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Digital Device Use before Bedtime and Sleep Quality among Secondary School Adolescents in Baghdad: A Cross-Sectional Study

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Abstract: Adolescent sleep health has declined alongside the spread of digital devices, yet local data from Iraq remain scarce. This study aimed to estimate the prevalence of poor sleep quality among secondary school students in Baghdad and to examine its association with digital device use, sleep habits and socio-demographic characteristics. A cross-sectional analytical study was conducted from January to April 2024 in the Al-Karkh Al-Oula educational directorate, Baghdad. Using multi-stage random sampling across seven school sectors, 400 students aged 15–17 years were enrolled from public and private schools. Data were collected with a self-administered bilingual questionnaire that included the Pittsburgh Sleep Quality Index (PSQI), and a global score above 5 defined poor sleep quality. Chi-square tests and binary logistic regression were used for analysis. The sample comprised 188 males (47.0%) and 212 females (53.0%), with a mean age of 16.0 ± 0.81 years. Overall, 244 students (61.0%) had poor sleep quality, and only 23.0% slept the recommended seven hours or more per night. Poor sleep was more common among females than males (71.7% vs. 49.0%; $p < 0.001$) and among students living in crowded homes (69.8% vs. 35.3%; $p < 0.001$). Daily device use of two hours or more was the strongest independent predictor of poor sleep quality (OR = 2.97; 95% CI: 2.07–4.27), followed by bedtime at or after 10 pm (OR = 2.25), sleep-onset latency longer than 30 minutes (OR = 2.03), device shutdown at or after 10 pm (OR = 1.62), hypnotic medication use (OR = 1.57) and morning dissatisfaction (OR = 1.41). Poor sleep quality affects about six in ten secondary school adolescents in Baghdad and is linked mainly to long evening screen use, late bedtimes and crowded homes. School-based sleep-hygiene education, family counselling and attention to housing conditions are recommended.

Keywords: Adolescents, Sleep quality, Pittsburgh Sleep Quality Index, Digital devices, Screen time.

INTRODUCTION

Adequate sleep is essential for adolescent cognitive development, emotional regulation, immune function and academic performance. Current guidelines recommend 8–10 hours of nightly sleep for teenagers, yet surveys from many countries show that adolescents commonly sleep less than this [Cain N *et al*, 2010; Wheaton AG *et al*, 2016]. The rapid spread of smartphones, tablets and gaming consoles, which are now present in almost every adolescent bedroom, has become one of the most important modifiable contributors to this sleep deficit [LeBourgeois MK *et al*, 2017].

Digital devices disturb sleep through at least three related mechanisms. First, short-wavelength (400–490 nm) blue light emitted by screens suppresses melatonin secretion from the pineal gland, which delays the circadian phase and postpones sleep onset [Wahl S *et al*, 2019; Tosini G *et al*, 2016]. Second, the stimulating and emotionally arousing content of social media, online gaming and video streaming increases physiological arousal and prolongs sleep-onset latency even after the device is switched off [Scott H *et al*, 2019]. Third, notifications during the night interrupt sleep and cause repeated brief arousals [Woods HC *et al*, 2016]. Together, these mechanisms form a self-reinforcing cycle in which device use delays sleep, short sleep causes daytime fatigue, and fatigue leads to further device use [Touitou Y *et al*, 2016].

Studies from different countries consistently link two or more hours of daily recreational screen time with poorer sleep quality, shorter total sleep time and more insomnia symptoms among adolescents [Hale L *et al*, 2015; Lund L *et al*, 2021]. However, it is uncertain whether these findings apply equally to Middle Eastern populations. Cultural practices in Iraq, including late-evening family gatherings and high household density, may add to the physiological effects of screen exposure in ways that Western data do not capture [Al-Wandi AS *et al*, 2020; Ali RH *et al*, 2023]. A 2023 study from Baghdad reported that internet and social media use disrupted sleep among secondary school students, but it had a smaller sample and focused on social media only [Ali RH *et al*, 2023]. Representative data on the full range of device-use behaviours and their association with standardised measures of sleep quality are still lacking for Baghdad. The novelty of the present study lies in combining device-use timing and duration, sleep habits and household conditions in one analysis using a validated instrument in a randomly

