



## Original Article

# Moving into poverty during childhood is associated with later sleep problems



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## ARTICLE INFO

## Article history:

Received 29 November 2016

Received in revised form

7 June 2017

Accepted 7 June 2017

Available online 24 June 2017

## Keywords:

Adolescence

Sleep

Poverty

Longitudinal

## ABSTRACT

**Objective:** A social gradient in sleep has been demonstrated across the life span, but previous studies have been cross-sectional and used self-reported socioeconomic status (SES) indicators. Using registry-based data on family income trajectories, the current study examined the association between relative poverty in childhood and subsequent sleep in adolescence.

**Methods:** Data on family income during 2004–2010 was obtained from the National Income Registry. Poverty was defined as household income <60% of the mean national income. Information on self-reported sleep was based the youth@hordaland-survey ( $n = 8873$ ) conducted in 2012 when the adolescents were 16–19 years old. Latent class analysis (LCA) was used to identify trajectories of family household poverty, and analysis of variance and general linear models were used to examine associations between income trajectories and sleep, adjusting for confounders.

**Results:** LCA identified four classes: 'never poor', two classes characterized by moving in or out of poverty, and 'chronically poor'. Compared to the 'never poor' group, adolescents from families in the 'moving into poverty' group displayed worse sleep across most sleep measures, including shorter sleep, lower sleep efficiency, and more nocturnal wake time (but not sleep onset latency). Neither adolescents from families who had moved out of poverty by increasing family income, nor the 'chronically poor' group differed significantly from the reference group.

**Conclusions:** The study found that downward socioeconomic mobility was associated with increased adolescent sleep problems. More studies are required on the mechanisms that may account for the association, to find targeted and effective strategies to prevent short sleep duration in adolescents from families with unstable financial circumstances.

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## 1. Introduction

Short sleep duration and inadequate sleep are associated with a range of adverse outcomes in adolescence, such as reduced mental and physical health [1,2], poor academic performance [3], and increased school absenteeism [4]. Many adolescents do not get the recommended 8–10 h of sleep that both experts and adolescents themselves deem necessary [5–8]. There are also indications that

adolescents have less sleep nowadays than they did a few decades ago [9]. Adolescents living in poverty may be at especially high risk of poor sleep, given the relationship between low socioeconomic status (SES) and other health variables [10]. However, little is known about the relationship between socioeconomic factors and adolescent sleep. In order to identify targeted preventive interventions, we may need to improve knowledge regarding this association and possible underlying mechanisms.

The established link between sleep duration and SES is primarily based on studies in children and adults [11,12], with individuals from families with low SES typically displaying shorter sleep duration. A few studies have explored this association in adolescent populations, and with mixed findings. A small cross-sectional study

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of 141 Canadian adolescents did not find parent-reported income and education to be significantly associated with sleep duration in their offspring [13]. In contrast, a large-scale US longitudinal study found that adolescents with less-educated parents were significantly more likely to get <7 h of sleep per night compared to their peers [9]. Similarly, a US study of 155 young adolescents (mean age 12.6 years) found that lower SES was significantly correlated with later bedtimes and shorter sleep duration on school nights [14], and a Chinese study of 997 adolescents (mean age 15 years) found that family economic hardship was significantly associated with adolescents' sleep quality [15]. And recently, using cross-sectional data from the Norwegian youth@hordaland survey (the same base population as the current study), it was found that lower SES was a robust determinant of adolescent sleep patterns and sleep problems [16]. However, based on the limited number and cross-sectional nature of these studies, more prospective research is needed to examine the nature of the possible social gradient in sleep in adolescence.

While few studies have directly assessed poverty and sleep duration in adolescence, a recent meta-analysis of risk factors for short sleep in adolescence found a negative family environment to be one of the strongest predictors of short sleep duration [17]. One of the studies included in this review found that being from a disorganized family was associated with a shorter adolescent sleep duration, and that this association was mediated by sleep hygiene practices [18]. Adolescents from negative family environments had poorer sleep routines and practices, and this was reflected in lower total sleep time and increased daytime sleepiness [18].

