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Screen Exposure, Circadian Rhythm, Sleep, Physical Activity, and Health Anxiety in University Students During Online Education

Sümeyye AKÇAY*, Mehmet Burak UYAROĞLU**, Gamze KOYUTÜRK***, Zuhal KUNDURACILAR****, Emre Serdar ATALAY*****, Burcu AKKURT******

Abstract

Aim: This study aimed to examine the associations between screen exposure, sedentary behavior, circadian rhythm, sleep, physical activity, and health anxiety among university students during the online education period.

Method: A total of 130 healthy university students participated. Data on socio-demographic characteristics, sleep onset latency, wake-up times, nighttime light exposure, and screen time were collected. Participants also completed the Morningness-Eveningness Questionnaire, the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Scale (ESS), the International Physical Activity Questionnaire (IPAQ), and the Short Health Anxiety Inventory.

Results: The sample included 101 females (78%) and 29 males (22%). Weak positive correlations were found between wake-up time and sleep onset latency, phone use and sleep duration, PSQI and several sleep parameters, ESS and phone use, and health anxiety with both PSQI and ESS. Weak negative correlations were observed between phone use and computer time, circadian rhythm and both sleep duration and phone use, and between circadian rhythm and PSQI and ESS. There was a moderate positive association observed between the ESS and PSQI scores.

Conclusion: The findings suggest that lifestyle changes associated with online education may be linked to alterations in students' circadian rhythm, sleep quality, and health anxiety. However, most associations were weak, indicating that these outcomes are likely influenced by multiple interacting factors.

Keywords: Digital device use, sleep quality, daytime sleepiness, sedentary lifestyle, student health.

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* Asst. Prof., Fenerbahçe University, Faculty of Health Sciences, Department of Occupational Therapy, Istanbul, Türkiye. E-mail: sumeyye.akcay@fbu.edu.tr ORCID https://orcid.org/0000-0001-8951-6369
** Asst. Prof., Fenerbahçe University, Vocational School of Health Sciences, Physiotherapy Program, Istanbul, Türkiye. E-mail: mehmet.uyaroglu@fbu.edu.tr ORCID https://orcid.org/0000-0003-0300-1140
*** Asst. Prof., Istanbul Topkapı University, Faculty of Health Sciences, Department of Occupational Therapy, Istanbul, Türkiye. E-mail: gamzekoyuturk@topkapi.edu.tr ORCID https://orcid.org/0000-0002-7240-9425
**** Prof., Istanbul Gelişim University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Türkiye. E-mail: zkunduracilar@gelisim.edu.tr ORCID https://orcid.org/0000-0002-1351-2967
***** Asst. Prof., Sağlık Bilimleri University, Faculty of Gülhane Physiotherapy and Rehabilitation, Department of Physiotherapy and Rehabilitation, Istanbul, Türkiye. E-mail: emreserdar.atalay@sbu.edu.tr ORCID https://orcid.org/0000-0002-8249-8628
****** Asst. Prof., Fenerbahçe University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Türkiye. E-mail: burcu.akkurt@fbu.edu.tr ORCID https://orcid.org/0000-0001-8394-9702

ETHICAL STATEMENT: This study was carried out with the approval of the Ethics Committee of Saglık Bilimleri University, dated 22/04/2022 and numbered 12/8. A signed subject consent form in accordance with the Declaration of Helsinki was obtained from each participant.

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Çevrim İçi Eğitim Döneminde Üniversite Öğrencilerinde Ekran Maruziyeti, Sirkadiyen Ritim, Uyku, Fiziksel Aktivite ve Sağlık Anksiyetesi

Öz

Amaç: Bu çalışma, çevrim içi eğitim döneminde üniversite öğrencilerinde ekran maruziyeti, sedanter davranış ile sirkadiyen ritim, uyku, fiziksel aktivite ve sağlık anksiyetesi arasındaki ilişkileri incelemeyi amaçladı.

Yöntem: Toplam 130 sağlıklı üniversite öğrencisi çalışmaya katıldı. Sosyo-demografik özellikler, uykuya dalma süresi, uyanma zamanları, gece ışık maruziyeti ve ekran süresi ile ilgili veriler toplandı. Katılımcılar ayrıca Sabahçılık-Akşamcılık Anketi, Pittsburgh Uyku Kalitesi İndeksi (PUKİ), Epworth Uykululuk Ölçeği (EUÖ), Uluslararası Fiziksel Aktivite Anketi (UFAA) ve Kısa Sağlık Anksiyetesi Envanteri'ni doldurdu.

