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The effect of Covid 19 pandemic on childhood obesity in Turkey

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Abstract

Aim We aimed to investigate the effect of the coronavirus disease 2019 (COVID-19) pandemic on the prevalence of obesity in childhood, laboratory parameters associated with obesity and children's lifestyle changes.

Patients and Method We included exogenous children with obesity and overweight between the ages of 6 and 17 who applied to the General Pediatric Polyclinic of Istanbul Faculty of Medicine between 2018 and 2021. We allocated the participants to two groups: those who applied before and after April 2020 (when the first patient was diagnosed with COVID-19 in Türkiye) and compared anthropometric measurements, biochemical values, and imaging results. We also subjected a survey regarding the demographic characteristics of the cases, nutritional behaviors, and physical activities.

Results Sex distribution did not alter during the pandemic. However, the prevalence of exogenous obesity doubled, morbidly obese people rate increased, fasting insulin, insulin resistance, and low-density lipoprotein-cholesterol (LDL-C) levels increased, and triglyceride levels decreased during the COVID-19 pandemic. There was no significant difference between the two periods regarding Hemoglobin A1c, alanine aminotransferase, aspartate aminotransferase, total cholesterol, high-density lipoprotein levels, blood pressures, and hepatosteatosis. Consumption of pastries, packaged foods, and desserts increased during the pandemic. Also, children's physical activity decreased whereas screen time and sleep time increased. *Adolescents' Food Habits Checklist* scores did not alter significantly.

Conclusion There were significant increase in consuming unhealthy foods, becoming physically inactive, and screen time during pandemic with insulin resistance, obesity and increased LDL-C.

Keywords Children, Obesity, COVID-19

Dear Editor; The proof program did not let us to revise "section heading numbers" and "affiliation numbers". We need to adress these issues. Kind Regards

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Introduction

Coronavirus disease 2019 (COVID-19) is a highly contagious disease that causes morbidity, hospitalization, and death [1]. The World Health Organization depicted COVID-19 infection as a pandemic on March 11, 2020 [1]. The COVID-19 pandemic has brought significant lifestyle changes such as curfew and physical distance. The sedentary time increased in all age groups, especially in the children's age group [2]. Decreased physical activity and increased sedentary time negatively affect the physical and mental health of children and adolescents, worsen health conditions, and lead to a further decrease in physical activity and a further increase in sedentary life in a vicious circle [3]. Meta-analyses in the literature have shown that the prevalence of being overweight and obese increased in children and adolescents [4, 5]. The increase in obesity occurs due to the difference between energy intake and consumption, and the positive increase in energy balance is closely related to lifestyle and the types of food consumed. Environmental factors, lifestyle preferences, family eating habits, and cultural environment are critical in obesity. As well as excessive sugar intake and increased portions, an individual's genetic characteristics are also effective in the development of obesity [6].

The purpose of this study was to investigate the effect of the COVID-19 pandemic on obesity prevalence in children aged 6–17 years who applied to Istanbul University Istanbul Faculty of Medicine General Pediatrics outpatient clinics with anthropometric measurements and laboratory comparing these parameters with the cases before the pandemic. In addition, we conducted a survey to investigate the effect of the COVID-19 pandemic on the etiological factors of pediatric obesity. We thought the results would give essential outcomes regarding healthy food consumption, maintaining physical activity, raising awareness for the education team and parents regarding children's nutritional behavior, reducing screen time, and increasing physical activity.

Materials and Methods

We retrospectively included all children with obesity and overweight who applied to Istanbul University, Istanbul Faculty of Medicine, Department of Child Health and Diseases, General Pediatrics Polyclinic between January 1, 2018, and December 31, 2021, in this descriptive and analytical research.

Selection of Cases

We recorded all children diagnosed with obesity and overweight in the hospital information management system. We excluded patients with endocrinologic disorders (Cushing's syndrome, hypothyroidism, growth hormone deficiency), genetic/syndromic diseases or medication which tends to obesity, and children with mental illness, mental retardation, autism, and chronic illnesses. We included children with obesity and overweight without no known underlying etiology aged between 6 and 17 years. We established two groups: group 1 before and group 2 during the pandemic. The prevalence before (2018, 2019, and the first three months of 2020) and during the pandemic (the last nine months of 2020 and 2021) was also calculated.

