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How Are Adolescents Sleeping? Adolescent Sleep Patterns and Sociodemographic Differences in 24 European and North American Countries

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A B S T R A C T

Purpose: Insufficient and poor sleep patterns are common among adolescents worldwide. Up to now, the evidence on adolescent sleep has been mostly informed by country-specific studies that used different measures and age groups, making direct comparisons difficult. Cross-national data on adolescent sleep that could inform nations and international discussions are lacking. We examined the sleep patterns of adolescents across 24 countries and by gender, age, and affluence groups.
Methods: We obtained sleep data on 165,793 adolescents (mean age 13.5 years; 50.5% girls) in 24 European and North American countries from the recent cross-sectional Health Behaviour in School-aged Children surveys (2013–2014 and 2017–2018). For each country, we calculated the age-standardized mean in sleep duration, timing, and consistency and the proportions meeting

IMPLICATIONS AND CONTRIBUTION

The sleep patterns of adolescents vary across countries and by sociodemographic groups. Insufficient sleep on school days is prevalent cross-nationally. National policies and strategies that

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sleep recommendations on school and nonschool days from self-reported bedtimes and wake times. We conducted stratified analyses by gender, age, and family affluence group.

Results: Adolescent sleep patterns varied cross-nationally. The average sleep duration ranged between 7:47 and 9:07 hours on school days and between 9:31 and 10:22 hours on nonschool days, and the proportion of adolescents meeting sleep recommendations ranged between 32% and 86% on school days and between 79% and 92% on nonschool days. Sleep patterns by gender and affluence groups were largely similar, but older adolescents slept less and went to bed later on school days than younger adolescents in all countries.

Conclusions: The sleep patterns of adolescents vary across countries and sociodemographic groups. Insufficient sleep on school days is common in many countries. Public health and policy efforts to promote healthy adolescent sleep are encouraged.

Adolescent sleep is a public health concern in many countries. Poor sleep patterns—including sleep that is insufficient, inconsistent, nonrestorative, disrupted, or poorly timed (e.g., late bedtime)—affect some 30%–70% of adolescents in Europe and North America [1,2], where at least one fourth of adolescents have difficulty falling asleep at night and feel tired during the day [1]. Sleep patterns of adolescents differ on school and nonschool days, and their circadian sleep–wake cycle is delayed by 2–3 hours relative to adults [1,3]. Early school start times conflict with this circadian shift [3,4], leading to truncated sleep during the week [5–7]. On weekends and holidays, adolescents tend to sleep longer and later [1]. This discrepancy in sleep times is called social jetlag [8] and has been associated with health, behavioral, and cognitive issues [9–11]. Overall, poor sleep is linked to physical health problems such as colds, headaches, and obesity [12,13], emotional problems such as anxiety, depression, and suicidal thoughts [10,12,14], risky behaviors [15], poor academic performance [9,12], and worse quality of life [13]. Poor sleep also relates to physical inactivity, sedentary behaviors including excessive screen time, and poor diet [12], underscoring the need to include healthy sleep into youth health promotion efforts.

The evidence on adolescent sleep is mostly informed by country-specific studies that involve different measures and age groups over the last few decades, making direct comparisons difficult [1,2,16–18]. Nonetheless, there are indications that adolescent sleep varies across regions and cultures. A 2011 systematic review of 41 studies found later bedtimes in Europe than in North America (22:46 vs. 22:06) and longer sleep on school days (8:26 vs. 7:28 hours) and weekends (10:01 vs. 8:48 hours) [1]. The review also found that going to bed about 2 hours later on weekends than on school days was common across regions. Moreover, contemporary information on cross-national sleep patterns is scarce and mostly describes sleep duration, whereas new evidence shows that other sleep patterns also affect health [11].

Social patterns in sleep are found between age, gender, and socioeconomic groups. Older adolescents go to bed later, sleep less on school days, and sleep more on weekends—a common trend in Europe, North America, and Asia [1,18,19]—attributable to biological [3,4], behavioral [20], and social changes [21] during adolescence. Some studies found that boys sleep less and go to bed later than girls [16,19,22], particularly on weekends [19], whereas others found that boys sleep more [2,16,17]. Furthermore, studies from Canada, the U.S., Australia, and Norway found that shorter and poorer quality sleep is more common in lower socioeconomic groups [2,16,23], but comparable data from other countries are scarce.

