

# Sleep in adolescence: sex matters?

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## ABSTRACT

**Objective:** Sleep is of utmost importance for everybody and especially for adolescents who face life and leisure challenges that may impair their sleep. This study aimed to verify if girls are at a higher risk to present sleep problems and if associations of a sleep perception are different between sexes even when accounting for biological maturation. **Methods:** Data is from the HBSC Portuguese survey 2014, all variables were self-reported. Participants were 3869 adolescents (2057 girls), mean age 14.8 years. Participants' socio-demographic characteristics included sex, age, school grade, father and mother education; besides participants were inquired about sleep duration and characteristics of their sleep quality. **Results:** Sleep deprivation was reported by 13.1% of the adolescents (girls 14.3%, boys 11.7%,  $p < 0.05$ ). The most prevalent characteristics of poor sleep quality were waking up tired (50.8%) and difficulties falling asleep (19.5%), for both girls presented higher prevalence than boys. Overall, girls presented a poorer sleep health with low quality and quantity of sleep. Furthermore, associations of an enough and good sleep were different between boys and girls, even when controlling for the impact of delayed pubertal maturity. **Discussion:** Together with screen time, substance use, poorer nutrition, sedentary behaviours and abuse of screen time, sleep is an issue that must be addressed by professionals, families and public policies with impact in family life and family routines. Modelling a health education in schools should include the sleep topic. In addition, yes, sex matters and must be included on board.

**Keywords:** sleep deprivation; sleep quality; adolescent; gender and health; health behaviour.

## INTRODUCTION

Sleep is fundamental for health and quality of life<sup>1,2</sup>. In spite of recent recommendations<sup>3</sup> it may be difficult to determine the adequate sleep need for adolescents<sup>4</sup>, but it is possible to describe specific features of disturbed sleep that can compromise optimal daytime functioning, including mainly poor sleep quality, difficulty falling asleep and waking up frequently during the night<sup>5</sup>. These aspects may result in daytime sleepiness and further sleep disorders, bringing more difficulties when dealing with academic, social and emotional demands and putting at risk a healthy development<sup>6</sup>.

The biological and social changes that occur during adolescence can disrupt health and behaviour, including sleep<sup>7</sup>. For instance, screen time is pointed out as having a harmful effect on young people's sleep<sup>8,9</sup>. Furthermore, during adolescence the central circadian clock starts to shift later, i.e., there is a phase delay<sup>10</sup>. Additionally, one important factor influencing the sleep of adolescents are the school schedules, namely the school starting time, that together with other factors such as circadian phase delay, bedtime autonomy, academic pressure, screen time and social networking, nudges adolescents to late bedding and early rising<sup>11</sup>. Also, higher sedentary time, higher adiposity markers and increased and inadequate food intake are associated with short sleep duration<sup>12</sup>. Adolescents with less-healthy sleeping patterns have lower scores on emotional, social, school, psychosocial functioning, and global quality of life<sup>6,13</sup>, and adolescents who are sleep deprived experience less positive and more negative effects<sup>14,15</sup>. Sleeping less than recommended for adolescents is also linked to symptoms of depression and lower self-esteem<sup>16</sup>. Most investigations about adolescents' sleep show a pattern of later sleep timing and reduced sleep duration as they grow older with a tendency to increase sleep debt along pubertal stages<sup>4,17</sup>. In spite of contradictory results in the past, this epidemic of sleep deprivation during adolescence appears to be present both in younger and older teenagers, and in boys and girls<sup>18</sup>.

Since early adolescence, studies have shown that there are sex differences in sleep quality and quantity<sup>19,21</sup>, with girls reporting more complains about poor sleep than boys. It is suggested that girls' poor sleep may be related with psychological issues, such as depression and anxiety symptoms, and emotion-focused coping strategies, regardless of age<sup>19</sup>. Furthermore, differences can also be associated with consumption of caffeine or other substances, since more girls than boys drink caffeine drinks after dinner<sup>21</sup>. When looking at sex differences in adolescents' sleep, researchers have found that girls have more irregular sleep patterns, with longer time in bed, more sleep time and later wake up times than boys during weekends<sup>22</sup>. These differences appear to be related with female higher pubertal stages when compared to boys of the same chronological age, evidencing the already described association between puberty and sleep mechanisms. Lee et al.<sup>23</sup> have demonstrated that girls had significant earlier wake times during weekdays than boys and that they were more likely to report daytime sleepiness or even falling asleep more easily during the afternoon. However,

there were no sex differences in self-reported difficulty falling asleep and daytime sleepiness.

