ORIGINAL ARTICLE

The Effect of Overexposure to Blue Light from Digital Screens before Bed on Children's Sleep and Bruxism in Ages 6–12

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Abstract

Introduction: Exposure to blue light from digital screens at bedtime may suppress melatonin production and disrupt circadian rhythms, potentially affecting sleep quality. Bruxism, a parafunctional habit involving teeth grinding, is often linked to stress and sleep disturbances. In children, it may result in tooth wear, jaw discomfort, and poor sleep, raising questions about its association with bedtime screen use. **Objectives:** This study investigates the relationship between bedtime blue light exposure, sleep quality, and pediatric sleep bruxism (SB) in Saudi children. **Methodology:** This cross-sectional study was conducted across Saudi Arabia to examine the association between pre-bedtime blue light exposure and the occurrence of sleep disturbances and bruxism in children aged 6–12 years. Data were obtained using a three-part structured questionnaire, adapted from a validated instrument, and distributed to parents via social media platforms. The Arabic-language questionnaire collected information on demographics, screen use patterns, bedtime routines, and bruxism-related symptoms. Sleep-related variables were assessed through 24 statements rated on a 4-point Likert scale, yielding a maximum score of 72 points, with sleep disturbance severity classified as low, moderate, or high according to Bloom's cut-off points. In addition, four open-ended questions explored qualitative aspects of children's sleep patterns, and responses were subjected to descriptive analysis. **Results**: A total of 827 responses were analyzed, including detailed information on demographics, digital device use, bedtime habits, sleep patterns, and bruxism-related symptoms. Key findings demonstrated that 21.5% of parents observed teeth grinding during sleep, 16.6% reported a dentist's diagnosis of bruxism, and 15.2% noticed abnormal tooth wear in their children. Nearly half (48.4%) of the children routinely used digital devices before bedtime, with mobile phones and tablets being the most frequently used. Difficulty falling asleep following device use was reported in 53.3% of participants, with increased sleep latency and fragmented sleep observed in more than half of cases. Statistically significant associations were found between high or moderate risk of sleep disturbance and bruxism, and sociodemographic factors, including relation to child, region, age, and gender. Specifically, higher prevalence was noted among male children and those residing in certain regions. Most children (86.0%) were classified as low risk, while 12.1% were moderate and only 1.9% high risk for sleep disturbance and bruxism. **Conclusion:** The results underscore an important link between evening screen exposure, melatonin suppression, altered circadian rhythms, and poor sleep outcomes that predispose to SB. Limitations include self-reported data, lack of clinical or polysomnographic confirmation, and possible selection bias due to high parental educational attainment. This research highlights the need for parental regulation of screen time and further longitudinal studies to elucidate causal mechanisms and inform targeted interventions for pediatric sleep health.

Key words: Blue light, children, pediatric bruxism, screen time, sleep quality

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Received: 22-11-2025
Revised: 23-12-2025
Accepted: 30-12-2025

INTRODUCTION

Sleep bruxism (SB) is a type of masticatory muscular activity that can be classified as either non-rhythmic (tonic) or rhythmic (phasic) when you're asleep. In otherwise healthy people, it is not regarded as a movement condition or a sleep disorder. Primary or SB is defined as clenching and/or grinding of the teeth while you're asleep, whereas secondary or awake bruxism is defined as the same behavior while you're awake.[1]

SB is increasingly reported among children, with prevalence estimates ranging from 3% to 40%.[2] Present evidence attributes its development less to occlusal factors and more to psychological and neurophysiological influences. Anxiety, reported in 2.5–5% of the general pediatric population but rising to 24% in children with SB, reinforces the need to integrate psychological considerations into diagnosis and treatment.[3]

Screen time (ST) has also emerged as a contributing factor to sleep disturbances and emotional dysregulation. The use of digital devices, especially in the evening, can impair sleep quality and increase arousal, potentially leading to SB.[4]

A 2019 study on the impact of electronic devices on children's sleep found that while longer evening tablet use was marginally significantly associated with fewer hours of sleep at night, children's use of electronic media was not linked to their nocturnal sleep. The hypothesis of sleep time shifting was prompted by these observations.[5]

In addition, a study about SB was conducted in 2023. It highlighted how SB is impacted by psychological stress, poor sleep, and evening ST. Because blue light from screens disrupts the control of melatonin secretion and circadian rhythm, it has been recognized as an indirect risk factor.[6]

