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Original Article

Relationship between obesity, digital game addiction, and sleep quality in secondary school students: a cross-sectional study

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ABSTRACT

Objective. The aim of this study was to determine the prevalence of obesity and to examine the associations between digital game addiction, sleep quality, and body mass index (BMI) among secondary school students.

Materials and Methods. This cross-sectional study included 902 students in grades 6–8 in Konya, a central province of Türkiye. Data were collected using a sociodemographic questionnaire, the Digital Game Addiction Scale (DGAS), and the Pittsburgh Sleep Quality Index (PSQI). Anthropometric measurements were performed, and BMI percentiles were calculated according to national reference charts.

Results. The prevalence rates of overweight and obesity were 13.2% and 3.8%, respectively. High-risk digital game addiction patterns (risky, addicted, or highly addicted) were identified in 50.8% of the cohort, and 72.2% of participants were classified as having poor sleep quality (PSQI > 5). No statistically significant associations were observed between BMI measures and either DGAS or PSQI scores ($p > 0.05$). In multivariable linear regression analysis, higher DGAS scores were significantly associated with poorer sleep quality (higher PSQI scores) (B = 0.049, 95% confidence interval: 0.037–0.062, $p < 0.001$; adjusted $R^2 = 0.138$).

Conclusion. Digital game addiction was not directly associated with weight status in this adolescent population, but it was significantly associated with poorer sleep quality. These findings highlight the potential role of problematic gaming behaviors in adolescent sleep health. Targeted school-based interventions addressing digital gaming behaviors may help improve sleep outcomes in early adolescence.

Key words: digital game addiction, sleep quality, obesity, adolescent, secondary school.

Obesity, defined by the World Health Organization as abnormal or excessive fat accumulation that presents a risk to health, has become a major public health concern worldwide and is commonly assessed using body mass index (BMI), calculated as weight in kilograms divided by height in meters squared (kg/m^2). The prevalence of obesity has risen markedly in recent decades, particularly among children and adolescents.[1] In Türkiye, recent studies have reported high rates of overweight and obesity among school-aged populations, indicating that childhood obesity represents a significant and growing national health concern.[2,3] Global projections for 2020–2035 suggest that this trend will continue, with obesity expected to reach 20% in boys and 18% in girls.[4]

A key contributor to the rising prevalence of childhood obesity is the shift toward sedentary lifestyles, largely driven by increased reliance

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on digital technologies. Digital gaming has become a ubiquitous activity across all age groups and may displace physical activity while contributing to prolonged sedentary behavior among adolescents.[5] Although digital gaming has become a widespread form of entertainment among young people, excessive or uncontrolled use may lead to negative behavioral and functional outcomes, including impaired social and physical functioning and problematic use or addiction.[6] According to the results of a comprehensive meta-analysis, the prevalence of digital game addiction in the general population is 6.04%.[7] However, recent studies have reported high rates of problematic digital gaming behaviors among adolescents, reaching 41.5% in a study by Ayaz-Alkaya et al. published in 2025.[8]

Sleep is a fundamental physiological process essential for metabolic, cognitive, and psychological health. In adolescents, insufficient or poor-quality sleep has been associated with metabolic disturbances, impaired cognitive performance, and behavioral problems.[9] Excessive screen exposure may negatively affect sleep through both behavioral and biological mechanisms, including delayed sleep onset, increased cognitive arousal, and suppression of melatonin secretion due to blue light exposure, thereby disrupting circadian rhythms. Collectively, these mechanisms highlight the potential adverse effects of screen exposure on sleep duration, quality, and circadian regulation in adolescents.[10,11]

Adolescence represents a critical developmental period during which patterns of digital media use, sleep, and health-related behaviors are established.[12] Although previous studies have examined the relationships between digital gaming, sleep, and obesity, these factors have often been investigated separately, and evidence assessing all three variables concurrently, particularly in adolescent populations, appears to be limited. In this context, by evaluating these interrelated factors simultaneously in a Turkish adolescent population and incorporating multiple lifestyle-related variables, this study adopts a more comprehensive behavioral health perspective.

Therefore, this study aimed to examine the interrelationships between obesity, digital game addiction, and sleep quality among secondary school students.

