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## Prevalence and stability of insomnia from preschool to early adolescence

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# PREVALENCE AND STABILITY OF INSOMNIA FROM PRESCHOOL TO EARLY ADOLESCENCE

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ABSTRACT

Background

There is limited knowledge about the prevalence and stability of DSM-defined insomnia. We therefore provide such estimates from preschool to early adolescence and explore potential sex differences.

Methods

We followed a representative community sample ( $n=1,037$ ) biennially from 4 to 14 years of age. Insomnia diagnoses and symptoms were captured by a semi-structured clinical interview of parents and children (from age 8 years).

Results

At ages 4 and 6 years approximately 2.5% of children met the criteria for insomnia, whereas at ages 8, 10, 12, and 14 years the prevalence ranged between 7.5–12.3%. During the 10-year period examined nearly one in five children had insomnia at least once (18.7%). Sex differences were apparent with DSM-IV, but not DSM-5, criteria: boys had more insomnia than girls did at ages 4 to 10 years, whereas girls had more insomnia than boys did at ages 12 and 14 years. Insomnia proved moderately stable, with 22.9–40.1% of children retaining their diagnosis two years later. Having current insomnia produced odds ratios of between 5 and 15 for subsequent insomnia compared with not having preceding insomnia.

Conclusions

Insomnia was less prevalent than previous research indicates, with nearly one in five participants having insomnia at least once between the ages of 4 to 14 years. Female preponderance emerged in early adolescence. Having insomnia at one time point was a considerable risk for subsequent insomnia, indicating that insomnia is persistent and warrants clinical attention.

Childhood insomnia is associated with negative outcomes that include emotional, behavioural, and cognitive problems.[1-3] Prevalence estimates and a description of the course of insomnia may aid preventative and treatment efforts. However, most previous research on this topic in children has examined insomnia symptoms[4-11] that may not have the severity, duration, intensity, or associated impairment that warrants a clinical *diagnosis*. Moreover, research has almost exclusively relied on questionnaires/checklists,[12-14] with various biases.[15] In clinical interviews, on the other hand, the interviewer probes until it is clear whether a symptom is present or not according to diagnostic criteria.

Only three previous studies have estimated the prevalence of childhood insomnia through clinical interviews,[16-18] two addressing early childhood[16,17] and one reporting averaged rates for the age span 8 to 18 years.[18] In addition, two questionnaire-based longitudinal studies have assessed insomnia into early adolescence.[12,13] Hence, there is a dearth of studies on the prevalence of diagnosable insomnia from preschool to adolescence based on interview data. We will therefore provide such estimates.

If, once established, childhood insomnia evinces a chronic course, early intervention may be warranted. However, if insomnia is transient there is less need to intervene. Preschool-age insomnia has been found to increase the risk of later insomnia,[17] and studies of preadolescents indicate that insomnia symptoms are moderately stable.[6-8,12,13] However, these studies used questionnaires and checklists; thus, the stability reported may reflect the stability of the rater rather than of the symptoms. By using clinical interviews, as we do here, rater bias and common method biases are reduced and hence more accurate stability estimates can be obtained.

From the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)[19] to the fifth (DSM-5),[20] the symptom of experiencing sleep as non-restorative has been replaced with that of early morning awakenings accompanied by the

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inability to return to sleep. The impact of this change on prevalence estimates and course in children is unknown but will be examined here.

Using a semi-structured clinical interview in a large and representative community sample (over six waves, from age 4 to 14 years) we tested the following hypotheses: 1) the rate of insomnia will decrease from preschool to middle childhood and rise again in early adolescence; 2) insomnia is more prevalent in girls than in boys in early adolescence, as shown earlier regarding insomnia symptoms;[4,18,21-23] 3) the two year persistence of insomnia is moderate.