Using data on sleep collected in school-based surveys of adolescents in Europe and Canada, we examined cross-national differences in sleep duration, sleep times, and social jetlag and differences by gender, age, and socioeconomic groups. We hypothesized that sleep patterns would vary across countries and between sociodemographic subgroups. Specifically, we anticipated that older adolescents would go to bed later, sleep less on school days, and sleep more on weekends than younger adolescents, and that lower socioeconomic groups would sleep less than higher socioeconomic groups, but we were agnostic about gender differences, given the mixed findings in the literature.

Methods

Sample and procedure

The Health Behaviour in School-aged Children (HBSC) study is a World Health Organization collaborative cross-sectional study currently conducted in 47 countries across Europe and North America (http://www.hbsc.org) [24]. Data collection procedures in all countries were conducted in accordance with a standardized international protocol [24]. Each member country obtained ethics clearance to conduct the survey from a university-based review board or equivalent regulatory body. Data are collected in school settings every 4 years from a nationally representative random cluster sample of 11-, 13-, and 15-year-old adolescents in each participating country. The HBSC survey uses a two-stage sampling to recruit students within stratified samples of schools that represented the regional, economic, and public-private distribution in each country. The primary sampling units are schools. More detailed information about methodology of the HBSC study is reported elsewhere [24]. For the first time in 2013–2014 and again in 2017–2018, the HBSC survey included sleep items in one of the survey's optional questionnaire packages. HBSC countries could choose to add this optional package or survey items on sleep to the HBSC mandatory questionnaire, depending on their needs and priorities. Twenty-four countries elected to include sleep items in their 2013–2014 or 2017–2018 national survey and were included in this study (n = 185,278). For the nine countries that collected sleep data in their 2013–2014 and 2017–2018 surveys, we combined the samples of both surveys to maximize the use of the available data and the statistical power to estimate subgroup differences within each country. Sleep patterns across the 2013–2014 and 2017–2008

surveys were comparable. Participants who did not respond to any sleep item (n = 18,489) or did not report their age (n = 996) were excluded, leaving a final sample of 165,793 participants from 24 countries (Table 1 and Supplementary Table 1).

Measures

Sleep patterns were determined using four items that asked, "When do you usually go to bed?" and "When do you usually wake up?" on school days and weekends or holidays (nonschool days). Bedtimes ranged in half-hour intervals from "No later than 21:00" to "2:00 or later" for school days and to "4:00 or later" for nonschool days. Wake times ranged in half-hour intervals from "No later than 5:00" to "8:00 or later" for school days and from "No later than 7:00" to "14:00 or later" for nonschool days. We calculated sleep duration on school and nonschool days using bed and wake times. For each half-hour interval, we used the time at midpoint in our calculations (e.g., 22:15 if the bedtime response was "between 22:00 and 22:30"). For responses at the ends of the scale, we used the minimum/maximum stated time (e.g., 14:00 if the waketime response was "14:00 or later" and 5:00 if the waketime response was "No later than 5:00"). We calculated social jetlag using the difference in bedtimes on nonschool and school days [25]. We also assessed whether students met the minimum sleep recommendation for their age using current international guidelines [26,27], which recommend at least 9 hours for those aged 5–13 years (optimal range 9–11 hours) and 8 hours for those aged 14–17 years (optimal range 8–10 hours).

Socioeconomic status (SES) was assessed using the Family Affluence Scale, a checklist of six family assets: number of cars, having own bedroom, number of computers, number of bathrooms, family holidays in the past year, and having a dishwasher. The Family Affluence Scale is a validated scale for comparative measures of family affluence for European and North American adolescents [28]. We categorized students into tertile groups of low, medium, or high family affluence relative to the distribution of total scores from the same age, gender, country, and survey year. We also used self-reported age and gender (boy or girl). Stratified analyses used the three sampled age groups in HBSC [24], 11-year-olds (10.5–12.4 years), 13-year-olds (12.5–14.4 years), and 15-year-olds (14.5–16.5 years).