Daily stressors have also been associated with short sleep duration in adolescents [19]. While studies have not specifically explored risk factors in relation to family financial circumstances or SES, daily stressors and family disorganization are likely to be more frequent in poor families [20]. The higher rate of mental health problems, including depression and worries among adolescents from families with low SES [21], is another potential pathway linking SES to poor sleep. For example, both pre-sleep worries and environmental conditions mediated the association between SES and sleep duration in an actigraphic study of 271 children [22]. However, it is believed that this relationship has not been investigated in adolescent samples.

One important aspect that has not been addressed in the literature is how changes in financial circumstances affect adolescent sleep. While some families may be poor right through a child's early years and adolescence, other families' financial status may either improve or worsen over this time. The relationship between sleep patterns to changes in the financial situation during childhood and adolescence currently remains unknown. It is believed that this may be important and provide a more dynamic view of the influence of SES on sleep. The present study hypothesized that adolescents who grow up in relative poverty have shorter sleep duration and sleep efficiency than their peers. It was also predicted that those adolescents from families who have experienced a change in financial circumstance, from being well off to poor, would have worse sleep parameters. Specifically, the study investigated how trajectories of poverty relate to sleep duration and sleep efficiency.

## 2. Methods

### 2.1. Procedure and participants

This population-based study used data from the youth @hordaland-survey of adolescents in the county of Hordaland in Western Norway. The main aim of the youth@hordaland-survey was to assess mental health problems, including sleep, among adolescents aged 16–19 years.

In brief, all adolescents in upper secondary education received information via e-mail, and one classroom school hour was allocated for them to complete the questionnaire. Those not in school received information by postal mail to their home addresses. The questionnaire was web-based and covered a broad range of mental health issues, sleep behaviors and sleep problems, daily life functioning, use of health care and social services, demographics, as well as a request for permission to obtain school data, and to link the information with national registries. Uni Research Health collaborated with Hordaland County Council to conduct the study. The Regional Committee for Medical and Health Research Ethics in Western Norway approved the study. Overall, Hordaland County is considered representative of Norway with regards to gender and rural/urban residence distribution, and the median household income is also similar to that of the national average [23].

All adolescents born between 1993 and 1995 were invited ( $n = 19\,430$ ) to participate in the study during the first months of 2012; 10 220 agreed to participate, yielding a participation rate of 53%. No incentives were offered for participation. All sleep variables were manually checked for validity, with subjects providing obvious invalid responses being omitted for further analyses. Invalid responses included: (1) sleep onset latency (SOL) or wake after sleep onset (WASO) > 12 h, (2) SOL + WASO > time in bed (TIB), and (3) negative values of sleep duration and sleep efficiency. This resulted in 374 subjects being omitted. Thus, the total eligible sample in the study was 9846, of which 8873 (90.1%) consented to linkage to external registers.

As required by Norwegian legislation, the adolescents consented themselves to linkage to registries. Personal identifiers (for those who consented) were obtained and linked to the dataset using study-specific identification numbers. These data were securely transmitted to Statistics Norway, who linked these data to information about income. When the data were returned, the personal identifiers and the study-specific identification numbers were replaced with new identification numbers to preserve anonymity of the respondents.

## 3. Measures

### 3.1. Measure of family income

The Norwegian national income register measured family income. Using each participant's personal identification number, information was obtained about the *equivalised disposable household income* for the years 2004 (when the children were 8–11 years old) to 2010 (when the children were 14–17 years old). Equivalised household income is a measure of household income that is adjusted by an equivalence scale in order to facilitate comparison between households of different size and composition, and may be viewed as an indicator of the economic resources that are available to a standardized household. The European Union (EU) scale (a modification of the OECD (Organisation for European Economic Cooperation) equivalence scale) was the equivalence scale used in the current study, where the first adult was given a weight of one, subsequent adults were given a weight of 0.5, and each child <14 was given the weight 0.3 [24,25]. From this measure of family income, the proportion of adolescents in relative poverty was calculated; relative poverty was defined as having an equivalised household income <60% of the equivalised national median income for that particular year (eg, to calculate poverty proportions for 2004, the median income for 2004 was used) [26]. The national median income for each year is detailed in Table 1 for Norwegian kroner (NOK), Euros (€), and US dollars (US\$), with the income corresponding to the EU scale (60% of median income) in the columns to the right. Participants with income below this value were classified into the 'poor' group at each point in time.

