achieve through movements such as bending, rotating, and reaching from a fixed point in the waist, back leg, and hip area. The flexibility measurements of the students were performed on a flexibility bench. The student placed one foot on the bench while sitting on the ground, without wearing shoes. The student was asked to bend the other leg and pull it towards themselves. Then, with the standing leg straight, arms extended and hands stacked on top of each other, the student was asked to reach forward and push the ruler on the measurement bench with their fingertips. After waiting for 1-2 seconds at the furthest point the student could reach, the distance of the stretch was measured. Measurements were recorded for the right and left sides. A flexibility bench was used in our study.

1.3. Push-Up Test (60 seconds)

The students' muscle strength and endurance were assessed using the push-up test. During the test, the student assumed the push-up position with the face facing down, arms and hands shoulder-width apart, fingers straight, palms on the ground, legs slightly apart and tense, and toes touching the ground. The student was instructed to push off the ground and lift the body, then lower the body towards the ground using the arms until the elbows reached a 90-degree angle and the shoulders were parallel to the ground. The test was terminated when the student could no longer perform the movement or when they broke the proper push-up form for the first time. The test was also stopped if the student experienced pain or strain. The number of correctly performed push-up repetitions by the student was recorded. The number of repetitions in 1 min was noted.

1.4. Sit-Up Test (60 seconds)

This test was performed to measure the students' muscle strength endurance. The student laid on a mat in a supine position, with the knees bent at approximately 140 degrees, feet apart, heels on the ground, arms parallel to the body, and palms on the ground in the test position. First, the student's fingertips were placed touching a strip that was 11 cm wide, and then the student was asked to pass their hand over the strip while performing the crunches movement. The test was terminated when the student could no longer perform the movement, broke the proper crunches form twice, or reached a total of 75 sit. The number of repetitions in 1 min was noted.

1.5. Statistical Analysis

SPSSv.22 package program was used for statistical analysis. As a result of the Shapiro Wilk normality test, the comparison of the first and last test measurements of the students participating in the study was made with the dependent variable, paired t test. A p value less than 0.05 was determined as the level of statistical significance.

2. Findings

When the physical fitness parameters related to health were compared for all participants, there was a statistically significant difference in body weight, height, body mass index (BMI), number of sit-ups, and number of push-ups ($p<0.05$), while there was no statistically significant difference in right leg and left leg flexibility values ($p>0.05$) (Table 1).

Table 1. Comparison of Health-Related Physical Fitness Parameters of All Participants

Parameters	n	Pre-Test (Mean±SD)	Post-Test (Mean±SD)	f	p	Cohen's d
Body Weight (kg)	41	38,98 ± 10,07	50,88 ± 10,74	11,902	**,001***	**1.1**
Length (cm)	41	140,51 ± 6,42	154,20 ± 7,43	13,683	**,001***	**2.14**
BMI (kg/m²)	41	19,572 ± 4,11	21,324 ± 3,88	1,7526	**,001***	**0.43**
Sit-Reach Right (cm)	41	22,27 ± 4,64	22,22 ± 5,58	,049	,953	**.009**
Sit- Reach Left (cm)	41	22,90 ± 5,33	22,63 ± 5,18	,268	,725	**.005**
Crunches (pcs)	41	9,07 ± 5,64	20,00 ± 10,75	10,927	**001***	**1.27**
Push-up (pcs)	41	2,20 ± 1,50	3,56 ± 3,24	1,366	**,011***	**0.53**

BMI: Body Mass Index, SD: Standart Deviation

When boy students were evaluated among themselves, there was a statistically significant difference in body weight, height, BMI, number of sit-ups, and number of push-ups ($p<0.05$), while there was no statistically significant difference in right leg and left leg flexibility values ($p>0.05$) (Table 2).

Table 2. Comparison of Health-Related Physical Fitness Parameters of Boy Students

Parameters	n	Pre-Test (Mean±SD)	Post-Test (Mean±SD)	f	p	Cohen's d
Body Weight(kg)	20	41,70 ± 10,84	55,35 ± 11,57	13,650	**,001***	**1.21**
Length(cm)	20	141,70 ± 6,28	154,80 ± 8,33	13,100	**,001***	**1.77**
BMI (kg/m²)	20	20,585 ± 4,34	23,013 ± 4,11	2,42750	**,001***	**0.98**
Sit-Reach Right (cm)	20	21,00 ± 4,80	20,20 ± 4,99	,800	,560	0.16
Sit- Reach Left (cm)	20	21,30 ± 5,37	21,20 ± 4,83	,100	,939	0.03

SD: Standart Deviation

When girl students were evaluated among themselves, there was a statistically significant difference in body weight, height, BMI, and number of sit-ups ($p<0.05$), while there was no statistically significant difference in right leg and left leg flexibility values and number of push-ups ($p>0.05$) (Table 3).

