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Research

The Effect of Physical Activity During the COVID-19 Pandemic on the Metabolic Control in Children with Type 1 Diabetes Mellitus

COVİD-19 Pandemisi Sürecindeki Fiziksel Aktivitenin Tip 1 Diabetes Mellitus Tanılı Çocuklardaki Metabolik Kontrol Üzerine Etkisi

Diğdem Bezen[1], Pınar Yılmazbaş[2], Ayşe Koca[1]

[1]University of Health Sciences Türkiye, İstanbul Prof. Dr. Cemil Taşcıoğlu City Hospital, Clinic of Pediatrics, Division of Pediatric Endocrinology, İstanbul, Türkiye
[2]University of Health Sciences Türkiye, İstanbul Prof. Dr. Cemil Taşcıoğlu City Hospital, Clinic of Pediatrics, İstanbul, Türkiye

ABSTRACT

Objective: Coronavirus disease-2019 (COVID-19) pandemic caused lifestyle changes for many people. In this study, we evaluated the effects of physical activity (PA) at COVID-19 pandemic on the metabolic control of children with type 1 diabetes mellitus (T1DM).

Methods: Age, sex, blood pressure, comorbidity, anthropometric and sociodemographic data of 6-18 years old 82 patients with T1DM were recorded. Averages of glycosylated hemoglobin (HbA1c), lipid profiles, and daily insulin dose during the pandemic and a year prior were also recorded. With "Physical Activity Questionnaire-A/C" PA and screen time during the pandemic and a year prior were questioned. Patients were divided into 2 subgroups: normal weighted (group 1) and overweighted/obese (group 2) and were compared.

Results: Of the 82 patients, 47 were girls and mean age was 12.2±3.2 years. Group 1 had 64, group 2 had 18 patients and no difference was observed in terms of age, sex, comorbidity and sociodemographic data between the groups. There was a significant increase in screen time, the number of parents staying at home with children and body mass index (BMI) standard devation (SD), and a significant decrease in PA, blood pressure SD and low-density lipoprotein levels, but there was no change in HbA1c levels at the pandemic in both groups. The insulin dose was increased in group 1 at pandemic. There was a negative correlation between PA and the insulin dose.

Conclusion: During the pandemic, PA of patients with T1DM decreased, screen time, the number of parents staying at home with children and BMI SD was increased, but their metabolic controls did not deteriorate. This result was attributed to the fact that the support of the family might be much more decisive for metabolic control during a pandemic.

Keywords: COVID-19 pandemic, children, physical activity, metabolic control, type 1 diabetes mellitus

ÖZ

Amaç: Koronavirüs hastalığı-2019 (COVİD-19) pandemisi birçok insanda yaşam tarzı değişikliklerine neden oldu. Bu çalışmada COVİD-19 pandemisinde fiziksel aktivitenin (FA) tip 1 diabetes mellituslu (T1DM) çocukların metabolik kontrolü üzerindeki etkilerini değerlendirmeyi amaçladık.

Gereç ve Yöntem: Altı-18 yaş arası 82 T1DM hastasının yaş, cinsiyet, tansiyon, komorbidite, antropometrik ve sosyodemografik verileri kaydedildi. Pandemi sırasında ve bir yıl öncesinden glikat hemoglobin (HbA1c), lipid profilleri ve günlük insülin dozu ortalamaları da ayrıca kaydedildi. "Fiziksel Aktivite Anketi-A/C" ile pandemi sırasında ve bir yıl öncesindeki FA ve ekran süresi sorgulandı. Hastalar normal ağırlıklı (grup 1) ve fazla tartılı/obez (grup 2) olmak üzere 2 alt gruba ayrıldı ve birbirleri ile karşılaştırıldı.

Bulgular: Seksen iki hastanın 47'si kızdı ve yaş ortalamaları 12,2±3,2 yıl idi. Grup 1'de 64, grup 2'de 18 hasta vardı ve gruplar arasında yaş, cinsiyet, komorbidite ve sosyodemografik veriler açısından fark izlenmedi. Her iki grupta da pandemide ekran süresi, evde çocuklarla kalan ebeveyn sayısında ve vücut kitle indeksi (VKİ) standart sapmada (SS) anlamlı artış, FA, kan basıncı SS ve düşük yoğunluklu lipoprotein düzeylerinde

Address for Correspondence: Diğdem Bezen, University of Health Sciences Türkiye, Prof. Dr. Cemil Taşcıoğlu City Hospital, Clinic of Pediatrics, Division of Pediatric Endocrinology, İstanbul, Türkiye
Phone: +90 532 628 37 71 E-mail: demboli4@yahoo.com ORCID ID: orcid.org/0000-0003-3977-5527

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anlamlı düşüş oldu ancak HbA1c düzeylerinde değişiklik olmadı. Pandemide grup 1'de günlük insülin dozu arttı. FA ile insülin dozu arasında negatif bir ilişki vardı.