**Table 1**  
Equivalised median income for the years 2004–2010 in different currencies.<sup>a</sup>

Years	Median income in NOK			60% of median income		
	NOK	EURO	US\$	NOK	EURO	US\$
2004	NOK 219 276	EUR 23 228	US\$ 25 981	NOK 131 566	EUR 13 937	US\$ 15 588
2005	NOK 230 951	EUR 24 465	US\$ 27 364	NOK 138 571	EUR 14 679	US\$ 16 418
2006	NOK 242 200	EUR 25 657	US\$ 28 697	NOK 145 320	EUR 15 394	US\$ 17 218
2007	NOK 262 486	EUR 27 806	US\$ 31 100	NOK 157 492	EUR 16 683	US\$ 18 660
2008	NOK 283 121	EUR 29 992	US\$ 33 545	NOK 169 873	EUR 17 995	US\$ 20 127
2009	NOK 286 667	EUR 30 367	US\$ 33 965	NOK 172 000	EUR 18 220	US\$ 20 379
2010	NOK 295 549	EUR 31 308	US\$ 35 018	NOK 177 329	EUR 18 785	US\$ 21 011

<sup>a</sup> Values in Euros and US\$ from 2004 to 2010 based on the conversion rates of May 31, 2017 (1 EURO = NOK 9.44, and 1 US\$ = 8.44 NOK).

### 3.2. Sleep variables

Information on sleep was collected as part of the youth@hordaland survey from 2012, when the adolescents were 16–19 years old. The adolescents' typical self-reported bedtime and rise time were indicated in hours and minutes, using a scroll down menu with 5-min intervals, and were reported separately for weekend and weekdays. Typical TIB was calculated by subtracting bedtime from rise time. The SOL was measured by asking the adolescent?: 'How long does it usually take from you to fall asleep after going to bed', while WASO was assessed by asking 'How long are you typically awake during the night after first having fallen asleep?' Responses were given in minutes and hours, and adolescents were instructed to provide an appraisal of their own estimated time. Sleep duration was defined as TIB minus SOL and WASO. Sleep efficiency was calculated as sleep duration divided by TIB multiplied by 100 (reported as percentage).

### 3.3. Other variables

Gender and date of birth was identified through the personal identity numbers in the Norwegian National Population Register. Exact age was estimated by calculating the interval of time between date of birth and date of participation. Maternal and paternal education were reported separately with three response options; 'primary school', 'secondary school', and 'college or university'. Symptoms of depression were assessed using the short version of the Mood and Feelings Questionnaire (SMFQ) [27]. The SMFQ comprises 13 items assessing depressive symptoms rated on a three-point Likert scale: 'not true', 'sometimes true' and 'true'. High internal consistency between the items and a strong unidimensionality have been shown in population-based studies [28], which were recently confirmed in a study based on the same sample as in the present study [29].

### 3.4. Statistics – analytic strategy

Latent class analysis (LCA) was used to identify participants who shared a similar pattern of family income across all seven time points (2004–2010). Latent class analysis is a person-centered approach, where the number of latent classes that could be established was estimated based on the family income. The following criteria were used to decide on the number of classes to retain: Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample size adjusted BIC (adj BIC) [30]. The AIC, BIC, and adjusted BIC aim to gauge the balance between parsimony and fit to data of the suggested models, and are considered comparative fit indices. As such they are used to compare two or more models, with lower values indicating a better fit. Entropy was used to assess the quality of classification, with values closer to 1.0 indicating higher classification accuracy. Vuong-Lo-Mendell-Rubin (VLMR) adjusted likelihood ratio test

was also used for testing the hypothesis that a model with one less class performs just as well.