Bulgular: Örneklem 101 kadın (%78) ve 29 erkek (%22) öğrenciden oluştu. Uyanma zamanı ile uykuya dalma süresi, telefon kullanımı ile uyku süresi, PUKİ ile çeşitli uyku parametreleri, EUÖ ile telefon kullanımı ve sağlık anksiyetesi ile hem PUKİ hem de EUÖ arasında zayıf pozitif korelasyonlar bulundu. Telefon kullanımı ile bilgisayar süresi, sirkadiyen ritim ile hem uyku süresi hem de telefon kullanımı arasında, ayrıca sirkadiyen ritim ile PUKİ ve EUÖ arasında zayıf negatif korelasyonlar gözlendi. EUÖ ile PUKİ puanları arasında ise orta düzeyde pozitif bir korelasyon saptandı.

Sonuç: Bulgular, çevrim içi eğitime bağlı yaşam tarzı değişikliklerinin öğrencilerin sirkadiyen ritimlerin, uyku kalitesinde ve sağlık anksiyetesinde değişimlerle ilişkili olabileceğini göstermektedir. Ancak çoğu ilişki zayıf düzeydedir, bu da sonuçların muhtemelen çoklu etkileşimli faktörlerden etkilendiğini düşündürmektedir.

Anahtar Sözcükler: Dijital cihaz kullanımı, uyku kalitesi, gündüz uykululuğu, sedanter yaşam tarzı, öğrenci sağlığı.

Introduction

Since the widespread adoption of online education, lifestyles have changed in many aspects. Social isolation and altered work and educational conditions have led to significant modifications in daily routines, including sleep patterns, circadian rhythms, and physical activity. Alongside these changes, concerns regarding health, fear of illness, and social isolation have been important contributors to anxiety and stress during the remote learning period[1].

Circadian rhythms are 24-hour cycles generated by molecular clocks that regulate physiological and behavioral processes. The circadian pacemaker, situated in the suprachiasmatic nucleus of the anterior hypothalamus, coordinates these signals to synchronize internal biological timing with external environmental cues. Disruptions in this system may result in cognitive dysfunction, metabolic syndrome, and mood disorders such as depression[2].

Sleep, regulated by both circadian rhythm and homeostatic balance, is essential for emotional and physical health. Sleep disturbances are linked to daytime tiredness, reduced concentration and memory performance, as well as difficulties in learning. Melatonin, which is released by the pineal gland, has a key function in controlling the human sleep–wake rhythm. During the remote learning period, increased screen light exposure and reduced social interaction have been shown to alter melatonin secretion, sleep duration, and circadian rhythms[3,4].

Physical activity also influences circadian rhythms by modulating skeletal muscle molecular clocks. Exercise not only regulates tissue-specific gene expression but also improves circadian rhythm amplitude and phase. Engaging in regular aerobic exercise can improve sleep quality, lower cardiovascular risk factors, and promote melatonin secretion, thereby contributing to healthier sleep patterns[5,6].

The psychological burden associated with rapid lifestyle changes and remote learning has been considerable. Research has highlighted long-term lifestyle-related effects that involve neurocognitive, psychological, and neurological consequences[7]. According to a meta-analysis conducted by Xiong et al., the prevalence of anxiety disorders ranged between 6.3% and 50.9% during the early period of remote learning[8]. Circadian rhythm disorders and sleep disturbances are closely linked to affective disorders, and changes in mood and anxiety syndromes are common in this context[7]. In addition, health anxiety-defined as excessive concern about illness and health—has emerged as an important issue during and after the remote learning transition.