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selected school sample. The study therefore aimed to estimate the prevalence of poor sleep quality, measured by the Pittsburgh Sleep Quality Index (PSQI), among secondary school students in Baghdad; to describe patterns of digital device use before bedtime; and to identify independent predictors of poor sleep quality, taking into account device-use behaviours, sleep habits and socio-demographic factors.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional analytical study was conducted between January and April 2024 in the Al-Karkh Al-Oula educational directorate, one of three educational directorates on the Al-Karkh side of Baghdad. The directorate includes seven geographically distinct school sectors serving both public and private secondary schools. Data were not collected during the month of Ramadan (March 2024) to avoid the effect of Ramadan-related changes in daily schedules on sleep measures.

Participants and Sampling

Students aged 15–17 years enrolled in day-shift secondary schools were eligible. Students were excluded if their parents refused written consent, if they reported a diagnosed sleep disorder, or if they had a documented neurological or major psychiatric disorder. A multi-stage random sampling procedure was used: (1) Al-Karkh side was selected randomly from the two sides of Baghdad; (2) the Al-Karkh Al-Oula educational directorate was selected randomly from the three Al-Karkh directorates; (3) all seven sectors were included; (4) four schools per sector (two public and two private, each pair including one male and one female single-sex school) were selected by simple random sampling from 80 eligible schools; (5) one class per school grade was selected by lot; and (6) all students in the selected classes were invited. A pilot study on 40 students (10% of the target sample) was carried out before the main data collection to improve the clarity of the questionnaire; pilot data were excluded from the analysis.

Sample size was calculated using the standard formula for cross-sectional studies, $n = Z^2 \times P(1 - P) / d^2$ [Beard J, 2024], with $Z = 1.96$ (95% confidence level), $P = 0.50$ (a conservative assumption because local data were limited) and $d = 0.05$. This gave a minimum of 384 participants, and 400 students were recruited to allow for non-response.

Data Collection Instrument

Data were collected using a structured, self-administered bilingual (English/Arabic) questionnaire developed from the literature and reviewed by three subject experts before finalisation. The questionnaire had five parts:

(i) Socio-demographic data: age, sex, school type, parental education (secondary or below vs. above secondary), parental occupation, household crowding index (number of family members divided by number of rooms; ≤2 = not crowded, >2 = crowded) [WHO, 2018] and living arrangement.

(ii) Bedroom device inventory: number of devices in the bedroom (<3 vs. ≥3); type of device used before sleep (smartphone only vs. multiple devices, including tablets, laptops, televisions and gaming consoles); daily device use (<2 vs. ≥2 hours/day); device shutdown time (before 10 pm vs. at or after 10 pm); and whether the mobile phone was left on overnight.

(iii) Sleep pattern: sleep-onset latency (≤30 vs. >30 minutes); bedtime (before 10 pm vs. at or after 10 pm); wake time (before 7 am vs. at or after 7 am); night-time awakenings; and habitual daytime napping.

(iv) Lifestyle variables: morning satisfaction; attendance at the first class; morning fatigue; dinner time (before 9 pm vs. at or after 9 pm); use of caffeinated beverages; and use of hypnotic medication.

(v) Pittsburgh Sleep Quality Index (PSQI): a validated 19-item instrument that assesses seven sleep components (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction), each scored 0–3. The global score ranges from 0 to 21; a score of 5 or less indicates good sleep quality and a score above 5 indicates poor sleep quality [Buysse DJ *et al*, 1989].

Ethical Considerations

The study was approved by the Scientific Council of Community Medicine of the Arab Board for Health Specializations in Iraq and by the Iraqi Ministry of Education. Written informed consent was obtained from the parents of all participants before data collection. Student participation was voluntary and anonymous and had no effect on academic assessment.