METHODS

Procedure and participants

Data came from the Trondheim Early Secure Study (TESS).[24] All children born in 2003 and 2004 in Trondheim (N=3,456), Norway, were invited to participate through a letter of invitation ahead of an ordinary community health check-up at the age of 4 years; 1,250 families were selected to participate and were then followed up biennially. Age in years at initial testing (T1) was  $M_{age}=4.59$ ,  $SD=.25$ , and at subsequent assessments was as follows: T2:  $M_{age}=6.72$ ,  $SD=.19$ ; T3:  $M_{age}=8.79$ ,  $SD=.23$ ; T4:  $M_{age}=10.51$ ,  $SD=.17$ ; T5:  $M_{age}=12.50$ ,  $SD=.14$ ; T6:  $M_{age}=14.35$ ,  $SD=.16$ . In all, we had diagnostic information on at least one time-point for 1,037 participants, thus forming the analytical sample (descriptive statistics in eTable 1). Details of procedure and participation rates are presented in online supplementary eFigure 1, and in our cohort paper.[23] None of the study variables predicted attrition, except that boys had higher attrition at 10 (OR=1.39, 95% CI=1.07, 1.81), 12 (OR=1.31, 95% CI=1.01, 1.69) and 14 years of age (OR=1.40, 95% CI=1.09, 1.80). The proxy R<sup>2</sup> values for sex were all <1%. The Regional Committee for Medical and Health Research Ethics Mid-Norway approved the study.

## Participant and Public involvement

The planning, implementation, carry through and dissemination from TESS is guided by a user group consisting of participating adolescents and parents, researchers from TESS, St Olavs Hospital, the Municipal education officer in Trondheim, the youth division of the user group Mental Health Norway, and Department of Education – Trøndelag county.

## Measures

At ages 4 and 6 years, DSM-IV-defined insomnia was measured by the Preschool Age Psychiatric Assessment (PAPA),[25] a parent interview that follows a structured protocol. PAPA is a revised version of the Child and Adolescent Psychiatric Assessment (CAPA), which is appropriate for older children and hence was used in this study when the children was 8, 10, 12, and 14 years of age.[26] Children and parents were interviewed separately. Symptoms of insomnia were considered present if reported by either parent or child.

The interviewers ( $n=7$ ) had at least a bachelor's degree in a relevant field and extensive prior experience working with children and families. Blinded raters recoded 9% of audio-recorded interviews and interrater reliability between multiple raters for insomnia was  $k=.75$ .

### *Diagnosing Insomnia*

According to the DSM-IV,[19] the International Classification of Sleep Disorders-2 (ICSD-2),[27] and the International Classification of Diseases-10 (ICD-10),[28] insomnia is characterised by difficulties initiating and/or maintaining sleep and/or a subjective experience of non-restorative sleep that lasts for a considerable amount of time and causes clinically significant distress or impairment in important areas of functioning. However, in the absence of a cutoff for the frequency or duration of insomnia symptoms, epidemiological research on insomnia has been challenging. As no child-specific insomnia criteria exist in the DSM, we relied on normative sleep latency, night awakenings, and sleep duration in childhood.[10,29-



32] Insomnia at 4 and 6 years of age was classified as preschool insomnia, at ages 8–10 and 12–14 years as middle childhood insomnia and early adolescence insomnia, respectively.

*DSM-IV Insomnia*

Based on these studies and the DSM-IV criteria with suggested cutoffs, we defined DSM-IV insomnia as: (1)  $\geq 30$  minutes to fall asleep or the use of sleep medication; (2)  $\geq 20$  minutes awake after sleep onset; or (3) non-restorative sleep (insufficiently rested after sleep). The symptom(s) had to have occurred at least three times a week over the previous three months and be accompanied by reports of clinically significant distress or impairment in important areas of functioning. Because CAPA probes sleep onset or night awakenings in hours rather than minutes, it should be noted that we used  $\geq 1$  hour as the cutoff at age 8 years before correcting this by expanding the insomnia interview from age 10 years onwards to include time in minutes too. Hence, data from age 8 years should be viewed as yielding a conservative, proxy insomnia measure.