Recent studies have shown that screen exposure, sleep quality, physical activity, and psychological well-being are closely related in student populations. In online university students, higher levels of physical activity have been associated with fewer sleep problems, lower screen time, and better mental health indicators[9]. Similarly, among undergraduate healthcare students, physical activity, recreational screen time, sleep quality, and mood-related outcomes have been reported to be interrelated[10]. Recent studies in college students also suggest that physical activity may be associated with better sleep quality, while mobile phone-related behaviors may negatively affect sleep-related outcomes[11,12]. Therefore, evaluating screen exposure, sedentary behavior, circadian rhythm, sleep quality, daytime sleepiness, physical activity, and health anxiety within the same framework may provide a more comprehensive understanding of the lifestyle-related consequences of online education. Accordingly, this study aimed to examine the associations between screen exposure, sedentary behavior, circadian rhythm, sleep quality, daytime sleepiness, physical activity, and health anxiety among university students during the online education period.

Materials and Methods

Study Design

The participants of this study were university students enrolled in various faculties of the University of Health Sciences. The required sample size was determined using G*Power version 3.1 before data collection. Since the primary aim of the study was to examine the relationships among the study variables, the calculation was based on a two-tailed bivariate correlation analysis. The expected correlation coefficient was set at $\rho = 0.243$ based on a similar previously published study conducted among university students, which reported weak correlations between sleep quality and physical activity- and stress-related variables[13]. With $\alpha = 0.05$, $\rho H0 = 0$, $\rho H1 = 0.243$, and a statistical power of 80%, the minimum required sample size was calculated as 130 participants.

No stratification method based on gender, age, academic department, or year of study was used during participant recruitment. Participants were recruited according to the predefined inclusion and exclusion criteria.

Inclusion criteria:

- Age 18–25 years
- Body mass index 18.5–29.5 kg/m²
- Non-smokers, non-alcohol users

Exclusion criteria:

- Chronic illness or orthopedic problems
- Antibiotic use within the past 8 weeks
- Vitamin, mineral, probiotic, steroid, or gastrointestinal medication within the past 4 weeks
- Surgical operation in the past year
- Hormone therapy
- Psychiatric or psychological treatment history

The BMI range of 18.5–29.5 kg/m² was selected to exclude individuals with underweight or obesity, as extreme BMI values may independently affect sleep quality, circadian rhythm, physical activity level, and anxiety-related outcomes. This criterion was used to reduce potential confounding effects related to body weight status.

Data Collection Tools

Prior to the commencement of the study, participants' socio-demographic information, including age, height, and weight, was collected. In addition, participants were asked about their sleep onset latency, wake-up times, nighttime light exposure, and screen time.

Morningness–Eveningness Questionnaire: The questionnaire serves to classify individuals as morning or evening types based on their circadian rhythm characteristics. The questionnaire form consists of a total of 19 Likert-type questions, and the answers are given in four options. Typing is determined by summing the scores obtained after the application of the questionnaire. Individuals scoring between 70 and 86 points are classified as definite morning types, whereas those obtaining scores between 16 and 30 are identified as definite evening types. The Turkish adaptation, along with validity and reliability analyses of the questionnaire, was previously performed[14,15].

Pittsburgh Sleep Quality Index (PSQI): The scale, originally developed by Buysse et al., assesses sleep quality and related disturbances over the preceding month. The PSQI consists of seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each domain is rated on a scale from 0 to 3, and their sum yields the overall score. A total score above five reflects poor sleep quality, whereas a score of five or lower suggests good sleep quality[16]. The Turkish version of the scale was previously validated[17].

Epworth Sleepiness Scale (ESS): Johns designed this self-report scale to assess daytime sleepiness by evaluating an individual's likelihood of dozing off in different daily contexts and at specific times. The scale contains eight questions answered by the individual. The overall score varies from 0 to 24, where higher scores reflect a greater tendency toward daytime sleepiness[18]. The Turkish adaptation has been conducted[19].

Although both the PSQI and ESS are sleep-related instruments, they assess different dimensions of sleep. The PSQI evaluates sleep quality and sleep-related disturbances over the previous month, whereas the ESS assesses the tendency for daytime sleepiness in daily situations. Therefore, both scales were used together to provide a more comprehensive assessment of sleep-related outcomes.

International Physical Activity Questionnaire (IPAQ): This questionnaire was designed to assess physical activity levels among individuals aged 15 to 65. It offers reliable and comparable data by evaluating daily activity patterns reported by participants. The tool records time spent on walking, moderate- and vigorous-intensity activities, as well as sedentary behavior[20]. The Turkish version has been previously validated and tested for reliability[21].