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Statistical Analysis

Data were entered and analysed using IBM SPSS Statistics version 26. Frequencies and percentages were used to describe demographic and behavioural characteristics. Associations between categorical variables and sleep quality were tested with Pearson's chi-square test, or Fisher's exact test when an expected cell frequency was below five. Variables with $p \leq 0.05$ in the bivariate analysis were entered into a binary logistic regression model with poor sleep quality as the dependent variable. Results are presented as odds ratios (OR) with 95% confidence intervals (CI), and model fit was checked with the Hosmer–Lemeshow test. A p-value $\leq$ 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics

Table 1 shows the socio-demographic characteristics of the 400 participants. The sample was balanced by sex (47.0% male, 53.0% female) and school type (50.0% public, 50.0% private). The mean age was 16.0 ± 0.81 years. Most fathers (60.0%) had education above secondary level, whereas most mothers (57.0%) had secondary education or less. Most mothers were housewives (67.0%) and nearly all fathers were employed (98.5%). Household crowding was common, with 74.5% of students living in homes with more than two persons per room. Most students (87.5%) lived with both parents.

Table 1: Socio-demographic characteristics of the study participants (n = 400)

Variable	n	%
Age (years), mean ± SD: 16.0 ± 0.81		
15	128	32.0
16	132	33.0
17	140	35.0
Sex		
Male	188	47.0
Female	212	53.0
School type		
Public	200	50.0
Private	200	50.0
Mother's education		
≤ Secondary school	228	57.0
> Secondary school	172	43.0
Father's education		
≤ Secondary school	160	40.0
> Secondary school	240	60.0
Mother's occupation		
Employed	132	33.0
Housewife	268	67.0
Father's occupation		
Employed	394	98.5
Unemployed	6	1.5
Crowding index		
≤ 2 persons/room	102	25.5
> 2 persons/room	298	74.5
Living arrangement		
Both parents	350	87.5
Single parent/other relatives	50	12.5

Sleep Duration and Prevalence of Poor Sleep Quality

Fewer than one quarter of participants (23.0%) slept the recommended seven hours or more per night; 32.5% slept 6–7 hours, 37.0% slept 5–6 hours and 7.5% slept less than 5 hours. According to the PSQI, 244 students (61.0%) had poor sleep quality and 156 students (39.0%) had good sleep quality. Almost all students (94.0%) went to bed at or after 10 pm, and 67.0% took daytime naps.

The prevalence of poor sleep quality in this study (61.0%) is close to that reported among Indian

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school children (61.5%) [G CS *et al*, 2024] but much higher than that reported among Turkish adolescents (13.6%) [Tetik NG *et al*, 2021]. These differences show that prevalence estimates depend on local daily schedules, household characteristics and the cut-off points used, and that findings from high-income Western settings cannot be assumed to apply to adolescents in the Middle East. The finding that more than three quarters of students slept less than seven hours is also of concern, because short sleep in adolescence is linked to poorer school performance, mood problems and risk behaviours [Wheaton AG *et al*, 2016; Touitou Y *et al*, 2016].

Digital Device Use and Sleep Quality

Smartphones were the main device used before sleep (55.0%), while 45.0% of students used multiple devices such as televisions, laptops, tablets or gaming consoles (Table 2). Overall, 60.0% used digital devices for two hours or more daily, 61.5% switched their devices off at or after 10 pm and 53.5% left their mobile phone on overnight. Three or more devices were present in the bedroom in 37.5% of cases.

Table 2: Digital device use patterns among the study participants (n = 400)

Variable	n	%
Number of devices in bedroom		
< 3	250	62.5
≥ 3	150	37.5
Type of device used before sleep		
Smartphone only	220	55.0
Multiple devices	180	45.0
Daily device use		
< 2 hours/day	160	40.0
≥ 2 hours/day	240	60.0
Device shutdown time		
Before 10 pm	154	38.5
At or after 10 pm	246	61.5
Mobile phone left on overnight		
Yes	214	53.5
No	186	46.5

Daily device use of two hours or more was strongly associated with poor sleep quality: 70.0% of heavy users had poor sleep compared with 47.5% of light users ($p < 0.001$) (Table 3). Device shutdown at or after 10 pm was also associated with poor sleep (72.4% vs. 42.9%; $p < 0.001$). Leaving the mobile phone on overnight was not significantly associated with sleep quality ($p = 0.262$), nor were the number of devices in the bedroom ($p = 0.138$) or the type of device used ($p = 0.681$).