Regarding sex differences in the circadian phase preference, there are contradictory results that may be related with changes in sexual hormones production<sup>24</sup>. The tendency for eveningness is probably linked with the release of sexual hormones, which can explain the rapid progression of this chronotype in adolescents. Roenneberg et al.<sup>25</sup> have already stated that women have their peak of eveningness earlier than men, supporting the notion that sexual hormones may play an important role in circadian regulation of sleep. Both boys and girls have later bedtimes across higher pubertal stages and there are some evidence sustaining the hypothesis of a greater influence of puberty in the adolescent sleep phase delay, more than psychosocial factors which appear to be less influential regarding phase preference<sup>26</sup>. However, some psychosocial factors like light exposure, such as screen time, at night are also suggested to have an essential role on phase delay of adolescents<sup>8,9</sup>. This pattern appears to be more significant in girls, although it could be related to methodological issues since some female samples present higher percentage of advanced stages of maturation than boys<sup>26</sup>. Notwithstanding, some studies have not found any sex differences in sleep complaints and patterns, suggesting a sociocultural influence that can minimize biological sleep regulatory processes<sup>27</sup>. Looking at sleep structure<sup>28</sup> it appears that girls spend less time in rapid eye movement (REM) sleep, have lower REMs activity and lower REMs density. There is still much to learn about a sex related framework of adolescent sleep patterns, since studies have reported conflicting results when comparing boys and girls<sup>28</sup>. Furthermore, it is important to recognize that the need for sleep appears to be relatively stable across adolescents' development in spite of all the developmental changes and sex differences<sup>18</sup>.

The underlying mechanisms that can explain the differences between sexes are not clear<sup>29,30</sup>. However, biological maturation, levels of physical activity, excessive use to electronic equipment, eating habits and substance consumption may explain the differences<sup>31,32</sup>. Therefore, this study aimed to verify if girls are at a higher risk to present sleep problems both in quantity and quality of sleep, and if associations of a good or a poor sleep perception are different between boys and girls either considering the comparison of same age boys and girls either introducing an age gap to balance delayed puberty in boys (2 years).

## METHODS

### Study design, participants and procedures

The present study uses data from the Health Behaviour in School-Aged Children (HBSC) Portuguese survey 2014<sup>33</sup>. HBSC is a nationally representative school-based survey on health behaviours and lifestyles and their context in young people conducted every four years<sup>34</sup>. The HBSC Portuguese database comprises a representative sample of 6026 adolescents. However, for this study only students from grades 8 and 10 were selected, because the questions about sleep were only addressed

to them, according to the national survey design, meaning students from grade 6 were therefore excluded ( $n=2157$ ). The final sample consisted of 3869 adolescents (2057 girls 53.2%, 1812 boys 46.8%), aged 13-19 years old (mean age= $14.8\pm 1.2$ ).

Public schools were randomly selected from a nationwide list, stratified geographically by administrative and educational regional divisions, and a self-administered questionnaire was applied to the students. The administration of the survey was conducted by trained teachers during class time, according to standard guidelines from the HBSC survey protocol<sup>34</sup>. Written consent from school administrators, legal guardians, and adolescents was previously obtained. Participation was voluntary, anonymous, and there were no incentives to participation. Research was conducted in accordance with both the Ethical Committee of Oporto Medical School and the National Data Protection System.

## Measures

All variables were self-reported. Participants' socio-demographic characteristics included sex, age, school grade, father education and mother education (response options: no education, primary school, middle school, secondary school and superior education). Adolescents were asked to report sleep deprivation and frequency of some characteristics of their sleep quality, such as sleeping less than wanted, having difficulties falling asleep, waking up tired and waking up in the middle of the night. It was inquired how many hours of sleep they have the nights before school days and the nights before non-school days (weekends). Sleep deprivation was defined as the difference between the reported hours of sleep before non-school days (weekend), minus the reported hours of sleep before school days: Sleep deprivation was considered when that difference was 3 hours or more<sup>6,35-37</sup>.

As for characteristics of their sleep quality response options were "rarely/never", "sometimes" and "always", and were posteriorly dichotomized into "no" ("rarely/never") and "yes" ("sometimes" and "always").

Adolescents were asked the number of days over the past week that they were physically active for a total of at least 60 minutes per day. Responses were given on an 8-point scale (0 = none to 7 = daily) and were posteriorly dichotomized into  $\leq 6$  times per week and daily, according to the physical activity guidelines (38). To assess sedentary behaviour, adolescents were requested to indicate the usual daily time spent watching TV (hours); it was dichotomized into  $\geq 4$  hours and  $< 4$  hours daily. Adolescents reported the frequency they ate fruit and vegetables and the frequency they drank alcohol drinks, such as beer, wine, and liquor/spirits. For fruit and vegetables consumption, the options were "never", "less than once a week", "once a week", "2-4 days a week", "5-6 days a week", "once every day" and "several times every day". The answers were dichotomised into not every day and every day, because fruit and vegetable are recommend to be eaten daily<sup>39,40</sup>. For each alcoholic drink, response options were "never," "rarely," "every month," "every week," and "every day". Responses were dichotomised into drinking

(independently of the frequency) and not drinking. Tobacco smoking habits was defined based on the question "How often do you smoke tobacco at present?" Answers options ranged from "every day" to "never". Since there is no threshold of safety for smoking, responses were dichotomized into smoking (regularly or sometimes), and not smoking. The following subjective health complaints were assessed: headache, sadness and tiredness. Adolescents were questioned about the frequency of subjective health complaints during the last six months on a five-point scale ranging from 1='rarely or never' to 5='about every day'. For the analysis, responses were recoded into "at least once a month" (from points 2 to 5) and "rarely or never".