Health Anxiety Inventory – Short Form: "Salkovskis et al. developed this scale to evaluate health anxiety levels. It comprises 18 self-reported items: 14 use a four-point Likert-type format assessing participants' psychological state, while the other four require individuals to imagine their emotional responses in the case of having a serious illness. Each item is scored between 0 and 3, and higher total scores correspond to greater health anxiety[22]. The Turkish validity and reliability study has been conducted[23].

Ethical Considerations

Approval for the research was granted by the Ethics Committee of Hamidiye Scientific Research at the University of Health Sciences (22.04.2022; Decision No: 12/8).

Statistical Analysis

The evaluation of the research data was carried out using the SPSS statistical package program (IBM Statistics, 22.0, Chicago, IL, USA). To evaluate the normality of the dataset, the Shapiro–Wilk test was performed. Correlations between measurements obtained from individuals were evaluated using parametric (Pearson) or non-parametric (Spearman) correlation analyses depending on whether the data distribution was normal or not. In addition to correlation analyses, logistic regression analysis was performed to identify factors associated with excessive daytime sleepiness. Participants were categorized according to ESS scores as having normal daytime sleepiness (ESS < 10) or excessive daytime sleepiness (ESS ≥ 10)[24]. Variables that were statistically significant or marginally significant in univariate logistic regression analyses were included in the multivariate logistic regression model using the Enter method. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

Results

A total of 130 healthy university students were evaluated. The demographic characteristics of the participants, sleep onset latencies, wake-up times, nighttime light exposure, average sleep durations, average time spent at the computer, and average time spent on the phone are shown in Tables 1 and 2.

Table 1. Distribution of participants by gender and dominant hand

Variable	n	%
Gender		
Female	101	77.7
Male	29	22.3
Dominant Hand		
Right	115	88.5
Left	15	11.5

n = number of participants, % = percentage

Table 2. Demographic Characteristics, Sleep Parameters, and Screen Time of Participants

Variables	N	Min.	Max.	Mean ± SD
Age (years)	130	18	25	21.29 ± 1.647
Height (cm)	130	147	194	167.68 ± 8.771
Weight (kg)	130	40	119	63.72 ± 14.434
Sleep Onset Latency (min)	130	5	240	29.68 ± 34.737
Wake-up Latency (min)	130	0	90	13.85 ± 13.778
Nighttime Light Exposure (min)	130	0	540	58.85 ± 98.260
Average Sleep Duration (hours)	130	4	10	7.64 ± 1.299
Average Time Spent at Computer (hours)	130	0	10	3.21 ± 2.654
Average Time Spent on Phone (hours)	130	0	12	4.62 ± 2.544

N = number of participants, Min. = Minimum, Max. = Maximum, SD = Standard Deviation

The scores obtained from the Morningness–Eveningness Questionnaire, PSQI, ESS, IPAQ, and Health Anxiety Inventory used in the study are presented in Table 3.

Table 3. Scores Obtained from the Morningness–Eveningness Questionnaire, PSQI, ESS, IPAQ, and Health Anxiety Scale

Variable	N	Min.	Max.	Mean ± SD
Morningness–Eveningness Questionnaire	130	22	72	47.83 ± 9.146
Pittsburgh Sleep Quality Index (PSQI)	130	11	25	15.80 ± 2.666
Epworth Sleepiness Scale (ESS)	130	0	20	7.15 ± 4.713
International Physical Activity Questionnaire (IPAQ)	130	0	26625	1799.34 ± 3206.827
Health Anxiety Scale	130	3	53	18.25 ± 7.630

n = number of participants, Min. = Minimum, Max. = Maximum, SD = Standard Deviation

In order to determine whether there is a linear relationship between the variables and, if so, its direction and strength, Spearman correlation analysis was performed (Table 4). A weak positive correlation was found between wake-up time and sleep onset latency, between time spent on the phone and average sleep duration, between PSQI and sleep

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onset latency, wake-up time and average sleep duration, between ESS and time spent on the phone, and between Health Anxiety Inventory scores and PSQI and ESS. A weak negative correlation was found between time spent on the phone and average computer time, between circadian rhythm and average sleep duration and time spent on the phone, between PSQI and circadian rhythm, and between ESS and circadian rhythm. A moderate positive correlation was found between ESS and PSQI scores.