Materials and Methods

Study design and ethical approval

This descriptive cross-sectional study was conducted between February and May 2023 among secondary school students in the central districts of Konya, Türkiye. The study adhered to the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Non-Pharmaceutical and Non-Medical Device Research Ethics Committee of KTO Karatay University Faculty of Medicine (Date: December 29, 2022, Decision No: 2022-001). Participation was strictly voluntary. Written informed consent was obtained from parents or legal guardians, and verbal/written assent was obtained from all participating students prior to data collection.

Sample size and sampling method

The study was conducted in six secondary schools located in the central districts of Konya (across three districts), with two schools selected from each district by the Konya Provincial Directorate of National Education. Analyses were conducted at the individual level.

The minimum sample size was calculated using OpenEpi v3.01 based on a study population of 101,500 students, assuming a hypothesized frequency of 50% to yield the maximum required sample size, a 5% margin of error, a 99% confidence level, and a design effect of 1. This resulted in a minimum required sample size of 660 participants. To account for potential data loss due to incomplete or erroneous responses, 1,000 participants were initially recruited. After excluding 98 questionnaires due to missing data or lack of parental consent, the final analysis included 902 participants. The inclusion criteria were: (i) attendance at school on the day of data collection, (ii) absence of known mental or physical disabilities, and (iii) sufficient literacy to complete the questionnaire independently.

Anthropometric measurements and BMI

Participants' body weight and height were measured according to standard anthropometric procedures. Weight was measured to the nearest 100 g using a calibrated portable digital scale, with participants wearing light indoor clothing and no shoes. Height was measured to the nearest 0.1 cm using a portable stadiometer while participants stood upright. BMI was calculated as weight divided by height squared (kg/m^2). BMI percentiles were determined according to age- and sex-specific national growth charts for Turkish children and adolescents.[13] Underweight was defined as the <5th percentile, normal weight as the 5th–85th percentile, overweight as the 85th–95th percentile, and obesity as ≥95th percentile. For the logistic regression analysis, participants were categorized as being below the 85th percentile or at or above the 85th percentile.

Data collection tools

Sociodemographic and lifestyle questionnaire

A structured questionnaire was used to collect sociodemographic and lifestyle data. Age, sex, parental education level, and socioeconomic status were assessed using predefined multiple-choice questions. Parental height and weight were reported by students based on information obtained from their parents. Parental BMI was calculated as weight (kg)/height squared (m^2). Parents were classified according to the World Health Organization adult BMI criteria as underweight/normal weight (BMI <25 kg/m^2) and overweight/obese (BMI ≥25 kg/m^2).[14]

Lifestyle-related variables included digital device ownership (smartphone, tablet, and computer), daily screen time, daily digital game time, weekly physical activity, dietary habits (breakfast frequency, consumption of three main meals per day, fast food consumption, and snacking behaviors, including snacking between meals, while playing digital games, and in front of a TV/computer), and sleep characteristics (sleep duration and sleep problems). These variables were assessed using structured multiple-choice or yes/no questions, as appropriate.

Digital Game Addiction Scale for Children

This 24-item scale, developed by Hazar et al. (2017) and validated for the Turkish population, assesses four subdimensions: (i) excessive focus on and conflict related to digital gaming, (ii) tolerance development during gameplay and the value attributed to gaming, (iii) postponement of individual and social duties/responsibilities, and (iv) psychological and physiological withdrawal symptoms and immersion in gaming. Each item is rated on a 5-point Likert scale, with total scores ranging from 24 to 120. Scores were categorized according to the original validation study as follows: Normal (1–24), low risk (25–48), risky (49–72), addicted (73–96), and highly addicted (97–120). DGAS scores were analyzed as continuous variables in regression analyses, while categorical classifications were used only for descriptive purposes. In the original validation study, Cronbach's alpha was 0.90.[15] In the present study, internal consistency was also high (Cronbach's alpha = 0.91)

Pittsburgh Sleep Quality Index

Sleep quality was assessed using the PSQI, developed by Buysse et al.[16] (1989) and validated for Turkish populations by Ağargün et al.[17] (1996). Although originally developed for adults, the PSQI has been widely used and validated in adolescent populations.[18] The PSQI evaluates sleep quality over the past month and includes seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is scored from 0 to 3, with total scores ranging from 0 to 21. A global score >5 indicates poor sleep quality. The internal consistency of the PSQI in this study was acceptable (Cronbach's alpha = 0.70).