Table 3. Comparison of Health-Related Physical Fitness Parameters of Girl Students

Parameters	n	Pre-Test (Mean±SD)	Post-Test (Mean±SD)	f	p	Cohen's d
Body Weight(kg)	21	36,38 ± 8,74	46,62 ± 8,02	10,238	**,001***	**1.22**
Length(cm)	21	139,38 ± 6,50	153,62 ± 6,62	14,238	**,001***	**2.17**
BMI (kg/m²)	21	18,60 ± 3,72	19,71 ± 2,91	1,11000	**,047***	**0.33**
Sit-Reach Right (cm)	21	23,48 ± 4,24	24,14 ± 5,53	,667	,508	0.13
Sit- Reach Left (cm)	21	24,43 ± 4,95	24,00 ± 5,24	,429	,615	0.11

Crunches (pcs)	21	9,90 ± 6,32	22,19 ± 10,27	12,286	**,001***	**1.44**
Push-up (pcs)	21	2,19 ± 1,37	2,86 ± 2,76	,667	,358	0.07

BMI: Body Mass Index, SD: Standart Deviation

7 students (41.46%) were classified as "Underweight (Low Weight)", 22 students (53.66%) as "Normal Weight", 1 student (2.44%) as "Overweight", and 1 student (2.44%) as "Obese Class 1". The average BMI was 19.57 kg/m^2. In the post-test measurements, 9 students (21.95%) were classified as "Underweight (Low Weight)", 26 students (63.41%) as "Normal Weight", 5 students (12.20%) as "Overweight", and 1 student (2.44%) as "Obese Class 2". The average BMI was 21.32 kg/m^2 (Table 4).

Table 4. BMI Definitions Table and % Distribution

			n	n %
BMI Pre Measurement Values	Underweight	B	7	35,00%
		G	10	47,62%
	Normal weight	B	11	55,00%
		G	11	52,38%
	Overweight	B	1	5,00%
		G	0	0,00%
	Obese 1	B	1	5,00%
		G	0	0,00%
	Obese 2	B	0	0,0%
		G	0	0,0%
	Obese 3	B	0	0,0%
		G	0	0,0%
BMI Post Measurement Values	Underweight	B	2	10,00%
		G	7	33,33%
	Normal weight	B	13	65,00%
		G	13	61,90%
	Overweight	B	4	20,00%
		G	1	4,77%
	Obese 1	B	0	0,00%
		G	0	0,00%
	Obese 2	B	1	5,00%
		G	0	0,00%
	Obese 3	B	0	0,00%
		G	0	0,00%

BMI: Body Mass Index

Conclusion

Between 2020 and 2022, there was a period of interrupted education and even occasional restrictions on movement due to the pandemic, which can be considered as a period of sedentary lifestyle. The level of physical fitness can regress during a sedentary period. In particular, sedentary lifestyle in children during the developmental period can play a contributing role in the development of obesity. Therefore, this study compared the Health-Related Physical Fitness Assessment (HRPFA) measurements of middle school students before the pandemic with the measurements taken after the pandemic. The results are presented under the relevant headings.

Anthropometric Measurements: When comparing the pre and post measurement values of girl and boy students in terms of height, it is observed that the increase in average height among girl students (14.24 cm) is higher than the average height of boy students (13.10 cm) depending on age. Statistically significant differences have been observed in the average values of height, which is one of the dependent variables of the study, based on the measurements.

In terms of weight measurements, when comparing the values of all students, it is seen that the increase in average body weight among boy students (13.65 kg) is higher than the increase in average body weight among girl students (10.24 kg) depending on age. Statistically significant differences have been observed in the average values of body weight, which is one of the dependent variables of the study, based on the measurements.

When comparing the measurement values of boy and girl students in terms of BMI, an increase of 2.42 kg/m2 in the average BMI value of boy students (from 20.59 to 23.01) and an increase of 1.11 kg/m2 in the average BMI value of girl

students (from 18.61 to 19.72) depending on age are observed. Furthermore, while the number of underweight students decreased in the last test, an increase was observed in the number of students with normal weight and overweight. In a study conducted by Dawson et al. (2001) it was found that there was a greater increase in the height of boy compared to girls and a greater increase in the body weight of girls compared to boys. Additionally, the BMI values of girls were found to be higher than those of boys. In a similar study, both boys and girls BMI values increased compared to the initial measurements.