Definition of Obesity

Children's weight and height measurements were used to calculate body mass index (BMI). As defined by the Centers for Disease Control and the Pediatric Endocrinology and Diabetes Association, BMI values ≥ 85th percentile were defined as overweight, ≥ 95th percentile as obesity [7, 8], and ≥ 99th percentile as severe/morbid obesity. Stage 2 obesity corresponds to the 99th percentile of BMI (approximately 2.33 standard deviations above the mean). It has been stated that obese people with a BMI of 99th percentile and above are at greater risk, especially for cardiometabolic complications (277). In light of this information, overweight/obese patients in our study; Being overweight (BMI ≥ 85.p-<95.p), those with BMI ≥ 95.p-<97.p, those with BMI ≥ 97.p-<99.p and those with BMI ≥ 99.p (morbid obesity). It is divided into four groups in total.

Laboratory Assessment

We assessed fasting glucose, fasting insulin, % hemoglobin A1c (HbA1c), alanine aminotransferase (ALT), aspartate aminotransferase (AST), fasting lipid profile (triglyceride, total cholesterol, low-density lipoproteins (LDL) and high-density lipoproteins (HDL), and HOMA-IR (insulin homeostatic model evaluation) was calculated for insulin resistance [9]. We defined fasting blood sugar ≥ 100 mg/dl as impaired fasting glucose and HbA1c between 5.7 and 6.4% as pre-diabetes [10]. Fasting plasma insulin and HOMA-IR vary significantly with age, increasing until approximately 13–15 years of age and then decreasing in both boys and girls [11, 12]. Accordingly, values of 2 standard deviations and above the median insulin value calculated according to sex in five different age groups between 7 and 18 years of age are considered hyperinsulinism [12, 13]. Percentile and standard deviation (SDS) values vary according to age and sex, and in our study, higher than two standard deviations and above the average were considered elevated [13, 14].

Arterial blood pressure (BP) measurements were evaluated according to the blood pressure classification published by the American Academy of Pediatrics in 2017 [15]. Blood pressure and BMI percentiles were determined using the application developed by the Turkish Society of Pediatric Endocrinology and Diabetes, which

calculates percentiles based on age, sex, and height measurements (https://www.ceddcozum.com) [16].

We gave detailed information about the research and survey via phone calls and online channels and obtained consent forms. A total of 77 cases and their parents who applied before the pandemic and 100 cases and their parents who applied during the pandemic agreed to participate in this survey. We asked the parents to answer their children' s nutritional habits, physical activity, sleep duration, and screen time separately: before and during the pandemic. The signed consents of the parents were obtained before participating in this study. In addition to the primary survey study, the AFHC questionnaire was administered to adolescent participants aged between 10 and 17 years. The original version of the questionnaire comprises 23 items; however, 4 items were omitted in the Turkish-adapted version [17].

The signed consents of the parents and the adolescents were obtained before participating in this study.

We estimated that we would need minimum 102 individuals (set type 1 error: 0.05, power (1-b):0.80, effect size d:0.5) to compare two independent groups.

Statistical Analysis

We presented descriptive statistics of the data as mean, standard deviation, median, lowest and highest results, prevalence, ratio, and number and percentage values. We used the Kolmogorov-Simirnov test for normality, the independent sample t-test or Mann-Whitney U test by considering the distribution to compare two independent groups with continuous variables, and the chi-square or Fisher exact test to compare categorical data. We used the paired sample t-test and Wilcoxon test for comparing two dependent groups with continuous variables and the MC Nemar test for comparing categorical data. p <0.05 was considered statistically significant. SPSS 28.0 package program was used in these analyses.

Table 1 Age, gender, and anthropometric measurements of the patients

	Before Pandemic		During Pandemic		
	mean ± sd (median)	**% (*n*)**	**mean ± sd (median)**	**% (*n*)**	***P* value**
Age (years)	10.5 ± 3.8 (11)		11 ± 3.7 (11)		*0.01*^{m}
Sex	-	Female 47.0% (*n* = 182)	-	Female 49.0% (*n* = 191)	0.589 $^{X^2}$
	-	Male 53.0% (*n* = 206)	-	Male 51.0% (*n* = 199)	
Weight (kg)	64 ± 25.8 (62)	-	67.5 ± 24.2 (66)	-	*0.029*^{m}
Weight percentile	96.6 ± 10.2 (99.3)	-	97.3 ± 7.3 (99.5)	-	0.222 ^{m}
Height (cm)	148 ± 20.4 (151)	-	149.2 ± 21 (153)	-	0.268 ^{m}
Height percentile	73.6 ± 27.2 (83.7)	-	66.5 ± 30.5 (75.5)	-	*0.003*^{m}
BMI (kg/m^2)	28.6 ± 7.3 (27.7)	-	29.8 ± 8.9 (28.4)	-	*0.044*^{m}
BMI percentile	97.5 ± 4.6 (99)	-	98 ± 5.8 (99.4)	-	*0*^{m}
BMI SDS	2.4 ± 0.7 (20.4)	-	2.5 ± 0.8 (2.5)	-	*0.021*^{t}