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0. Data distributions were assessed using Kolmogorov–Smirnov and Shapiro–Wilk tests. Normally distributed variables were expressed as the mean ± standard deviation, while non-normally distributed variables were presented as the median and interquartile range (IQR, 25th–75th percentiles). Categorical variables were compared using the chi-square test. For continuous variables, the Mann–Whitney U test was used for two-group comparisons. Multivariable logistic regression analysis was performed to identify factors associated with being in the higher BMI group (≥85th percentile). Multivariable linear regression analysis was conducted to examine factors associated with the PSQI score. Variables identified from the literature as clinically relevant to obesity and sleep quality, as well as variables showing significance in univariate analyses, were considered for inclusion in the multivariable models. Statistical significance was set at $p < 0.05$.

Results

Sociodemographic characteristics and weight status

The study included 902 participants (51.3% female, n = 463; 48.7% male, n = 439) aged 12–15 years (mean age: 12.86 ± 0.02 years). According to BMI percentile categories, 7.2% of the students were underweight, 75.8% were of normal weight, 13.2% were overweight, and 3.8% were obese. The mean physical activity level was 4.81 ± 0.17 hours/week. Most participants (85.8%) reported ownership of a computer, smartphone, or tablet. Daily screen time of ≥3 hours was reported by 54.5% of the students, and 36.6% reported a daily digital gaming time of ≥3 hours. While 20.2% of the participants reported subjective sleep problems, the PSQI global scores revealed that 72.2% had poor sleep quality (Table I).

Factors associated with overweight and obesity

Significant differences in BMI percentile categories were observed according to sex ($p < 0.001$), paternal BMI category ($p = 0.001$), snacking in front of a screen ($p = 0.022$), and the presence of sleep problems ($p = 0.012$). No statistically significant differences were found according to parental education level, screen time, or physical activity ($p > 0.05$) (Table II).

Digital game addiction levels

According to the categorical classification of the DGAS, 2.9% (n = 26) of participants were classified as normal, 46.2% (n = 417) as low risk, 40.1% (n = 362) as risky, 8.5% (n = 77) as addicted, and 2.2% (n = 20) as highly addicted. Overall, 50.8% of participants were classified as being at risk or above. DGAS scores differed according to sex, daily screen time of ≥3 hours, and daily digital gaming time of ≥3 hours ($p < 0.001$ for all). Scores were higher among participants who reported snacking while playing digital games, snacking in front of a screen, frequent fast-food consumption (≥2 days/week), and lower breakfast frequency (≤4 days/week) ($p < 0.05$ for all).

DGAS scores were higher among students who reported sleep problems and among those with poor sleep quality ($p < 0.001$) (Table III).

Multivariable analyses

In the multivariable logistic regression analysis, a BMI at or above the 85th percentile was associated with male sex (odds ratio [OR] = 2.296, 95% confidence interval [CI]: 1.483–3.555, $p < 0.001$), paternal overweight/obesity (OR = 2.014, 95% CI: 1.003–4.044, $p = 0.049$), and physical activity of ≥3 hours/week (OR = 0.623, 95% CI: 0.412–0.943, $p = 0.025$). No statistically

Table I. Sociodemographic, lifestyle, and sleep characteristics of participants (n = 902).

Variable	n (%) or mean ± SD
Age (years)	12.86 ± 0.02
Sex	
Female	463 (51.3)
Male	439 (48.7)
Family monthly income	
Low	44 (4.9)
Middle	465 (51.5)
High	393 (43.6)
Mother's education level	
Primary school	425 (47.1)
High school or above	477 (52.9)
Father's education level	
Primary school	317 (35.2)
High school or above	585 (64.8)
BMI percentile categories	
Underweight	65 (7.2)
Normal weight	684 (75.8)
Overweight	119 (13.2)
Obese	34 (3.8)
Physical activity (hours/week)	4.81 ± 0.17
Ownership of computer/smartphone/ tablet	
Yes	774 (85.8)
No	127 (14.2)
Daily screen time	
<3 hours	410 (45.5)
≥3 hours	492 (54.5)
Daily digital game time	
<3 hours	573 (63.4)
≥3 hours	329 (36.6)
Sleep duration	
≤8 hours	457 (50.7)
>8 hours	445 (49.3)
Sleep problems	
No	353 (39.1)
Sometimes	367 (40.7)
Often	182 (20.2)
PSQI	
Good	251 (27.8)
Poor	651 (72.2)

Data are presented as mean ± standard deviation (SD) for continuous variables and n (%) for categorical variables. BMI, body mass index; PSQI, Pittsburgh Sleep Quality Index.

significant associations were observed for age, maternal BMI category, family income, screen time, dietary variables, or digital gaming-related variables ($p > 0.05$). Daily sleep duration showed a borderline association ($p = 0.050$) (Table IV).