*DSM-5 Insomnia*

In recent years both the DSM-5[20] and the ICSD-3[33] have suggested cutoffs for subjective sleep latency and time awake after sleep onset of greater than 20–30 minutes. The DSM-5 parts with DSM-IV criteria regarding non-restorative sleep, replacing it with early morning awakening before eight hours of sleep and being unable to return to sleep. In addition, DSM-5 acknowledges that symptoms of sleep latency and nocturnal awakenings may be masked by caregiver intervention. We therefore regarded always relying on parental help to initiate or maintain sleep as validation of these symptoms.

**Statistical analyses**

All analyses were performed in Mplus, version 8.[34] We used a full information maximum likelihood approach to handle missing data. As the sample was screen-stratified (see eFigure 1), probability weights where the number of children in the stratum were divided

by the number of participants in the same stratum were calculated to arrive at corrected population estimates. A robust maximum likelihood estimator was used, which is robust to deviations from normality because it provides corrected error terms with respect to oversampling. Some categorical variables served as both predictor and outcome (e.g. insomnia at ages 6, 8, 10, and 12 years). Because Mplus cannot specify an endogenous variable as categorical, we performed bivariate regressions to assess the stability of insomnia. To investigate both the sex differences in the prevalence of insomnia at each time point and the stability between time points, we compared a model in which prevalence/stability was constrained to be equal in the two sexes with another model in which prevalence was freely estimated, using Wald tests.

## RESULTS

### Prevalence

Table 1 presents the prevalence of DSM-IV- and DSM-5-defined insomnia at all ages. The prevalence of insomnia increased sharply from 6 to 8 years. However, bear in mind that children were not included as informants before the age of 8 years and separate growth curve analyses for parents ( $M_{\text{growth}} = -0.05, p = .56$ ) and children ( $M_{\text{growth}} = 0.13, p = .49$ ) showed no increase in insomnia prevalence with age. Thus, the increase from age 8 years onwards might be due to having two sets of informants, as opposed to only the parents as informants at earlier ages. Close to every fifth child had DSM-IV insomnia at one point between 4 and 14 years of age; 12.8% had insomnia at one time point only, 4.1% at two points, 1.5% at three points, and 0.3% at four points.

The prevalence of insomnia for the two sexes is displayed online in eFigure 2. DSM-IV insomnia was more common in girls (13.7%) than in boys (6.7%) at the age of 14 years (Wald=6.79, df=1,  $p=0.009$ ), and marginally more common in girls than in boys when comparing the mean prevalence of DSM-IV-defined insomnia in early adolescence (ages

12–14 years; Wald=4.02, df=1,  $p=0.045$ ). Additionally, DSM-IV insomnia was more common among boys (11.5%) than among girls (5.4%) at the age of 8 years (Wald=7.64, df=1,  $p=0.006$ ), and more common among boys than girls when comparing means for insomnia for the two sexes in childhood overall (ages 4–10 years; Wald=8.98, df=1,  $p=0.003$ ). No sex difference in insomnia was found using DSM-5 insomnia criteria.

The prevalence of the specific symptoms of DSM-IV and DSM-5 insomnia is displayed in Table 2. Prolonged latency of sleep onset was the most common insomnia symptom throughout the study period. The least frequent DSM-IV symptom was nocturnal awakenings, while none of the participants was troubled with the DSM-5’s symptom of early morning awakenings. Comparing the prevalence of DSM-IV and DSM-5 symptoms for the two sexes revealed that the symptom of non-restorative sleep (DSM-IV) was more common in girls (17.8%) than in boys (8.0%) at the age of 14 years (Wald=11.87, df=1,  $p=0.001$ ).

