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**QUALITY OF INFANT SLEEP, ELECTRONIC DEVICES AND  
BULLYING BEHAVIORS IN SCHOOLS**

Ana Gomes (a)\*, Sandra Figueiredo (b), Beatriz Silva (c), Edite Ferreira (d),  
Alexandre Castro-Caldas (e), Juliana Cercatti (f)

\*Corresponding author

- (a) Universidade Autónoma de Lisboa, Luís de Camões, Rua Santa Marta, 56 - Palácio dos Condes do Redondo, 1169-023 Lisbon, Portugal, ana.m28.gomes@gmail.com  
(b) Universidade Autónoma de Lisboa, Luís de Camões, Rua Santa Marta, 56 - Palácio dos Condes do Redondo, 1169-023 Lisbon, Portugal, sfigueiredo@ual.pt  
(c) Universidade Autónoma de Lisboa, Luís de Camões, Rua Santa Marta, 56 - Palácio dos Condes do Redondo, 1169-023, Lisbon, Portugal, beatrizltsilva@gmail.com  
(d) Universidade Autónoma de Lisboa, Luís de Camões, Rua Santa Marta, 56 - Palácio dos Condes do Redondo, 1169-023, Lisbon, Portugal, beatrizltsilva@gmail.com  
(e) Portuguese Catholic University, Palma de Cima, 1649-023 Lisbon, Portugal, acaastrocaldas@ics.lisboa.ucp.pt  
(f) Universidade Autónoma de Lisboa, Luís de Camões, Rua Santa Marta, 56 - Palácio dos Condes do Redondo, 1169-023, Lisbon, Portugal, majucercatti\_19@hotmail.com

***Abstract***

This research investigates the relationship between infant sleep quality, the use of electronic devices and video games before bedtime, and bullying behaviors in school context. Is infant sleep quality and the use of electronic devices before bedtime related to bullying? Does the use of electronic devices before bedtime affect sleep duration and sleep latency? The purpose of this study is to examine the relationship between the use of electronic devices before bedtime and infant sleep quality. Furthermore, it aims to analyze the relationship between infant sleep duration and latency, the daily use of electronic devices and video games, and bullying behaviors in school context. Participants were divided into two groups. One group included 860 children who responded to the Pittsburgh Sleep Quality Index, the Children's Sleep Habits Questionnaire (CSHQ-PT), and a Sociodemographic Questionnaire. The other group contained 51 children who answered a Sociodemographic Questionnaire and the Children's Sleep Habits Questionnaire (CSHQ-PT). A statistically significant relationship between sleep quality and the use of electronic devices before bedtime was found, for all devices except television. A statistically significant relationship between sleep quality and bullying behaviors was observed. A relationship between the use of electronic devices before bedtime and bullying behaviors was found which was statistically significant only for listening to music. A negative correlation was also discovered between sleep latency and daily use of video games. There seems to be a relationship between sleep quality and bullying behaviors in school and between the use of electronic devices and sleep quality. Also, listening to music before bedtime is positively related to bullying behaviors. Moreover, the daily use of video games before bedtime significantly affects children's sleep latency (and REM sleep).

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**Keywords:** Children, bullying, sleep disturbance, sleep latency.



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## 1. Introduction

Sleep can be conceived as a physiological necessity of neurobiological nature that begins organizing itself still in the intrauterine medium. It requires certain brain regions to be involved in complex physiological activity to produce sleep cycles that alternate between vigil and rest. Sleep cycles occur in a successively manner throughout the night, promoting a balanced dynamic of the hormonal, psychological, and neurological dimensions (Valle, Valle, & Reimão, 2009). These cycles also occur alternately, repetitively, and are reversible (Cías, Zuaznábar, & López, 2006).