In a study by Koç (2014), who examined the physical activity and physical fitness levels of secondary school students, it was determined that height, body weight, and BMI measurements of the students increased with age. Santos et al. (2019) stated in their study that girls had higher body fat content, while boys had higher lean mass content. Similar to this study, Cole et al. (2000) showed significant increases in height and weight with increasing age.

Increased body mass and BMI can be attributed to an imbalance between energy intake and expenditure. There is little evidence that children have increased energy intake in recent years (Rolland-Cachera &Bellisle, 1986; Troiano et al., 2000) but many studies have observed decreases in energy expenditure, especially in physical activity (Dollman et al., 1988; Dumin, 1992; Van Mechelen et al., 2020). Therefore, these gender-related changes in height, body weight, and BMI may be due to the aging of children during the pandemic and the developmental differences associated with it. However, although weight gain is considered normal for children in the developmental stage, it should not be forgotten that they have experienced a period of inactivity during the Covid-19 pandemic. Many studies confirm the significant decrease in body mass among children with different levels of physical activity (Korcz & Monyeki, 2018; Dassanayake et al., 2016; Ubago-Guisado et al., 2017).

According to the results of the sit-and-reach flexibility measurement, there was a tendency towards a decrease in average right flexibility value (from 23.48 to 23.19 cm) by -0.29 cm and average left flexibility value (from 24.43 to 23.38 cm) by -1.05 cm when comparing the pre and post measurement values of girl students. When comparing the pre and post measurement values of boy students, there was a tendency towards a decrease in average right flexibility value (from 20.00 to 19.00 cm) by -1.00 cm and average left flexibility value (from 20.30 to 19.80 cm) by -0.50 cm. It is noteworthy that in both measurements, girl students had higher flexibility values.

Dawson et al (2001), unlike our study, found an increase in sit-and-reach flexibility values in both boys and girls. However, similar to the findings in this study, they also reported higher flexibility values in girls than in boys. These results are consistent with the results of many previous studies in children and adolescents (Secchi et al., 2014; Tambalis et al., 2016; De Miguel-Etayo et al., 2014; Saint-Maurice et al., 2015; Vanhelst et al., 2020; Golle et al., 2015; Cadenas-Sanchez et al., 2019; Roriz De Oliveira et al., 2014).

Koç (2014), examined the levels of physical activity and physical fitness of secondary school students in an evaluation study. The study found a significant decrease in flexibility measurement values of boy students with increasing age. However, no significant differences were found in flexibility measurements among girl students.

Saygın (2010), investigated the relationship between physical activity and physical fitness in children. As a general result, the study determined that girls are more flexible than boys at all ages. These differences can be attributed to the distinct development, growth, and maturation of boys and girls. Additionally, cultural, social, and environmental factors can influence the development of motor performance and the adoption of a physically active lifestyle.

When comparing the pre and post test measurement values of sit-ups (crunches) for girl and boy students, the average sit-up value for girl students (9.90 / 22.19) tends to increase by 12.29 units, while the average sit-up value for boy students (8.20 / 17.70) tends to increase by 9.50 units, depending on age. However, the magnitude of change is greater in girl students compared to boy students. A statistically significant difference was observed between the mean values of the first and last sit-up measurements, which are dependent variables of the study.

When comparing the pre and post measurement values of push-ups for girl and boy students, the average push-up value for girl students (2.19 / 2.86) tends to increase by 0.67 units, while the average push-up value for boy students (2.20 / 4.30) tends to increase by 2.10 units, depending on age. However, the magnitude of change is greater in boy students compared to girl students. A statistically significant difference was observed between the mean values of the first and last push-up measurements, which are dependent variables of the study.

It has been shown that other physical fitness parameters develop with age in children (Malina, Bouchard & Bar-Or, 2004). During childhood, muscle strength increases as muscle fiber size increases with body growth (Beunen et al., 1992). The increased cross-sectional area of muscles leads to an increase in muscle strength throughout childhood. The improved strength demonstrated by the increasing number of push-ups and sit-ups in the participants of this study over a two-year period is likely due to developmental changes.