Table 1
Survey years and sample size of Health Behaviour in School-aged Children countries with sleep data

Country	Survey years	Sample size
Flemish Belgium	2017–2018	4,305
French Belgium	2013–2014, 2017–2018	9,791
Canada	2013–2014	11,295
Czech Republic	2013–2014, 2017–2018	15,432
Denmark	2013–2014, 2017–2018	6,019
Estonia	2013–2014, 2017–2018	8,633
Finland	2013–2014, 2017–2018	7,975
Greece	2017–2018	3,817
Hungary	2013–2014, 2017–2018	7,397
Iceland	2017–2018	6,967
Latvia	2013–2014, 2017–2018	9,887
The Netherlands	2017–2018	4,634
Norway	2017–2018	3,085
Poland	2017–2018	5,205
Portugal	2017–2018	2,971
Republic of Moldova	2017–2018	4,682
Scotland	2013–2014, 2017–2018	8,794
Slovakia	2013–2014, 2017–2018	10,736
Slovenia	2013–2014	4,982
Spain	2013–2014	7,576
Sweden	2013–2014	7,511
Switzerland	2013–2014	2,667
Ukraine	2017–2018	6,600
Wales	2013–2014	4,832

Statistical analysis

All analyses were run separately for each country. We first conducted a descriptive analysis of the sample characteristics. We then estimated the age-standardized average sleep durations, bedtimes, wake times, and social jetlag. We standardized the results for age using the age distribution of all countries combined as a reference to account for the different age distributions across countries. Finally, we conducted stratified analyses by gender, age, and family affluence groups in each country. We statistically compared differences in subgroups using the adjusted Wald test for continuous sleep outcomes and the corrected weighted Pearson chi-square statistic for categorical sleep outcomes to account for the complex survey design. Because of the varying sample sizes across countries (n range from 2,667 to 15,432), we interpreted the statistical significance with caution and with consideration for the public health relevance of the estimates. Analyses were done using Stata/SE 15 (StataCorp LLC, College Station, TX). We accounted for clustering at the school level and incorporated sampling weights where relevant to ensure results were representative of the country using the svy option in Stata.

Results

Average sleep patterns on school and nonschool days by country are presented in Figures 1 and 2, respectively, and in Supplementary Table 2. School day sleep duration ranged from 7:47 hours in Poland to 9:07 hours in Flemish Belgium, whereas on nonschool days, it ranged from 9:31 hours in Greece to 10:22 hours in Flemish Belgium. School day bedtimes ranged from 21:42 hours in Flemish Belgium to 23:18 hours in Greece, whereas nonschool day bedtimes ranged from 23:14 hours in Flemish Belgium to 0:54 hours in Spain. School day wake times ranged from 06:18 hours in Hungary to 07:23 hours in Spain. Nonschool day wake times ranged from 09:11 hours in Hungary to 10:36 hours in Spain. The percentage of adolescents meeting sleep recommendations on school days ranged from 32.0% in Poland to 86.3% in Flemish Belgium and on nonschool days from 79.2% in Greece to 92.4% in Flemish Belgium (Figure 3). Social jetlag ranged from 1:11 hours in Moldova to 2:12 hours in Sweden.

Boys reported longer sleep duration on school days than girls in two thirds of countries (15/24 countries), although differences were small (≤10 minutes), even if statistically significant. On nonschool days, girls slept longer in all countries, from 4 minutes more in Switzerland to 34 minutes more in Slovenia. Boys had slightly later bedtimes on school days (2–10 minutes) and nonschool days (1–27 minutes). On school days, girls woke earlier than boys in all countries, but on nonschool days, boys woke earlier than girls in about two thirds of countries. Although boys were more likely to meet sleep recommendations on school days in most countries (17/24 countries), girls were more likely to meet sleep recommendations on nonschool days in all countries. Boys had about the same or slightly more social jetlag than