Sleep cycles may be divided into two stages: sleep and vigil. The sleep stage is characterized by an oscillation between moments of rest, during which there is no reaction to stimuli and stillness is predominant. The vigil stage is defined by the existence of reaction to stimuli. These are complex neurobiological processes that lead to the regular alternation of the cycles. There is a set of multifactorial dimensions that structure the dynamics of the circadian and homeostatic sleep processes (Bertolazi, 2008; Parchão, 2011).

Sleep is composed of 4 stages (1,2,3,4) that contribute to its structure. These stages occur during NREM sleep (Non-Rapid Eye Movement) and REM sleep (Rapid Eye Movement; Ribeiro & Ito, 2010). A night of sleep is only restful when these stages occur several times throughout the same night. Therefore, each stage involves cycles that can be completed between 70 and 120 minutes (Fernandes, 2006).

Sleep is a multidimensional construct and a component that interferes with the total activity of the individual during the 24 hours of the day (Matricciani et al., 2018).

Sleep hygiene comprises a set of bedtime habits which influence sleep quality and quantity (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010; Zimmerman, 2008). Good sleep hygiene during childhood is crucial in the promotion of an adequate and restful sleep, which in turn is an essential factor for children's normal development (Bruni & Novelli, 2010). Yet, the sleep quality and quantity that individuals need will depend on their age. Several studies show that individuals nowadays tend to sleep less than they did a few decades ago, including children (Matricciani et al., 2011). Some authors suggest that 30% of school-age children exhibit poor quality sleep and 40% of children may experience sleep problems at any time in their existence (Owens, 2007). Sleep has an undoubtedly important role in human development since an adequate sleep hygiene promotes physical, mental, and social well-being of children and adults (Matricciani et al., 2018).

Sleep problems can be transitory and eventually disappear without requiring specific intervention. However, these problems may also persist for some time and compromise important dimensions of child development, such as emotional and behavioral regulation and physical and mental health. Additionally, these problems may affect children's academic performance in terms of learning skills, memory capacity, concentration, and attention (Bruni & Novelli, 2015). Sleep problems include the common difficulty in falling asleep, sleep apnea, waking up often, agitation, or feeling too tired and drowsy in the vigil period (Paavonen, 2014; Santos et al., 2015). Therefore, sleep quality may influence the way children organize their emotions and behaviors throughout the day (Bruni & Novelli, 2015).

### 1.1. Sleep and Bullying Behavior

The most common type of violence in the school context is school bullying. Bullying may be defined as a repetitive aggressive behavior with the intention of harming or harassing someone. This intimidation

behavior may be physical (eg., hitting, pushing, or kicking), verbal (eg., name-calling, provoking, threatening, or spreading rumors), or social (eg., excluding someone). Bullying behavior can have serious consequences for the mental health of both victims and aggressors. Given that there is a high prevalence of bullying in our school universe, we are interested in reflecting on the variables involved in fostering the occurrence of aggressive behaviors among school age children.

Sleep affects behavioral and emotional regulation in children (Gregory & Sadeh, 2012; Kamphuis et al., 2012; O'Brien et al., 2011; Vriend et al., 2013). Poor sleep hygiene, irregular sleep schedules, sleep deprivation, and sleep disorders are associated with a greater tendency to exhibit behavioral problems, lack of attention, increased propensity for aggression, and hyperactivity (Alfano et al., 2009; Dahl, 2006; Haynes et al., 2006; Kamphuis et al., 2012; Muñoz-Quintero & Bianchi, 2017; Peach & Gaultney, 2013). The behavioral problems that may arise due to poor sleep quality are associated with a higher prevalence of aggressive behaviors directed at other individuals, both in children and adolescents (Muñoz-Quintero & Biachi, 2017; O'Brien, 2009). Besides that, poor sleep quality is also related to self-regulation difficulties, leading to an emotional instability and great reactivity to negative stimuli. As a result, these children have more difficulties in social interactions with peers, which in turn facilitates bullying behaviors in the school context (O'Brien et al., 2011).