A 2024 study revealed that 41.7% of participating children exhibited probable SB. Evening screen use was significantly associated with increased rates of sleep disturbances, such as snoring, nightmares, delayed sleep onset, and frequent nocturnal awakenings, which in turn correlated with a higher incidence of SB.[7]

Evening exposure to blue light from digital devices suppresses melatonin secretion, disrupts circadian rhythms, and shortens sleep duration. These mechanisms plausibly contribute to behaviors, such as bruxism; however, most available studies focus on adolescents or adults, with little pediatric-specific evidence.[8,9]

Saudi Arabian children are frequently exposed to screens on a regular basis, and they frequently use them right before bedtime. However, no locally gathered data have been found to investigate the relationship between bruxism, sleep quality, and pre-bed blue light exposure in this population. Creating such data can assist in guiding culturally appropriate health advice.

Objectives

This study aims to determine the prevalence of SB among children aged 6–12 years in Saudi Arabia and to investigate its association with bedtime blue light exposure from digital screens and sleep quality. By assessing how frequently SB occurs and identifying behavioral and environmental factors contributing to it.

METHODOLOGY

Study design and setting

This research adopted a cross-sectional observational design and was conducted nationwide across Saudi Arabia over a 6-month period, from July 2025 to December 2025. Eight hundred and twenty seven participants were required to ensure adequate statistical power.

Subject: Participants, recruitment, and sampling procedures

This study targeted healthy Saudi children, both male and female, aged 6–12 years. Participants were recruited from various regions across Saudi Arabia. Recruitment was conducted by distributing a structured, self-administered questionnaire to parents or legal guardians through social media platforms, including Twitter, Snapchat, Instagram, and WhatsApp. The survey collected information on children's screen usage before bedtime, sleep habits, and signs of SB, such as teeth grinding sounds during sleep or jaw pain upon waking. To ensure accessibility and comprehension, the questionnaire was provided in Arabic.

Sample size

In this research, the data collection involved a target sample of 384 patients (confidence level: 95%; margin of error: 5%). The sample size was estimated using the formula:

$$n = P(1-P) * Z\alpha\ 2/d\ 2 \text{ with a 95\% confidence level.}$$

n: Calculated sample size.
Z: The z-value for the selected level of confidence (1−a) = 1.96
P: An estimated prevalence of knowledge.
Q: (1–0.50) = 50%, i.e., 0.50
D: The maximum acceptable error = 0.05

Therefore, the calculated minimum sample size was n = (1.96) 2 × 0.50 × 0.50/(0.05) 2 = 384.

Inclusion and exclusion criteria

This study targets children between the ages of 6 and 12 years who reside in Saudi Arabia and regularly use digital devices (such as tablets, smartphones, computers, or televisions) for at least 1 h before bedtime. Eligible participants must have been living in Saudi Arabia for at least 6 months. The survey was completed by one of the child's parents, who must provide informed consent. Participation also requires the willingness of both the parent and the child to complete a questionnaire assessing the child's sleep habits and oral behaviors.

Children were excluded if they have major neurological or developmental disorders that could interfere with participation, or if they are currently taking medications known to significantly affect sleep or muscle activity unless the medication has been used at a stable dose for at least 3 months. Other exclusion criteria include a diagnosis of moderate-to-severe obstructive sleep apnea that is currently under active treatment, recent dental procedures that may affect occlusion, and medical conditions that severely impact sleep unless such conditions have remained stable for at least 3 months. Children whose parents are unable or unwilling to comply with the study procedures were excluded.

Method for data collection and instrument (data collection technique and tools)

A structured, bilingual (Arabic/English), self-administered questionnaire was used as the primary data collection tool in this study. The questionnaire was developed based on a comprehensive literature review and adapted from validated tools used in previous studies. It began with a brief description of the study and a consent question and was divided into five parts. Part 1 collected demographic data about the participant, including their relationship with the child, age, nationality (Saudi or non-Saudi), education level, and marital status. Part 2 gathered information about the child, including age and gender. Part 3 included questions regarding the child's frequent digital device usage. In Part 4, participants were asked about the child's sleep quality following screen usage. Part 5 contained questions about possible bruxism habits and related symptoms observed after bedtime.

Scoring system

A total of 28 statements were used to assess children's digital device use before bedtime, sleep quality, and bruxism (teeth grinding) as reported by parents. The questionnaire included two open-ended questions asking about the child's age and usual bedtime, nine items addressing digital device use and habits, five items on sleep quality and difficulties, seven items on bruxism and related behaviors, and five items covering environmental and parental observations.

