patterns formed during adolescence tend to persist into adulthood, with both children and adults, with those in lower socioeconomic status reporting poorer sleep. 

Conclusions: Lower SES was a robust determinant of adolescent sleep patterns and sleep problems, corroborating evidence of a social gradient in sleep from young children and adults. Targeted intervention for adolescents in low SES may be indicated to improve sleep.

Introduction

The relationship between health disparities and health outcomes is a robust effect across different age groups and types of health problems. A social gradient in sleep has been demonstrated in both children and adults, with those in lower socioeconomic groups typically reporting poorer sleep. However, our knowledge of possible social determinants of sleep patterns remains limited. A large population-based study in Norway surveyed 10,220 adolescents aged 16–19 years in 2012. Multiple socioeconomic status (SES) indicators and assessment of sleep, including DSM-5 insomnia, sleep duration, weekend–weekdays differences, as well as sleep deficit and delayed sleep phase were included. Results: Insomnia was more frequent among adolescents from families with lower parental education, parents outside the workforce and among adolescents reporting lower perceived family financial circumstances. Adolescents from lower social strata reported a significantly shorter sleep duration, more sleep deficits, later bedtimes and larger weekend–weekday sleep differences. The associations were present across all SES measures. For example, the mean sleep duration was 6:03 (95% CI: 5:55–6:12) among adolescents with mothers with primary school education, compared with sleep duration of 6:24 (95% CI: 6:20–6:27) and 6:35 (95% CI: 6:31–6:38) among adolescent with mothers having a secondary school and university degree, respectively (P < 0.001). The highest rate of insomnia was found in families with worse perceived financial circumstances (32%), when compared with 17–18% in families with better perceived financial circumstances. Depressive symptoms and family cohesion could account for some, but not all of the association. Conclusions: Lower SES was a robust determinant of adolescent sleep patterns and sleep problems, corroborating evidence of a social gradient in sleep from young children and adults. Targeted intervention for adolescents in low SES may be indicated to improve sleep.
reduced, but remains strong even after accounting for a range of health variables. In adolescence specifically, the family context may be another important determinant by which the socioeconomic position exerts its influence on sleep. Families of lower social strata tend to have higher rates of family stress and conflict, which again is related to sleep problems. Similarly, parenting styles have been linked to several socioeconomic indicators, in addition to adolescent sleep problems.

Based on the above considerations, we aimed to examine the association between SES and sleep in a large population-based study of older adolescents. As the relationship to sleep has differed across socioeconomic indicators (e.g. El-Sheikh et al.), we examined multiple indicators of SES, including perceived family financial circumstances, parental education and parental work status. The included sleep outcome measures covered a wide range of sleep patterns and sleep problems relevant to adolescence. Finally, by including family factors and depression, we also were able to examine whether such factors could account for the association between SES and sleep in this age group.

Methods

Procedure

In this population-based study from 2012, we used data from the youth@hordaland-survey of adolescents in the county of Hordaland in Western Norway (http://uni.no/en/uni-health/rkbu-vest/the-bergen-child-study/). The general aim of the youth@hordaland-survey was to assess mental health, lifestyle, school performance and health-service use in adolescents. All adolescents born between 1993 and 1995 and all students attending secondary education were, through collaboration with the Hordaland County, invited to participate. The adolescents received information about the study via their official school e-mail account, and one school class period (about 45 min) during regular school hours was allocated for them to complete the online questionnaire. A teacher was present to organize the data collection. Adolescents who were not attending school received information by post to their home addresses. Survey staff was available by phone for both the adolescents and school personnel to answer queries related to the research. The adolescents’ parents were informed about the study but the adolescents themselves consented to participation (Norwegian regulation states that individuals aged 16 years and older can give consent to participate in research studies). The study was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway.

Sample

All adolescents born between 1993 and 1995 were invited (n = 19,430) to participate in the current study, of which 10,220 agreed, yielding a participation rate of 53%. Sleep variables were initially checked for consistency of responses, which resulted in 374 adolescents being omitted due to obvious invalid responses (e.g. negative sleep duration or sleep efficiency).

Instruments

Gender and date of birth were identified through personal identity number in the Norwegian National Population Register. Age was calculated based on the interval of time between date of birth and date of participation.