In the multivariable linear regression analysis, the model was statistically significant ($F = 16.981$, $p < 0.001$) and explained 13.8% of the variance in the PSQI score (adjusted $R^2 = 0.138$). PSQI score was associated with the DGAS score (B = 0.049, 95% CI: 0.037–0.062, $p < 0.001$), age ≥13 years (B = 0.448, 95% CI: 0.175–0.721, $p = 0.001$), daily screen time of ≥3 hours (B = 0.644, 95% CI: 0.213–1.074, $p = 0.003$), sex (B = −0.969, 95% CI: −1.392 to −0.546, $p < 0.001$), and breakfast frequency of >4 days/week (B = −0.923, 95% CI: −1.342 to −0.504, $p < 0.001$). No associations were found with physical activity, fast food consumption, snacking while playing digital games, or BMI (kg/m^2) ($p > 0.05$) (Table V).

Discussion

This study examined the relationships between obesity-related indicators, digital game addiction, and sleep quality among secondary school students. The findings demonstrated that digital game addiction was independently associated with poorer sleep quality, whereas no significant relationships were observed between BMI and either digital game addiction or sleep quality after adjustment for confounders. To contextualize these findings, the following discussion addresses anthropometric outcomes, digital gaming behaviors, and sleep-related indicators in turn, before considering their interrelationships.

The prevalence of overweight (13.2%) and obesity (3.8%) observed in the present study was lower than the prevalence reported in several previous studies conducted among Turkish adolescents. Studies from different regions of Türkiye have reported higher rates, including 20.3% for overweight and 13.2% for obesity in İstanbul and a combined

Table II. Sociodemographic characteristics and lifestyle habits according to BMI percentile categories.

Variable	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	p
Sex					**<0.001**
Female	34 (52.3)	378 (55.3)	46 (38.7)	5 (14.7)	
Male	31 (47.7)	306 (44.7)	73 (61.3)	29 (85.3)	
Age (years)					0.218
<13 years	19 (29.2)	237 (34.6)	40 (33.6)	17 (50.0)	
≥13 years	46 (70.8)	447 (65.4)	79 (66.4)	17 (50.0)	
Mother's education level					0.545
Primary school	53 (81.5)	524 (76.6)	91 (76.5)	29 (85.3)	
High school or above	12 (18.5)	160 (23.4)	28 (23.5)	5 (14.7)	
Father's education level					0.534
Primary school	44 (67.7)	464 (67.8)	79 (66.4)	27 (79.4)	
High school or above	21 (32.3)	220 (32.2)	40 (33.6)	7 (20.6)	
Maternal BMI category					0.125*
Underweight/Normal weight	65 (100.0)	669 (97.8)	114 (95.8)	32 (94.1)	
Overweight/Obese	0 (0.0)	15 (2.2)	5 (4.2)	2 (5.9)	
Paternal BMI category					**0.001***
Underweight/Normal weight	64 (98.5)	650 (95.0)	107 (89.9)	27 (79.4)	
Overweight/Obese	1 (1.5)	34 (5.0)	12 (10.1)	7 (20.6)	
Physical activity (hours/week)					0.106
<3 hours	29 (44.6)	373 (54.5)	65 (54.6)	24 (70.6)	
≥3 hours	36 (55.4)	311 (45.5)	54 (45.4)	10 (29.4)	
Daily screen time					0.396
<3 hours	45 (69.2)	463 (67.7)	73 (61.3)	20 (58.8)	
≥3 hours	20 (30.8)	221 (32.3)	46 (38.7)	14 (41.2)	
Daily digital game time					0.353
<3 hours	29 (44.6)	258 (37.7)	47 (37.5)	9 (26.5)	
≥3 hours	36 (55.4)	426 (62.3)	72 (60.5)	25 (73.5)	
Snacking while playing digital games					0.571
Yes	34 (52.3)	303 (44.3)	56 (47.1)	17 (50.0)	
No	31 (47.7)	381 (55.7)	63 (52.9)	17 (50.0)	
Fast food consumption (days/week)					0.709
<2 days	30 (46.2)	296 (43.3)	53 (44.5)	18 (52.9)	
≥2 days	35 (53.8)	388 (56.7)	66 (55.5)	16 (47.1)	
Breakfast frequency (days/week)					0.290
≤4 days	15 (23.1)	252 (36.8)	36 (30.3)	13 (38.2)	
>4 days	50 (76.9)	432 (63.2)	83 (69.7)	21 (61.8)	