A point scale was applied using either a 3- or 4-point Likert scale, depending on the type of question. Frequency-based questions were scored as follows: 0 = Did not happen/Never, 1 = Rarely/Sometimes, 2 = Occasionally (2–3 times/week), and 3 = Daily/always. Yes/no questions were scored as 0 = No and 1 = Yes. The total maximum score was 21 points.

Participants were divided into three groups based on their scores, according to Bloom's original cut-off points: Scores of 0–11 indicated a low risk of sleep disturbance and bruxism, scores of 12–15 indicated a moderate risk, and scores of 16–21 indicated a high risk. The two open-ended questions regarding the child's age and usual bedtime were not included in the scoring system but were analyzed separately using descriptive statistics to provide additional context on children's sleep patterns.

Pilot test

A pilot test was conducted by administering the questionnaire to 20 participants to evaluate its clarity and the practicality of the study design. The data collected during this phase was not included from the final analysis.

Data analysis

Data were input into the computer using the "Microsoft Office Excel Software" program (2016) for Windows. For statistical analysis, the data were then transferred to the Statistical Package of 10 Social Science Software (SPSS) application, version 20 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). Descriptive statistics were used to summarize the numerical variables for baseline characteristics. For categorical variables, frequencies and percentages were calculated. The Chi-square test was used to identify associations between categorical variables.

RESULTS

Table 1 displays various demographic parameters of the participants with a total number of 827. The mean age of parents was 37.7 years (standard deviation = 9.7), with the highest percentage of 40–45 years (23.0%), then 34–39 years (20.1), and 46 years and above (20.7%). Mothers constituted 66.9% of those who responded with 33.1% fathers. The sample was mostly Saudi (92.6%) and most of them were married (87.4%). In the region, more than half of the respondents lived in the Western Region (50.4%), with Eastern (19.8%), and Southern regions (15.2%). The majority (70.7) of caregivers had a bachelor's degree. Children were spread in age range, 27.3% 10–12 years and 26.5% 8–9 years, and males were 59.3% of the sample.

As shown in Figure 1, Most children in the study primarily used mobile phones (34.3%) and tablets (32.2%), followed

Table 1: Sociodemographic characteristics of participants (*n*=827)

Parameter	No.	Percentage
Age (mean: 37.7, STD: 9.7)		
28 or less	159	19.2
29–33	141	17.0
34–39	166	20.1
40–45	190	23.0
46 or more	171	20.7
Relation to child		
Father	274	33.1
Mother	553	66.9
Nationality		
Non - Saudi	61	7.4
Saudi	766	92.6
Marital status		
Single	64	7.7
Married	723	87.4
Divorced	35	4.2
Widowed	5	0.6
Residential region		
Northern region	31	3.7
Southern region	126	15.2
Central region	89	10.8
Eastern region	164	19.8
Western region	417	50.4
Educational qualification		
Primary school	5	0.6
Middle school	10	1.2
High school	115	13.9
Bachelor's degree	585	70.7
Master's degree	101	12.2
PhD	7	0.8
Uneducated	4	0.5
Child age group		
5 years or less	188	22.7
6–7	194	23.5
8–9	219	26.5
10–12	226	27.3
Child's sex		
Female	337	40.7
Male	490	59.3

STD: Standard Deviation

by television (28.5%), while computer use was the least common (5.0%).

Table 2 shows the usage of digital devices among children. The most often used devices were mobile phones (34.3)

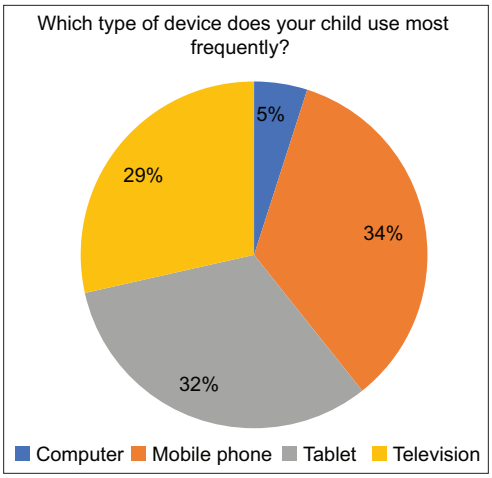

Figure 1: Type of digital device used among participants' children

and tablets (32.2), followed by television (28.5), with the computer providing a very low 5.0. The daily ST was significantly high, as 46.1% spent 3–4 h on the devices and 21.0% spent more than 4 h daily. Use of a device was mostly during the afternoon (55.3%), evening (32.2%), and almost half of the children (48.4) used devices before bedtime. Out of them, 29.1% spent 30–60 and 24.1% over an hour. The majority of children used devices in the living room (72.4%), but 21.9% used devices in the bedroom. Notably, 48.9% of the devices were used partially in dark settings and half of the caregivers (50.4%) were always restrictive in the use of devices before bedtime.