**Stability and course**

Figures 1 and 2 display the course of DSM-IV and DSM-5 insomnia. Between 32–40% of those with an insomnia diagnosis at one time point experienced the same disorder two years later, participants aged 4 to 6 years being the exception (23%). Table 3 reveals insomnia to exhibit a moderately high two-year stability, with current insomnia increasing the probability of subsequent insomnia by 5 to 15 times compared with not having an insomnia disorder at the preceding time point. In addition, insomnia during preschool years (ages 4 to 6 years) increased the risk of insomnia in middle childhood (ages 8 to 10 years), and insomnia in middle childhood predicted insomnia in early adolescence (ages 12 to 14 years).

Sex-specific analyses showed that DSM-IV insomnia was more stable in boys from age 4 to age 6 years than in girls (who displayed no stability; Wald=58.81, df=1,  $p<0.001$ ). No other sex differences in stability was found. There was no difference in two-year stability between DSM-IV- and DSM-5-defined insomnia.

## DISCUSSION

Biennial interview-based assessments from ages 4 to 14 years revealed that approximately 2.5% of children met the criteria for insomnia diagnosis at 4 and 6 years of age, whereas at ages 8, 10, 12, and 14 years the prevalence ranged from 7.5% to 12.3%. Insomnia proved to be moderately stable; 23–40% of children had retained their diagnosis two years later and current insomnia increased the probability of insomnia two years later by 5–15 times.

### Prevalence of insomnia diagnosis

No previous study has examined the prevalence of diagnosable insomnia from preschool to early adolescence. The three studies employing semi-structured interviews that have been carried out reported considerably higher prevalence estimates, ranging from 16.6–21.2%, [16–18] compared with the present findings. The discrepancy may be due to these former studies employing broader age ranges [18] or using DSM-IV criteria with more liberal cutoffs for sleep latency and time awake after sleep onset. [16,17] Notably though, our estimate of the prevalence of insomnia substantially *exceeds* the rate of children and adolescents receiving insomnia diagnoses in primary care (0.05–1.20%), [35,36] suggesting that insomnia is under-diagnosed in children aged 4–14 years.

The increase in insomnia from preschool to middle childhood does not match previous research on childhood insomnia, [12,13,17,18] probably due to our inclusion of children as informants. As children grow older, parents may be unaware of their offspring's sleeping difficulties (e.g. staying in bed despite difficulty falling asleep), thus insomnia prevalence research relying on parents only probably underestimates prevalence estimates.

In the current study female preponderance emerged in early adolescence, which is in line with the typical 11–12 years of age reported in the literature. [21,22,37] The sex difference found with DSM-IV criteria indicating that insomnia is more common in boys than

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in girls in the period from 4 to 10 years of age is novel in the insomnia literature and should therefore be interpreted cautiously. Notably, no sex differences were found with DSM-5 criteria. This is probably down to the observed sex difference in non-restorative sleep (DSM-IV) rather than in the prevalence of early morning awakenings (DSM-5) at age 14 years.

**The course of insomnia**

Our results reveal that for approximately 23% to 40% of children, insomnia is stable over a two-year span. Thus, for most children insomnia is transient. In adults, on the other hand, insomnia usually fosters further sleep problems through maladaptive coping behaviours (e.g. daytime naps) and negative beliefs about sleep (e.g. exaggeration of the consequences of the lack of sleep)[38] as well as conditioning.[39] That said, for a subgroup of children insomnia is persistent and warrants clinical attention. Hence, research identifying the characteristics of those with persistent insomnia is much needed.

**Limitations**

Aside from the strengths of the current study – including entailing a large longitudinal community sample followed up biennially for ten years and administering clinical interviews based on formal diagnostic criteria – there are notable limitations. First, we applied a conservative, proxy diagnosis for children at 8 years of age (a 1-hour threshold for sleep latency and night awakenings) and might thus have underestimated the prevalence and stability of insomnia. Second, as the sample was mainly of Norwegian origin our findings may not apply to more ethnically diverse populations or other geographical locations. Lastly, although there are numerous similarities between the DSM-IV and DSM-5 criteria, this study applied only DSM-IV insomnia data for the whole study period as this was the diagnostic manual in use at the start of the study. Still, our results indicate that DSM-IV and DSM-5 insomnia criteria do not yield significantly different prevalence or stability estimates at age 10–14 years. Sex differences, however, were found with DSM-IV criteria only.

