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Abstract
Aims: To investigate trend data in the prevalence of sleep-onset difficulties among Norwegian adolescents covering the age groups 11, 13 and 15 years. Methods: Data were based on the Health Behaviour in School-aged Children – A WHO Cross-National Survey (HBSC) – and were collected on six occasions between 1983 and 2005. At each point in time data were obtained from representative samples comprising between 3402 and 5026 adolescents. Results: The prevalence of sleep-onset difficulties was higher among 11-year-old students compared to the 13- and 15-year-olds. Girls reported a higher prevalence than boys. A logistic regression analysis showed that the prevalence of sleep-onset difficulties overall had increased significantly since 1983, which constituted the reference year. When the analysis was broken down by age and gender, the same tendency was found in all groups. Conclusions: The prevalence of sleep-onset difficulties among adolescents has increased during the last decades. This development gives reason for concern and should receive more attention from teachers, parents and health professionals.

Key Words: Adolescent, prevalence, sleep, sleep-onset difficulties

Background

Sound sleep is of vital importance for daytime functioning and may strongly influence the way children and adolescents think, behave and feel during daytime hours [1]. During adolescence, defined as the ages from 10 to 19 [2] sleep regulation seems to undergo some characteristic changes which cause a delay in the sleep phase, making it more difficult to fall asleep in due time in the evening and more difficult to wake up at an appropriate time in the morning. The processes behind these changes are related both to biological aspects and social inputs. When it comes to the biological aspects, studies have shown that the build-up of sleepiness during wakefulness occurs at a slower rate for mature than for less mature adolescents [3,4].

Timing of sleep also depends upon the circadian timing system. This system regulates states such as sleep and waking in a pattern normally oscillating with a period of about 24 hours. This system is governed by an internal pacemaker, the suprachiasmatic nucleus, which normally has an endogenous period somewhat longer than 24 hours. Adherence to a 24 rhythm is achieved by exposure to external stimuli such as light, which entrain the endogenous circadian rhythm [5]. With biological maturity is has been shown that the length of the period of the endogenous circadian rhythm increases [6]. Hence, puberty implies biological changes which give rise to a delay of the circadian rhythm. When the circadian rhythm is delayed, the time for sleep onset and sleep end normally becomes postponed [7]. With regard to social influences on the sleep of adolescents, data
have shown that parental control of the timing of sleep decreases as the adolescent becomes older. This co-occurs with an increase in academic obligations and a greater access to evening social activities [8]. The consequences of these social inputs are that teenagers tend to stay up relatively later in the evening compared to behaviours seen at earlier ages.

In line with the delay of the circadian rhythm taking place at puberty, several epidemiological studies have confirmed that sleep-onset difficulties are quite common among young people. In one study of 1359 Chinese adolescents it was found that 10.8% suffered from sleep-onset insomnia, whereas 6.3% and 2.1% suffered from maintenance and early morning insomnia, respectively [9]. In a nationwide representative survey among adolescents in Japan the corresponding figures were 14.8%, 11.3% and 5.5%, respectively [10]. Also, among older adolescents and younger adults, studies have shown that sleeplessness is most prevalent in the sleep initiation phase [11].

An important question to ask when it comes to the sleep of adolescents is whether sleep problems have shown an increasing trend due to societal changes. Along these lines, several authors have pointed to the toll that relatively new inventions such as multiple television channels, the internet, cellular phones, video games etc., may take on the sleep of young people [12–14]. Very few studies investigating population trends in sleep and sleep problems among adolescents have been conducted. In one study three Swiss birth cohorts (born in 1974, 1979 and 1986, respectively) were compared at ages 0 to 16 years. The results, based upon parental interviews, showed a substantial decrease in total sleep time in younger children between the 1970s and the 1990s. This change was attributed to a progressively later bedtime combined with a stable wake time from the mid-1970s to the 1990s across cohorts [15]. In a study comparing self-reported sleep length among 10- to 15-year-old south Australians it was also found that sleep length had decreased from 1985 to 2004 primarily due to a later bedtime in 2004 compared to 1985 [16]. In another study, polysomnography data based upon studies of normal adolescents published prior to 1990 were compared to similar studies published in the period 1990 to 2001. The results showed an increase in stage 1 and stage 2 sleep and a reduction in rapid eye movement (REM) and slow wave sleep from the pre-1990 to the post-1990 period. Based on these data it was concluded that sleep of normal adolescents is deteriorating [17]. The notion that the sleep of adolescents is deteriorating should, however, be substantiated by further trend data. This is especially imperative since the abovementioned trend studies focus upon quantitative changes in sleep, and do not convey information about trends concerning specific sleep pathology. Hence, there is a paucity of studies indicating whether the prevalence of sleep problems among young people is changing.