As shown in Figure 2, most children experienced some difficulty falling asleep after evening device use, with 46.2% reporting "sometimes" and 7.1% "always." Fewer children reported "rarely" (18.0%) or no difficulty (28.7%).

Table 3 studies the quality of sleep of participants. Almost fifty percent of the children (48.5) slept between 7 and 8 h/night, with 33.7% sleeping 9–10 h, with 9.9% sleeping <7 h. A bedtime distribution indicated that 38.2% of them went to sleep between the hours of 9 and 10 PM, and only 13.9% went to sleep in the hours of 11 PM onward. The problem with falling asleep when evening devices were used was reported as sometimes and sometimes always (46.2 and 7.1 percent, respectively). Sleep fragmentation is also characterized by 39.5% of those who say sometimes and 9.8% showing that they often wake up at night. Sleep latency duration was increased in most children, with 46.3 and 16.2 percent taking 15–30 and 30 min, respectively, to fall asleep after using the device.

Table 4 shows several important findings related to bruxism in children. About 21.5% of parents had observed their child grinding their teeth during sleep, and nearly one-fifth were unsure, indicating that some cases may go unnoticed. The prevalence of morning jaw ache or headache was 8.8 and 24.8%. Bruxism had been diagnosed by dentists in

Table 2: Parameters related to digital device usage (*n*=827)

Parameter	No.	Percentage
Which type of device does your child use most frequently?		
Computer	41	5.0
Mobile phone	284	34.3
Tablet	266	32.2
Television	236	28.5
On average, how many hours per day does your child spend on digital devices?		
<1 h	56	6.8
1–2 h	216	26.1
3–4 h	381	46.1
More than 4 h	174	21.0
When does your child mainly use these devices?*		
Morning	35	4.2
Afternoon	457	55.3
Evening	308	32.2
Immediately before bedtime	35	4.2
Does your child use digital devices before bedtime daily?		
No	427	51.6
Yes	400	48.4
Typical duration of use before bedtime:		
30–60 min	241	29.1
<30 min	187	22.6
More than 1 h	199	24.1
Never	200	24.2
Usual place of use:		
Bedroom	181	21.9
Living room	599	72.4
Another place	47	5.6
Does your child use devices in a completely dark environment?		
Always	65	7.9
Sometimes	404	48.9
No (light present)	358	43.3
Do you enforce a set time to stop device use before bedtime?		
Yes	417	50.4
Sometimes	301	36.4
No	109	13.2

*Results may overlap

Table 3: Participants' sleep quality (*n*=827)

Parameter	No.	Percentage
Average sleep duration per night		
<7 h	82	9.9
7–8 h	401	48.5
9–10 h	279	33.7
More than 10 h	65	7.9
Usual bedtime		
Before 9:00 PM	192	23.2
9–10 PM	316	38.2
10–11 PM	204	24.7
After 11:00 PM	115	13.9
Does your child experience difficulty falling asleep after evening device use?		
Always	59	7.1
Sometimes	382	46.2
Rarely	149	18.0
No	237	28.7
Is your child's sleep fragmented, or does he/she awake multiple times at night?		
Yes	81	9.8
Sometimes	327	39.5
No	419	50.7
How long does it typically take your child to fall asleep after turning off devices?		
<15 min	310	37.5
15–30 min	383	46.3
More than 30 min	134	16.2

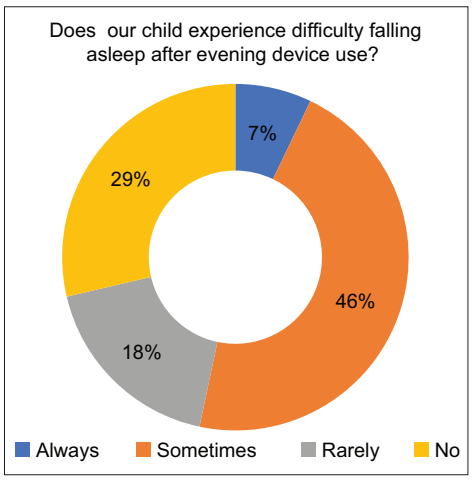

Figure 2: Illustrates having trouble falling asleep after device use among participants' children