Table 3: Sleep quality by digital device use pattern (n = 400)

Variable	Good sleep n = 156 (%)	Poor sleep n = 244 (%)	χ^2 (df); p-value
Daily device use			
< 2 hours/day	84 (52.5)	76 (47.5)	20.43 (1); < 0.001
≥ 2 hours/day	72 (30.0)	168 (70.0)	
Device shutdown time			
Before 10 pm	88 (57.1)	66 (42.9)	34.65 (1); < 0.001
At or after 10 pm	68 (27.6)	178 (72.4)	
Mobile phone left on overnight			
Yes	78 (36.4)	136 (63.6)	1.26 (1); 0.262
No	78 (41.9)	108 (58.1)	

Daily device use of two hours or more was also the strongest predictor of poor sleep quality in the multivariable model (OR = 2.97; Section 3.6). This effect size agrees with a systematic review that found high screen time to be consistently associated with shorter sleep and delayed bedtime in children and adolescents [Hale L *et al*, 2015]. Laboratory studies show that evening exposure to blue light suppresses melatonin secretion, shifts the circadian phase and reduces the depth of slow-

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wave sleep [Wahl S *et al*, 2019; Tosini G *et al*, 2016; Silvani MI *et al*, 2022]. The present study extends these findings to a community sample of Iraqi adolescents, in whom most device use appears to take place shortly before an already late bedtime. Device shutdown at or after 10 pm remained an independent predictor (OR = 1.62) separate from total daily use, which suggests that the timing of screen exposure, and not only its duration, should be targeted by interventions.

Socio-Demographic Factors and Sleep Quality

Female sex was significantly associated with poor sleep quality: 71.7% of females compared with 49.0% of males had poor sleep ($\chi^2 = 21.70$; $p < 0.001$) (Table 4). Age was not associated with sleep quality ($p = 0.909$). Household crowding was significantly associated with poor sleep quality, which was present in 69.8% of students living in crowded homes compared with 35.3% of those in uncrowded homes ($\chi^2 = 38.03$; $p < 0.001$). Students whose fathers were unemployed more often had good sleep quality (83.3%), although this group was very small (n = 6) (Fisher's exact $p = 0.035$). Parental education, mother's occupation, school type and living arrangement were not significantly associated with sleep quality.

Table 4: Sleep quality by socio-demographic characteristics (n = 400)

Variable	Good sleep n = 156 (%)	Poor sleep n = 244 (%)	χ^2 (df); p-value
Sex			
Male	96 (51.0)	92 (49.0)	21.70 (1); < 0.001
Female	60 (28.3)	152 (71.7)	
Age (years)			
15	48 (37.5)	80 (62.5)	0.19 (2); 0.909
16	52 (39.4)	80 (60.6)	
17	56 (40.0)	84 (60.0)	
Crowding index			
≤ 2 persons/room	66 (64.7)	36 (35.3)	38.03 (1); < 0.001
> 2 persons/room	90 (30.2)	208 (69.8)	
Father's occupation[a]			
Employed	151 (38.3)	243 (61.7)	Fisher's exact; 0.035
Unemployed	5 (83.3)	1 (16.7)	

[a] Fisher's exact test used because an expected cell count was below 5.

The higher frequency of poor sleep among females agrees with findings from Saudi Arabia [Alshoaibi Y *et al*, 2023] and with large population data showing poorer sleep quality among young women [Fatima Y *et al*, 2016]. Sex was not retained in the final regression model, which suggests that its effect may operate through other factors such as device use and bedtime. Possible explanations in the Iraqi setting include social norms that keep girls at home for longer periods, household responsibilities, and fewer outdoor leisure options, all of which may increase screen time at home [Woods HC *et al*, 2016; Ali RH *et al*, 2023].