A study by Vanhelst et al.(2017) also found that performance in physical fitness tests increased with age for both boys and girls. While research on adolescents indicates a stagnation or decline in physical capacity with age, improvement in physical capacity with increasing age has been reported in children. Motivation, concentration, the degree of motor skills, physical activity, and body composition can be factors explaining this difference (Berk, 2013). While all participants showed a significant increase in body weight, height, BMI, and the number of sit-ups after the pandemic, no significant difference was found in flexibility values. However, a significant difference was found only in push-up values among boys. These changes may be attributed to the children aging during the pandemic period and the developmental differences associated with it. However, although weight gain in children during the growth period may be considered normal, it should not be forgotten that they experienced a period of closure and inactivity during the Covid-19 pandemic.

This study demonstrated significant increases in body weight, height, BMI, and abdominal muscle endurance (sit-ups) among middle school students following the pandemic period, while no significant changes were observed in flexibility. Push-up performance improved only in boys, highlighting a gender-specific difference. These findings suggest that although weight gain and improvements in muscular endurance can be partially explained by normal growth and maturation, the pandemic-related sedentary lifestyle may have negatively influenced flexibility. The study emphasizes the importance of supporting children's physical fitness, particularly through school-based physical activity programs and family involvement, to mitigate the long-term effects of inactivity during extraordinary periods such as the Covid-19 pandemic.

The current study has both strengths and limitations. The main strength is that the physical fitness levels of these children were tested before the pandemic, allowing for a comparison after the lockdown. The limitation is that reference values for physical fitness in children should be obtained through longitudinal studies with repeated measurements due to individual growth and maturation changes. Additionally, further studies with more participants should be conducted to more fully characterize and determine cutoff points related to health outcomes for cardiorespiratory fitness, muscle strength, speed, and agility in the study. From a practical perspective, school administrations should support the integration of regular health-related physical fitness assessments into the curriculum and develop school-based programs that promote active lifestyles, particularly in extraordinary circumstances such as pandemics. Physical education lessons should emphasize not only sport-specific skills but also activities aimed at improving health-related physical fitness parameters, such as muscular strength, endurance, and flexibility. Families should be encouraged to limit children's sedentary time, promote outdoor and home-based physical activities, and establish routines that prioritize active living. Moreover, collaboration between schools, physical education teachers, and families can help ensure that children receive consistent support to maintain healthy levels of physical fitness.

References

Artymiak, P., Żegleń, M., & Kryst, Ł. (2024). Analysis of Changes in Physical Fitness in Children and Adolescents (11-15 Years) From Kraków (Poland) During COVID-19 Pandemic. *Journal of physical activity & health*, 1-8 . https://doi.org/10.1123/jpah.2023-0577.

Berggren, S., Almquist-Tangen, G., Wolfbrandt, O., & Roswall, J. (2023). Effects of the COVID-19 pandemic on the physical activity and screen time habits of children aged 11–13 years in Sweden. *Frontiers in Public Health*, 11. https://doi.org/10.3389/fpubh.2023.1241938.

Berk L.(2013). *Development through the lifespan*, (6th edn). Boston MA: Pearson Higher Education.

Beunen GP, Malina RM, Renson R, Simons J, Ostyn M, Lefevre J. (1992). Physical activity and growth, maturation and performance: a longitudnal study. Medicine and Science in Sports and Exercise. 25(5),576-585.

Cadenas-Sanchez C, Intemann T, Labayen I, Peinado AB, Vidal-Conti J, Sanchis-Moysi J. et al. (2019). Physical fitness reference standards for preschool children: The PREFIT project. *J Sci Med Sport.* 22(4),430-437.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Cole TJ, Bellizi MC, Flegal KM, Dietz WH. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 320,1240–1243.

Dassanayake TDMSB, Rajarathna AAJ, Rajarathna SA. (2016). Comparison of BMI and body fat percentages between national level teenage swimmers and controls. *Adv. Obes. Weight Manag. Contr.* 4, 00109.

Dawson K, Hamlin, M, Ross J, Duffy D. (2001). Trends in the health-related physical fitness of 10-14 year old New Zealand children. *New Zealand Physical Educator*. 34(1), 26.

De Miguel-Etayo P, Gracia-Marco L, Ortega FB, Intemann T, Foraita R, Lissner L, et al. (2014). IDEFICS consortium. Physical fitness reference standards in European children: the IDEFICS study. *Int J Obes (Lond).* 38(2), 57-66.

Dollman J, Olds T, Norton K, Stuart D. (1998). Trends in the health-related fitness of Australian children: 1985-1997. *In Proceeding of the Australian Conference of Science and Medicine in Sport.* Adelaide, Australia

Dumin JV. (1992). Physical activity levels - past and present. In N. Norgan (Ed.), *Physical Activity and Health* (pp. 20-27). Cambridge: Cambridge University Press.