16.6% of the respondents and 15.2% of the parents had observed abnormal wear of the teeth. The number of parents who were unsure was high (25.0%), but more grinding was reported after the bedtime use of the device (10.6%). Evening activities were not universal, with only 34.5% of

Table 4: Participants' bruxism (teeth grinding) (*n*=827)

Parameter	No.	Percentage
Have you ever observed your child grinding his/her teeth during sleep?		
Yes	178	21.5
No	485	58.6
Not sure	164	19.8
Does your child wake up complaining of jaw pain or headaches?		
Yes	73	8.8
Sometimes	205	24.8
No	549	66.4
Has a dentist ever informed you that your child suffers from bruxism?		
No	690	83.4
Yes	137	16.6
Have you noticed unusual wear or flattening of your child's teeth?		
Yes	126	15.2
No	536	64.8
Not sure	165	20.0
Do you observe increased teeth grinding on days when your child uses devices before bedtime?		
Yes	88	10.6
No	532	64.3
Not sure	207	25.0
Does your child follow a calming bedtime routine (e.g., reading, prayer, quiet time)?		
Always	285	34.5
Sometimes	283	34.2
No	259	31.3

them saying that their child always adhered to a bedtime routine.

Table 5 shows the score results of the risk of sleep disturbance and bruxism. It shows that most children (86.0%) were at low risk of sleep disturbance and bruxism, 12.1% were at moderate risk, and only 1.9% were classified as high risk

Table 6 shows that the risk of sleep disturbance and bruxism has a statistically significant relation to relation of parent to child (P = 0.0001), residential region (P = 0.0001), child age group (P = 0.0001), and child's gender (P = 0.0001). It also shows a statistically insignificant relation to age, marital status, nationality, and educational level. Participants who were fathers, from the northern region, with children aged between 8 and 9, and with male children, had children with a higher risk of developing sleep disturbance and bruxism.

Table 5: Risk of sleep disturbance and bruxism score results

Risk level	Frequency	Percentage
High risk of sleep disturbance	16	1.9
Moderate risk of sleep disturbance	100	12.1
Low risk of sleep disturbance	711	86.0
Total	827	100.0

DISCUSSION

SB is increasingly recognized as a pediatric concern, particularly in the context of modern screen-based behaviors and digital device exposure. The present study investigated the relationship between evening blue light exposure from digital screens before bed, sleep quality, and the prevalence of SB among Saudi children aged 6–12 years. This research aimed to determine the prevalence of SB and its association with sleep disturbance severity and bedtime screen use patterns, contributing local data to an area with limited evidence in Saudi Arabia.

The main findings revealed that 21.5% of parents observed their child grinding teeth during sleep, with 16.6% reporting a dentist's diagnosis of bruxism in their children and 15.2% of parents noticing abnormal tooth wear. Daily bedtime digital device use was reported in 48.4% of children, with the most common devices being mobile phones and tablets, mirroring a growing trend that has been associated with both increased SB frequency and sleep problems according to recent literature.[10,11] Sleep fragmentation and difficulties with sleep onset were reported in more than half of children using devices before bed. Notably, only 1.9% were at high risk of both sleep disturbance and bruxism, but a moderate risk was present in 12.1%.

These results align with global prevalence estimates for SB in children, which range widely from 13% up to 40%.[12,13] Recent systematic reviews reflect similar findings, revealing significant associations between evening screen exposure, delayed sleep onset, fragmented sleep, and increased SB rates.[13,14] Melatonin suppression from blue light exposure and disrupted circadian rhythms have been identified as underlying mechanisms that mediate the impact of digital device use on pediatric sleep health and bruxism.[15]

A systematic review by Restrepo *et al*. (2021) found that ST and increased sugar consumption acted synergistically to raise bruxism frequency in children.[13] In our study, the statistically significant relationship between risk of sleep disturbance and bruxism and demographic factors (relation to child, region, age group, and gender) supports the findings of local and international research. For instance, studies in the Arabian Gulf reported higher bruxism