It is extremely important to become acquainted with children's sleep habits and sleep quality and learn the impact these factors can have on variables such as behavior. To do this, several studies investigated the relationship between sleep and neurobehavioral functioning (Blunden & Chervin, 2008; Ravid, Afek, Suraiya, Shahar, & Pillar, 2009) and found that sleep problems undeniably have an impact on children's daytime functioning, leading to more irritability, restlessness, symptoms of depression, aggressive behavior, and inattention (Muñoz-Quintero & Bianchi, 2017). Other studies have also demonstrated the existence of a relationship between poor sleep quality and aggressive behavior towards peers, antisocial behavior, hyperactivity, and attention deficit (Beebe, 2011; Biggs et al., 2011). Additionally, Anderson and Platten (2011) showed that a single night of poor sleep is enough to increase reactivity and impulsiveness when facing adverse stimuli. Thus, sleep deprived individuals show more difficulty in inhibiting impulsive/aggressive responses.

Children with sleep problems also undergo emotional changes and display difficulties in managing their emotions, which in turn affects their behavior (Vriend et al., 2012). Poor sleep quality is at the base of the inability to appropriately experience and control emotions in varied contexts (Palmer, & Alfano 2015). It disrupts neurocognitive functioning and increases negative emotions, influencing the way that children experience them (Palmer, & Alfano 2015). Adequate sleep enables children to properly regulate their emotions by selecting and modifying situations and promoting attention mobilization, cognitive alteration, and response modulation. Moreover, it enhances the ability to identify an emotion as problematic and select and implement an appropriate emotionally regulated strategy. Van der Helm, Gujar, Matthew, and Walker, (2010) believe that sleep deprivation undermines the recognition of human emotions and suggest that sleep deficit interferes with affective neural systems, making it difficult to identify those emotions. This difficulty in emotional recognition may be associated with bullies reduced empathy in the interpersonal context, hindering the recognition of the victim's suffering. Interestingly, Vriend and colleagues (2012) found that the emotional difficulties of children with sleep deficits tend to decrease when

sleep quality is restored. Sleep breathing disorders are often associated with these problems. So, children who suffer from these disorders, usually sleep less and reveal a greater tendency to develop behavioral problems, such as bad conduct and indiscipline in school, compared to children who do not suffer from such disorders (O'Brien et al., 2011).

Children with sleep difficulties reveal greater evidence of attention problems, impulsiveness, and aggressive behaviors (Wang, et al. 2014). Therefore, sleep quality influences the occurrence of aggressive behavior but the existence of bullying behaviors also affects sleep dynamics (Gomes, Ferreira, Silva, & Castro Caldas, 2017). As such, children involved in bullying have worse sleep quality, shorter sleep length, greater sleep latency, and are more prone to develop sleep disorders. Sleep quality may have a moderator effect on aggression in children. This suggests that aggressive children are more vulnerable to sleep deprivation and, consequently, may manifest aggressive reactivity (Kubiszewski, Fontaine, Potard, & Gimenes, 2014).

### **1.2. Influence of Electronic Devices on Bullying Behaviors**

Devices such as television, computers, smartphones, and tablets are part of children's lives from early on and therefore its prevalence and usage are greatly increasing, which has brought severe consequences for children's development (Goh, Bay, & Chen, 2015).

The school-aged population is exposed to a set of stimuli that delays bedtime and reduces the number of hours asleep. The time before going to bed is frequently spent with activities such as watching television, surfing the internet, and playing video games. Due to the daily overload of working hours, parents tend to let their children stay awake until later (Oka, Susuki, & Inoue, 2008). Consequently, the American Psychological Association (2015) affirms that children are spending about five hours of daily contact with electronic devices and should only be spending up to two.