^{t} Independent t test/^{m} Mann-whitney u test/$^{X^2}$ Chi-square test

Results

There were 998 patients with obesity and overweight, and 778 patients had exogenous obesity among these cases. As we searched the hospital data system, we found that 198 cases applied to the outpatient clinic with obesity/overweighed in 2018, 251 cases in 2019, 174 cases in 2020, and 375 cases in 2021. The year with the highest number of overweight/obese patients was 2021. A total of 388 patients were admitted to the hospital before the pandemic and 390 during the pandemic. The total number of patients who applied to the General Pediatrics outpatient clinic before the pandemic was 42956, and the prevalence of exogenous obesity diagnosis was 0.9%, whereas the total number of patients during the pandemic was 20846 with a 1.8% prevalence of exogenous obesity.

The average age of all cases was 10.7 ± 3.7 (min:7 – max:14.4) years. A total of 373 (47.9%) of the cases were girls and 405 (52%) were boys. When we assessed age distribution, we observed that the 8–13 age group mostly applied (501 cases, 64.4%). Sex distribution was comparable between the two groups, and the average age was higher in the pandemic group (p = 0.010) (Table 1).

The average weight of the pandemic group was significantly higher (p=0.029). The mean weight percentiles of all patients were not statistically different between the two groups (p=0.222), but the height percentile of Group 2 was lower (p=0.003). The average BMI SDS and BMI percentile values of the cases admitted during the pandemic were statistically higher those admitted before pandemic (p=0.021 and p<0.001, respectively). (Figure 1). Anthropometric measurements are presented in Table 1.

12.4% of all cases were overweight, the rest were obese, and when classified according to obesity severity, the rate of severe obesity during the pandemic increased statistically significantly compared to before the pandemic (p = 0.028). Table 2 shows the distribution of these children according to obesity severity.

There were no significant difference between group 1 and 2 regarding systolic blood pressure (120.9 ± 12.8 mmHg vs 120.0 ± 13.3, respectively, p=0.452) and diastolic blood pressure (78.0 ± 9.2 vs 76.7 ± 11.6 mmHg, respectively, p=0.498). Hypertension (HT) was detected

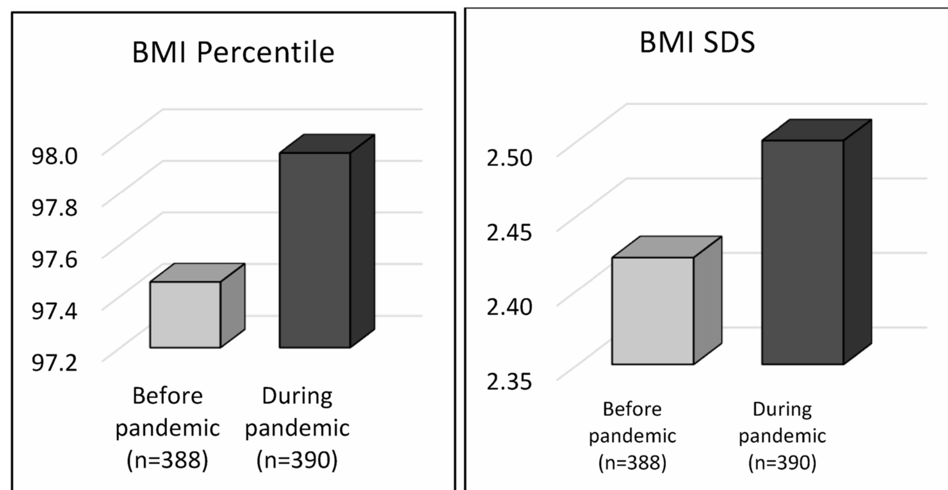

Fig. 1 Average BMI percentile and BMI SDS values of cases admitted before and during the pandemic