## Data analysis

Descriptive statistics (means, standard deviation and percentages) were calculated for the entire sample, and according to sex. Student t-test, Fisher's exact test and Chi square were used to assess the differences between sexes, sleep deprivation and characteristics of sleep quality. Associations between sleep deprivation, characteristics of sleep quality, health behaviours and subjective health complaints were assessed using the Fisher's exact test. Significant associations at this stage for sleep deprivation and each characteristics of sleep quality were included in posterior regression analyses. The relationship between sleep deprivation, characteristics of sleep quality and selected health behaviours and subjective health complaints by sex and adjusted for age, and all other health behaviours and subjective health complaints was analysed using binary logistic regression models. Following, to mitigate the maturational gap between girls and boys, the relationship between sleep deprivation, characteristics of sleep quality and selected health behaviours and subjective health complaints for 8<sup>th</sup> grade girls and 10<sup>th</sup> grade boys was tested using binary logistic regression models. Statistical analyses were performed using IBM SPSS Statistics 22.0. The level of significance was set at 0.05.

## RESULTS

Table 1 shows the sample characteristics, sleep deprivation and characteristics of sleep quality for the general sample and stratified by sex. More than half the adolescents had parents with middle or secondary education (total 62.5%, girls 64.8%, boys 60.1%). Sleep deprivation was reported by 13.1% of the adolescents (girls 14.3%, boys 11.7%,  $p<0.05$ ). The most prevalent characteristics of sleep quality were waking up tired (50.8%) and difficulties falling asleep (19.5%), for both girls presented higher prevalence than boys (53.4% versus 47.9%,  $p<0.001$ ; 22.1% versus 16.7%,  $p<0.001$ ). Girls also presented higher prevalence than boys in waking up in the middle of the night (10.3% versus 7.7%,  $p<0.01$ ).

The associations between sleep deprivation, characteristics of sleep quality and health behaviours are presented in table 2. Adolescents who watched TV more than four hours a day woke up tired more often than those who watched TV less than four hours a day (58.6% versus 49.3 %,  $p<0.001$ ). While, eating fruit and vegetables daily was associated with lower

**Table 1.** Characteristics of the participants.

	M±SD or %			<i>p</i>
	Total	Girls	Boys	
Age	14.8±1.2	14.8±1.2	14.8±1.2	0.311
Grade				0.002
8 <sup>th</sup> grade	60.9	58.6	63.6	
10 <sup>th</sup> grade	39.1	41.4	36.4	
Father education				< 0.001
No education	1.2	0.6	18.1	
Primary school	1.8	19.8	17.7	
Middle school	36.0	38.2	33.6	
Secondary school	26.5	26.6	26.5	
Superior education	17.4	14.8	20.4	
Mother education				< 0.001
No education	0.9	0.3	1.6	
Primary school	11.8	13.3	10.1	
Middle school	35.9	37.2	34.3	
Secondary school	29.2	28.6	29.9	
Superior education	22.2	20.5	24.1	
Sleep deprivation	13.1	14.3	11.7	0.026
Sleep less	13.9	14.3	13.4	0.503
Difficulties falling asleep	19.5	22.1	16.7	< 0.001
Waking up tired	50.8	53.4	47.9	0.001
Waking up middle of the night	9.1	10.3	7.7	0.007

Age was tested by Student t-test; education was tested by Chi square test; all other variables were tested by Fisher's exact test.

prevalence of sleep deprivation (10.7% versus 14.0%,  $p<0.05$ ), of sleeping less (11.6% versus 14.8%,  $p<0.05$ ) and of waking up tired (45.9% versus 52.8%,  $p<0.001$ ). However, those who engaged in physical activity every day reported more often to have difficulties falling asleep (25.5% versus 18.7%,  $p<0.01$ ) and to sleep less (21.2% versus 12.9%,  $p<0.001$ ). Drinking alcohol, smoking, having headache at least once a month, being sad at least once a month and being tired at least once a month were more often associated with reporting sleep deprivation and all characteristics of sleep quality.

Table 3 shows the results of the logistic regression models that analysed the relationship of sleep deprivation and characteristics of sleep quality with health behaviours by sex. Girls were 38% ( $p<0.01$ ) and 47% ( $p<0.001$ ) less likely to report sleep deprivation if they ate fruit and vegetables every day and did not drink alcohol, respectively. While boys were 41% ( $p<0.01$ ) and 30% ( $p<0.05$ ) less likely to report sleep deprivation if they did not drink alcohol and rarely or never had headaches, respectively.