Table 4. Correlational relationships among research variables

Variables		Sleep Onset Latency (min)	Wake-up Latency (min)	Nighttime Light Exposure (min)	Average Sleep Duration (h)	Avg. Time at Computer (h)	Avg. Time on Phone (h)	Morningness–Eveningness Score	PSQI Total Score	ESS Total Score	IPAQ Total Score	Health Anxiety Scale Score
Sleep Onset Latency (min)	r	1.000										
	p	.										
Wake-up Latency (min)	r	.337**	1.000									
	p	**.000**	.									
Nighttime Light Exposure (min)	r	-.010	.164	1.000								
	p	.912	.063	.								
Average Sleep Duration (h)	r	-.003	.023	-.112	1.000							
	p	.976	.799	.205	.							
Avg. Time at Computer (h)	r	.000	.021	.023	-.024	1.000						
	p	.997	.817	.795	.787	.						
Avg. Time on Phone (h)	r	.157	.082	-.072	.276**	-.184*	1.000					
	p	.074	.354	.414	**.001**	**.036**	.					
Morningness –Eveningness Score	r	-.143	-.299**	.011	-.322**	.144	-.246**	1.000				
	p	.105	**.001**	.897	**.000**	.103	**.005**	.				
PSQI Total Score	r	.310**	.213*	.026	.392**	.034	.110	-.393**	1.000			
	p	**.000**	**.015**	.772	**.000**	.702	.212	**.000**	.			
ESS Total Score	r	-.029	.102	.082	.135	-.149	.247**	-.208*	.412**	1.000		
	p	.745	.248	.352	.126	.092	**.005**	**.017**	**.000**	.		
IPAQ Total Score	r	.004	.058	.026	-.111	.017	.082	.002	-.111	-.007	1.000	
	p	.968	.517	.772	.209	.848	.357	.984	.212	.933	.	
Health Anxiety Scale Score	r	-.002	.141	-.091	.076	.067	.052	-.152	.318**	.371**	-.083	1.000
	p	.985	.111	.302	.389	.446	.557	.084	**.000**	**.000**	.347	.

Pearson Correlation Analysis **p < 0.01** (**); **p < 0.05** (*); min = minutes, h = hours, PSQI = Pittsburgh Sleep Quality Index, ESS = Epworth Sleepiness Scale, IPAQ = International Physical Activity Questionnaire

In the univariate logistic regression analyses, PSQI total score, health anxiety score, and average sleep duration were significantly associated with excessive daytime sleepiness, while average time spent on the phone and Morningness–Eveningness Questionnaire score showed marginal associations. Average time spent at the computer, IPAQ total score, and nighttime light exposure were not significantly associated with excessive daytime sleepiness.

In the multivariate logistic regression model, PSQI total score, health anxiety score, average time spent on the phone, and Morningness–Eveningness Questionnaire score were included as independent variables. The overall model was statistically significant (χ^2=33.872, df=4, p<0.001) and showed acceptable goodness of fit according to the Hosmer–Lemeshow test (χ^2=9.174, df=8, p=0.328). The model explained 32.2% of the variance in excessive daytime sleepiness according to Nagelkerke R^2. PSQI total score (OR=1.297, 95% CI:1.065–1.579, p=0.010) and health anxiety score (OR=1.118, 95% CI:1.043–1.199, p=0.002) were independently associated with excessive daytime sleepiness. Average time spent on the phone and Morningness–Eveningness Questionnaire score were not significant independent predictors in the multivariate model.

Table 5. Multivariate logistic regression analysis of factors associated with excessive daytime sleepiness

Variables	**B**	**SE**	**Wald**	**p**	**OR**	**95% CI for OR**
PSQI total score	0.260	0.100	6.713	0.010	1.297	1.065–1.579
Health Anxiety Scale total score	0.112	0.035	9.997	0.002	1.118	1.043–1.199
Average time spent on phone (h)	0.127	0.086	2.160	0.142	1.135	0.959–1.344
Morningness–Eveningness Questionnaire score	-0.007	0.027	0.073	0.787	0.993	0.941–1.047

Model statistics: χ^2 = 33.872, df = 4, p < 0.001; Hosmer–Lemeshow χ^2 = 9.174, df = 8, p = 0.328; Nagelkerke R^2 = 0.322.