Data are presented as n (%). $p < 0.05$ was considered statistically significant (bold).
* Fisher's Exact Test was used; all other p-values were calculated using Pearson's chi-square test.
BMI, body mass index.

Table II. Continued.

Variable	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	p
Three main meals per day (days/week)					0.201
≤4 days	27 (41.5)	371 (54.2)	60 (50.4)	20 (58.8)	
>4 days	38 (58.5)	313 (45.8)	59 (49.6)	14 (41.2)	
Snacking between meals					0.282
Yes	33 (50.8)	298 (43.6)	45 (37.8)	12 (35.3)	
No	32 (49.2)	386 (56.4)	74 (62.2)	22 (64.7)	
Snacking in front of TV/computer					**0.022**
Yes	23 (35.4)	184 (26.9)	23 (19.3)	4 (11.8)	
No	42 (64.6)	500 (73.1)	96 (80.7)	30 (88.2)	
Sleep problems					**0.012**
Yes	23 (35.4)	126 (18.4)	25 (21.0)	8 (23.5)	
No	42 (64.6)	558 (81.6)	94 (79.0)	26 (76.5)	
Daily sleep duration					0.109
≤8 hours	29 (44.6)	338 (49.4)	68 (57.1)	22 (64.7)	
>8 hours	36 (55.4)	346 (50.6)	51 (42.9)	12 (35.3)	

Data are presented as n (%). $p < 0.05$ was considered statistically significant (bold).
* Fisher's Exact Test was used; all other p-values were calculated using Pearson's chi-square test.
BMI, body mass index.

prevalence of 22.7% in Şanlıurfa.[2,3] These differences may be attributed to regional and demographic variations as well as differences in socioeconomic status, dietary habits, physical activity levels, and study populations. Within the present sample, further evaluation of factors associated with anthropometric outcomes revealed that paternal overweight or obesity was associated with higher odds of increased BMI in adolescents. This finding is consistent with previous studies that identified parental weight status as an important determinant of childhood obesity, likely reflecting shared genetic, environmental, and lifestyle factors within families. In contrast, some studies have emphasized maternal influences more strongly, suggesting that parental effects may vary across populations and cultural contexts.[19-21] Beyond familial factors, higher levels of physical activity were associated with lower odds of increased BMI in the multivariable analysis. Previous studies have generally reported an inverse relationship between physical activity and obesity-related indicators in children and adolescents; however findings differ across studies.[22,23] Considering the decline in physical activity during adolescence and the more pronounced changes in adiposity during this period, maintaining regular physical activity is particularly important for weight control in this age group.[24] Taken together, these findings suggest that both familial and lifestyle-related factors may be associated with anthropometric outcomes in this population.

Regarding digital gaming behaviors, the prevalence of problematic gaming observed in the present study indicates a substantial burden among adolescents. Previous studies from Germany (11.9%) and Taiwan (15.1%) have also reported notable levels of problematic gaming; however, direct comparisons are limited due to differences in assessment tools, definitions, and cutoff values across studies.[25,26] Notably, no significant association was observed between digital game addiction and BMI in univariate analyses, consistent with previous large-scale studies by Busch and Cameron.[27,28] However,

Table III. Comparison of sociodemographic and lifestyle characteristics according to digital game addiction scale scores.