Sonuç: Pandemi sırasında T1DM'li hastaların FA'sı azaldı, ekran süresi, evde çocuklarla kalan ebeveyn sayısı ve VKİ SS arttı, ancak metabolik kontrolleri bozulmadı. Bu sonuç, aile desteğinin pandemi sırasında metabolik kontrol için çok daha belirleyici olabileceği sonucuna bağlandı.

Anahtar Kelimeler: COVİD-19 pandemisi, çocuklar, fiziksel aktivite, metabolik kontrol, tip 1 diabetes mellitus

INTRODUCTION

The coronavirus disease-2019 (COVID-19) pandemic has affected everyone's daily lives all around the world (1). Children and adolescents with type 1 diabetes mellitus (T1DM) had a disease patterns similar to the children lacking diabetes (2). But despite this, with the outbreak of the pandemic, elective and scheduled healthcare appointments were canceled or changed to telemedicine visits, so people having chronic diseases, such as children having T1DM, had some difficulties. However, some studies showed that telemedicine visits successfully manage the metabolic control of T1DM (3,4).

T1DM is a lifelong illness that requires multiple daily insulin injection, healthy diet, psychological support and physical activity (PA) (5). In our country, patients never had any problem of gaining insulin at the pandemic. Regular PA or exercise is an important part of T1DM management because it helps get better glucose regulation, weight control, decrease in comorbidity (hypertension, dyslipidemia, cardiovascular diseases) and improves well-being (6-8). The PA of the children having T1DM in our country had to change during the pandemic because schools were closed and a long-term lockdown was declared in March 2020 by the government to prevent the spread of the disease. Studies have been conducted to evaluate the role of PA in the metabolic management of T1DM during the pandemic. Some showed that pandemic did not affect glycemic control (9,10), as well as those who stated that pandemic did not affect it negatively (11).

Considering this knowledge, in this study, we evaluated the PA changes during the COVID-19 pandemic and the effect of these changes on the metabolic control in children with T1DM.

METHODS

In our study, a patient group of 82 children, aged 6-18 years, who had T1DM for at least 2 years and had regular visits every 3 months to the pediatric endocrinology outpatient clinic of our hospital were included. The age, sex, comorbidity and sociodemographic data (mother's level of education, father's level of education, mother's and father's working status before and at pandemic, type of house, presence of park or recreation areas suitable for PA nearby house, the way of transportation to school) were recorded. The frequency of going to school (days/week) during the pandemic was also asked. The measurement of height, weight and blood pressure were measured in the last 60 days before the pandemic and in the last 60 days of the first year of the pandemic. Height standard deviation (SD), weight SD, the body mass index (BMI) (ratio of the weight in kilograms to height in meters squared- kg/m^2) and SD values were calculated through the usage of reference values of Turkish children (12). Systolic and diastolic blood pressure SD scores were calculated with the reference of "Clinical practice guideline for screening and management of high blood pressure in children and adolescents" (13). The averages of glycosylated hemoglobin (HbA1c) values requested every 3 months, lipid profiles [cholesterol, triglyceride, low-density lipoprotein (LDL), high-density lipoprotein (HDL)] requested once a year, and the daily insulin dose (U/kg/day) during the pandemic period and a year prior were recorded from their files. The international Physical Activity Questionnaire-A (PAQ-A) or PAQ-C (14), which was validated for Turkish children (15), was completed, and the PA and screen time during the pandemic period and a year prior were assessed with a score between 8 and 40. In this PA evaluation questionnaire, 10 questions were asked about the different physical activities and their frequency done in the last 7 days. The frequency of weekly activities was scored 1 to 5. Score 1 shows that the activity has been seldom done, and score 5 shows that the activity has been done almost every day, and the total score increases as the frequency of physical activities increases. The patients were divided into 2 goups: normal weighted (group 1) and overweighted/obese (group 2). All parameters measured during the pandemic period and a year prior were compared both within the groups and between groups 1 and 2. The correlation between PA-screen time and HbA1c, lipid profile and BMI SD was evaluated.