Table 2 Comparison of obesity status of the cases by pandemic

Obesity Stage	Before Pandemic		During Pandemic		P value
	n	%	n	%	
Overweighted (BMI ≥ 85-<95. percentile)	48	12.4	49	12.6	*0.028*
BMI ≥ 95.persantil -<97. percentile	50	12.9	26	6.7	
BMI ≥ 97.persantil -<99. percentile	75	19.3	74	19	
BMI ≥ 99.percentile	215	55.4	241	61.8	

Chi-square test

at a 62.3% rate in group 1, whereas it was a 38.6% ratio in group 2. The blood pressure stage did not differ significantly between the two groups (p=0.053).

There was no significant difference in the fasting blood sugar value and the ratio of patients with high blood sugar between Groups 1 and 2; however, the prevalence of hyperinsulinism statistically significantly higher during the pandemic (p = 0.041). The HOMA-IR results (p<0.001), the prevalence of insulin resistance (p=0.021), LDL cholesterol results (p:0.001) and the rate of patients with high LDL cholesterol (p:0.048) were statistically higher in those who applied during the pandemic than those who applied before. (Table 3). There was no significant difference regarding fatty liver disease between groups 1 and 2 (55% (n=304) vs 55.4% (n=88), respectively, p = 0.318).

The prevalence of ordering food from outside three days a week or more frequently (p=0.008), during the pandemic showed a statistically significant increase compared to before the pandemic (p=0.008, table4) as well as vegetable and fruit consumption (p = 0.001, table 5); however, there were no significant differences in the consumption of meat/egg/legumes (p=0.311) and milk/yogurt/cheese groups (p=0.135). The consumed portion amounts of various food groups are presented in Table 5.

Children's physical activity levels decreased significantly during the pandemic (p<0.001). In addition, children's daily screen exposure and daily sleep duration during the pandemic showed a statistically significant increase compared to before the pandemic (p<0.001 and p<0.001, respectively) (Table6).

There was no statistically significant difference in AFHC scores (minimum:0, maximum 17) among 141 participating adolescents between before and during pandemic groups (8.8±4.2 vs 8.9±4.1, respectively, p = 0.314).

Discussion

The COVID-19 pandemic has had many effects in our country as well as in the world, one of which is its negative impact on children's obesity with the lifestyle changes it causes. In our study, the prevalence of overweight/obesity doubled, and body weight and BMI SDS increased during the pandemic compared to before the pandemic. Yang et al. [18] reported that the BMI value of children and overweight/obesity prevalence increased during the pandemic. Another study on nursing students reported that nutrition and exercise behaviors were affected during this period, and 46.9% put on weight [19]. Another study in Germany also reported that children's BMI SDS increased during the pandemic in all weight and age groups [20]. Another aspect was that the average age of the cases admitted during the pandemic was higher in our study. A study conducted in America in the 6–17 age group stated that the weight gain of the 8–12 age group was higher than that of adolescents [21]. A large-scale study conducted in China on children between the ages of 6 and 17 stated that the increase in the BMI-Z score of children between the ages of 6 and 11 was more