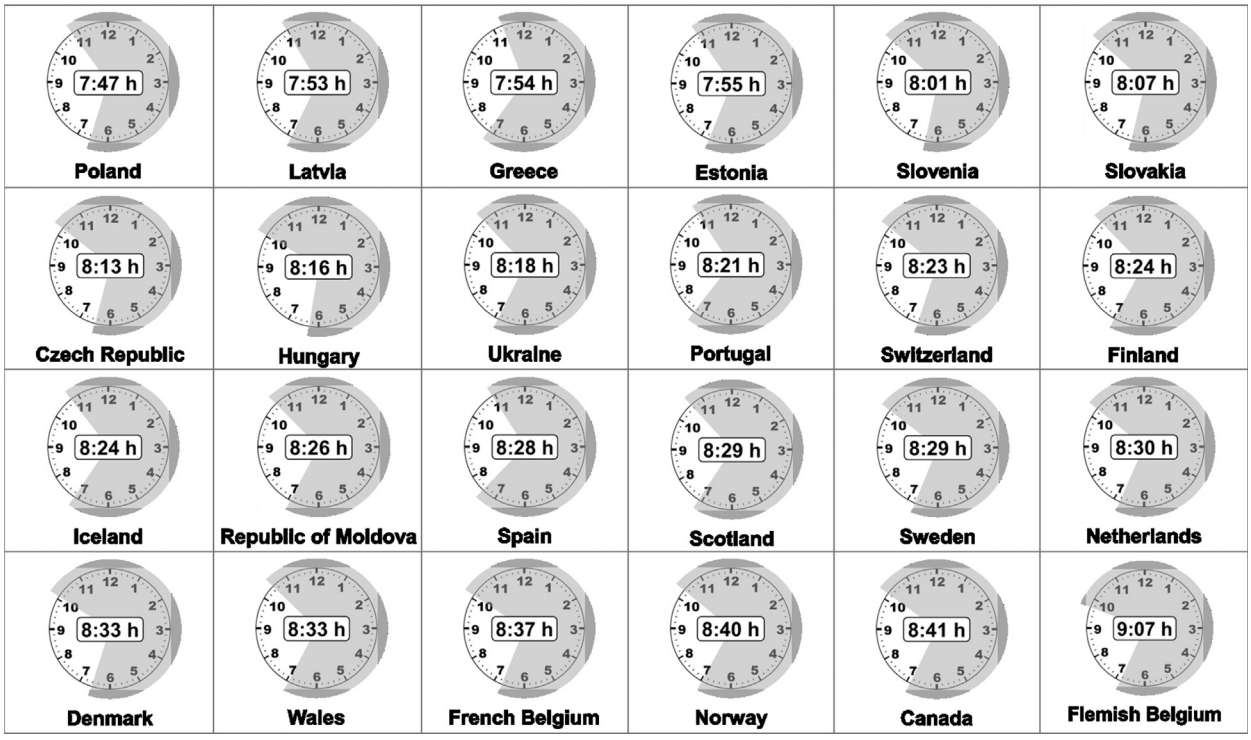

Figure 1. Average sleep times and sleep duration on school days by country.

girls, ranging from no difference in Ukraine to 22 minutes in Sweden.

Older adolescents slept less in all countries (Supplementary Table 3). On school days, differences between the youngest and oldest groups ranged from 54 minutes in Slovakia to 1:44 hours in Slovenia. On nonschool days, the smallest difference was 11 minutes in Flemish Belgium, and the greatest difference was 52 minutes in Ukraine. Most countries also saw longer delays in bedtimes in older adolescents, both on school days (from 52 minutes in Flemish Belgium to 1:35 hours in Iceland) and nonschool days (from 1:15 minutes in Flemish Belgium and Ukraine to 2:00 hours in Sweden). Although age differences in wake times on school days varied considerably between countries, wake times on nonschool days were consistently later in older adolescents, with 15-year-olds waking 23 minutes later than 11-year-olds in Ukraine and up to 1:22 hours later in Norway. Age differences were also found in the percentage of adolescents who met sleep recommendations. On school days, 11-year-olds were most likely to get the recommended amount of sleep, ranging from 42.8% in Poland to 92.9% in Flemish Belgium, whereas on nonschool days, 15-year-olds were most likely to meet recommendations, ranging from 83.7% in Greece to 96.3% in Iceland. Finally, more social jetlag was observed in the oldest group compared with the youngest in all countries.