Smaller devices with Internet access such as smartphones and tablets are particularly worrisome since they may be used anywhere, anytime, and provide access to diverse content and applications. Also, their miniature size requires them to be used near the eyes, increasing the impact of the screen light on the release of the sleep hormone, melatonin. Similarly, the sound of incoming messages or calls may also delay bedtime or promote awakening. Children who regularly use smaller devices show more sleep deficits than children who prefer watching television (Falbe et al., 2018). Arora, Brogliac, Thomas, and Taheri (2014) consider that frequent use of all types of technology is associated with poor sleep quality on weekdays. The researchers believe that listening to music or playing video games regularly before going to bed significantly prolongs sleep onset. The study also found a relationship between difficulty in falling asleep and the frequent use of smartphones, video games, and social networks. Nevertheless, the effect of listening to music on sleep is greater. Arora and colleagues concluded that frequent use of technology before bedtime and during work days is associated with disturbing effects on different sleep parameters.

The existence of electronic devices in children and adolescents' bedroom has a negative impact on sleep hygiene because its presence facilitates its usage, thus delaying bedtime (Falbe, Davison, Franckle, & Ganter, 2018). The excessive use of electronic devices is related to an increase of children and adolescents' body weight and sedentary lifestyles (Zaman & Mifsud, 2017). The simple presence of

electronic devices, such as video games or televisions, in children's rooms can foster an increase of activity before bedtime, which negatively influences the sleep-vigil patterns (Oka, Susuki, & Inoue, 2008).

The time that children spend using electronic devices varies considerably. The way they use them, whether in individual or social context, is also a factor to consider. The frequent use of these devices in an individual context can accentuate psychosocial and socioemotional difficulties at the level of peer interaction or interpersonal skills (Hinkley, Timperio, Salmon, & Hesketh, 2017). Children's exposure to violent video games may exhibit aggressive behaviors which have a negative impact on the quality of interpersonal relationships. Ferguson and colleagues (2014) explored this issue and did not find evidence of a higher frequency of bullying behavior among children and adolescents who played violent video games. Other authors like Milani, Camisasca and Caravita (2015) observed that children and adolescents who preferred violent games exhibited greater indicators of externalization and aggression. This data reinforces the relationship between violent video games and problems of aggressive behavior in childhood and early adolescence.

School bullying is often related to cyberbullying. Children who resort to cyberbullying are often bullies or aggressive victims who find in the electronic devices a way to maintain aggression after school (Cross Lester, & Barnes, 2015). Children's easy access to technology brings not only benefits but also risks because it increases the possibility of becoming victims of aggressive attacks carried out by their peers through the electronic devices. For this reason, electronic aggression is a severe problem of public health (Ferguson, C. & Olson, C., 2014).

There is still no consensus among researchers about the influence of the use of electronic devices on children's behavior. However, some studies point out to difficulties of an interpersonal nature in emotional self-regulation of children and adolescents who frequently use electronic devices.

### **1.3. Sleep Quality and the use of Video games by School-Aged Children**

Concerning the use of video games and its frequency during childhood (Parent et al., 2016), recent research has examined the influence of general technology use on sleep quality and sleep habits of children and adolescents (Beyens & Nathanson, 2018; Cain & Gradisar, 2010; Calamaro, Mason, & Ratcliff, 2009; Genuneit et al., 2018; Kevitiyagala et al., 2011; Moorman & Harrison, 2018). Hysing and colleagues (2015) developed a correlational study with 9.846 students to assess their sleep quality, considering a daily use of electronic devices before bedtime. The type of device and the frequency of use before bedtime were the main variables that showed a significant impact on sleep quality. This impact was already verified in more recent studies (Beyens & Nathanson, 2018; Cespedes et al., 2014; LeBourgeois et al., 2017; Moorman & Harrison, 2018), especially on sleep duration (Hysing et al., 2015). Other studies assessed sleep quality and the use of electronic devices before bedtime of school-aged children through actigraphy, which measured body temperature during the sleeping period (Paquin et al., 2014).

## **2. Problem Statement**

This research investigates the relationship between infant sleep quality, the use of electronic devices and video games before bedtime, and bullying behaviors in school context. Children who do not have an adequate sleep show difficulty in self-regulation, thus reacting more aggressively to their peers at school.