Table 3 Laboratory results of the patients with comparison

	Before Pandemic		During Pandemic		P value
	mean ± sd (median)	% (n)	mean ± sd (median)	% (n)	
Fasting Blood glucose (mg/dl)	89.5 ± 8.4 (89.0)		89.7 ± 8.8 (89)		0.672 m
Normal		88.9% (n = 287)		90.5% (n = 305)	
Elevated		11.1% (n = 36)		9.5% (n = 32)	
Fasting Plasma Insulin (mcu/ml)	20.7 ± 12.4 (17.6)		24.5 ± 14.1 (21.9)		*0* m
Normal		17.9% (n = 42)		11.4% (n = 32)	*0.041* X^2
Elevated		82.1% (n = 192)		88.6% (n = 248)	
HOMA-IR	4.6 ± 3 (3.9)	3	5.6 ± 3.4 (4.8)		*0* m
Normal		71.2% (n = 153)		61.2% (n = 159)	*0.021* X^2
Elevated		28.8% (n = 62)		38.8% (n = 101)	
HbA1C (%)	5.4 ± 0.4 (5.4)		5.3 ± 0.4 (5.3)		0.13 m
< 5.7		74.9% (n = 170)		80.4% (n = 209)	0.145 X^2
5.7–6.4		25.1% (n = 57)		19.6% (n = 51)	
ALT (U/L)	26.4 ± 24.6 (19)		28.4 ± 26.1 (20.3)		0.252 m
Normal		86.0% (n = 277)		80.6% (n = 278)	0.167 X^2
Elevated		11.5% (n = 37)		15.7% (n = 54)	
Decreased		2.5% (n = 8)		3.8% (n = 13)	
AST (U/L)	24.3 ± 10.3 (22)		25 ± 11.5 (22)		0.528 m
Normal		93.1% (n = 195)		90.9% (n = 310)	0.311 X^2
Elevated		6.9% (n = 22)		9.1% (n = 31)	
Triglyceride (mg/dl)	127.6 ± 69.1 (112)		118.1 ± 60.9 (102)		*0.034* m
Normal		79.2% (n = 259)		81.7% (n = 245)	0.438 X^2
Elevated		20.8% (n = 68)		18.3% (n = 55)	
Total cholesterol (mg/dl)	165.2 ± 32.1 (163.3)		171 ± 34.2 (168)		0.06 m
Normal		56.0% (n = 182)		52.9% (n = 162)	0.474 X^2
Border		29.8% (n = 97)		29.4% (n = 90)	
Elevated		14.2% (n = 46)		17.6% (n = 54)	
HDL cholesterol (mg/dl)	47.6 ± 11.3 (46)		47.9 ± 10.4 (46.6)		0.569 m
Normal		54. 2% (n = 174)		56.8% (n = 171)	0.779 X^2
Border		21.8% (n = 70)		21.3% (n = 64)	
Decreased		24.0% (n = 77)		21.9% (n = 66)	
LDL cholesterol (mg/dl)	93.4 ± 27.6 (91.2)		102.4 ± 29.1 (101)		*0.001* m
Normal		73.0% (n = 227)		67.6% (n = 202)	*0.048* X^2
Border		16.4% (n = 51)		16.4% (n = 49)	
Elevated		10.6% (n = 33)		16.1% (n = 48)	

m Mann-whitney u test/X^2 Ki-kare test

HOMA-IR Homeostatic Model Assessment for Insulin Resistance, *HbA1C* Glycosylated Haemoglobin, *ALT* Alanine aminotransferase, *AST* aspartate aminotransferase, *HDL* High density lipoprotein, *LDL* Low-density lipoprotein

pronounced [22]. Another study from Europe reported that average BMI increased in boys during pandemic; however, BMI decreased in girls during the pandemic [23]. Also, another study conducted in our country built with 6-year old children reported that 23.3% of the children were obese and overweighed during the pandemic, and the mean BMI increased around 1 sds from 2019 to 2021 [24].

As we focused on glucose and lipid metabolism, we did not find significance in fasting blood sugar in patients admitted before and during the pandemic in our study; however, fasting insulin levels, insulin resistance, and hyperinsulinemia rates increased significantly during the pandemic. Giannini et al. [25] reported that fasting blood sugar, insulin resistance, and blood pressure were higher, whereas HDL cholesterol levels were lower

Table 4 Food comsumption of the patients before and during pandemic

Snacks (Chips-Chocolate)	Before Pandemic	During Pandemic	*P* value
Seldom	17.3% (*n* = 30)	14.4% (*n* = 25)	*0.015*[N]
1–2/week	30.6% (*n* = 53)	26.0% (*n* = 45)	
3–4/week	28.3% (*n* = 49)	27.1% (*n* = 47)	
Almost everyday	23.7% (*n* = 41)	32.3% (*n* = 56)	
Pastry			
Seldom	45.9% (*n* = 79)	32.0% (*n* = 55)	*0.000*[N]
1–2/week	39.5% (*n* = 68)	32.6% (*n* = 56)	
3–4/week	9.9% (*n* = 17)	24.4% (*n* = 42)	
Almost everyday	4.7% (*n* = 8)	11.0% (*n* = 19)	
Pizza. potato. hamburger			
Seldom	63.5% (*n* = 108)	57.1% (*n* = 97)	*0.032*[N]
1–2/week	28.8% (*n* = 49)	28.2% (*n* = 48)	
3–4/week	5.9% (*n* = 10)	12.4% (*n* = 21)	
Almost everyday	1.8% (*n* = 3)	2.4% (*n* = 4)	
Fruit juice/Soda			
Seldom	46.2% (*n* = 78)	42.0% (*n* = 71)	0.111 N
1–2/week	20.7% (*n* = 35)	21.3% (*n* = 36)	
3–4/week	18.3% (*n* = 31)	22.5% (*n* = 38)	
Almost everyday	14.8% (*n* = 25)	14.2% (*n* = 24)	
Bakery Products (Bagels. rolls…)			
Seldom	23.1% (*n* = 39)	23.7% (*n* = 40)	0.213 N
1–2/week	34.3% (*n* = 58)	28.4% (*n* = 48)	
3–4/week	14.2% (*n* = 24)	18.3% (*n* = 31)	
Almost everyday	28.4% (*n* = 48)	29.6% (*n* = 50)	
Milk/Sherbet Dessert			
Seldom	51.5% (*n* = 88)	46.2% (*n* = 79)	*0.014*[N]
1–2/week	39.8% (*n* = 68)	39.2% (*n* = 67)	
3–4/week	7.6% (*n* = 13)	11.1% (*n* = 19)	
Almost everyday	1.2% (*n* = 2)	3.5% (*n* = 6)	