Household crowding was also associated with poor sleep quality. Crowded sleeping environments expose adolescents to noise and light that disturb sleep, and may reduce parents' ability to maintain regular bedtime routines [Philbrook LE *et al*, 2020; Cameron EE *et al*, 2022]. The fact that 74.5% of the sample lived in crowded conditions reflects the housing density and economic pressures in Baghdad, and suggests that structural determinants of sleep, and not only individual behaviours, need policy attention.

Sleep Habits, Lifestyle Factors and Sleep Quality

Sleep-onset latency longer than 30 minutes was strongly associated with poor sleep quality (82.9% vs. 45.8%; $p < 0.001$) (Table 5). Bedtime at or after 10 pm was also associated with poor sleep (63.3% vs. 25.0%; $p < 0.001$). Daytime napping was associated with poor night-time sleep quality (69.6% of nappers vs. 43.1% of non-nappers; $p < 0.001$), as were night-time awakenings (71.2% vs. 56.7%; $p = 0.007$) and late dinner at or after 9 pm (68.9% vs. 57.6%; $p = 0.033$). Hypnotic medication use was associated with poor sleep quality (90.9% vs. 57.3%; $p < 0.001$). Morning fatigue was reported by 69.0% of participants, and 77.5% of them had poor sleep quality ($p < 0.001$). Use of caffeinated beverages was very common (89.0%) but was not significantly associated with sleep quality (61.2% vs. 59.1%; $p = 0.783$).

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Table 5: Sleep quality by sleep pattern and lifestyle variables (n = 400)

Variable	Good sleep n = 156 (%)	Poor sleep n = 244 (%)	χ^2 (df); p-value
Sleep-onset latency			
≤ 30 min	128 (54.2)	108 (45.8)	56.18 (1); < 0.001
> 30 min	28 (17.1)	136 (82.9)	
Bedtime			
Before 10 pm	18 (75.0)	6 (25.0)	13.91 (1); < 0.001
At or after 10 pm	138 (36.7)	238 (63.3)	
Daytime napping			
Yes	82 (30.4)	188 (69.6)	26.01 (1); < 0.001
No	74 (56.9)	56 (43.1)	
Night-time awakenings			
Yes	34 (28.8)	84 (71.2)	7.30 (1); 0.007
No	122 (43.3)	160 (56.7)	
Dinner time			
Before 9 pm	118 (42.4)	160 (57.6)	4.55 (1); 0.033
At or after 9 pm	38 (31.1)	84 (68.9)	
Caffeinated beverage use			
Yes	138 (38.8)	218 (61.2)	0.08 (1); 0.783
No	18 (40.9)	26 (59.1)	
Hypnotic medication use			
Yes	4 (9.1)	40 (90.9)	18.59 (1); < 0.001
No	152 (42.7)	204 (57.3)	
Morning fatigue			
Yes	62 (22.5)	214 (77.5)	102.34 (1); < 0.001
No	94 (75.8)	30 (24.2)	

Late bedtime was the second strongest independent predictor (OR = 2.25). That 94.0% of the sample went to bed at or after 10 pm reflects both the natural delay in circadian timing during adolescence [Bartlett DJ *et al*, 2013] and the late-evening social and screen activities that are common in urban Iraqi households. The relationship between device use and bedtime is likely to work in both directions: screens delay the circadian phase, and late sleepers have more time for evening device use. Prospective studies that can model this two-way relationship are needed.

Prolonged sleep-onset latency (OR = 2.03) may be a shared result of several factors, including late-night screen use, late dinner and mental arousal caused by social media or gaming content. Although caffeine use was not significantly associated with sleep quality in this sample, possibly because almost all students consumed caffeinated drinks, its very high frequency (89.0%) is still important. Caffeine blocks adenosine receptors and reduces the build-up of sleep pressure, and its use to overcome morning tiredness can maintain a cycle of insufficient sleep [Vizentin NP *et al*, 2024]. Daytime napping, reported by 67.0% of students, was also linked to poor night-time sleep. Although naps can partly make up for lost sleep, long or late-afternoon naps reduce sleep pressure and delay the next sleep onset [Rea EM *et al*, 2025]. Together, these findings describe a 'screen–late bedtime–napping' cycle that is self-sustaining and unlikely to resolve without coordinated action at several levels.