Friel, C., Diaz, K., & Rupp, K. (2023). Physical Activity, Sleep, and Screen Time in Children and Adolescents Before and During the COVID-19 Pandemic: An Analysis of the 2019-2020 National Survey of Children's Health. *American Journal of Health Promotion*, 38, 197 - 204. https://doi.org/10.1177/08901171231210389.

Golle K, Muehlbauer T, Wick D, Granacher U. (2015). Physical fitness percentiles of German children aged 9–12 years: findings from a longitudinal study. *PLoS ONE*. 10(11),e0142393

Guide to the Implementation of the Health-Related Physical Fitness Report Card for Physical Education and Sports Teachers, (2017).

Gülhan YE, Akpınar S. (2021). Covid-19 salgını sürecinde 10-14 yaş aralığındaki çocukların fiziksel uygunluk düzeylerinin belirlenmesi. *Spor Bilimleri Araştırmaları Dergisi.* 6(2),365-383. doi:10.25307/jssr.971641

Ito, S., Fukumoto, T., Imagita, H., & Tabira, K. (2025). Changes in Children's Physical Fitness Following the COVID-19 Pandemic: A Retrospective Study. *Innovative Journal of Pediatrics*. https://doi.org/10.5812/ijpediatr-158617.

Kidokoro, T., Tomkinson, G., Lang, J., & Suzuki, K. (2022). Physical fitness before and during the COVID-19 pandemic: Results of annual national physical fitness surveillance among 16,647,699 Japanese children and adolescents between 2013 and 2021. *Journal of Sport and Health Science*, 12, 246 - 254. https://doi.org/10.1016/j.jshs.2022.11.002.

Koç K. (2014). *Ortaögretim ögrencilerinin fiziksel aktivite ve fiziksel uygunluk düzeylerinin incelenmesi* [Yüksek Lisans]. Kayseri: Erciyes Üniversitesi, Sağlık Bilimleri Enstitüsü [05.05.2023].

Korcz A, Monyeki MA. (2018). Association Between Sport Participation, Body Composition, Physical Fitness, and Social Correlates Among Adolescents: The PAHL Study. *Int. J. Environ. Res. Public Health*. 15, 2793.

Lake MA. (2022). What we know so far: COVID-19 current clinical knowledge and research. *Clinical medicine,* 20(2),124

Liu, Y., Zhang, E., Li, H., Ge, X., Hu, F., Cai, Y., & Xiang, M. (2024). Physical activity, recreational screen time, and depressive symptoms among Chinese children and adolescents: a three-wave cross-lagged study during the COVID-19 pandemic. *Child and Adolescent Psychiatry and Mental Health*, 18. https://doi.org/10.1186/s13034-024-00705-3.

Ludwig-Walz, H., Heinisch, S., Siemens, W., Niessner, C., Eberhardt, T., Dannheim, I., Bös, K., & Bujard, M. (2024). Physical fitness in youth: a systematic review of changes during and after the COVID-19 pandemic. *The European Journal of Public Health*, 34. https://doi.org/10.1093/eurpub/ckae144.2003.

Malina RM, Bouchard C, Bar-Or O.(2004). Growth, Maturation, and Physical Activity, 2nd edn. Champaign, IL: Human Kinetics.

Neville, R., Hopkins, W., McArthur, B., Draper, C., & Madigan, S. (2024). Associations Between Changes in 24-Hour Movement Behaviors in Children and Adolescents During the COVID-19 Pandemic: A Systematic Review and Mediation-Based Meta-Analysis.. *Journal of physical activity & health*, 1-10 . https://doi.org/10.1123/jpah.2023-0346.

Neville, R., Lakes, K., Hopkins, W., Tarantino, G., Draper, C., Beck, R., & Madigan, S. (2022). Global Changes in Child and Adolescent Physical Activity During the COVID-19 Pandemic: A Systematic Review and Meta-analysis.. *JAMA pediatrics*. https://doi.org/10.1001/jamapediatrics.2022.2313.