The LCA was conducted in an iterative manner, where it was started with one class, and increased the number of classes until the fit criteria suggested a good enough model. Deciding on the retained model, statistic criteria (as indicated by VLMR-test statistics), parsimony (as indicated by comparative fit indices), and meaningfulness based on visual inspection of the classes were considered collectively. Mplus version 7.1 (Los Angeles, California) was used for the LCA-analyses (Muthén & Muthén, 1998–2010). Differences in sleep variables between the identified classes of income were also tested in Mplus version 7.1 using the Bolck, Croon, and Hagenars (BCH) approach for estimating the means of distal outcomes across latent classes [31].

A sensitivity analysis – estimated marginal means (EMM) – was also calculated using IBM SPSS Statistics 23 for Mac (SPSS Inc., Chicago, Ill) adjusting for age, parental education, and symptoms of depression.

## 4. Results

### 4.1. Sample characteristics

In all, 8873 adolescents provided valid responses on the relevant sleep items in the linked sample. The mean age was 17.4 years (SD = 0.84), and the sample included more girls (53.5%) than boys (46.5%). The average sleep duration during weekdays was 6 h and 26 min (SD = 1:39). The average SOL and WASO were 47 min (SD = 57 min) and 14 min (SD = 39 min), respectively, yielding a mean sleep efficiency of 84.5% (SD = 17.6).

### 4.2. Classes of family income

The model fit statistics indicated that a four or five class solution fitted the data best (see Table 2). Inspection of the information criteria (AIC and BIC) indicated that little was gained by allowing for more than four classes. The LMR-LRT test did, however, indicate that five classes was better than four, and the entropy was slightly better (0.939 in the five class model versus 0.929). Comparison of the patterns in the four and five class models did, however, not

**Table 2**  
Model fit statistics for 2 through 6 classes. Bold indicates the selected model ( $n = 8873$ ).

Number of classes	AIC	Sample-size adjusted BIC	Entropy	LMR-LRT
2	18480.168	18538.862	0.947	<0.001
3	18103.726	18193.723	0.946	<0.001
<b>4</b>	<b>17808.447</b>	<b>17929.748</b>	<b>0.929</b>	<b>&lt;0.001</b>
5	17728.302	17880.907	0.939	<0.001
6	17702.906	17886.814	0.943	0.078

AIC, Akaike information criterion; BIC, Bayesian information criterion; LMR-LRT: Lo-Mendell-Rubin adjusted likelihood ratio test.

suggest that the added class yielded additional information that was qualitatively important. That is, four of the patterns were similar for the four and five class models, and the five class model did not seem to be able to identify any further patterns that were deemed substantively different from the model with one less class. Six classes were not supported by the data. Taken together, the four class model was chosen as the final model, based on the overall consideration of the fit statistics, the meaningfulness of the classes and model efficiency [32]. The final model discriminated among four estimated classes, all of which were considered substantively meaningful (see Fig. 1). The largest class by far was called ‘never poor’ (class 1; 89.6%), followed by two classes characterized by moving in or out of poverty: the ‘moving out of poverty’ (class 2; 4.5%) and the ‘moving into poverty’ (class 3; 3.1%). The smallest class was the ‘chronically poor’ (class 4; 2.8%). Class 1 (never poor) was used as the reference group in this paper.

#### 4.3. Family income and subsequent sleep behavior during adolescence

As detailed in Table 3, adolescents from families experiencing worsening in their family income from 2004 to 2010 (class 3: ‘moving into poverty’) reported significantly worse sleep on most sleep outcomes. While the average weekday sleep duration was 6 h and 28 min in the ‘never poor’ class, the sleep duration was 22 min shorter (5 h and 56 min) in adolescents from ‘moving into poverty’ families ( $p < 0.001$ ). Similarly, the average WASO was 24 min in the ‘moving into poverty’ class, compared to 14 min in the ‘never poor’ class (both  $p < 0.001$ ). With regards to sleep efficiency, adolescents in class 1 (‘never poor’) had a sleep efficiency of 85.7%, compared to 81.4% in the class 3 (‘moving into poverty’) ( $p < 0.001$ ). No significant differences between the classes were observed for SOL.