Indicators of SES

Maternal and paternal education completion levels were reported separately with three response options: ‘primary school’, ‘secondary school’ and ‘college or university’. Perceived family financial circumstances (i.e. how well off the adolescent perceived their family to be) were assessed by asking the adolescents about their family financial circumstances compared with most others. The response options were (i) ‘better financial circumstances’, (ii) ‘approximately like most others’ and (iii) ‘poorer financial circumstances’. The adolescents also indicated if they lived with both their parents (yes/no). Parental work status was based on an opened-ended question where the adolescents described their parents’ occupation. This was coded according to the International Standard Classification of Occupations (ISCO), and for the present study a binary variable was used, reported for mothers and fathers separately. The ‘work’ category consisted of parents with a work ISCO code and parents who were reported as students. The ‘out of work’ category consisted of parents who were not in work (including parents on sick leave, on disability pensions, being unemployed or being at home (not specified).

Sleep measures

The adolescents’ self-reported usual bedtime and rise time were indicated in hours and minutes using a scroll down menu with 5-min intervals and data were reported separately for weekdays and weekends. Time in bed (TIB) was calculated as the difference between bedtime and rise time. Sleep onset latency (SOL) and wake after sleep onset (WASO) were indicated in hours and minutes using a scroll down menu, and sleep duration was defined as TIB minus SOL and WASO. For the purpose of the present study, sleep duration was also split into five categories: <5:00 (15.4%/n = 1470), 5–5:59 (11.5%/n = 1059), 6–6:59 (26.9%/n = 2472), 7–7:59 (32.2%/n = 2959), ≥8:00 (13.8%/n = 1270). Sleep efficiency was calculated as sleep duration divided by TIB multiplied by 100 (reported as percentage). Subjective sleep need was reported in hours and minutes, and sleep deficit was calculated separately for weekends and weekdays by subtracting total sleep duration from subjective sleep need.

Insomnia was operationalized according to the DSM-5 criteria for insomnia. Difficulties initiating and maintaining sleep (DIMS) were rated on a three-point Likert-scale with response options ‘not true’, ‘somewhat true’ and ‘certainly true’. Given a positive response (‘somewhat true’ or ‘certainly true’), the participants were then asked how many days per week they experienced problems either initiating or maintaining sleep. The participants also provided information on the duration of DIMS. A joint question on tiredness/sleepiness was rated on a three-point Likert-scale with response options ‘not true’, ‘somewhat true’ and ‘certainly true’. If confirmed (‘somewhat true’ or ‘certainly true’) participants reported the number of days per week they experienced sleepiness and tiredness, respectively. To fulfil the DSM-5 criteria for insomnia, the adolescents had to report DIMS for at least three times a week, with a duration of 3 months or more, as well as tiredness or sleepiness on at least 3 days per week.

Control variables

Symptoms of depression were assessed using the short version of the Mood and Feelings Questionnaire (SMFQ). The SMFQ comprises 13 items assessing depressive symptoms rated on a three-point Likert scale as either ‘not true’, ‘sometimes true’ or ‘true’. High-internal consistency between the items and a strong uni-dimensionality confirmed in a study based on the same sample as included in the present study.

Family cohesion was assessed by a subscale in the Resilience Scale for Adolescents (READ), which consists of 28 items rated on a five-point Likert scale comprising: personal competence, social competence, structured style, family cohesion and social resources. Cronbach’s α for the READ Family Cohesion subscale was 0.90.
Statistics
Pearson’s $\chi^2$ test (proportions) and independent sample $t$-tests or one-way analysis of variance (ANOVA) (means) with Bonferroni adjusted/corrected post hoc tests were used to examine differences between sleep variables and the different SES measures. Multinomial logistic regression analyses were conducted to examine the predictive effect of SES (independent variables) on sleep duration categories (dependent variable), using 7–8 hours as the reference category (as this was the most frequent sleep duration category). Three models were examined, adjusting for the following control variables: (i) age and gender, (ii) Model 1 + depressive symptoms and (iii) Model 2 + READ family cohesion. We also tested for interactions between the SES variables and gender, by entering the product of these variables in separate blocks. However, as none of these interactions were statistically significant, they were not included in the final analyses presented in the current paper. IBM SPSS Statistics 23 for Mac (SPSS, Inc., Chicago, IL, USA) was used for all analyses.

Results
Sample characteristics
A total of 9846 adolescents provided valid responses on the relevant sleep and SES questionnaires. The mean age was 17.8 years, and the sample included more girls (53.3%) than boys, and the majority (97.8%) was high school students. In terms of maternal education, 10.1% (of the mothers) had completed primary school, 41.3% had completed secondary school and 48.6% had a university or college education. The corresponding proportions for paternal education were 10.6, 46.4 and 43.0%, respectively. Regarding perceived financial circumstances, 67.4% reported being ‘like most others’, while 25.5% reported ‘better’ circumstances and 7.1% reported ‘worse’ financial circumstances. In terms of parents being outside the workforce, 7.1% of the adolescents reported that their mother was not working, while 3.7% had a father who was not working at the time of the survey.