Note: Excessive daytime sleepiness was defined as ESS ≥ 10. Variables were entered into the model using the Enter method. SE = Standard Error; OR = Odds Ratio; CI = Confidence Interval; PSQI = Pittsburgh Sleep Quality Index; ESS = Epworth Sleepiness Scale.

Discussion

This study evaluated the associations between lifestyle changes during the remote learning period and circadian rhythm, sleep patterns, physical activity, and health anxiety among university students. Data were collected during the early normalization period in Turkey, when online education was still ongoing. Thus, the findings reflect a transitional stage in which students were adapting to new routines while adjusting to changes brought by the shift to online education.

One of the most important findings was the increase in students' screen exposure. Extended use of digital devices has been linked in previous studies to disrupted sleep patterns and delayed circadian rhythms[25]. In our sample, sleep quality was below the ideal level, consistent with meta-analyses showing significant declines in sleep quality during the remote learning period[26,27]. Although our Epworth Sleepiness Scale (ESS) results indicated relatively good daytime functioning, poor sleep quality was still observed, highlighting the discrepancy often reported between subjective sleep quality and daytime sleepiness[28].

Circadian rhythm disturbances have been widely reported during the remote learning period, particularly in the form of delayed sleep phase and eveningness tendencies[25]. In our study, however, Morningness–Eveningness Questionnaire scores were within the medium range, suggesting no radical shift in chronotype. This may reflect the role of structured class schedules, which helped students maintain regular wake–sleep timing. Awareness of healthy lifestyle habits may also have mitigated a shift toward eveningness.

Interestingly, physical activity levels in our study were generally above average. Similar findings were reported by Blanco et al., who observed that sedentary behaviors increased during the remote learning period but that physical activity levels also rose, possibly due to individuals' greater awareness of health risks and their deliberate efforts to remain active[29]. On the other hand, other studies documented decreases in physical activity among students[30]. These conflicting results may be explained by differences in socioeconomic status, living conditions, or regional restrictions. Our findings suggest that at least some students successfully adapted their routines by incorporating physical activity despite increased sedentary behaviors.

Health anxiety levels were within normal limits in our sample. This contrasts with population-based studies reporting elevated anxiety during the early transition to online education, with rates rising as high as 50.9%[8]. A possible explanation is that our participants were students from health-related fields. Greater knowledge about disease processes and coping strategies may have reduced anxiety levels, buffering against stressors related to lifestyle changes.

In the multivariate logistic regression analysis, poorer sleep quality and higher health anxiety scores were independently associated with excessive daytime sleepiness. This finding supports the close relationship between subjective sleep quality, daytime functioning, and psychological factors in university students.

Limitations: This study has several limitations. First, the data were collected during the early normalization period following the transition to online education, when restrictions had eased but online education was still ongoing. Therefore, the results may not fully reflect conditions during the strict lockdown period. Second, the cross-sectional design does not allow causal inferences. Third, variables such as stress level, diet, medication use, or psychiatric history, which could influence sleep and anxiety, were not controlled. Fourth, reliance on self-report questionnaires introduces the risk of subjective bias. Finally, the unequal gender distribution of the sample, with a higher proportion of female participants, may limit the generalizability of the findings to the broader university student population and should be considered when interpreting the results. Future studies with larger and more gender-balanced samples are recommended.

Conclusion

Despite these limitations, the study contributes to the growing body of evidence on how lifestyle changes associated with online education and increased screen exposure may influence sleep, circadian rhythm, physical activity, and health anxiety in university students. Although most associations were weak, the findings suggest complex interactions between behavioral, psychological, and physiological factors. Future longitudinal and multi-center studies are needed to clarify causal pathways and long-term consequences.

Ethics Committee Approval: This research complies with all relevant national regulations, institutional policies, and the principles of the Helsinki Declaration, and was approved by the Ethics Committee of Hamidiye Scientific Research, University of Health Sciences (Date: 22.04.2022; Decision No: 12-8).

Informed Consent: The rights of all participants were protected, and written informed consent was obtained prior to procedures, in accordance with the Helsinki Declaration.

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