N Mc-Nemar test. Data is presented as % (n)

Table 5 Healthy food comsumption of the patients before and during pandemic

	Before Pandemic	During Pandemic	*P* value
Fruits/Vegetables			
Seldom/Never	14.1% (*n* = 23)	13.4% (*n* = 22)	*0.007*[N]
1–2 portions/day	40.5% (*n* = 67)	34.1% (*n* = 56)	
3–4 portions/day	20.2% (*n* = 33)	26.2% (*n* = 43)	
≥ 5 portion/day	25.2% (n=	26.2% (*n* = 43)	
Fruits/Vegetables			
Seldom/Never	14.0% (*n* = 23)	14.6% (*n* = 24)	*0.001*[N]
Insufficient	48.8% (*n* = 80)	39.6% (*n* = 65)	
Sufficient	37.2% (*n* = 61)	45.7% (*n* = 75)	
Meat. Egg. Dried Legume			
Seldom/Never	4.3% (*n* = 7)	6.2% (*n* = 10)	0.056 N
1–2 portions/day	52.1% (*n* = 85)	46.6% (*n* = 76)	
≥ 3 portion/day	43.6% (*n* = 71)	47.2% (*n* = 77)	
Meat. Egg. Dried Legume			
Seldom/Never	4.3% (*n* = 7)	5.6% (*n* = 9)	0.311 N
Insufficient	24.0% (*n* = 39)	22.0% (*n* = 36)	
Sufficient	71.7% (*n* = 117)	72.4% (*n* = 118)	
Milk. Cheese. Yogurt			
Seldom/Never	6.7% (*n* = 11)	8.6% (*n* = 14)	0.135 N
1–2 portions/day	39.3% (*n* = 64)	35.6% (*n* = 58)	
≥ 3 portion/day	54.0% (*n* = 88)	55.8% (*n* = 91)	
Milk. Cheese. Yogurt			
Seldom/Never	6.7% (*n* = 11)	8.0% (*n* = 13)	0.135 N
Insufficient	38.7% (*n* = 63)	35.6% (*n* = 58)	
Sufficient	54.6% (*n* = 89)	56.4% (*n* = 92)	

N Mc-Nemar test. Data is presented as % (n)

during the pandemic period among their obese and overweight children who were under follow-up for around 13 years. There was no statistically significant alteration in HDL cholesterol and average blood pressure in our study in those admitted during the pandemic, which could be related to the fact that most of our patient population applied to the outpatient clinic for the first time with gaining too much weight without having a long history of obesity. We think the pandemic decreased the children's physical activity levels and increased consumption of foods such as desserts and junk foods with high glycemic index during this period, which led to hyperinsulinemia and insulin resistance.