Insomnia and SES
As shown in figure 1, the prevalence of DSM-5 insomnia was (significantly) associated with all measures of SES. For example, the prevalence of insomnia among adolescents with parents having a university degree was 17–18%, compared with 22–23% among adolescents whose parents only had primary school education. The same pattern was evident across all other SES indicators, with a higher rate of adolescent insomnia in families with poor financial circumstances, and among parents outside the workforce. The highest rate of insomnia was found in families with worse perceived financial circumstances (32%), when compared with 17–18% in families with perceived financial circumstances equal to or better than others (see figure 1 for details).

Sleep patterns and SES indicators
Most sleep patterns were significantly associated with the four SES indicators, and in a dose-response manner. For example, as detailed in table 1, the mean sleep duration was 6:03 hours among adolescents with mother with primary school education, compared with sleep duration of 6:24 and 6:35 hours among adolescent with parents having a secondary school and university degree, respectively. Adolescents of families from lower SES strata also reported significantly more sleep deficiency, as well as larger bedtime differences across all SES measures. The adolescents’ bedtimes were only partially associated with SES (see table 1 for details).

Sleep duration and SES, the role of depression and family cohesion
Multinomial regression analyses were conducted separately for each SES indicators with sleep duration categories as the outcome. As detailed in table 2, there were significant increased odds of short sleep duration in the lower social strata, evident across all SES indicators. For example, adolescents reporting poor family financial circumstances had 2.3-fold increased odds of a sleep duration <5 hours, compared with families with financial circumstances ‘like most others’. When adjusting for depression (SMFQ total score) in addition to age and gender, the odds were somewhat attenuated (OR = 1.54), but remained significant across all SES indicators. Further adjustment for family cohesion (READ subscale) reduced several of the associations to a non-significant level, but the odds for short sleep duration (<5 hours) remained significant for low-parental education as well as parental outside the workforce (see table 2 for details). Long sleep duration (8 hours or more) was not significantly associated with any of the SES indicators (data not shown).
Table 1 Adolescent sleep and family socioeconomic status (SES) in the youth@hordaland study (n=9846)

<table>
<thead>
<tr>
<th>Sleep characteristics</th>
<th>Maternal education</th>
<th>Paternal education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary school</td>
<td>Secondary school</td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td></td>
<td>(weekdays and weekends)</td>
<td>(weekdays and weekends)</td>
</tr>
<tr>
<td>Bedtime</td>
<td>23:21 (1:08)</td>
<td>23:17 (0:59)</td>
</tr>
<tr>
<td>Sleep duration</td>
<td>6:03*** (1:55)</td>
<td>6:24 (1:37)</td>
</tr>
<tr>
<td>Sleep deficiency</td>
<td>2:34*** (2:55)</td>
<td>2:05 (2:29)</td>
</tr>
<tr>
<td>Bedtime difference</td>
<td>2:43*** (2:49)</td>
<td>2:30 (2:18)</td>
</tr>
<tr>
<td></td>
<td>(weekdays and weekends)</td>
<td>(weekdays and weekends)</td>
</tr>
<tr>
<td>Perceived family financial circumstances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worse</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Like others</td>
<td>2:30 (2:18)</td>
<td>2:24 (2:10)</td>
</tr>
<tr>
<td>Better</td>
<td>2:26</td>
<td>2:08</td>
</tr>
<tr>
<td>Mother work status</td>
<td>23:20** (1:06)</td>
<td>23:16 (0:58)</td>
</tr>
<tr>
<td>Working</td>
<td>23:17 (0:58)</td>
<td>23:20 (1:03)</td>
</tr>
<tr>
<td>Not working</td>
<td>2:06*** (2:28)</td>
<td>2:36 (2:42)</td>
</tr>
<tr>
<td>Father work status</td>
<td>2:32** (2:30)</td>
<td>2:24 (2:10)</td>
</tr>
<tr>
<td>Working ot working</td>
<td>2:25** (2:10)</td>
<td>2:46</td>
</tr>
</tbody>
</table>

P-values are based on significance level from the independent samples t-tests (two groups) or ANOVAs (three groups) within each SES measure.
*P<0.05.  
**P<0.01.  
***P<0.001.

Discussion

This large population-based study demonstrates that there is a consistent social gradient across a range of sleep problems in older adolescence. Adolescents of parents with low-parental education, parents outside the work force and adolescents with perceived lower family financial circumstances had higher rates of DSM-5 insomnia. Most associations between low SES and poor sleep formed a dose–response pattern.