Supplementary Table 4 shows cross-national sleep patterns by family affluence groups. An equal mix of positive and negative affluence gradients was observed for sleep duration. However, most differences between affluence groups were small. On school days, the difference in sleep duration between the least and most affluent adolescents ranged from −31 minutes in Moldova to +10 minutes in Scotland and Switzerland. On nonschool days, sleep duration between the least and most affluent adolescents ranged from −22 minutes less sleep in Moldova to +13 minutes more sleep in Scotland. On school days, bedtimes were later in the high affluence group compared with the low affluence group in most countries. The greatest difference was in Moldova (+31 minutes). In contrast, the high affluence group went to bed earlier in French Belgium, Denmark, Scotland, Wales, and Switzerland, up to 19 minutes earlier in Switzerland. On nonschool days, bedtimes were later in the high affluence group in half the countries, with the largest difference in Moldova (+54 minutes) and earlier in other countries, the largest difference in Scotland (−30 minutes). There was little variability in wake times among affluence groups. On school days, the difference ranged from +5 minutes later in Canada and Hungary to −10 minutes earlier in Switzerland. There was also no dominating trend on nonschool days. The difference between the high and low affluence groups ranged from +32 minutes in Moldova to −18 minutes earlier in Scotland. On school days, more low affluence adolescents met sleep recommendations in about half the countries. The greatest difference was in Moldova (+19.1 percentage points). The high affluence group better met sleep recommendations in other countries, with the highest difference found in Scotland (+7.2 percentage points). Similar trends were observed on nonschool days. The proportion meeting sleep recommendations on nonschool days was higher in the high affluence group in some countries, with the largest difference in French Belgium (+5.2 percentage points), and higher in the low affluence group in other countries, with the largest difference reported in Moldova (+6.5 percentage points). More affluent adolescents reported more social jetlag in most countries. The greatest increase was in Switzerland, where high affluence adolescents had 35 minutes more social jetlag than low affluence adolescents. Conversely, low affluence adolescents had

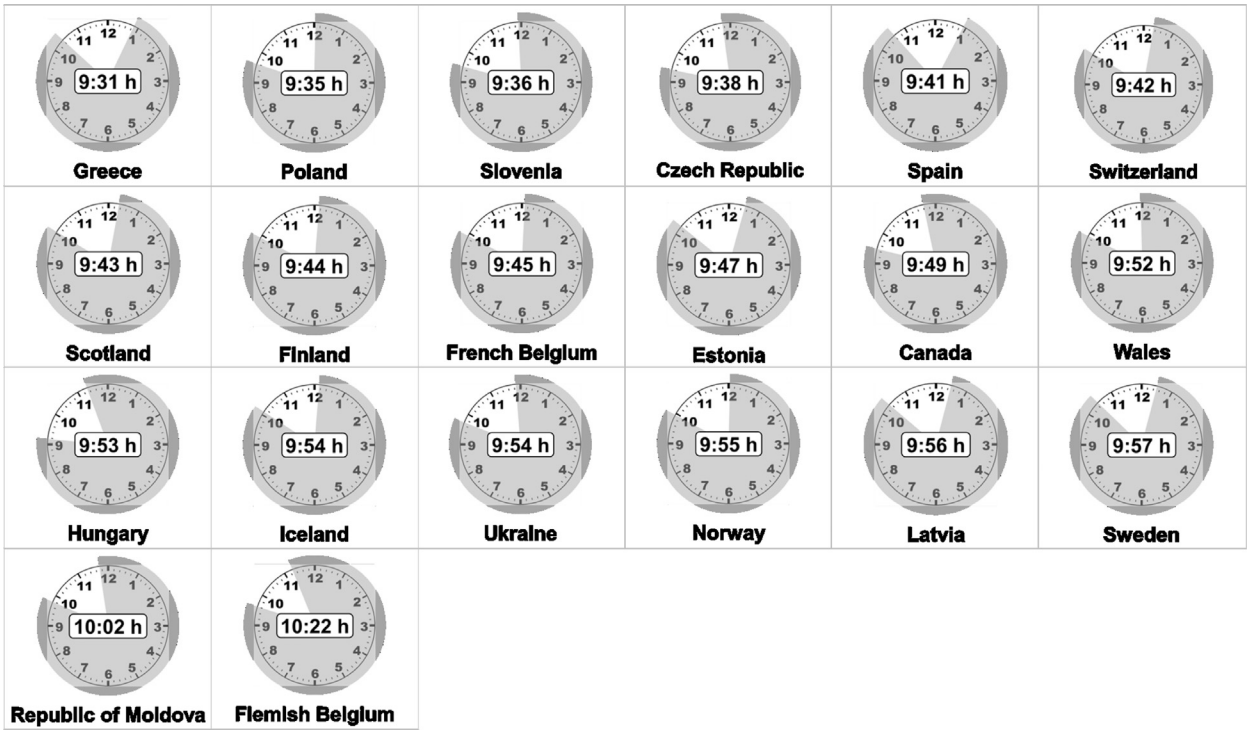

Figure 2. Average sleep times and sleep duration on nonschool days by country.

greater social jetlag in other countries, up to 25 minutes in French Belgium.