The patients and the families of the participants were informed about the study and signed informed consent

forms were obtained according to the Helsinki Declaration before they have were included in the study. The study was conducted after approval was given by the Ethics Committee of University of Health Sciences Türkiye, İstanbul Prof. Dr. Cemil Taşcıoğlu City Hospital (approval no: 48670771-514.10, date: 21 June 2021).

Statistical Analysis

For the statistical analyses, in the descriptive statistics of the data, mean, SD, median, minimum, maximum, frequency and ratio values were used. The distribution of variables was measured with the Kolmogorov-Smirnov test. The Mann-Whitney U test was used for two independent groups that did not show a normal distribution, and the Wilcoxon test was used for the comparison of two dependent groups that did not show a normal distribution. Chi-square test was used in the analysis of qualitative independent data, and Fisher's Exact test was used when the chi-square test conditions were not met. Spearman correlation analysis was used in the correlation analysis. "p" value <0.05 was considered as statistically significant.

RESULTS

The mean age of the patients was 12.2±3.2 years (median 12.4 years), and 47 (57.3%) of them were female, 35 (42.7%) of them were male. Group 1 (normal weighted) had 64, group 2 (overweighted/obese) had 18 patients. When these 2 groups were compared, no difference was observed in terms of age, sex, comorbidity and sociodemographic data (mother's level of education, father's level of education, type of house, presence of park or recreation areas suitable for PA nearby house, the way of transportation to school) and the frequency of going to school at pandemic (Table 1).

The number of fathers who went out to work did not change significantly, but the number of mothers staying at home increased significantly at pandemic (p<0.001) (Table 2).

There was no difference within the groups and between the groups in terms of height SD, HbA1c levels, cholesterol, HDL and triglyceride levels when compared before the pandemic and at pandemic period. LDL levels and although the patients were normotensive, systolic blood pressure SD and diastolic blood pressure SD were significantly decreased at the pandemic in both groups, but the difference was not significant when the two groups were compared. Weight SD and BMI SD increased significantly in both groups at the pandemic. Eight patients switched from group 1 to 2 in terms of BMI, and this shift was significant (p=0.004). The daily insulin dose was significantly higher in group 1 at pandemic. A comparison of anthromopetric measurements, biochemical parameters and insulin requirements between the pandemic period and the year prior is shown in Table 3.

The PA index was significantly decreased whereas the screen time (h/day) was significantly increased at pandemic in both groups (Table 4). There was no correlation between PA-screen time and HbA1c levels, lipid profile and BMI SD. There was a negative correlation between the PA and daily insulin dose (p=0.037, r=-0.261) (Table 5).

DISCUSSION

This study showed that the PA decreased and screen time and the number of parents staying at home with children increased, but the glycemic control of the children having T1DM did not change at a pandemic.

The regular PA is an important component of effective treatment of T1DM (6-8), but it is also reported to be ineffective in glycemic control in some studies (16-19). The COVID-19 pandemic, most of the people's PA opportunities had were greatly reduced due to lock down. Sarıkaya et al. (20) and Al Agha et al. (9) found no change in HbA1c levels of children having T1DM during the COVID-19 pandemic, whereas glycemic control was reported to be better in some other studies (3,10,21). In our study, despite the significant decrease in PA and increase in screen time because of prolonged school closure and home confinement of the children during the pandemic period, no significant change in HbA1C levels and no correlation between these parameters were found. During at pandemic, the number of parents staying at home compared to the year prior, has increased. The parents and children had more chance to make decisions together about the management of the disease. The support of the family might be the reason of no significant change in glycemic control of children having T1DM.

T1DM is associated with a high risk of microvascular and macrovascular complications and cardiovascular risk factors such as obesity, hypertension, hyperglycemia, dyslipidemia, and insulin resistance (22). Exercise is reported to increase aerobic fitness, improve lipid profile, but does not change BMI (7,17). Al Agha et al. (9) showed an increase in BMI