The current study provides new evidence of the existence of a social gradient across several sleep problems among older adolescents. These results are consistent with previous findings in both children and adults. To the best of our knowledge, only two previous studies have examined this question in older children and adolescents. However, these two studies were either small and included children (age range 8–17), or included crude and unspecific measures of sleep. In the latter study, adolescents with low SES were less likely to answer affirmatively to a single question about whether they got at least 7 hours of sleep. Thus, the average sleep duration among children from lower SES in the current study of 5:28 hours further emphasizes the very short sleep duration among some subgroups of adolescents. If the differences are clinically significant could be discussed. In Lichstein’s quantitative criteria for insomnia, 30 min is considered the cut-off for long SOL for an insomnia disorder. In the present study, the differences are often close to 30 min and thus could be considered clinically significant from this perspective.

A major strength of the current study is that we focused specifically on sleep problems and sleep patterns that are typical and characteristic for adolescents. For example, insomnia has previously been found to be highly prevalent among older adolescents and the present study confirms that it is even more so among adolescents from families with low SES, exemplified by about one-third of the adolescents with low perceived financial circumstances. While insomnia symptoms have been included in previous studies in adults and children, these are most often brief or single item questions and not diagnostic approximations. As such, our operationalization of insomnia according to the latest DSM revision is a significant strength. Still, all information was assessed as part of an epidemiological study, and thus not based on a structured clinical interview or physiological measurements, which provide the most accurate sleep data.

Another methodological strength is the measures of sleep duration, which included both SOL and WASO, and such detailed assessments are rarely performed in population-based studies. Recent studies have shown that such self-report sleep assessments are accurate for the characterization of sleep parameters in both clinical and population-based research. A study of young adolescents in Hong Kong recently found good agreement between actigraphy measured and questionnaire reported sleep durations. Another limitation is the inclusion of a relatively low number of adolescents not in school. Although the few adolescents not attending school in the present study did not have a higher rate of sleep problems, a higher participation rate among these adolescents would be needed to draw conclusions regarding this group specifically.

By controlling for potential confounders, we aimed to identify possible mechanisms, which may be involved in the association between low SES and poor sleep. In the current study, depression accounted for some of the associations between low SES and poor sleep, in line with previous studies in adults. Of note, other studies have also found depression to be a possible pathway linking SES to other health outcomes, although not uniformly so (see Chen and Miller for an overview). While the present study did not specifically address the exact mechanisms by which depression may account for a reduction in the SES-sleep association, other studies may help us understand this phenomenon. Also, studies of late adolescence and to adulthood have found worry to be an important factor attenuating the association between SES and sleep. Furthermore, children from lower SES have shown to not only have more negative life events than their peers from more affluent families, but they may also be more prone to negative appraisals of negative events.

While the familial influence on sleep in early childhood is evident, the influence of familial SES in the adolescent years has
Table 2. Results from multinomial regression analyses between socioeconomic status (SES) and short sleep duration in the youth@hordaland study (n = 9846)

<table>
<thead>
<tr>
<th>Exposure variable</th>
<th>Model 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Model 2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Model 3&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal education&lt;sup.§&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary school</td>
<td>1.43 (1.22-1.68)***</td>
<td>1.31 (1.11-1.55)**</td>
<td>1.26 (1.05-1.49)*</td>
</tr>
<tr>
<td>Primary school</td>
<td>2.25 (2.00-2.53)***</td>
<td>1.26 (1.01-1.57)***</td>
<td>1.14 (0.85-1.58)***</td>
</tr>
<tr>
<td>Paternal education&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary school</td>
<td>1.45 (1.23-1.71)***</td>
<td>1.22 (0.74-1.52)</td>
<td>1.16 (0.85-1.58)***</td>
</tr>
<tr>
<td>Primary school</td>
<td>2.01 (1.57-2.58)***</td>
<td>1.25 (1.02-1.42)***</td>
<td>1.21 (0.90-1.62)***</td>
</tr>
<tr>
<td>Family economy&lt;sup&gt;$&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poorer than others</td>
<td>2.23 (1.77-2.83)***</td>
<td>1.54 (1.04-1.97)***</td>
<td>1.19 (0.95-1.49)***</td>
</tr>
<tr>
<td>Better than others</td>
<td>0.94 (0.81-1.10)</td>
<td>0.93 (0.83-1.06)</td>
<td>0.94 (0.80-1.11)***</td>
</tr>
<tr>
<td>Parental work status&lt;sup&gt;#&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother not working</td>
<td>1.90 (1.48-2.42)***</td>
<td>1.45 (1.16-1.82)***</td>
<td>1.36 (1.10-1.74)***</td>
</tr>
<tr>
<td>Father not working</td>
<td>1.84 (1.32-2.58)***</td>
<td>1.20 (0.88-1.65)</td>
<td>1.23 (0.91-1.64)***</td>
</tr>
</tbody>
</table>