Variables	Total score	DGAS subdimensions			
		Excessive focus & conflict	Tolerance / value attribution	Role postponement	Withdrawal / immersion
Age (years)					
<13 years	51 (40–62)	13 (11–18)	17 (14–21)	11 (8–14)	8 (6–10)
≥13 years	48 (37–59)	13 (9–17)	17 (13–21)	10 (7–14)	7 (6–9)
p*	0.026	0.009	0.265	0.063	0.090
Sex					
Female	44 (34–55)	12 (9–15)	15 (11–19)	9 (7–12)	7 (5–9)
Male	53 (42–66)	14 (11–19)	19 (15–23)	11 (8–15)	8 (6–10)
p*	<0.001	<0.001	<0.001	<0.001	<0.001
BMI percentile categories					
Underweight/Normal weight	49 (38–60)	13 (10–17)	17 (13–22)	10 (7–14)	7 (6–9)
Overweight/Obese	48 (40–61)	13 (10–17)	17 (13–21)	11 (8–14)	8 (6–10)
p*	0.840	0.758	0.641	0.322	0.318
Daily screen time					
<3 hours	45 (36–55)	12 (9–16)	16 (12–20)	9 (7–12)	7 (5–9)
≥3 hours	56 (46–72)	15 (12–21)	20 (16–25)	12 (9–17)	9 (7–11)
p*	<0.001	<0.001	<0.001	<0.001	<0.001
Daily digital game time					
<3 hours	46 (36–55)	12 (9–16)	16 (12–20)	10 (7–13)	7 (5–9)
≥3 hours	64 (49–76)	17 (13–22)	22 (17–27)	14 (10–17)	9 (8–11)
p*	<0.001	<0.001	<0.001	<0.001	<0.001
Snacking while playing digital games					
Yes	53 (42–70)	14 (11–20)	19 (15–24)	11 (8–15)	8 (6–10)
No	47 (37–58)	12 (9–16)	16 (12–21)	10 (7–13)	7 (6–9)
p*	<0.001	<0.001	<0.001	<0.001	<0.001
Fast food consumption (days/ week)					
<2 days	47 (36–57)	12 (9–16)	16 (12–20)	10 (7–13)	7 (5–9)
≥2 days	50 (39–63)	13 (10–18)	18 (14–22)	11 (8–14)	8 (6–10)
p*	<0.001	0.005	<0.001	0.007	0.014
Breakfast frequency (days/week)					
≤4 days	52 (40–64)	14 (10–18)	17 (14–21)	11 (8–15)	8 (6–10)
>4 days	48 (38–59)	13 (9–17)	17 (13–21)	10 (7–14)	7 (6–9)
p*	0.009	0.009	0.651	0.001	0.008

Data are presented as median (25th–75th percentile). Group comparisons were performed using the Mann–Whitney U test. $p < 0.05$ was considered statistically significant. The DGAS consists of four subdimensions: (i) excessive focus on and conflict related to digital gaming, (ii) tolerance development during gameplay and value attributed to gaming, (iii) postponement of individual and social duties/responsibilities, and (iv) psychological and physiological withdrawal symptoms and immersion in gaming.
BMI, body mass index; DGAS, Digital Game Addiction Scale; PSQI, Pittsburgh Sleep Quality Index.

Table III. Continued.

Variables	Total score	DGAS subdimensions			
		Excessive focus & conflict	Tolerance / value attribution	Role postponement	Withdrawal / immersion
Three main meals per day (days/week)					
≤4 days	50 (39–63)	13 (10–18)	17 (13–22)	11 (8–14)	8 (6–10)
>4 days	48 (38–59)	13 (9–17)	17 (13–21)	10 (7–14)	7 (6–9)
p*	0.040	0.107	0.502	0.008	0.031
Snacking between meals					
Yes	52 (39–65)	14 (10–18)	18 (14–23)	11 (8–14)	8 (6–10)
No	47 (37–58)	12 (9–16)	17 (13–20)	10 (7–13)	7 (6–9)
p*	0.001	<0.001	0.001	0.013	0.096
Snacking in front of TV/ computer					
Yes	55 (45–70)	15 (12–21)	20 (16–26)	11 (9–16)	8 (6–11)
No	46 (36–56)	12 (9–16)	16 (12–20)	10 (7–13)	7 (5–9)
p*	<0.001	<0.001	<0.001	<0.001	<0.001
Sleep problem					
Yes	54 (42–71)	15 (11–21)	19 (15–25)	12 (8–15)	8 (6–11)
No	48 (37–58)	13 (9–16)	17 (13–21)	10 (7–14)	7 (6–9)
p*	<0.001	<0.001	<0.001	<0.001	0.001
Sleep quality (PSQI)					
Good	44 (34–55)	12 (9–14)	16 (12–20)	9 (7–12)	7 (5–9)
Poor	51 (40–64)	13 (10–18)	18 (14–22)	11 (8–14)	8 (6–10)
p*	<0.001	<0.001	<0.001	<0.001	<0.001