As a result, it is pertinent to question: does the use of electronic devices before bedtime affect children's sleep quality, causing them to display bullying behaviors in the school context?

### 3. Research Questions

This study aims to verify the relationship between the use of electronic devices before bedtime, sleep quality and bullying behaviors displayed by school-aged children in school.

- Is infant sleep quality and the use of electronic devices at bedtime related to bullying?
- Does the use of electronic devices before bedtime affect sleep duration and latency?

### 4. Purpose of the Study

This study aims to:

- characterize the sleep quality of the sample;
- observe if there is a relationship between the use of electronic devices before bedtime and children's sleep quality;
- find out if there is a significant relationship between sleep quality and bullying behaviors in school;
- verify the existence of a relationship between the use of electronic devices, sleep quality, and bullying behaviors in school-aged children;
- examine the relationship between the daily use of electronic devices before bedtime and infant sleep duration and latency.

### 5. Research Methods

In order to answer both research questions, two different studies with two samples from Portuguese elementary schools were created. The collected data was analyzed through quantitative methods. Both studies and respective findings will be addressed in the following sections.

#### 5.1. Study 1

##### 5.1.1. Participants

The sample included 860 children, aged between 6 and 12 years old ( $M = 8.5$ ,  $SD = 1.2$ ), who were attending elementary school. These were divided into male ( $N = 425$ , 49.4%) and female ( $N = 435$ , 50.6%). All the children met the inclusion criteria and were authorized to participate in the study by their parents.

**Table 01.** Characterization of the sample: gender and school year

	N	%
<b>Gender</b>		
Female	435	50,6
Male	425	49,4
<b>Age (M; SD)</b>	8.5 (1.2)	
<b>School year</b>		
1 <sup>st</sup> year	189	22,0

2 <sup>nd</sup> year	200	23,3
3 <sup>rd</sup> year	222	25,8
4 <sup>th</sup> year	249	29,0

## 5.2. Materials and Procedure

The instruments used are suitable for measuring the variables under study. The children completed a set of three questionnaires: a sociodemographic questionnaire, the Pittsburgh Sleep Quality Index, and the Bullying Questionnaire - aggressiveness among children in the school setting. Parents completed the Children's Sleep Habits Questionnaire.

### 5.2.1. Sociodemographic questionnaire

This questionnaire was created for the present investigation and can be divided into two parts. The first part contains questions about the sociodemographic characteristics of the child and parents. The second part contains questions about the child's sleeping habits, the use of electronic devices before bedtime and the presence of such devices in the bedroom.

### 5.2.2. Children's Sleep Habits Questionnaire (CSHQ-PT) (Owens, 2000, Portuguese version adapted by Silva, Silva, Braga, & Neto, 2014)

This is a retrospective questionnaire, composed of 45 items addressed to parents. It aims to analyze the sleep behavior of children between two and 10 years of age. It includes questions about common symptoms of sleep disorders in school-age children, such as bedtime resistance, sleep onset, sleep duration, sleep anxiety, nocturnal awakenings, sleep-disordered breathing, parasomnias, and daytime sleepiness. This questionnaire showed psychometric properties similar to the versions of other countries and is suitable for the assessment of sleep disorders in children (Silva, Silva, Braga, & Neto, 2014).

### 5.2.3. Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989; Portuguese version adapted by Ramalho (2007, cit. In Seixas, 2009)

The PSQI is considered a very effective instrument and can be administered to children from six years old. It aims to measure sleep quality and sleep patterns during the month prior to its administration. This questionnaire analyses seven parameters: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping pills, and dysfunction related to daytime sleepiness. It consists of 19 self-rated questions, of which 15 are multiple choice items and are related to the frequency of sleep disturbances and subjective sleep quality.