For sensitivity purposes, EMM was also computed, adjusting for age, gender, parental education and symptoms of depression; however, marginal differences were observed, and all class comparisons remained statistically significant (results not shown).

## 5. Discussion

In this large population-based study linked with official income data, adolescents’ sleep patterns were examined according to trajectories of family poverty during childhood. Compared to the reference group, adolescents from families with decreasing family

income trajectory (the ‘moving into poverty’ group) displayed worse sleep across most sleep measures, including shorter sleep duration and lower sleep efficiency, as well as longer WASO (but not SOL). In contrast, neither adolescents from the ‘moving out of poverty’ group, nor the ‘chronically poor’ group differed significantly from the reference group on any of the sleep indicators.

The results only partly confirmed the hypothesis. It was expected that all three groups of adolescents experiencing poverty during childhood would differ from their peers on the sleep measures. It was especially surprising that the ‘chronically poor’ group did not differ from the ‘never poor’ group, as it could be expected that the longer a child has lived in poverty, the more likely it is that they have negative health consequences. However, such an accumulation model did not fit the results of the current study. Rather, the findings indicated that only downward mobility in family income (those experiencing increased poverty recently) was related to subsequent sleep problems in the adolescents.

This is the first study to evaluate the influence of childhood family income trajectories on adolescent sleep duration, and thus further replications are needed. A similar pattern was demonstrated in a study of family income trajectories during childhood on alcohol use in adolescence, where the authors similarly found that downward mobility in poverty was linked to increased alcohol use, whereas neither the upward mobility group nor the chronically poor income group were associated with adolescents’ alcohol use [33]. Others have suggested that economic instability in itself may be a risk factor for negative developmental outcomes [34].

In terms of possible mechanisms explaining the findings, downward mobility may be caused by unemployment, parental health and changes in family composition, which in turn may account for some of the association. Norway is a wealthy country with relatively small income inequalities, where absolute deprivation is uncommon [35]. Although a group of adolescents living in stable relative poverty was identified, few of these participants were poor in an absolute sense or in comparison to many other countries. This may suggest that it is not the level of income per se that is responsible for the negative effects on sleep, but rather the experience of downward mobility or the stressors associated with such a shift in income. Feelings of loss and the subjective feeling of economic deprivation may be greater when there is a loss of relative income for the family. As such, it was hypothesized that depressive symptoms could be one likely candidate to account for the association between poverty and sleep. However, adjusting for depression

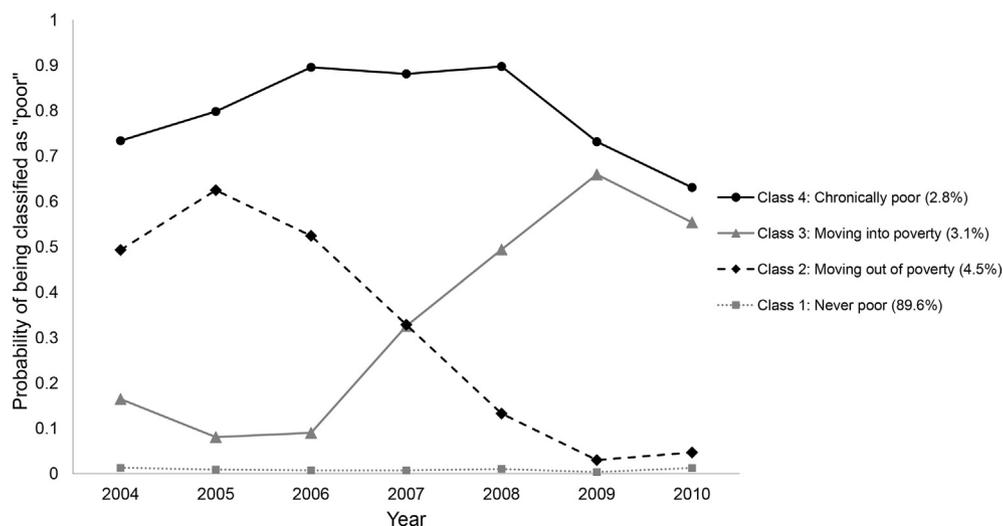


Fig. 1. Latent classes across 7 time points from 2004 to 2010 ( $n = 8873$ ).