Discussion

This study examined sleep duration, timing, and consistency in over 165,000 adolescents from 24 primarily European countries. Sleep duration ranged from 7:47 to 9:07 hours on school days and from 9:31 to 10:22 hours on nonschool days. A considerably smaller proportion of students met sleep duration recommendations on school days (range 32%–86%) than on nonschool days (range 79%–92%). Social jetlag was observed in all countries, as bedtimes were consistently later and sleep durations consistently longer on nonschool than school days. These differences between school and nonschool days are consistent with adolescent sleep patterns previously observed in the literature [1].

In line with previous studies, sleep timing and duration changed with age [1,18,19] but were only slightly different between boys and girls [2,16,17,19,22]. Older adolescents slept less, went to bed later, and experienced greater social jetlag than younger adolescents. These changes reflect the normative developmental course of the circadian clock, which shifts toward eveningness around puberty, peaks at around age 16 years, and shifts back in early adulthood [3,4]. The increased demands of schoolwork and the use of social media and electronic devices [20] further delay sleep times and add to the biological tendency of older adolescents to fall asleep later, at a time when parental control over sleep times diminishes [21].

However, we examined differences in sleep patterns across age and not pubertal development. Pubertal stage was not assessed in most HBSC countries. Previous studies note that changes in sleep during adolescence are attributable to various physiological and hormonal changes related to puberty and less so with age per se [29,30]. Future studies could add nuance to these analyses by addressing pubertal development in addition to age.

Although we found little overall gender differences in sleep patterns, there were notable country-specific differences. For example, boys slept 10 minutes longer on school days than girls in Poland, and girls slept 34 minutes longer on nonschool days in Slovenia, suggesting that gender differences in behavioral patterns, roles, or responsibilities may influence adolescent sleep in some countries.

We observed some socioeconomic gradients in sleep measures, but they tended to be small and fluctuate between countries (i.e., positive in some countries and negative in others). Our results differ from previous studies reporting an association between lower SES and shorter sleep among adolescents [2,16,23]. However, previous evidence stemmed from smaller, national samples and used different SES measures. Furthermore, a retrospective cohort study from Norway found that sleep problems were more common in adolescents who experienced downward socioeconomic mobility compared with stable or upward mobility [31]. The discrepancy with our findings may therefore point to methodological differences but also suggest that the relationship between SES and sleep is complex and varies across national and cultural settings.

This study found significant cross-national variations in sleep patterns, suggesting that country-level factors may play a role in protecting and promoting adolescent sleep. One determinant may be differences in school start times. A growing body of evidence finds that later school start times are associated with longer sleep durations, primarily by delaying wake times [5–7].