Okely, A., Kariippanon, K., Guan, H., Taylor, E., Suesse, T., Cross, P., Chong, K., Suherman, A., Turab, A., Staiano, A., Ha, A., Hamdouchi, E., Baig, A., Poh, B., Del Pozo-Cruz, B., Chan, C., Nyström, C., Koh, D., Webster, E., Lubree, H., Tang, H., Baddou, I., Del Pozo-Cruz, J., Wong, J., Sultoni, K., Nácher, M., Löf, M., Cui, M., Hossain, M., Chathurangana, P., Kand, U., Wickramasinghe, V., Calleia, R., Ferdous, S., Van Kim, T., Wang, X., & Draper, C. (2020). Global effect of COVID-19 pandemic on physical activity, sedentary behaviour and sleep among 3- to 5-year-old children: a longitudinal study of 14 countries. *BMC Public Health*, 21. https://doi.org/10.1186/s12889-021-10852-3.

Pan A, Liu L, Wang C, Guo H, Hao X, Wang Q, et al. (2020). Association of public health interventions with the epidemiology of the COVID-19 outbreak in Wuhan, China. *Jama,* 323(19), 1915-1923.

Rolland-Cachera ME, Bellisle E. (1986). No correlation between adiposity and food intake: Why are working class children fatter? *American Journal of Clinical Nutrition.* 44, 779-787.

Roriz De Oliveira MS, Seabra A, Freitas D, Eisenmann JC, Maia J. (2014). Physical fitness percentile charts for children aged 6–10 from Portugal. *J Sports Med Phys Fitness.* 54(6), 780-792.

Rowland TW. (1990). Exercise and Children's Health. Champaign, IL: Human Kinetics.

Saint-Maurice PF, Laurson KR, Kaj M, Csányi T. (2015). Establishing normative reference values for standing Broad Jump among Hungarian youth. *Res Q Exerc Sport.* 86(5), 37-S44.

Santos LP, Santos IS, Matijasevich A, Barros AJD. (2019). Changes in overall and regional body fatness from childhood to early adolescence. *Sci. Rep.* 9, 1888.

Saygın E. (2010). *Çocuklarda fiziksel aktivite ve fiziksel uygunluk ilişkisinin araştırılması* [Yüksek Lisans Tezi]. Gaziantep: Gaziantep Üniversitesi, Sağlik Bilimleri Enstitüsü.

Secchi JD, García GC, España-Romero V, Castro-Piñero J. (2014). Physical fitness and future cardiovascular risk in argentine children and adolescents: an introduction to the ALPHA test battery. *Arch Argent Pediatr.* 112(2), 132-40.

Storz MA. (2020). The COVID-19 pandemic: an unprecedented tragedy in the battle against childhood obesity. *Clin Exp Pediatr.* 63(12), 477-482.

Tambalis KD, Panagiotakos DB, Psarra G, Daskalakis S, Kavouras SA, Geladas N, et al. (2016). Physical fitness normative values for 6-18-year-old Greek boys and girls, using the empirical distribution and the lambda, mu, and sigma statistical method. *Eur J Sport Sci.* 16(6),736-46.

Troiano RP, Briefel RR, Carroll MD, Bialostosky K. (2000). Energy and fat intakes of children and adolescents in the united states: Data from the national health and nutrition examination surveys. *American Journal of Clinical Nutrition*. 72(5),1343-1353.

Ubago-Guisado E, Mata E, Sánchez-Sánchez J, Plaza-Carmona M, Martín-García M, Gallardo L. (2017). Influence of different sports on fat mass and lean mass in growing girls. *J. Sport Health Sci.* 6, 213–218.

Van Mechelen WILLEM, Twisk JW, Post GB, Snel JAN, Kemper HC. (2020). Physical activity of young people: the Amsterdam Longitudinal Growth and Health Study. *Medicine & Science in Sports & Exercise.* 32(9),1610-1616.

Vanhelst J, Labreuche J, Béghin L, Drumez E, Fardy PS, Chapelot D, et al. (2017). Physical Fitness Reference Standards in French Youth: The BOUGE Program. *J Strength Cond Res.* 31(6), 1709-1718.

Vanhelst J, Ternynck C, Ovigneur H, Deschamps T. (2020). Normative health-related fitness values for French children: The Diagnoform Programme. Scandinavian *Journal of Medicine & Science in Sports*. 30(4),690-699.

Woods JA, Hutchinson NT, Powers SK, Roberts WO, Gomez-Cabrera MC, Radak Z, et al. (2020). The COVID-19 pandemic and physical activity. *Sports Medicine and Health Science,* 2(2):55-64.

Zaccagni, L., & Gualdi-Russo, E. (2025). Reduced Physical Activity and Increased Weight Status in Children and Adolescents During the COVID-19 Pandemic: A Systematic Review. *Children*, 12. https://doi.org/10.3390/children12020178.