### 5.2.4. Bullying Questionnaire - aggressiveness among children in the school space (Olweus, 1989, Portuguese version adapted by Pereira & Tomás, 1994 and reviewed by Pereira & Melim, 2010)

This questionnaire is divided into 4 areas. The first integrates the sociometric data. The second identifies victimization behaviors, their frequency, how they happened, and where they occurred, characterizes aggression in terms of number, gender, and age of the aggressors, the aggressors' class, if teachers and school staff usually intervene in these situations, if the victims complained, if a classmate tried

to defend the respondent during the aggression, and finally the respondent's attitude when observing a peer being victimized. The third part of the questionnaire identifies aggressive behaviors carried out by the respondent and their frequency, the motivation for the aggression, and the participation in group bullying. The questionnaire ends by asking the respondent if he or she would help assaulting a classmate for not liking him or her (Melim, 2011).

### **5.3. Procedure**

Schools' principals were contacted and meetings were held, in order to explain the objectives and procedures of the study. The children took letters addressed to their parents, briefly explaining the purpose of the study and requesting their consent for their children's participation. The authorized children answered the questionnaires in the schools, the youngest ones were helped individually by the researchers, while the older ones filled the questionnaires in small groups or as a class. Parents had one week to fill the questionnaires at home and deliver them to the school secretaries, where they were collected by the researchers. All questionnaires were answered only once.

The collected data was inserted into a database and statistically analyzed. An initial analysis through descriptive statistics was performed using means, standard deviations, and frequency distribution. This procedure was followed by the main statistical analysis with SPSS software, version 25.0 of Windows.

### **5.4. Study 2: Preliminary Results**

The sample of this study is composed by 51 children, aged between 7 and 10 years old ( $M = 8.6$ ;  $SD = 1.0$ ), from which 28 are females ( $n = 54.9\%$ ) and 23 are males ( $n = 45.1\%$ ). The children attend public elementary schools from Cascais area, Lisbon district, 75% have brothers and 47% are from families living together in the same household (father, mother, and siblings). The mean age for mothers is 38.8 years old ( $SD = 4.2$ ) and for fathers is 40.8 years old ( $SD = 4.9$ ).

Instruments used were the Sociodemographic Questionnaire (1) and the Portuguese version of the Children Sleep Habits Questionnaire (CSHQ-PT). In the present study, the internal consistency was .71, considered as appropriate for our research development.

The statistical analysis was performed through absolute and relative frequency descriptive tests (%), as well as inferential statistics. The SPSS version 25 was used.

## **6. Findings**

### **6.1. Part I – Results**

The analysis of the sample's sleep habits revealed that children go to bed at 9:28 p.m., (average value) ranging from 8:00 p.m. to 11:30 p.m. The majority falls asleep easily (52.4%), enjoys sleeping (83%), and almost all are supervised by their parents at bedtime (96.3%). Before sleeping, most children watch television (81.7%), play games (65.2%), and do not use the cell phone (87.3%) or listen to music (82.7%). The devices most commonly used are Tablets (40.2%) and Playstation (20.3%). Most of the children who play games before going bed, do it in the living room (70.8%) or in the bedroom (42.6%).



### 6.1.1. Bullying behaviour

Children who claim having been victims of bullying represent almost 70% of the sample. 61.2% claimed they had also performed one aggressive behavior. Those that were only victimized (n = 233) represent 27.1%, while those who only performed aggressions (n = 62) represented 7.2% of the sample.

### 6.1.2. Sleep quality

According to the cut-off values of the CSHQ-PT, we can identify 50.3% (n = 433) of children with sleep disturbances. These results point to the existence of a statistically significant relationship between sleep quality and bullying behaviours,  $\chi^2(3) = 27.795$ ,  $p = .001$ . Children who are neither victims nor aggressors have better sleep quality (28.7% vs 13.5%) than children categorized simultaneously as victims and aggressors with poor sleep quality (50.5% vs 38.1).