Girls and boys who engaged in physical activity every day had higher odds of reporting sleeping less (girls, OR=1.75, 95% CI: 1.01-3.03,  $p<0.05$ ; boys OR=2.30, 95% CI: 1.66-3.19,  $p<0.001$ ) and difficulties falling asleep (girls, OR=1.64, 95% CI: 1.03-2.63,  $p<0.05$ ; boys OR=1.89, 95% CI: 1.39-2.55,  $p<0.001$ ). Whereas, lower odds of sleeping less were related with not

drinking alcohol (OR=0.69, 95% CI: 0.51-0.92,  $p<0.05$ ), not smoking (OR=0.67, 95% CI: 0.47-0.96,  $p<0.05$ ), rarely or never being sad (OR=0.58, 95% CI: 0.43-0.78,  $p<0.001$ ) and rarely or never being tired (OR=0.51, 95% CI: 0.34-0.76,  $p<0.001$ ) for girls; and not drinking alcohol (OR=0.67, 95% CI: 0.49-0.92,  $p<0.05$ ), not smoking (OR=0.62, 95% CI: 0.40-0.95,  $p<0.05$ ), rarely or never having headache (OR=0.66, 95% CI: 0.47-0.92,  $p<0.05$ ) for boys. Last, lower odds of having difficulties falling asleep were related with rarely or never having headache (OR=0.62, 95% CI: 0.48-0.80,  $p<0.001$ ), rarely or never being sad (OR=0.50, 95% CI: 0.39-0.64,  $p<0.001$ ) and rarely or never being tired (OR=0.70, 95% CI: 0.52-0.95,  $p<0.05$ ), for girls; and rarely or never having headache (OR=0.64, 95% CI: 0.47-0.87,  $p<0.01$ ) and rarely or never being sad (OR=0.70, 95% CI: 0.51-0.96,  $p<0.05$ ), for boys.

Girls watching TV less than four hours a day (OR=0.60, 95% CI: 0.44-0.82,  $p<0.01$ ), eating fruit and vegetables every day (OR=0.72, 95% CI: 0.58-0.88,  $p<0.01$ ), not drinking alcohol (OR=0.68, 95% CI: 0.55-0.85,  $p<0.01$ ), rarely or never having headaches (OR=0.71, 95% CI: 0.58-0.88,  $p<0.01$ ), rarely or never being sad (OR=0.79, 95% CI: 0.64-0.97,  $p<0.01$ ) and rarely or never being tired (OR=0.63, 95% CI: 0.50-0.79,  $p<0.001$ ) had lower odds of waking up tired. While boys watching TV less than four hours a day (OR=0.70, 95% CI: 0.50-0.96,  $p<0.05$ ), not smoking (OR=0.69, 95% CI: 0.55-0.86,  $p<0.01$ ) and not drinking alcohol (OR=0.69, 95% CI: 0.48-0.99,  $p<0.05$ ) had lower odds of waking up tired. Waking up in the middle of the night was related with rarely or never having headaches (girls, OR=0.47, 95% CI: 0.32-0.68,  $p<0.001$ ; boys OR=0.55, 95% CI: 0.36-0.84,  $p<0.01$ ) and rarely or never being sad (girls, OR=0.47, 95% CI: 0.32-0.68,  $p<0.01$ ; boys OR=0.52, 95% CI: 0.34-0.80,  $p<0.05$ ) for both sexes. Additionally, waking up in the middle of the night was also related to not smoking (OR=0.62, 95% CI: 0.41-0.94,  $p<0.05$ ), and rarely or never being tired (OR=0.56, 95% CI: 0.34-0.91,  $p<0.001$ ) only for girls, and engaging in physical activity everyday (OR=2.18, 95% CI: 1.46-3.26,  $p<0.001$ ) and not being bullied (OR=0.52, 95% CI: 0.33-0.81,  $p<0.01$ ) only for boys.

In order to address the impact of the delayed pubertal maturity in boys compared to girls, older boys (10<sup>th</sup> grade,  $M_{age}=15.98\pm0.74$ , age range 15-19) were compared with younger girls (8<sup>th</sup> grade,  $M_{age}=13.96\pm0.75$ , age range 13-17). Sleep deprivation was reported by 10% of the younger girls and 15.8%, of the older boys ( $p<0.001$ ). The most prevalent characteristics of sleep quality were waking up tired (girls 50.8%, boys 49.8%), followed by difficulties falling asleep (girls 21.1%, boys 13.8%,  $p<0.001$ ), sleeping less (girls 10.3%, boys 14.3%,  $p<0.05$ ), and waking up middle of the night (girls 8.8%, boys 6.9%). Logistic regression models to analyse the relationship between sleep deprivation, characteristics of sleep quality and health behaviours for 8<sup>th</sup> grade girls and 10<sup>th</sup> grade boys are showed in table 4.

For girls, lower odds of sleep deprivation were associated with eating fruit and vegetables daily (OR=0.54, 95% CI: 0.32-0.90,  $p<0.05$ ) and not drinking alcohol (OR=0.34, 95% CI: 0.22-0.53,  $p<0.001$ ). Sleeping less was associated with smoking

**Table 2.** Associations between sleep deprivation, characteristics of sleep quality, health behaviours and subjective health complaints.