Table 6: Relation between risk of sleep disturbance and bruxism and sociodemographic characteristics

Parameters	Risk of sleep disturbance and bruxism		Total (*n*=827) (%)	*P*-value
	High or moderate risk of sleep disturbance (%)	Low risk of sleep disturbance (%)		
Relation to child				
Father	57	217	274	0.0001
	49.1	30.5	33.1	
Mother	59	494	553	
	50.9	69.5	66.9	
Age				
28 or less	22	137	159	0.737
	19.0	19.3	19.2	
29–33	21	120	141	
	18.1	16.9	17.0	
34–39	27	139	166	
	23.3	19.5	20.1	
40–45	27	163	190	
	23.3	22.9	23.0	
46 or more	19	152	171	
	16.4	21.4	20.7	
Marital status				
Single	8	56	64	0.178
	6.9	7.9	7.7	
Married	107	616	723	
	92.2	86.6	87.4	
Divorced	1	34	35	
	0.9	4.8	4.2	
Widowed	0	5	5	
	0.0	0.7	0.6	
Nationality				
Non-Saudi	7	54	61	0.551
	6.0	7.6	7.4	
Saudi	109	657	766	
	94.0	92.4	92.6	
Residential region				
Northern Region	21	10	31	0.0001
	18.1	1.4	3.7	
Southern Region	31	95	126	
	26.7	13.4	15.2	
Central Region	22	67	89	
	19.0	9.4	10.8	
Eastern Region	14	150	164	
	12.1	21.1	19.8	
Western Region	28	389	417	
	24.1	54.7	50.4	
Educational level				
Primary school	1	4	5	0.113
	0.9	0.6	0.6	
Middle school	3	7	10	
	2.6	1.0	1.2	
High school	11	104	115	
	9.5	14.6	13.9	
Bachelor's degree	91	494	585	
	78.4	69.5	70.7	
Master's degree	8	93	101	
	6.9	13.1	12.2	
PhD	2	5	7	
	1.7	0.7	0.8	
Uneducated	0	4	4	
	0.0	0.6	0.5	
Child age group				
5 years or less	16	172	188	0.0001*
	13.8	24.2	22.7	
6–7	36	158	194	
	31.0	22.2	23.5	
8–9	45	174	219	
	38.8	24.5	26.5	
10–12	19	207	226	
	16.4	29.1	27.3	
Child's sex				
Female	30	307	337	0.0001
	25.9	43.2	40.7	
Male	86	404	490	
	74.1	56.8	59.3	

**P*-value was considered significant if ≤0.05

prevalence among males compared to females,[16] and associations with urban residency and caregiver education level.[17] Our sample's high proportion of Saudi mothers mirrors previous research on digital device-related health behaviors in the region.[18]

Importantly, sleep in children plays a mediating role in behavioral, cognitive, and emotional outcomes.[19] Excessive device use and poor sleep have been associated with hyperactivity, irritability, and reduced sleep duration, as well as increased incidence of sleep disorders, including SB.[20] This underscores the importance of health education and parental regulation of ST to mitigate these adverse outcomes.

The limitations of the present study include the cross-sectional design, which precludes establishing causality, reliance on parental reporting without objective clinical or polysomnographic verification, and the potential for recall bias. The study population was limited to children aged 6–12 years residing in Saudi Arabia, possibly affecting generalizability to other age groups and geographical settings. Questionnaire-based assessment, although validated, can miss subtle clinical features or underreport SB, as up to 19.8% of parents were unsure about their child's bruxism status. Finally, the sample composition showed high educational attainment among caregivers, potentially introducing selection bias.

CONCLUSION

Our findings demonstrate a significant association between evening digital device use and increased risk of SB and sleep disturbances in Saudi children, consistent with international trends and mechanistic evidence. Further prospective longitudinal studies employing robust objective sleep measurements are recommended to elucidate causal pathways and develop targeted interventions.

ACKNOWLEDGMENT

We acknowledge all volunteers who provided samples for this research.

ETHICAL APPROVAL

The study was fully explained to all participants, and it was emphasized that participation was voluntary. Written informed consent was obtained from each participant before enrollment. All collected information was securely stored and used exclusively for research purposes.

INFORMED CONSENT

Written informed consent was obtained from all study participants.

DATA AND MATERIALS AVAILABILITY

All data generated or analyzed during this study are included in this published article.

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Source of Support: Nil. **Conflicts of Interest:** None declared.