The data obtained through the Pittsburgh Sleep Quality Index (PSQI) revealed the following statistically significant differences:

**Table 02.** Bullying and sleep quality (PSQI dimensions)

	Not a victim or aggressor		Only aggressor		Only victim		Aggressive-victim		F
	Aver.	SD	Aver.	SD	Aver.	SD	Aver.	SD	
Subjective Sleep Quality	,44	,61	,68	,81	,64	,90	,71	,80	7.267***
Sleep latency	,74	,95	,92	1,08	,91	1,05	,96	1,02	2.134
Sleep duration	,02	,16	,02	,13	,03	,24	,03	,21	0.188
Transformed sleep efficiency	,05	,30	,03	,18	,06	,30	,07	,34	0.311
Sleep Disorders	1,10	,57	1,34	,57	1,29	,59	1,40	,60	11,590***
Use of sleeping pills	,44	,61	,68	,81	,64	,90	,71	,80	7,267***
Daytime dysfunction	,31	,74	,56	,97	,59	,93	,66	,93	8,470***
Global PSQI	3,08	2,33	4,21	3,06	4,11	2,88	4,51	2,82	14,480***

\*  $p \leq .05$  \*\*  $p \leq .01$  \*\*\*  $p \leq .001$

*Subjective sleep quality*,  $F(3, 246,211) = 7,267$ ,  $p = .001$ , children categorized simultaneously as victims and aggressors have significantly higher values in this dimension than those who are neither victims nor aggressors.

*Sleep disturbances*,  $F(3, 248,318) = 11,590$ ,  $p = .001$ , children considered neither victims nor aggressors reveal significantly lower values in this dimension than the rest.

*Use of sleeping pills*,  $F(3, 246,211) = 7,267$ ,  $p = .001$ , children categorized simultaneously as victims and aggressors obtain significantly higher values in this dimension than those who are neither victims nor aggressors.

*Daytime dysfunction*,  $F(3, 245,256) = 8,470$ ,  $p = .001$ , children considered simultaneously victims and aggressors exhibit significantly higher values in this dimension than those categorized as neither victims nor aggressors. Children considered victims have significantly higher values in this dimension than those categorized as neither victims nor aggressors.

*Global PSQI*,  $F(3, 243-816) = 14-480$ ,  $p = .001$ , children categorized as neither victims nor aggressors score significantly lower than the rest.

### 6.1.3. Sleep quality and use of electronic devices before bedtime

We did not find statistically significant differences in sleep quality and sleep disturbances due to watching television before bed.

Children who play games before bedtime show significantly higher values in the Global PSQI,  $t(858) = -2.467, p = .014$ ; and in the dimensions of Sleep latency,  $t(858) = -2.817, p = .005$ ; Sleep Disorders,  $t(858) = -2.815, p = .005$ ; Parasomnia,  $t(858) = -3.217, p = .001$  and Sleep-Disordered Breathing,  $t(858) = -2.230, p = .026$ .

Children who talk on the cell phone before bedtime have significantly higher values in the dimension of Sleep disturbances,  $t(858) = -2.294, p = .023$ .

Children who listen to music before bedtime have significantly higher values in the Global PSQI,  $t(858) = -2.625, p = .009$ ; in the dimensions of Sleep Disorders,  $t(858) = -3.948, p = .001$ ; Daytime Dysfunction,  $t(858) = -3.037, p = .003$ ; Total CSHQ,  $t(858) = -2.134, p = .034$ ; Nighttime awakenings,  $t(858) = -2.344, p = .020$  and Parasomnia,  $t(858) = -3.329, p = .001$ .

The relationship between watching television before bedtime and bullying behaviors is not statistically significant,  $\chi^2(3) = 0.624, p = .89$ . Similarly, the relationship between playing games before bedtime and bullying behaviors is also not statistically significant,  $\chi^2(3) = 5.599, p = .133$ . Finally, the relationship between talking on the cell phone before bedtime and bullying behaviors is not statistically significant,  $\chi^2(3) = 2.842, p = .417$ .

The relationship between listening to music before bedtime and bullying behaviors is statistically significant,  $\chi^2(3) = 10.416, p = .015$ . There is a significantly higher proportion of children categorized simultaneously as neither victims or abusers who do not usually listen to music before bedtime.