	Sleep deprivation (%)		Sleep less (%)		Difficulties falling asleep (%)		Waking up tired (%)		Waking up middle of the night (%)	
	Yes	<i>p</i>	Yes	<i>p</i>	Yes	<i>p</i>	Yes	<i>p</i>	Yes	<i>p</i>
Physical activity		0.753		< 0.001		0.001		0.798		0.007
≤6 days/week	13.1		12.9		18.7		50.8		8.6	
Every day	12.4		21.2		25.5		51.5		12.8	
TV		0.113		0.484		0.195		< 0.001		0.133
≥4 hours/day	15.6		15.1		21.9		58.6		6.9	
<4 hours/day	12.5		13.7		19.0		49.3		9.2	
Fruit and vegetables		0.010		0.011		0.612		< 0.001		0.751
Not every day	14.0		14.8		19.7		52.8		9.0	
Every day	10.7		11.6		19.0		45.9		9.3	
Drink alcohol		< 0.001		< 0.001		0.007		< 0.001		0.024
Yes	19.2		19.5		21.9		58.7		10.4	
No	9.4		10.6		18.1		46.1		8.2	
Smoke cigarettes		< 0.001		< 0.001		0.002		< 0.001		< 0.001
Yes	19.1		24.9		25.4		63.1		15.6	
No	12.3		12.5		18.8		49.2		8.3	
Headache		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
At least once a month	16.3		17.7		26.1		57.7		13.8	
Rarely/never	10.7		11.1		14.8		45.8		5.7	
Sadness		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
At least once a month	16.1		19.5		28.4		57.8		14.8	
Rarely/never	11.4		10.8		14.7		46.9		5.9	
Tiredness		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
At least once a month	15.3		16.5		22.5		55.6		10.9	
Rarely/never	9.5		9.7		14.9		43.1		6.2	
Being bullied		0.165		0.003		< 0.001		0.129		< 0.001
Yes	15.1		18.7		26.2		54.2		15.4	
No	12.6		13.2		18.5		50.3		8.2	

All variables tested with Fisher's exact test.

(OR=0.53, 95% CI: 0.29-0.97,  $p<0.05$ ) and tiredness (OR=0.46, 95% CI: 0.27-0.78,  $p<0.01$ ), while having difficulties falling asleep was associated with sadness (OR=0.58, 95% CI: 0.42-0.81,  $p<0.01$ ), tiredness (OR=0.65, 95% CI: 0.45-0.94,  $p<0.01$ ) and headaches (OR=0.64, 95% CI: 0.46-0.89,  $p<0.05$ ). Watching TV less than four hours a day (OR=0.56, 95% CI: 0.39-0.79,  $p<0.01$ ), eating fruit and vegetables every day (OR=0.63, 95% CI: 0.48-0.83,  $p<0.01$ ), not drinking alcohol (OR=0.66, 95% CI: 0.48-0.90,  $p<0.05$ ), rarely or never being sad (OR=0.73, 95% CI: 0.55-0.98,  $p<0.05$ ) and rarely or never being tired (OR=0.62, 95% CI: 0.47-0.83,  $p<0.01$ ) were associated with lower odds of waking up tired. Not smoking (OR=0.51, 95% CI: 0.27-0.96,  $p<0.05$ ), rarely or never being sad (OR=0.47, 95% CI: 0.28-0.79,  $p<0.01$ ) and rarely or never having headaches (OR=0.54, 95% CI: 0.33-0.89,  $p<0.05$ ) were associated with lower odds of waking up in the middle of the night.

For boys, not drinking alcohol was associated to lower odds of reporting sleep deprivation (OR=0.60, 95% CI: 0.37-0.97,  $p<0.05$ ), sleeping less (OR=0.46, 95% CI: 0.27-0.77,  $p<0.01$ ), difficulties falling asleep (OR=0.55, 95% CI: 0.33-

0.92,  $p=0.023$ ) and waking up tired (OR=0.62, 95% CI: 0.44-0.87,  $p<0.01$ ). Similarly, rarely or never having headaches was related to lower odds of sleep deprivation (OR=0.58, 95% CI: 0.35-0.96,  $p<0.05$ ), sleeping less (OR=0.48, 95% CI: 0.28-0.82,  $p<0.01$ ) and difficulties falling asleep (OR=0.49, 95% CI: 0.29-0.82,  $p<0.01$ ). On the other hand, engaging in physical activity every day was related to higher odds of sleeping less (OR=2.67, 95% CI: 1.49-3.44,  $p<0.01$ ). A synoptic view of typical sexed differences for girls is displayed in figure 1.

## DISCUSSION

Quantity and quality of sleep problems are related to a large myriad of other health problems, and this association is already present in adolescence<sup>5,7,13,36,37</sup>. Similar to many other health related behaviours/situations, sleep is a sexed issue, as several researchers report sex differences in sleep quality and quantity that tend to harm girls more<sup>19-21</sup>. What this study adds to the previous ones is that it surfaced that not only sleep patterns are different in boys and girls, but that also the patterns of other features associated to a better or worse quality of sleep follow this pattern, suggesting that tailored interventions that

**Table 3.** Relationship between sleep deprivation, characteristics of sleep quality, health behaviours and subjective health complaints by sex (logistic regression).