Table 1. Sociodemographic data of the patients

		Group 1*		Group 2†		p-value
		Mean ± SD		Mean ± SD		
Age (years)		12.4±3.1		11.5±3.6		0.274‡
		n	%	n	%	
Sex	Female	38	59.4	9	50.0	0.477§
	Male	26	40.6	9	50.0	
Comorbidity	No	47	73.4	12	66.7	0.572§
	Yes	17	26.6	6	33.3	
	Celiac disease	5	29.4	2	33.3	1.000§
	Hashimato thyroiditis	11	64.7	3	50.0	0.526§
	Other	2‖	11.8	1¶	16.6	0.270§
Mother's level of education	Primary school	3	4.7	3	16.7	
	Middle school	43	67.2	9	50.0	
	High school	15	23.4	3	16.7	0.891§
	University	3	4.7	3	16.7	
Father's level of education	Primary school	2	3.2	2	11.1	
	Middle school	33	51.6	8	44.4	0.839§
	High school	23	35.9	5	27.8	
	University	6	9.4	3	16.7	
Type of house	Apartment	58	90.6	17	94.4	
	Apartments with association	2	3.1	1	5.6	1.000
	Single family house	4	6.3	0	0.0	
Parks and recreation areas nearby house	No	37	57.8	11	61.1	0.802§
	Yes	27	42.2	7	38.9	
	Walking	42.0	65.6	11.0	61.1	
Way of transportation to school before the pandemic	Schoolbus	18.0	28.1	3.0	16.7	0.723§
	Family car	4.0	6.3	4.0	22.2	
Gone to school at the pandemic	No	31.0	48.4	5.0	27.8	0.119§
	Yes	33.0	51.6	13.0	72.2	
Days gone to school at pandemic (days/week)	2	33.0	100.0	12.0	92.3	0.283§
	5	0.0	0.0	1.0	7.7	

*Normal weighted patients, †Overweighted/obese patients, ‡Mann-Whitney U test, §Chi-square test, SDS: Standard deviation, ‖vitiligo, ¶Hydronephrosis

of children having T1DM during the COVID-19 pandemic and attributed this result to the decrease in rates of PA and following a healthy diet. However, Turan et al. (11) and Shah et al. (21) found that BMI of children having T1DM was not affected significantly during the COVID-19 pandemic although the weight was increased. In our study BMI SD was significantly increased during the pandemic in both groups, but the difference in increase between the groups was not significant. There was a significant shift in group 1 to 2. This might be due to decreased PA and increased screentime, which means an increase in sedentary behavior.

Table 2. The mothers and fathers working status before and after the pandemic

	BP	AP	p-value
Number of working mothers (n)	31	12	<0.001*
Number of mothers staying home (n)	51	70	
Number of working fathers (n)	62	59	0.59*
Number of fathers staying home (n)	20	23	

BP: Before the pandemic, AP: At pandemic, *Chi-square test

Lifestyle factors are determinants of children's blood pressure levels; increase in BMI, waist circumference and frequency of eating while watching television are found to elevate the blood pressure (23). No relationship was found between PA and blood pressure in healthy children and children having T1DM (7,18,24). Incompatible to the literature, although BMI SD was higher after the pandemic, we found a significant decrease in systolic and diastolic blood pressure SD in both groups, when compared the pandemic period and the year prior. As far as we know, there is no study in the literature, evaluating the blood pressure values of the children having T1DM during the pandemic. Although the children with T1DM and their caregivers are educated about managing T1DM, these children do not have enough support at school. There is "Diabetes at School Program" in our country for about 10 years, but strengthening diabetes care in schools in Türkiye for the children with T1DM is still a work in progress (25). At the pandemic, children managed the disease with the family support at home, instead of managing it alone at school. We thought that the reduction in blood pressure SD in our study may be due to the low anxiety about managing the disease. For this hypothesis to be supported, questionnaires assessing anxiety about managing T1DM are needed.

PA is an effective factor in decreasing the insulin requirements of children having T1DM (7,18). The weight and adipose tissue is another important factor in adjusting the insulin dose (6). Turan et al. (11) and Shah et al. (21) reported in their studies that the insulin requirement for treating T1DM did not change during the pandemic, and there was no significant difference in BMI values, too. In our study, we found a significant increase in the daily insulin dose of group 1 during the pandemic and a negative correlation between the PA and daily insulin dose. Eight patients in group 1 became overweighted/obese at pandemic and this shift was significant. Based on this result, it was thought that in addition to the decrease in PA, the increase in adipose tissue and the shift of BMI to the overweight/obese group may explain the increase in daily insulin requirement at the pandemic in group 1.