Data are presented as median (25th–75th percentile). Group comparisons were performed using the Mann–Whitney U test. $p < 0.05$ was considered statistically significant. The DGAS consists of four subdimensions: (i) excessive focus on and conflict related to digital gaming, (ii) tolerance development during gameplay and value attributed to gaming, (iii) postponement of individual and social duties/responsibilities, and (iv) psychological and physiological withdrawal symptoms and immersion in gaming.
BMI, body mass index; DGAS, Digital Game Addiction Scale; PSQI, Pittsburgh Sleep Quality Index.

higher digital game addiction scores were associated with certain unhealthy dietary behaviors, including snacking during gaming or screen use, frequent fast-food consumption, and lower breakfast frequency, similar to findings reported by Aşut et al.[29]

Sleep-related outcomes represented another key domain examined in this study. The prevalence of poor sleep quality (72.2%) was higher than the rates reported in previous Turkish adolescent studies (53.0% and 65.7%).[30,31] This difference may be related to behavioral factors such as increased screen exposure and gaming habits, as well as physiological mechanisms including the suppression of melatonin secretion due to blue light exposure.[32] In the multivariable analysis, higher digital game addiction scores and longer daily screen time were associated with poorer sleep quality, consistent with previous findings linking digital media use to sleep disturbances in adolescents.[10,33]

Several additional factors may also have contributed to the relatively high prevalence of poor sleep quality observed in the present study.

Table IV. Factors associated with overweight / obesity: multivariable logistic regression analysis.

Variable	β	SE	Wald	p	OR (95% CI)
Sex (male vs female (ref.))	0.831	0.223	13.884	<0.001	2.296 (1.483–3.555)
Age (≥13 vs <13 years (ref.))	-0.097	0.140	0.477	0.490	0.908 (0.690–1.195)
Family monthly income (low vs high (ref.))	-0.064	0.208	0.093	0.760	0.938 (0.624–1.412)
Paternal BMI category (overweight/obese vs normal (ref.))	0.700	0.356	3.873	0.049	2.014 (1.003–4.044)
Maternal BMI category (overweight/obese vs normal (ref.))	-0.126	0.650	0.038	0.846	0.881 (0.246–3.152)
Physical activity (≥3 vs <3 hours/week (ref.))	-0.473	0.211	5.010	0.025	0.623 (0.412–0.943)
Sleep duration (≤8 vs >8 hours (ref.))	-0.405	0.207	3.826	0.050	0.667 (0.445–1.001)
Daily screen time (≥3 vs <3 hours (ref.))	0.226	0.223	1.029	0.310	1.253 (0.810–1.938)
Daily digital game time (≥3 vs <3 hours (ref.))	0.000	0.006	0.001	0.970	1.000 (0.987–1.012)
Fast food consumption (≥2 vs <2 days/week (ref.))	-0.005	0.211	0.001	0.980	0.995 (0.658–1.503)
Snacking between meals (yes vs no (ref.))	0.110	0.225	0.238	0.626	1.116 (0.718–1.735)
Snacking while playing digital games (yes vs no (ref.))	0.247	0.263	0.886	0.347	1.281 (0.765–2.143)

Reference categories are indicated in parentheses. $p < 0.05$ was considered statistically significant.
β, regression coefficient; BMI, body mass index; CI, confidence interval; OR, odds ratio; SE, standard error; Wald, Wald statistic.

Table V. Multivariable linear regression analysis of factors associated with PSQI score.