	OR (95% CI)				
	Sleep deprivation	Sleep less	Difficulties falling asleep	Waking up tired	Waking up middle of the night
<b>Girls</b>					
Physical activity Every day		1.75 (1.01-3.03)	1.64 (1.03-2.63)		1.22 (0.64-2.34)
TV <4 hours/day				0.60 (0.44-0.82)	
Fruit and vegetables Every day	0.62 (0.45-0.86)	0.79 (0.58-1.08)		0.72 (0.58-0.88)	
Drink alcohol No	0.53 (0.39-0.71)	0.69 (0.51-0.92)	1.03 (0.80-1.33)	0.68 (0.55-0.85)	1.04 (0.75-1.44)
Smoke cigarettes No	0.86 (0.59-1.25)	0.67 (0.47-0.96)	0.92 (0.65-1.29)	0.88 (0.64-1.22)	0.62 (0.41-0.94)
Headache Rarely/never	0.82 (0.61-1.10)	0.89 (0.66-1.20)	0.62 (0.48-0.80)	0.71 (0.58-0.88)	0.47 (0.32-0.68)
Sadness Rarely/never	0.91 (0.67-1.22)	0.58 (0.43-0.78)	0.50 (0.39-0.64)	0.79 (0.64-0.97)	0.46 (0.32-0.66)
Tiredness Rarely/never	0.78 (0.55-1.12)	0.51 (0.34-0.76)	0.70 (0.52-0.95)	0.63 (0.50-0.79)	0.56 (0.34-0.91)
Being bullied No		0.73 (0.50-1.07)	0.84 (0.61-1.17)		0.70 (0.47-1.04)
<b>Boys</b>					
Physical activity Every day		2.30 (1.66-3.19)	1.89 (1.39-2.55)		2.18 (1.46-3.26)
TV <4 hours/day				0.70 (0.50-0.96)	
Fruit and vegetables Every day	1.07 (0.76-1.51)	0.78 (0.56-1.08)		0.83 (0.66-1.03)	
Drink alcohol No	0.59 (0.42-0.82)	0.67 (0.49-0.92)	0.80 (0.60-1.07)	0.69 (0.55-0.86)	1.09 (0.73-1.64)
Smoke cigarettes No	1.17 (0.71-1.94)	0.62 (0.40-0.95)	0.81 (0.53-1.25)	0.69 (0.48-0.99)	0.58 (0.33-1.03)
Headache Rarely/never	0.70 (0.50-0.99)	0.66 (0.47-0.92)	0.64 (0.47-0.87)	0.82 (0.64-1.05)	0.52 (0.34-0.80)
Sadness Rarely/never	1.05 (0.72-1.53)	0.87 (0.61-1.23)	0.70 (0.51-0.96)	0.93 (0.72-1.21)	0.60 (0.39-0.94)
Tiredness Rarely/never	0.79 (0.56-1.11)	0.93 (0.67-1.29)	1.15 (0.85-1.54)	0.85 (0.69-1.06)	1.36 (0.89-2.07)
Being bullied No		0.76 (0.51-1.13)	0.70 (0.49-1.00)		0.52 (0.33-0.81)

OR, odds ratio; CI, confidence interval

Reference categories: physical activity,  $\leq 6$  days/week; TV,  $\geq 4$  hours/day; Fruit and vegetables, not every day; Drink alcohol, yes; Smoke cigarettes, yes; Headache, at least once a month; Sadness, at least once a month; Tiredness, at least once a month; Being bullied, yes.

Analyses were adjusted for age and all other health behaviours.

Significant odds are in bold.

may include and differentiate the needs and characteristics of both sexes should be implemented.

A few researchers associate these sex differences to pubertal status that occurs earlier in girls<sup>4,17</sup>. To address this issue, older age-cohort boys were compared to younger age-cohort girls. Although a few sleep differences blurred, sex difference did not disappear when lowering the age pubertal difference by comparing 10<sup>th</sup> grade boys with 8<sup>th</sup> grade girls. Several studies point out that girls tend to present a less optimistic way of coping with life and are more frequently and intensely prone to worries with life in general, school issues, family issues and friends problems<sup>13</sup>. Furthermore, they associate these problems with poorer sleep. Klerman<sup>41</sup> even suggested that in laboratory controlled situations, there are no sex differences in sleep patterns but, when inquired about sleep quantity and quality females describe in general their sleep as poor. In that case, that would be a bias in the perception and not a real sex difference in sleep characteristics. Nevertheless, in the end, what happens is that women report (and live with) a lower perception of well-being, no matter if it is a reality or a perception.