In the “Health Behaviour in School-aged Children – A WHO Cross-National Survey”, data on several health related issues have been collected approximately every fourth year in Norway since 1983, using representative samples of adolescents aged 11, 13 and 15 years as informants. One item pertaining to difficulties initiating sleep has been included in all of these surveys. This item seems to be highly relevant for the sleep of adolescents as problems initiating sleep seem by far to be the most frequent complaint among this group and because such an item can be assumed to be the most sensitive to a delay of the circadian rhythm. In order to investigate whether the prevalence of sleep-onset difficulties among adolescents has changed during the period 1983 to 2005 we analysed data from the Norwegian part of the “Health Behaviour in School-aged Children – A WHO Cross-National Survey” for the period in question.

Method

Participants

A total of 27,069 adolescents, aged 11, 13 and 15 years participated and returned satisfactory data (see Table I). Samples were selected independently on a random basis with school classes (covering the three age groups 11, 13, and 15) as the sampling unit. The proportion of boys was 50.4%, 50.5%, 50.5%, 50.7%, 50.8%, and 51.8% in 1983, 1985, 1993, 1997, 2001, and 2005, respectively. Classes were drawn from a list of all the grade-specific school classes in Norway (sequential selection from a geographically sorted list), starting with a random number on the list to obtain a nationally representative sample.

Table I. Number of participants by age and survey year.

<table>
<thead>
<tr>
<th>Year</th>
<th>11-year-olds</th>
<th>13-year-olds</th>
<th>15-year-olds</th>
<th>Total</th>
<th>Response rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>1,070</td>
<td>1,266</td>
<td>1,066</td>
<td>3,402</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>1,756</td>
<td>1,633</td>
<td>1,648</td>
<td>3,955</td>
<td>86</td>
</tr>
<tr>
<td>1993</td>
<td>1,614</td>
<td>1,701</td>
<td>1,637</td>
<td>4,952</td>
<td>82</td>
</tr>
<tr>
<td>1997</td>
<td>1,733</td>
<td>1,623</td>
<td>1,670</td>
<td>5,026</td>
<td>79</td>
</tr>
<tr>
<td>2001</td>
<td>1,660</td>
<td>1,739</td>
<td>1,624</td>
<td>5,023</td>
<td>78</td>
</tr>
<tr>
<td>2005</td>
<td>1,586</td>
<td>1,591</td>
<td>1,534</td>
<td>4,711</td>
<td>58</td>
</tr>
</tbody>
</table>
Materials

This study is based on an ongoing survey entitled “Health Behaviour in School-aged Children – A WHO Cross-National Survey” (HBSC), initiated in 1982. A key aim of the HBSC survey is to develop national information systems with regard to lifestyles and health among school-aged children in European and North American countries. Questionnaire surveys have been conducted among 11-, 13- and 15-year-olds in the participating countries in accordance with a standard protocol. Currently 41 countries are involved in the studies and Norway has participated since the start in 1982. A standard cluster sampling method is followed, providing target groups that are representative of the national populations in terms of age, gender, and geographical distribution. The philosophy, study design, and methods of the HBSC surveys have been described in detail elsewhere [18–22].

Procedures

The analyses are based on data from the HBSC surveys undertaken in Norway in December between 1983 and 2005. Data from the year 1989 were excluded as the wording of the sleep item differed in 1989 compared to the item included in the other years of the surveys. The total response rates varied between 58% and 86%, with the lowest response rate recorded in 2005 (see Table I). The response rate for the 1983 survey is not available. The 1983 survey did, however, follow the same procedures as the 1985 survey and is also conducted relatively close in time to this. Therefore, it is reasonable to believe that the response rate in 1983 is similar to the 1985 survey. The two main sources of non-responses were schools and classes refusing to participate and individual pupils refusing to participate or who were absent on the day of the administration of the questionnaire. The mean ages of the three target groups were 11.5, 13.5, and 15.5 years respectively, with 90% of the respondents falling within a 6-month range of the mean.

In each survey year the data were collected anonymously through self-completion questionnaires. Data collection took place under supervision in the classroom. Teachers administered the data collection following a standard set of instructions, and the participants were provided with individual envelopes in which to seal their questionnaires before returning them to the teachers. All data have been cleaned and reordered, when necessary, into a consistent format at the Databank Management Centre at the University of Bergen, Norway.