Variable	B	SE	β	t	p-value	95% CI
DGAS total score	0.049	0.006	0.265	7.648	<0.001	0.037–0.062
Age (≥13 vs <13 years (ref.))	0.448	0.139	0.102	3.215	0.001	0.175–0.721
Sex (male vs female (ref.))	-0.969	0.216	-0.148	-4.493	<0.001	-1.392– -0.546
Daily screen time (≥3 vs <3 hours (ref.))	0.644	0.219	0.098	2.936	0.003	0.213–1.074
Breakfast frequency (>4 vs ≤4 days (ref.))	-0.923	0.213	-0.135	-4.325	<0.001	-1.342– -0.504
Physical activity (<3 vs ≥3 hours/week (ref.))	-0.091	0.208	-0.014	-0.437	0.662	-0.498–0.317
Fast food consumption (≥2 vs <2 days (ref.))	0.153	0.208	0.023	0.733	0.463	-0.256–0.562
Snacking while playing digital games (yes vs no (ref.))	-0.207	0.238	-0.028	-0.870	0.385	-0.674–0.260
BMI (kg/m^2)	0.001	0.002	0.023	0.752	0.452	-0.002–0.004

Reference categories are indicated in parentheses. $p < 0.05$ was considered statistically significant (bold).
B, unstandardized coefficient; β, standardized coefficient; BMI, body mass index; CI, confidence interval; DGAS, Digital Game Addiction Scale; SE, standard error; t, t-statistic.

Self-reported sleep measures may not fully capture objective sleep parameters that can be assessed by actigraphy or polysomnography.[34] From a developmental perspective, this age group is characterized by a biologically driven circadian phase delay, in which sleep onset shifts later and may conflict with early school start times, potentially contributing to reduced sleep duration.[35,36] Pubertal hormonal changes may further amplify these sleep disturbances during this developmental period.[35] Finally, differences in the socioeconomic and lifestyle characteristics of the study population may have played a role in the observed findings.

A further consideration is the discrepancy between subjective sleep complaints and PSQI-defined poor sleep quality. This may reflect differences between the global self-perception of sleep and the multidimensional structure of the PSQI, which assesses domains such as sleep latency, duration, and daytime dysfunction. Adolescents may underreport sleep problems in general assessments, whereas structured instruments such as the PSQI may capture broader sleep-related difficulties. Therefore, these findings should be interpreted within this methodological context.[18]

With respect to the relationship between anthropometric and sleep-related outcomes, BMI was not significantly associated with the PSQI score in the multivariable model used in this study. This finding is consistent with some adolescent studies but contrasts with others, suggesting that behavioral and developmental factors such as physical activity, dietary habits, and circadian changes may play a more prominent role than BMI during early adolescence.[37-39] Supporting this interpretation, several lifestyle factors identified in this study, including lower breakfast frequency, irregular meal patterns, increased snacking, and prolonged screen exposure, were associated with poorer sleep quality, highlighting the importance of behavioral factors in shaping sleep outcomes in adolescents.

Several limitations of the present study should be acknowledged. The cross-sectional design precludes causal inference, and self-reported measures of physical activity, digital game addiction, and screen time may be subject to recall bias and misclassification. Self-reported parental BMI and socioeconomic status may also introduce reporting bias. Furthermore, the absence of data on pubertal status and mental health factors may limit the interpretation of the findings, and the school-based sampling frame may restrict generalizability to the broader adolescent population. Despite these limitations, the study has notable strengths, including the use of validated instruments (PSQI and DGAS) and a relatively large school-based sample, which support the reliability and generalizability of the findings.

In conclusion, digital game addiction was associated with poorer sleep quality among secondary school students. In contrast, no significant associations were observed between BMI and either digital game addiction or sleep quality. These findings suggest that behavioral factors related to digital gaming may play a more prominent role in adolescent sleep health than anthropometric indicators during early adolescence. The high prevalence of both problematic gaming behaviors and poor sleep quality highlights the importance of addressing digital health behaviors in adolescent health assessments. Further longitudinal studies are needed to clarify the underlying mechanisms and causal pathways.

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Ethical approval

The study was approved by Non-Pharmaceutical and Non-Medical Device Research Ethics Committee of KTO Karatay University Faculty of Medicine (date: December 29, 2022, number: 2022-001). Written informed consent was obtained from parents or legal guardians, and verbal/written assent was obtained from all participating students prior to data collection.

Author contribution

The authors confirm contribution to the paper as follows: Study conception and design: SP; data collection: MÖ; analysis and interpretation of results: MÖ, SK; draft manuscript preparation: MÖ, SK, SP. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interest.

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