In the present study, sleep deprivation (three or more hour difference between school weeknights and weekend nights) was around 13% overall and was more often reported by adolescent females. These results are different from previous findings

from older studies where the prevalence of sleep deprivation was around 19% and not differences between boys and girls were found<sup>6</sup>. The differences between sexes in this study may be explained as generally, the most prevalent characteristics of poor sleep quality were waking up tired and difficulties falling asleep, and for both, girls presented higher prevalence than boys. Previous studies have also found that girls have more health complaints than boys that may be related to sleep deprivation<sup>6</sup>. Additionally, some sex differences were found in the associations between sleep quality and health behaviour, as girls presented more associations that boys did. For instance, girls were less likely to report sleep deprivation if they ate more fruit and vegetables and did not drink alcohol, while boys were less likely to report sleep deprivation if they did not drink alcohol and rarely or never had headaches. Despite having different association patterns some similarities can be found, especially regarding drinking alcohol and watching TV. These behaviours were associated with the same characteristics of sleep quality in both sexes. Overall, some factors related to sleep deprivation, sleeping less, having difficulties to fall asleep, waking up tired and waking up in the middle of the night, are the same among boys and girls, but the strength of these associations might vary by sex, while some do not exist.

In order to take into account the hypothesis that sex differences in sleep observed among adolescents are linked to a

**Table 4.** Relationship between sleep deprivation, characteristics of sleep quality, health behaviours and subjective health complaints for 8th grade girls and 10th grade boys (logistic regression).

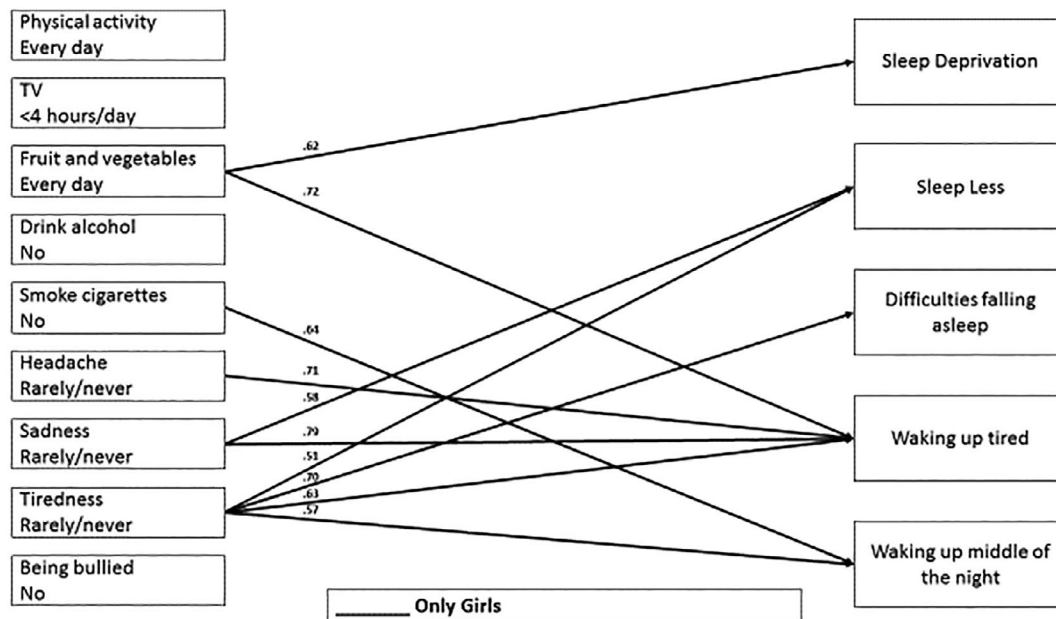
Girls	OR (95% CI)				
	Sleep deprivation	Sleep less	Difficulties falling asleep	Waking up tired	Waking up middle of the night
Physical activity Every day		1.66 (0.80-3.45)	1.74 (0.98-3.10)		1.34 (0.60-2.99)
TV <4 hours/day				0.56 (0.39-0.79)	
Fruit and vegetables Every day	0.54 (0.32-0.90)	0.67 (0.42-1.06)		0.63 (0.48-0.83)	
Drink alcohol No	0.34 (0.22-0.53)	0.86 (0.55-1.36)	0.99 (0.70-1.42)	0.66 (0.48-0.90)	1.02 (0.62-1.68)
Smoke cigarettes No	1.45 (0.70-3.01)	0.53 (0.29-0.97)	0.88 (0.52-1.50)	1.18 (0.71-1.96)	0.51 (0.27-0.96)
Headache Rarely/never	0.73 (0.46-1.16)	0.87 (0.56-1.35)	0.64 (0.46-0.89)	0.88 (0.67-1.16)	0.47 (0.28-0.79)
Sadness Rarely/never	0.98 (0.61-1.55)	0.73 (0.47-1.15)	0.58 (0.42-0.81)	0.73 (0.55-0.98)	0.54 (0.33-0.89)
Tiredness Rarely/never	0.80 (0.48-1.31)	0.46 (0.27-0.78)	0.65 (0.45-0.94)	0.62 (0.47-0.83)	0.62 (0.34-1.10)
Being bullied No		0.80 (0.48-1.33)	0.95 (0.63-1.41)		0.84 (0.49-1.45)
Boys	Sleep deprivation	Sleep less	Difficulties falling asleep	Waking up tired	Waking up middle of the night
Physical activity Every day		2.67 (1.49-3.44)	1.14 (0.58-2.24)		1.23 (0.50-3.06)
TV <4 hours/day				1.17 (0.62-2.21)	
Fruit and vegetables Every day	1.20 (0.73-1.96)	0.85 (0.49-1.46)		0.79 (0.54-1.15)	
Drink alcohol No	0.60 (0.37-0.97)	0.46 (0.27-0.77)	0.55 (0.33-0.92)	0.62 (0.44-0.87)	1.03 (0.53-2.03)
Smoke cigarettes No	1.26 (0.66-2.41)	0.77 (0.42-1.41)	0.99 (0.53-1.87)	0.63 (0.38-1.04)	0.71 (0.31-1.63)
Headache Rarely/never	0.58 (0.35-0.96)	0.48 (0.28-0.82)	0.49 (0.29-0.82)	0.78 (0.53-1.15)	0.65 (0.32-1.33)
Sadness Rarely/never	1.15 (0.67-1.97)	0.97 (0.56-1.68)	0.66 (0.38-1.12)	0.83 (0.55-1.25)	0.51 (0.25-1.03)
Tiredness Rarely/never	0.90 (0.55-1.49)	1.05 (0.61-1.79)	1.37 (0.80-2.34)	0.88 (0.61-1.25)	1.14 (0.55-2.38)
Being bullied No		1.04 (0.49-2.27)	0.74 (0.37-1.51)		0.46 (0.20-1.03)