Statistics

Sleep-onset difficulties was defined as answering “approximately daily” or “more than once a week” to the question “how often during the last 6 months have you experienced difficulties falling asleep?”. Choosing the other response alternatives “approximately every week”, “approximately every month” or “seldom or never” were not defined as sleep-onset difficulties. Data analyses were performed using SPSS (version 15.0) [23]. Chi-square analyses were conducted in order to investigate whether the prevalence of sleep-onset difficulties differed across the three age groups and gender. In order to investigate whether the prevalence of sleep-onset difficulties had increased during the years from 1983 to 2005, a logistic regression analysis was conducted for the whole sample, using the year of the survey as a predictor, and setting 1983 as the reference year. Sleep-onset difficulties (0=not present, 1=present) comprised the criterion variable. Furthermore, to explore whether changes in the prevalence of sleep-onset difficulties over the period (1983–2005) differed by age and gender, separate logistic regression analyses were conducted for girls and boys, further broken down by age groups (11, 13, and 15 years). For all the logistic regression analyses the result was significant when the 95% confidence interval did not include 1.00. Due to some missing data (n=770) the number of respondents for which data are analysed deviates somewhat from the total number who participated overall. In order to investigate whether a linear trend for the prevalence of sleep-onset difficulties existed, a logistic regression analysis for the whole sample was conducted where study year was entered as a continuous variable.

Results

The overall prevalence of sleep-onset difficulties was 16.8%. The prevalence was related to age (χ²=113.6, df=2, p<0.01). Eleven-year-olds had a higher prevalence (20.4%) compared to the prevalence (14.9%) among 13-year-olds (χ²=89.8, df=1, p<0.01) and to the prevalence (15.4%) among the 15-year-olds (χ²=74.0, df=1, p<0.01). There was no difference in the prevalence of sleep-onset difficulties among the 13- and 15-year-olds (χ²=0.7, df=1, p>0.05). A larger proportion of girls (18.6%) compared to boys (15.1%) suffered from sleep-onset difficulties (χ²=57.8, df=1, p<.01). The logistic regression analysis for the whole sample showed an increasing trend in the prevalence of sleep-onset difficulties from 1983 to 2005. The prevalence of sleep-onset difficulties was significantly
higher for all years (1985, 1993, 1997, 2001, and 2005) compared to 1983 (see Table II). Analysing the data for 11- and 13-year-old boys showed that the prevalence of sleep-onset difficulties was higher in 2001 and 2005 compared to the reference year 1983. For 15-year-old boys it was only for 2005 that the prevalence of sleep-onset difficulties was higher than for 1983. For 11-year-old girls the data showed that the prevalence of sleep-onset difficulties was higher in 1985, 1993, 2001 and 2005 compared to 1983. Thirteen-year-old girls reported a higher prevalence of sleep-onset difficulties in 1997, 2001 and 2005 compared to 1983. For the 15-year-old girls the prevalence of sleep-onset difficulties was higher for all years (1985, 1993, 1997, 2001 and 2005) compared to the reference year 1983. Figure 1 shows the prevalence of sleep-onset difficulties for the whole sample from 1983 to 2005 and includes error bars showing the 95% confidence intervals. The odds ratio for the linear trend based on the whole sample was 1.02 (95% CI 1.02–1.02).

### Discussion

The data showed that sleep-onset difficulties were more frequently reported by the 11-year-olds compared to the 13- and 15-year-olds. Seen from a strictly biological point of view this is surprising given the overwhelming evidence pointing to a phase

<table>
<thead>
<tr>
<th>Year</th>
<th>Prevalence</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>12.5%</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>15.9%</td>
<td>1.33</td>
<td>1.16–1.53</td>
</tr>
<tr>
<td>1993</td>
<td>16.7%</td>
<td>1.41</td>
<td>1.24–1.61</td>
</tr>
<tr>
<td>1997</td>
<td>15.2%</td>
<td>1.26</td>
<td>1.11–1.44</td>
</tr>
<tr>
<td>2001</td>
<td>18.7%</td>
<td>1.62</td>
<td>1.43–1.84</td>
</tr>
<tr>
<td>2005</td>
<td>20.4%</td>
<td>1.80</td>
<td>1.59–2.05</td>
</tr>
</tbody>
</table>
delay of the sleep-wake rhythm as adolescents mature [24], thus an opposite trend would be expected. However, it has been shown that a considerably larger proportion of 10–11-year-old adolescents have their bedtime determined by their parents, compared to older (12–13 years old) adolescents [8]. Since older adolescents to a larger extent than younger adolescents go to bed when they themselves decide to, they are probably more sleepy at this point, which normally would decrease the sleep-onset latency [25]. Unfortunately, our data do not include information about the degree of self-determination of bedtime, precluding us from further analysis of this issue. Still, previous studies have shown in general that total sleep time decreases [26] and that daytime sleepiness increases [27] with age in adolescents. As a consequence and in line with the results from the present study, sleep-onset latency could then be expected to be shorter for older than for younger adolescents.