## 6.2. Part II – Results

72.8% of school-aged children watch television before bedtime and 43.1% play video games frequently on several electronic devices (parents identified the devices that are most commonly used: tablets). Other activities were also performed before bedtime (Table 03).

**Table 03.** Activities before bedtime: use of electronic devices and frequency

Activities	No (N)	%	Yes (N)	%
Television	14	27.5	37	72.5
Video games	29	56.9	22	43.1
Smartphone	46	90.2	5	9.8
Listening to music	45	88.2	6	11.8

Results revealed a statistically significant relationship between the use of electronic devices before bedtime and sleep quality (regarding 8 subscales). More specifically, this study found a negative correlation between video games and sleep onset ( $r = -.430$ ). The correlation has remained negative and statistically significant for daytime sleepiness ( $r = .399$ ). Frequent use of electronic devices before bedtime is moderately related to its negative impact on children's sleep quality.

## **7. Conclusion**

### **7.1. Study 1**

Playing video games before bedtime revealed to have a significant impact on general sleep and specifically on sleep latency, sleep disturbances, parasomnias, and sleep-disordered breathing. These results support the findings of Mundy et al. (2016), who related the activation caused by video games to sleep onset difficulties, poor sleep quality in general and behavioural changes.

Talking on the cell phone before bedtime significantly affects sleep in general and specifically in the dimension of sleep disturbances. This finding is in line with a study by Van den Bulck (2003).

Our results indicate that listening to music affects sleep in general and is particularly related to sleep disturbances, such as daytime dysfunction, nocturnal awakenings, and parasomnias. Although there are not many studies associating music audition with sleep quality, Arora et al. (2014) found a relationship between listening to music before bed and a reduction of sleep length during the weekdays and a sleep onset about seven minutes longer. However, it is important to point out that the nature of the mechanisms that influence the relationship between listening to music and sleep is not yet fully understood.

No significant relationship was found between exposure to television and sleep quality. We also did not find a relationship between the use of television, video games, and cell phones before bedtime and bullying behaviors. However, a significant relationship was found between listening to music before bedtime and bullying behavior. There is a higher proportion of children not involved in bullying who do not usually listen to music before bedtime (24.9% vs. 14.1%).

### **7.2. Study 2**

The results of this study confirmed the negative impact of video games use on children's sleep quality, specifically concerning sleep onset and daytime sleepiness. Our results are supported by previous studies that demonstrated the negative impact of children's use of electronic devices before bedtime (Beyens & Nathanson, 2018; Brunborg et al., 2011; Cespedes et al., 2014; Gradisar et al., 2013; Higuchi et al., 2005; Hysing et al., 2015; LeBourgeois et al., 2017; Moorman & Harrison, 2018; Nathanson & Beyens, 2016; Oka et al., 2008; Parent et al., 2016; Weaver et al., 2010).

Sleep latency - a measure of the time between sleep onset and REM sleep – was severely affected by the frequent use of video games before bedtime. Our analysis revealed that a high percentage of children play video games daily for 30 minutes (52.2%) or 60 minutes (13.0%). The data showed that children are authorized by their parents to use the electronic devices before bedtime under their supervision and monitorization (parents establish times for the use of the devices). Nevertheless, our data also showed that children display daytime sleepiness during school hours.

In fact, the use of electronic devices, mainly video games, may be the cause of sleep loss and may create high levels of vigil states with the “dislocation” of the sleep onset of children (Arora et al., 2014). This behavior may lead to a longer sleep latency and consequently daytime sleepiness, which in turn may interfere with the academic and cognitive performance on school tasks. This study should be replicated with similar populations (mainly school aged populations) in order to examine how the use of electronic devices (and respective schedules at home) may affect sleep and the general development of human beings.

Parents should learn the importance of establishing appropriate times for the use of video games, its duration, and frequency.

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