Many studies have reported that PA improves the lipid profile (7,8,17-19,24,26). Ludvigsson (4) evaluated the effect of a pandemic on lipid profile of children having T1DM and found no deterioration. In our study we found a significant decrease in LDL levels in both groups at the pandemic. Based on this finding, we thought that although the PA, which is an important factor in preventing the development of dyslipidemia, decreased, the LDL decrease might be due to the possibility of eating healthier meals in the family environment, rather than school canteens and due to limitations of snacks.

The American Academy of Pediatrics recommends that television watching among children should be limited to less than 2 h/day (27). Li et al. (28) showed in their longitudinal 5 year follow up study that, a decrease in screen time (3 h a day to 1 h a day) improves HbA1c levels in children having T1DM. The habit of snack consumption in front of the screen negatively affects metabolic control. In our study, we found a significant increase in screen time (h/day) at the pandemic in both groups, which was mostly for online school education. There was no correlation between screen time and HbA1c levels, lipid profile and BMI SD. We thought that most of the screen time increase was due to active class participation in front of the camera in the online education system, so it was impossible to snack during this time.

Our study had some limitations. Firstly, we didn't ask the daily dietary intake, snacks, junk food and fizzy drinks, so we couldn't evaluate the relationship between nutrition and BMI, HbA1c levels. Secondly, we couldn't measure PA with a device like a pedometer before and after the pandemic and compare activity levels. These would be more helpful in explaining the results of the study.

CONCLUSION

In conclusion, this study demonstrated that during the pandemic, the PA of patients with T1DM decreased, their screen time, the number of parents staying at home with children and BMI SD increased, but their glycemic and metabolic controls did not deteriorate. This result was attributed to the fact that although PA is a cornerstone in the management of T1DM, the support of the family might be much more decisive for metabolic control during the pandemic.

Table 3. Comparison of anthromopetric measurements, biochemical parameters and insulin requirements between the pandemic period and the year prior

	Group 1*		Group 2†		p-value‖
	Mean ± SD	Median	Mean ± SD	Median	
Systolic blood pressure SD					
BP	0.16±0.83	0.32	0.37±0.99	0.68	0.228‡
AP	0.12±0.83	0.40	0.27±0.95	0.63	0.316‡
BP/AP difference	-0.04±0.13	-0.05	-0.11±0.22	-0.04	0.702‡
p¶		0.001§		0.029§	
Diastolic blood pressure SD					
BP	0.34±0.81	0.37	0.41±0.70	0.40	0.831‡
AP	0.28±0.82	0.28	0.29±0.52	0.37	0.920‡
BP/AP difference	-0.06±0.08	-0.06	-0.12±0.29	-0.05	0.774‡
p¶		0.001§		0.005§	
Weight SD					
BP	-0.61±1.09	-0.40	0.70±1.38	0.74	0.001‡
AP	-0.27±1.17	-0.06	0.94±1.55	1.19	0.001‡
BP/AP difference	0.34±0.62	0.25	0.24±0.47	0.19	0.487‡
p¶		0.001§		0.043§	
Height SD					
BP	-0.38±1.24	-0.44	-0.58±1.60	-0.52	0.836‡
AP	-0.30±1.18	-0.40	-0.62±1.60	-0.55	0.924‡
BP/AP difference	0.08±0.51	-0.05	-0.04±0.33	-0.14	0.426‡
p¶		0.508§		0.433§	
BMI SD					
BP	-0.57±0.97	-0.50	1.21±0.79	1.26	0.001‡
AP	-0.15±1.04	0.05	1.44±1.96	1.38	0.001‡
BP/AP difference	0.42±0.80	0.35	0.23±0.40	0.22	0.398‡
p¶		0.001§		0.029§	
Daily insulin dose (U/kg/day)					
BP	0.97±0.32	1.00	0.87±0.33	0.85	0.339‡
AP	1.01±0.31	1.00	0.90±0.31	0.80	0.150‡
BP/AP difference	0.04±0.19	0.00	0.03±0.12	0.01	0.898‡
p¶		0.004§		0.203§	
Cholesterol (mg/dL)					
BP	166.3±39.7	161.5	179.5±56.0	173.5	0.361‡
AP	158.0±36.3	151.0	169.2±34.4	166.0	0.211‡
BP/AP difference	-7.2±27.2	6.0	-7.8±34.0	2.5	0.458‡
p¶		0.052§		0.349§	