Outcome: Sleep duration in categories (reference: 7:00 to 7:59)

- Model 1: Adjusted for age and gender.
- Model 2: Model 1 + adjustment for depressive symptoms (SMFQ total score).
- Model 3: Model 2 + adjustment family cohesion (Read Subscale).

- §: Reference: “university/college”
- $: Reference: “like most others”
- #: Reference: “working”
- *: p <.05
- **: p <.01
- ***: p <.001

Social gradients in adolescent sleep 69

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been debated. In the current study, family cohesion attenuated some of the association between SES and sleep, suggesting that the family environment may be an important factor in sleep-SES association. Furthermore, importance of getting adequate sleep may also be conveyed more strongly in higher SES families, as suggested by a US study in which sleep duration was low among low SES adolescents, but the perceived sleep deficit differed.

Lower SES may also be related to more structural variables that may contribute to impaired sleep. The current study did not gather detailed information about housing and living conditions, but it would be interesting to examine the potential role these variables play in influencing sleep in future studies. Perceived financial situation could be dependent on the neighbourhood or school the adolescent goes to, and thus clustering effects could be expected. We did not have the possibility to analyze on school or neighbourhood level, and this is a limitation of the present study.

The significance of increased understanding of social gradients in sleep during adolescence may be important to prevent the persistent impact of familial socioeconomic status in adults. Still, there is a need for intervention studies that specifically target high-risk groups before firm conclusions can be reached. Based on the present study, educational efforts to ensure knowledge of the importance of sleep in this age group may be one viable strategy in low SES groups. Parental involvement may also be a fruitful perspective as well as taking a transdiagnostic stand that includes co-occurring health problems.

Acknowledgements

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Conflicts of interest: None declared.

Key points

- Low SES was a robust determinant of adolescent sleep patterns in a large-scale population-based study.
- The association between low SES and sleep was evident across types of sleep problems including higher odds of shorter sleep duration, insomnia and delayed sleep phase.
- Depressive symptoms and family cohesion could account for some, but not all of the association between SES and sleep.
- Targeted sleep prevention and interventions for adolescence in low SES are recommended to improve sleep in high-risk groups and to prevent the negative consequences of poor sleep.

References

Introduction

The precise knowledge of age is necessary for assessing a child’s nutritional status, in particular for calculating the most common indicators of undernutrition: stunting and underweight. However, in low- and middle-income countries, especially in sub-Saharan Africa and South-East Asia, where undernutrition is a public health issue, information on age is frequently imprecise or absent, mainly due to the low practice of registering children at birth. The unknown or unreliable age is also a common condition among the huge number of migrants and refugees who are coming to Europe. Such people include minors, who have experienced stress and trauma during their long journeys and need adequate health care.

The ‘scandal of invisibility’, which affects more than 230 million children under five worldwide, has been widely debated in relation to social, political, ethical, and also epidemiological implications, but rarely in relation to nutritional status. However, the consequences of insufficient or imprecise age data on stunting and underweight estimates are substantial. In a recent article, we have calculated the effect of age bias and random error on stunting and underweight prevalence, and showed an overview of possible compensative strategies that could be used in public health.

Nutritional evaluation of undocumented children: a neglected health issue affecting the most fragile people

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The precise knowledge of age is necessary for assessing a child’s nutritional status. We show the magnitude and the effects of age error in real and hypothetical situations, and discuss possible compensative strategies. Using data collected in different years, we found that 79.8% of 1056 Ugandan children had some age knowledge, but there was a mean shift of 7.5 (±8.8) months between ages obtained from different sources. Using a free software for calculating the effect of bias and random error, we showed the variation in malnutrition prevalence in hypothetical cases.

Magnitude of age errors in real contexts

In a recent nutritional study on 1056 Ugandan children (508 males; 548 females; 3–16 years), two of us collected age data in different years (2012, 2014, 2015) and from various sources (parents, teachers, nurses, school or social workers registers).

Effects of age error on malnutrition prevalence

We have calculated the effect of age bias and random error on stunting and underweight prevalence, and showed an overview of different scenarios of age error (figure 1). Calculations of z-scores...