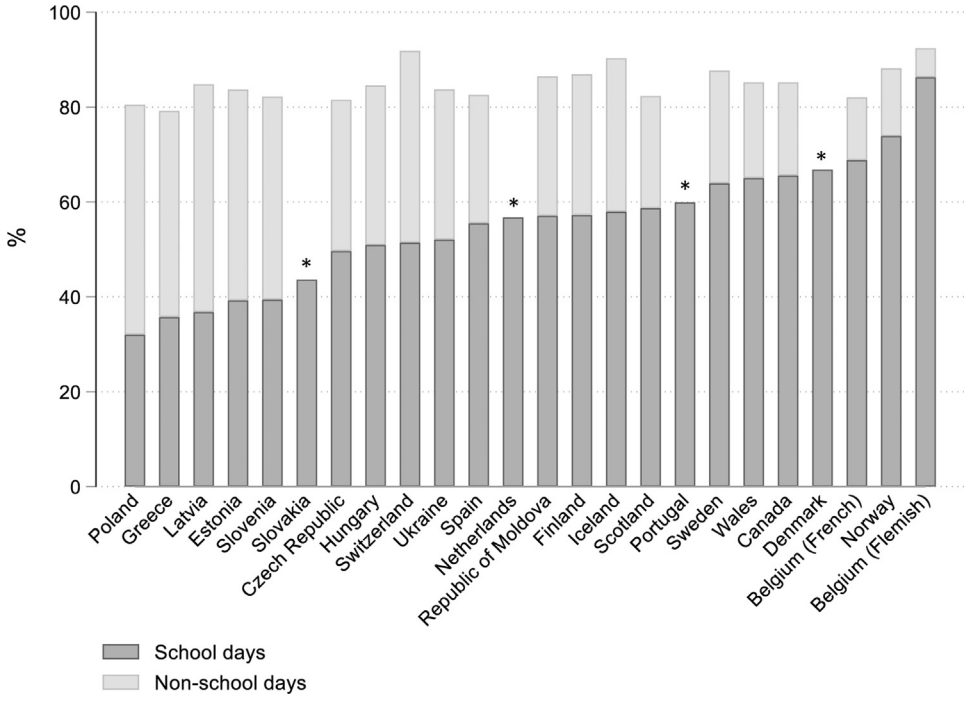

Figure 3. Percentage of adolescents that meet sleep recommendations on school days and nonschool days by country.

Intervention studies have replicated these findings [32], supporting the implementation of this policy to protect adolescent sleep. The HBSC surveys did not collect information on school start times, and national data on school start times are not available. However, a study from Canada found a national average school start time of 08:43 hours in 2013–2014 [6], whereas a study from the U.S. found an average national start time of 08:03 hours in 2011–2012 [7], indicating variability in school start times across countries. Commuting time to school may also affect the sleep patterns for adolescents and vary between countries [33]. The results from a time use study on American high school students suggest that each additional minute spent commuting to school was associated with 1.3 fewer minutes sleeping [34]. The mode of transportation to commute to school (e.g., walking vs. driving) that is normative or accessible in different countries may also affect sleep. In addition, time spent on homework is associated with shorter sleep in adolescents [14] and varies across countries [35]. Moreover, cultural differences in bed times and meal times [36] and in health and lifestyle norms, such as physical activity and healthy eating [20], may contribute to differences in adolescent sleep patterns across countries. Finally, geographic differences could also add to cross-national sleep variations. For instance, in countries situated at higher latitudes, changes in daylight timing and duration throughout the year tend to correlate with sleep times, such that the later and longer daylight of the summer relates to later bedtimes and less sleep compared with the winter [37].

A notable strength of our study is the use of an international standardized protocol for data collection, thereby ensuring high validity of cross-national comparisons. By using large, nationally representative samples from a total of 24 countries, the present study adds significantly to the literature on sociodemographic differences in adolescent sleeping patterns by documenting a number of robust differences across national settings and by highlighting the relevance of national influences for sleep.

Our study used self-reported sleep data. Although some studies found that self-reported sleep correlates highly with actigraphy data [38], others have found discrepancies that suggest caution with interpretation [39,40]. However, sleep data were measured using standardized sleep questions making relative cross-national comparisons more likely to be valid despite imprecisions. Furthermore, self-reported sleep data generally overestimate sleep durations because sleep onset tends to be later than bedtime, therefore resulting in more conservative estimates in our study. The cutpoints used to define minimal sleep recommendations [26,27] were based on a systematic review of the best available evidence [13]. However, much of this evidence was not of high quality [13], and it is possible that the cutpoints could change in the future as the quantity and quality of evidence improve. Nonetheless, sleep duration recommendations, even when based on weaker evidence, are important from a population health perspective, as they play an important role in surveillance and public health policy formation. Finally, our data are limited to students attending school and may not be generalizable to adolescents outside the school setting.

This study provides the largest cross-national account of adolescent sleep and sociodemographic patterning to date. The results show that, although the sleep patterns of adolescents vary across countries and sociodemographic subgroups, insufficient sleep and poor sleep patterns are prevalent among adolescents in most countries and subgroups. These results build on previous evidence from country-specific studies and point to national settings and sociodemographic groups as strong influences to consider in the promotion of healthy adolescent sleep. Because good sleep is essential to several aspects of a healthy adolescent development, public health policies should

include cross-sectoral interventions that target adolescent sleep. These policies should consist of modifiable, policy-level measures that support healthy adolescent sleep, such as delaying school start times and educating adolescents, parents, and teachers about the importance of sleep hygiene. Further research on cross-national differences of other aspects of sleep, such as sleeping difficulties and subjective sleep quality, is warranted, as they are important components of overall sleep. Future research is also needed to understand the cross-country behavioral factors and the social, structural, and cultural determinants that influence sleep patterns, such as school and work schedules.

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jadohealth.2020.03.013.

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