OR, odds ratio; CI, confidence interval

Reference categories: physical activity, ≤6 days/week; TV, ≥4 hours/day; Fruit and vegetables, not every day; Drink alcohol, yes; Smoke cigarettes, yes; Headache, at least once a month; Sadness, at least once a month; Tiredness, at least once a month; Being bullied, yes.

Analyses were adjusted for all other health behaviours.

Significant odds are in bold.



**Figure 1.** Significant associations between sleep features and other health related variables (associations that were only significant for girls).

mere developmental gap (delay in puberty among boys), logistic regression models were carried out for 8th grade girls and 10th grade boys. Sleep deprivation was significantly less reported by 8<sup>th</sup> grade girls than by 10<sup>th</sup> grade boys, and sex differences regarding waking up tired or waking up in the middle of the night persisted, suggesting that regardless of the age maturational gap, girls have poorer sleep quality than boys. Additionally, the associations between sleep quality and health behaviour in these specific age groups showed, even more distinct patterns for each sex than when considering all ages. When considering the strength of the association, it was observed that for girls the stronger associations were for drinking alcohol and sleep deprivation, tiredness and sleeping less and headaches and waking up in the middle of the night. On the other hand, the stronger associations for boys were found for drinking alcohol, headaches, physical activity and sleeping less and between headaches and having difficulties falling asleep. This suggests that boys may be more affected by these behaviours in sleeping less and girls are affected in several ways. Furthermore, drinking alcohol may affect sleep in a greater way than other behaviour, especially in boys.

Overall girls presented a poorer sleep health with low quality and quantity of sleep, and the pubertal maturity gap was not convincing to explain these sex differences, because they did not disappear when comparing 10<sup>th</sup> grade boys with 8<sup>th</sup> grade girls. Furthermore, factors associated with an enough and a good sleep were different between boys and girls, even when the delayed pubertal maturity impact was taken into account. Girls seem on the whole less privileged regarding quantity and quality of sleep. However their sleep seems more positively affected by a good nutrition and more negatively affected by features related to negative psychological state (sadness, fatigue), while boys seem more negatively affected by negative physical states (headache), even if headaches are more frequent in girls. Substance use (alcohol and tobacco) have a negative impact on sleep quality and quantity in both sexes. Physical activity practise has only impact in boys, and the direction of the impact (impairing sleep) is still to be explored.

The present study had some limitations that must be acknowledged. The study was cross-sectional, which makes it impossible to establish cause-effect relationships among sleep quality and duration and the several health variables assessed. Furthermore, data was self-reported rather than objectively measured, which could be subject to bias. School schedules and caffeine consumption were not assessed and therefore its associations to sleep quality and quantity were unable to be analysed or be used as control variables, this is of importance as school schedules, namely beginning of classes and caffeine are associated with sleep. A major strength was the HBSC database that includes a large and representative sample of Portuguese adolescents.

With substance use, poorer nutrition, sedentary behaviours and abuse of screen time sleep quality and quantity are issues that must be addressed by professionals, families and public policies, having an increased impact in family life and family routines and modelling. Furthermore, because it has an obvious impact on daily functioning and, learning capacities, sleep is a

topic that has to be addressed by health education in schools more thoroughly. In addition, yes, sex matters and must be included on board, with developmentally adapted programs and messages, from early school years.

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