In our patient group, consumption of junk food increased during the pandemic compared to before the pandemic, and almost one in three children consumed these snacks daily. In another study from our country reported daily junk food consumption as 50.3% during the pandemic [24]. This finding is similar to other studies showing that junk food consumption increased during the pandemic [26, 27]. A study reported that Turkish adolescents preferred foods for snacks like biscuits, candy, chocolate, and cake at a 42.7% rate during the pandemic, whereas raw vegetables, yogurt, nuts, fresh fruit, and dried fruit preferences were in disfavor [27]. The consumption prevalence of fast food also increased significantly during the pandemic in our study, and approximately 43% of children consumed these foods at least 1–2 times a week. Another study in our country reported that 48.9% of adolescents did not pay attention to their nutrition during the pandemic period, eating habits were negatively affected by 52.7% during the pandemic, 55% had increased body weight, and 36.6% consumed fast-baked foods such as pizza and potatoes 2–6 times a week during the pandemic [28], which were consistent with our study. Staying at home/isolated and the stress and anxiety brought on by the pandemic affected the food consumption habits of adolescents [26, 29]. Hence, Ruiz-Roso et al. [30] reported that fast-food consumption decreased during the pandemic compared with the pre-pandemic period, and they stated that this may be due to the increased prevalence of cooking at home; however, they also reported that people daily consuming

Table 6 Physical activity, screen time, and sleep time of the patients before and during pandemic

	Before Pandemic	During Pandemic	*P* value
Physical activity			
Sedentary	17.1% (*n* = 30)	69.1% (*n* = 121)	*0.000*[N]
Light Exercise (< 1 h)	58.3% (*n* = 102)	16.0% (*n* = 28)	
Moderate Exercise 3 Days/Week	18.3% (*n* = 32)	6.9% (*n* = 12)	
Moderate exercise Every Day	5.7% (*n* = 10)	6.3% (*n* = 11)	
High Intensity Exercise Every Day	0.6% (*n* = 1)	1.7% (*n* = 3)	
Screen time			
< 1 h	10.8% (*n* = 19)	2.9% (*n* = 5)	*0.000*[N]
1–2 h	24.6% (*n* = 43)	5.7% (*n* = 10)	
2–3 h	18.8% (*n* = 33)	6.9% (*n* = 12)	
3–4 h	12.0% (*n* = 21)	10.9% (*n* = 19)	
≥ 4 h	33.7% (*n* = 59)	73.7% (*n* = 129)	
Sleep time			
< 6 h	5.5% (*n* = 9)	3.0% (*n* = 5)	*0.000*[N]
6–8 h	56.1% (*n* = 92)	29.9% (*n* = 49)	
9–10 h	32.3% (*n* = 53)	41.5% (*n* = 68)	
10–12 h	4.9% (*n* = 8)	20.7% (*n* = 34)	
> 12 h	1.2% (*n* = 2)	4.9% (*n* = 8)	

N Mc-Nemar test. Data is presented as % (n)

desserts increased from 14% to 20.7%. In our study, the rate of those who consumed milk-based desserts three or more days a week was 8.8% before the pandemic, while it increased to 14.6% during the pandemic, and the prevalence of dessert consumption increased significantly. This result was consistent with the literature. Also, fruit and vegetable consumption increased during the pandemic in our study. While the rate of those consuming sufficient amounts of vegetables and fruits before the pandemic was 37.2%, it increased to 45.7% during the pandemic. Although there was an increase in percentage, more than half of the children still consume vegetables and fruits below the daily amount they should consume. We think the increased consumption of vegetables and fruits during the pandemic is related to the trend towards a diet rich in vitamins to strengthen the immune system to protect against COVID-19 infection or to get over the disease mildly and that mothers cook at home more frequently. Similarly, Ruiz-Roso et al. [30] reported that the consumption of fruits and vegetables increased during the pandemic, while the rate of adolescents consuming vegetables every day before the pandemic period was 35.2%, which increased to 43% during pandemic. Another aspect was that the prevalence of ordering food from outside (three days a week or more) has increased in our study; however, another two studies reported that ordering food at home decreased during the pandemic [31, 32].

In our study, a significant decrease occurred in children's exercise levels; hence, the rate of children meeting the *Centers for Disease Control and Prevention* recommendation was at a 6.3% rate before the pandemic, whereas it increased to 8% during the pandemic. However, the rate of sedentariness was 17.1% before the pandemic, which increased to a high rate of 69.1%. While the rate of those who did not exercise regularly was 75.4% before the pandemic, it increased to 85.1% during the pandemic. When we look at other studies investigating the physical activity levels of children and adolescents during the pandemic, a study reported that the rate of students who did not exercise regularly was 56.7% [19], and another reported 79.4% [28]. A meta-analysis concluded that COVID-19 impaired physical activity levels in 12 studies but had a positive effect in 3 studies [33].