When it comes to gender differences in sleep-onset difficulties, data have consistently shown these to be more prevalent among females than males, at least among adults [28]. The results have been more mixed for children and adolescents. Some studies have shown clear-cut gender differences [29], whereas other studies indicate none or negligible gender differences [30]. Some investigators have shown that differences between the genders primarily exist for older adolescents leading them to hypothesize that biological changes occurring during puberty, such as menses, make girls more susceptible to sleeplessness than boys [31]. Still, in this study the gender differences in sleep-onset difficulties were significant at all ages, confirming the general notion about gender differences in the prevalence of sleep-onset difficulties.

The main question, however, that we wanted to address in the present study concerned the trend in the prevalence of sleep-onset difficulties, covering the period from 1983 to 2005. During this period data collection took place six times, which gives us a good opportunity to investigate whether a real trend existed or not. The results show that the prevalence of sleep-onset difficulties has increased significantly from 1983 to 2005, for both genders and for all ages. The overall probability for suffering from sleep-onset difficulties in 2005 compared to 1983 was 1.8, which could be regarded as a considerable increase. Looking at the odds ratios from 1983 to 2005, they seem to indicate an almost linear increase over the years and the logistic regression analysis using year as a continuous variable as a predictor confirmed the presence of a significant linear trend.

The reasons for this increase are, however, not clear. If the claim that individuals reach puberty at
an increasingly earlier age is correct this would imply that a biologically based delay of the circadian rhythm would also occur at an equivalent earlier age. Data from the USA do indicate a decrease in the age of onset of puberty during the last 40 years [32]. However, the increase is modest, and has taken place over a considerably longer time span than the period covering the trend data analysed in the present study. In addition, data from Scandinavia indicate that although physical height has increased over the past decades, the timing of puberty has remained stable [33]. In sum, this indicates that a biological based explanation for our findings regarding the increased prevalence in sleep-onset difficulties seems unlikely. When it comes to explanations based upon social factors, one possible explanation is related to the willingness to admit and report different sorts of health problems, which may have arisen over the last decades [34]. Thus, the increasing prevalence of sleep-onset difficulties seen over the past 22 years may not be related to real changes in the sleep of adolescents, but to changes in responses to the sleep related item. Although this factor may have contributed to the results reported here, it is unlikely that it explains large proportions of the increase in the prevalence of sleep-onset difficulties as the present study covered a relatively short time span. Thus, the most plausible explanation for the results are that they reflect real increases in the prevalence of sleep-onset difficulties, not explained by biological factors, nor changes in societal values concerning willingness to report health problems. In order to understand the increase of sleep-onset difficulties among young people, we probably have to look at factors that may have altered the living conditions for adolescents during the last 2 decades.

There is no doubt that the increase in television channels and the introduction of the internet, new generations of video games and cellular phones during the last 2 to 3 decades may represent stimuli that contribute to an elevated activation in the evening for many adolescents [12,35]. In one study, for example, it was found that long durations of watching television and playing video games were significantly associated with prolonged sleep-onset latency [36]. But, also other societal changes may have impacted the sleep of adolescents. Studies have indicated that there has been an increase in the prevalence of a wide range of mental health problems among adolescents during the last decades [37], of which many are associated with poor sleep [38]. Societal factors such as rising divorce rates, a greater number of cohabiting couples, increasing numbers of single parent and step families and dual-earner households, and increase in socioeconomic inequalities are assumed to have contributed to this development [37]. It has also been pointed out that adolescents have experienced a greater emphasis on educational attainment during the last decades [37]. As studies have shown that life, family and academic stress are all predictors of sleeplessness [39] it is reasonable to conclude that an increase of those factors will be reflected in poorer sleep among young people.

Study limitations

The data were based on a single item only, thus our results should be interpreted with some caution. It could furthermore be argued that our definition of sleep-onset difficulties as having problems falling asleep more often than once a week is too lenient. In clinical practice sleep problems are often defined by their frequency and often a cut-off set to three or more times per week is used [40]. In the present study none of the response alternatives included “three times a week”. We therefore choose to use “more than once a week” as cut-off as this came closest to the often used clinical cut-off.

The response rate seems to deteriorate over time in the present study which might induce a selection effect. However, as non-response is often associated with health problems [41] it is unlikely that this can explain the trend found over the years, showing an increase in sleep-onset difficulties. In addition, the response rate is high overall compared to recent surveys such as the 2006 Sleep in America Poll [42].

It should be noted that clustered sampling might introduce design effects that bias standard error downwards. In the present study the design effect was close to one across the surveys, indicating a weak clustering effect. Thus, in the present study analyses were conducted using random sample assumptions.

Conclusions

We conclude that there is a trend established over the last 2 decades showing an increase in the prevalence of sleep-onset difficulties among adolescents. This trend is probably due to the introduction and expansion of new technologies and an increase in family, life and academic stress. As poor sleep may seriously impact academic achievement and mental health [1] the increased prevalence of sleep-onset difficulties reported here gives reason for concern and should receive more attention from teachers, parents and health professionals.
References