Independent Predictors of Poor Sleep Quality

Binary logistic regression identified six independent predictors of poor sleep quality (Table 6). Daily device use of two hours or more was the strongest predictor (OR = 2.97; 95% CI: 2.07–4.27; p < 0.001), followed by bedtime at or after 10 pm (OR = 2.25; 95% CI: 1.73–2.92), sleep-onset latency longer than 30 minutes (OR = 2.03; 95% CI: 1.42–2.90), device shutdown at or after 10 pm (OR = 1.62; 95% CI: 1.45–1.85), hypnotic medication use (OR = 1.57; 95% CI: 1.37–1.87) and morning dissatisfaction (OR = 1.41; 95% CI: 1.31–1.53). Sex, household crowding and father's occupation were not retained as independent predictors. The model showed acceptable fit (Hosmer–Lemeshow p = 0.24).

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Table 6: Independent predictors of poor sleep quality: binary logistic regression (n = 400)

Variable	OR	95% CI lower	95% CI upper	p-value
Daily device use ≥ 2 hours	2.97	2.07	4.27	< 0.001
Late bedtime (≥ 10 pm)	2.25	1.73	2.92	< 0.001
Sleep-onset latency > 30 min	2.03	1.42	2.90	< 0.001
Device shutdown ≥ 10 pm	1.62	1.45	1.85	0.003
Hypnotic medication use	1.57	1.37	1.87	0.009
Morning dissatisfaction	1.41	1.31	1.53	< 0.001

OR = odds ratio; CI = confidence interval. Hosmer–Lemeshow goodness-of-fit test: p = 0.24.

Hypnotic medication use, reported by 11.0% of the sample, is a worrying finding in an adolescent population. Hypnotic drugs change sleep architecture, suppress rapid-eye-movement sleep and carry risks of dependence and rebound insomnia after stopping [Wesselhoeft R *et al*, 2021]. Their use in this sample probably reflects poorly managed long-standing sleep difficulties and points to the need for counselling that puts sleep hygiene first in primary health care and school health services. Because the data are cross-sectional, hypnotic use may also be a marker, rather than a cause, of poor sleep.

Strengths and Limitations

The strengths of this study include a large sample balanced by sex and school type, multi-stage random sampling across all seven school sectors of Al-Karkh Al-Oula, the use of the PSQI as a widely validated instrument, and the exclusion of the month of Ramadan to limit its effect on sleep timing. Several limitations should be noted. The cross-sectional design does not allow causal conclusions, and reverse causality (poor sleepers using screens more) cannot be ruled out. Self-reported device use and sleep duration may be affected by recall and social desirability bias. Objective sleep measurement such as actigraphy or polysomnography was not feasible. The study was limited to one educational directorate, which limits generalisation to the whole of Baghdad and to rural Iraqi adolescents.

CONCLUSION

Poor sleep quality affects about six in ten secondary school adolescents in Baghdad. It is independently associated with long daily screen use (two hours or more), late bedtime, delayed sleep onset, late device shutdown, hypnotic medication use and morning dissatisfaction, while female sex and household crowding are associated with poor sleep at the bivariate level. In our view, these findings support several actions: integrating sleep-hygiene education into school health programmes, with emphasis on a screen-free period of at least 60 minutes before bedtime; awareness programmes for parents and adolescents on the effects of evening light exposure, caffeine and late meals on sleep; giving priority to behavioural rather than pharmacological approaches when managing adolescents with sleep problems; and recognising household crowding as a structural determinant of sleep in urban housing policy. Longitudinal and interventional studies are needed to test whether school- and family-based device curfews can break the cycle between excessive screen use and delayed sleep in this cultural setting.

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