Table 3. Continued

	Group 1*		Group 2†		p-value‖
	Mean ± SD	Median	Mean ± SD	Median	
Triglyceride (mg/dL)					
BP	93.1±65.2	71.0	132.6±142.1	77.5	0.175‡
AP	101.3±50.1	90.0	118.2±62.9	97.0	0.266‡
BP/AP difference	6.9±59.7	6.0	-1.9±89.8	10.5	0.737‡
p¶		0.069§		0.571§	
HDL (mg/dL)					
BP	57.6±13.5	58.0	56.6±12.5	56.5	0.758‡
AP	60.5±12.7	59.5	58.1±12.3	59.5	0.541‡
BP/AP difference	2.1±12.3	1.0	1.9±12.4	1.0	0.856‡
p¶		0.099§			0.619§
LDL (mg/dL)					
BP	91.7±28.0	87.0	127.0±86.2	97.0	0.129‡
AP	80.5±28.1	76.5	90.3±29.1	90.0	0.165‡
BP/AP difference	-9.2±19.1	-6.0	-22.8±52.3	-6.5	0.796‡
p¶		**0.001**§		**0.016**§	
HbA1c (%)					
BP	8.6±1.6	8.4	8.1±1.1	8.0	0.241‡
AP	8.5±1.9	8.2	8.1±1.4	7.9	0.473‡
BP/AP difference	-0.16±1.58	-0.10	-0.02±1.12	-0.20	0.711‡
p¶	0.100§			0.631§	

*Normal weighted patients, †overweighted/obese patients, ‡Mann-Whitney U test, §Wilcoxon test, ‖p-value for the comparison of the parameters between group 1 and 2, ¶p-value for the comparison of the parameters in each group within themselves, SD: Standard deviation, BP: Before pandemic, AP: At pandemic, BMI: Body mass index, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, HbA1c: Glycosylated hemoglobin

Table 4. Comparison of physical activity and screen time between the pandemic period and the year prior

	Group 1*		Group 2†		
	Medium ± SD	Median	Medium ± SD	Median	p‖
Physical activity index					
BP	25.9±7.2	26.0	25.9±5.4	25.5	0.951‡
AP	14.7±4.6	14.0	15.3±4.8	14.0	0.698‡
BP/AP difference	-11.2±6.6	-12.0	-10.7±5.1	-10.5	0.707‡
p¶	0.001§		0.001§		
Screen time (h/day)					
BP	4.2±1.7	-	4.3±2.3	4.0	0.927‡
AP	7.3±2.0	-	7.7±1.9	8.0	0.392‡
BP/AP difference	3.0±1.7	-	3.3±2.6	2.0	0.728‡
p¶	0.001§		0.001§		
For online school education AP	4.0±2.2	4.0	3.7±2.3	4.0	0.819‡

*Normal weighted patients, †Overweighted/obese patients, ‡Mann-Whitney U test, §Wilcoxon test, ‖p-value for the comparison of the parameters between group 1 and 2, ¶p-value for the comparison of the parameters in each group within themselves, SD: Standard deviation BP: Before the pandemic, AP: At pandemic

Table 5. Correlation between physical activity-screen time and lipid profile, HbA1c, BMI SD

		Triglyceride	HDL	LDL	HbA1c	Cholesterol	BMI SD	Daily insulin dose
Physical activity index	r*	-0.178	-0.073	0.010	-0.094	-0.114	0.118	-0.261
	p	0.160	0.566	0.936	0.461	0.370	0.355	0.037
Screen time	r*	0.254	-0.108	0.004	0.049	-0.120	0.198	-0.183
	p	0.051	0.394	0.972	0.698	0.343	0.117	0.148

*Spearman correlation, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, HbA1c: Glycosylated hemoglobin, BMI: Body mass index, SDS: Standard deviation

ETHICS

Ethics Committee Approval: The study was conducted after approval was given by the Ethics Committee of University of Health Sciences Türkiye, İstanbul Prof. Dr. Cemil Taşcıoğlu City Hospital (approval no: 48670771-514.10, date: 21 June 2021).

Informed Consent: The patients and the families of the participants were informed about the study and signed informed consent forms were obtained according to the Helsinki Declaration before they have were included in the study.

Authorship Contributions

Concept: D.B., P.Y., A.K., Design: D.B., P.Y., A.K., Data Collection or Processing: D.B., P.Y., A.K., Analysis or Interpretation: D.B., P.Y., Literature Search: D.B., P.Y., Writing: D.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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