The time spent with digital screens such as TVs, tablets, and mobile phones increased during the pandemic. Those who spent 4 h or more a day before the pandemic constituted 33.5% of the participants before the pandemic, which increased to 73.7% during the pandemic. A meta-analysis reported that the time children and adolescents spent on the screen increased during the COVID-19 pandemic [33].

In our study, children's sleep duration during the pandemic showed a statistically significant increase compared to before the pandemic. A study reported that sleep duration increased in school children aged 8–16 during the pandemic [34], and another reported an increase in sleep duration in 34.2% of children [35]. As schools were closed, waking up late and sleeping late (no school in the morning) may be efficacious in increasing sleep duration. Similarly to this finding, Kaditis et al. [36] reported that children went to bed later and woke up later during the pandemic.

AFHC survey scores during the pandemic did not alter significantly compared to results before the pandemic in our study. The average AFHC score was reported at a 10.9 rate in a study conducted with adolescents in Italy [37], a 10.4 rate in Korea [38], and 8.74 ± 4.03 in overweight/obese children in Turk adolescents in 2012 [17] before the pandemic. The average score we found in our study is almost the same as Arıkan's finding and is close to the scores in international studies. The AFHC results among Polish adolescents before the pandemic was 12.72 ± 5.22, slightly increasing to 13.31 ± 5.40 during the pandemic. Although they thought that the slightly increased score during the pandemic was related to the fact that they gave more importance to health and weighing control, hence they still reported that, in line with our observation, those who had healthy eating habits before the pandemic did not change their eating habits much, while those who had unhealthy eating habits before the pandemic did the same. They stated that the proportion

of participants who changed their eating habits from healthy to unhealthy or vice versa was almost the same and that the changes observed for the general population could not be reduced to individuals [39]. For these reasons, we think the score between the two periods in our study is similar. In addition to the negative change during the pandemic, the positive change in fruit and vegetable consumption may have caused the score obtained in the two periods, which reached a balance in our patient group.

Strength and Limitations

The number of cases examined in our study is higher than in other studies in Turkey. The study includes both retrospective data and a survey and is a large-scale study evaluating the laboratory data of children with obesity and overweight. However, the limitations were that we could not reach the BMI of some patients. We think that the prevalence of obesity is higher than we calculated.

Conclusion

During the Covid-19 pandemic, an increase in obesity and morbid obesity was observed, influenced by the various factors mentioned above. BMI SDS, insulin resistance, fasting insulin, and LDL cholesterol levels were significantly higher in patients who sought care during the pandemic. No significant changes were observed in ALT, AST, total cholesterol, HDL levels, blood pressure measurements, or hepatosteatosis. The average triglyceride levels were lower among patients who applied during the pandemic. It was also noted that children had an increased consumption of pastries, junk food, fast food, sweets, and nighttime snacks during this period. However, there was a positive increase in their intake of fruits and vegetables. Additionally, children engaged in less physical activity during the pandemic compared to pre-pandemic levels, spent more time in front of screens, and children's sleep duration was extended. No significant difference was found in the AFHC score.

Obesity comorbidities (considering that obesity has antecedence in adolescenthood) like ischemic heart disease and stroke, which are among the most common causes of death in adults worldwide, are closely related to obesity, as the COVID-19 pandemic seems to have increased obesity through various factors mentioned above.

With globalization, an epidemic that starts in a city can spread all over the world in a short time. During another possible epidemic and the quarantine processes, governments and health authorities should make a ready, and parents, schools, healthcare professionals, and children should be informed about this issue.

Abbreviations

COVID-19	Coronavirus disease 2019
BMI	Body mass index
HbA1c	Hemoglobin A1c
ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
LDL	Low-density lipoproteins
HDL	High-density lipoproteins
HOMA-IR	Homeostatic Model Assessment for Insulin Resistance
SDS	Standard deviation
BP	Blood pressure
HT	Hypertension

Authors' contributions

Conceptualization: HA, AK, MO, MAVMethodology: HA, AK, MO, IY, IK, MAV, MYFormal analysis and investigation: HA, AK, IY, Figures: HA, IY, MAVWriting - review and editing: HA, AK, MO, IY, IK, MAV, MYResources: HA, AK, MYSupervision: AK, MO, IY, MAV, MY.

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Data availability

The data will be shared upon reasonable requests by the main author.

Declarations

Ethics approval and consent to participate

Istanbul University Faculty of Medicine Ethical Committee (10.02.2022, number 744996).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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