**Table 3**  
Sleep variables in adolescence stratified by classes of family income during childhood ( $n = 8873$ ).

Sleep variable	Class 1 'Never poor' ( $n = 7950, 89.6\%$ )	Class 2 'Moving out of poverty' ( $n = 399, 4.5\%$ )	Class 3 'Moving into poverty' ( $n = 275, 3.1\%$ )	Class 4 'Chronically poor' ( $n = 248, 2.8\%$ )	Chi-squared	$p$	Pairwise comparisons
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)			
Sleep duration (min)	387.9 (1.2)	376.3 (6.7)	356.2 (9.4)	382.9 (8.8)	16.246	0.001	1 > 3
Sleep onset latency (min)	47.5 (0.7)	46.5 (3.7)	55.1 (5.6)	41.7 (4.1)	3.207	0.361	n.s
Wake after sleep onset (min)	14.2 (0.4)	17.2 (2.8)	23.7 (4.4)	23.7 (3.9)	14.871	0.002	1 < 3; 1 < 4
Sleep efficiency (%)	85.7 (0.2)	85.1 (1.2)	81.4 (1.8)	84.0 (1.6)	8.409	0.038	1 > 3

and other potential confounders only marginally attenuated the observed associations in the current study. A possible more direct influence to the developing brain might also exist, which was suggested in a recent review [36]. However, the current findings do not fit very well with this perspective, which relied more on an accumulation theory, in which children exposed to poverty from an early age and for longer periods would be more affected.

Some methodological issues about the current study should be acknowledged. First, the registry-based income information over 6 years was a significant strength. However, income information was not used for the last two years prior to the study, which was a limitation. Although income data from these years do exist in the official databases, it is not possible to separate the families' household incomes from that of the adolescents' own personal incomes when adolescents move to attend high school. This would then artificially inflate the rates of relative poverty, as most adolescents' own incomes would be substantially smaller than their household incomes prior to moving. Second, it would have further strengthened the study if there were more information on possible mechanisms related to poverty and sleep, such as sleep environment (noise, crowding) and parental sleep behavior (parental set bedtimes and parental strategies). It was similarly not possible to examine the influence of the immediate environment such as school or neighborhood. Moreover, attrition from the study could have affected generalizability, with a response rate of about 53% and with adolescents in schools overrepresented. The problem with non-participation in survey research unfortunately seems to be on the rise [37]. Official data show that in 2012, 92% of all adolescents in Norway aged 16–18 attended high school [38], compared to 98% in the current study. Based on previous research from the former waves of the Bergen Child Study (the same population as the current study), non-participants have also been shown to have more psychological problems than participants [39], and it is therefore likely that the prevalence of sleep problems may have been underestimated in the current study.

The lack of an objective measurement (actigraphy or polysomnography) of sleep variables was a limitation of the current study. However, a methodological strength of the study was the measure of sleep duration, which included both SOL and WASO; 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 [40]. Also, the accuracy of self-reported SOL and WASO are generally better among adolescents than in older adults [41], and a study of young adolescents in Hong Kong recently found good agreement between actigraphy measured and questionnaire reported sleep durations [42].

The present study is the first step in filling a gap in knowledge of a possible social gradient in sleep for adolescents. Due to the inconsistencies in the earlier literature, it would be premature to make firm conclusions based on one study. However, the results do suggest that adolescents with families with a downward social

mobility may be an especially vulnerable group. More studies are required on the mechanisms that may account for the association, to find targeted and effective strategies to prevent short sleep duration in adolescents from families with unstable financial circumstances.

### Acknowledgment

The authors would like to thank Regional Centre for Child and Youth Mental Health and Child Welfare at Uni Research Health and the Bergen Child Study group for collecting the data and making the data available for this study. The authors would also like to thank the participants for their time and effort. The Norwegian Research Council (project number 228189) supported this work.

### Conflict of interest

The authors report no conflicts of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <http://dx.doi.org/10.1016/j.sleep.2017.06.005>.

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