## CONCLUSIONS

The present study is the first to provide age-specific population prevalence estimates and chronicle the stability of insomnia, from preschool to early adolescence, obtained through clinical interviews. DSM-defined insomnia was less prevalent (i.e. 2.4–10.5%) than has been indicated by previous research. No difference in prevalence or stability estimates for insomnia was found using DSM-IV vs. DSM-5 criteria. Girls had marginally more DSM-IV insomnia in early adolescence (age 12–14 years) than did boys, while boys had more insomnia than did girls in childhood (age 4–10 years). Yet no sex differences were found using the DSM-5 criteria, probably due to no child having the newly added DSM-5 symptom of early morning awakenings. Insomnia proved moderately stable, as illustrated by results showing that between 23–40% maintained their insomnia disorder over a two-year period, and those with current insomnia (compared with those without) were 5–15 times as likely to have subsequent insomnia.

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**What is already known on this topic**

There is a dearth of studies on the prevalence and stability of interview-based DSM-IV and DSM-5 diagnosable insomnia in childhood. Previous work is characterised by differing estimates depending on the definition of sleep difficulties (e.g. from problems to disorders) and methodological approach (i.e. time-span, informants). In early adolescence, a female preponderance in the prevalence of insomnia is typically reported.

**What this study adds**

The present study is the first to provide age-specific population estimates of insomnia, from preschool to early adolescence, obtained through clinical interviews. Both DSM-IV- and DSM-5-defined insomnia were less prevalent in this study than previous research indicates, and sex differences were found applying DSM-IV criteria only. Insomnia was moderately stable; those with current insomnia (compared with those without) were 5–15 times as likely to have subsequent insomnia.

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**Table 1.** Prevalence (%) of DSM-IV and DSM-5 Defined Insomnia (n = 1,037)

Age (in years)	DSM-IV Insomnia (95% CI)	DSM-5 Insomnia (95% CI)
Aged 4	2.6% (1.6, 3.5)	-
Aged 6	2.4% (1.4, 3.5)	-
Aged 8 <sup>1</sup>	8.3% (6.2, 10.5)	-
Aged 10	10.2% (7.8, 12.6)	12.3% (9.5, 15.2)
Aged 12	7.9% (5.6, 10.1)	7.5% (5.3, 9.8)
Aged 14	10.5% (7.8, 13.1)	10.5% (7.5, 13.4)
At least once, age 4–14	18.7% (16.2, 21.2)	-
At least once, age 10–14	18.6% (15.6, 21.6)	18.1% (15.0, 21.1)

Note. CI = confidence interval. <sup>1</sup> Proxy measure of insomnia.

**Table 2.** Prevalence (%) of Symptoms of DSM-IV and DSM-5 Insomnia (n = 1,037)

	Aged 4 years (95% CI)	Aged 6 years (95% CI)	Aged 8 years (95% CI) <sup>1</sup>	Aged 10 years (95% CI)	Aged 12 years (95% CI)	Aged 14 years (95% CI)
DSM-IV Insomnia						
Initiating symptom	7.8 (6.0, 9.6)	10.0 (7.8, 12.2)	15.5 (12.6, 18.5)	18.0 (15.0, 21.1)	15.7 (12.8, 18.7)	12.3 (9.5, 15.2)
Maintaining symptom	4.7 (3.3, 6.2)	3.1 (1.8, 4.4)	1.0 (0.2, 1.8)	1.0 (0.3, 1.7)	1.0 (0.2, 1.8)	0.8 (0.0, 1.6)
Not rested symptom	3.3 (2.1, 4.6)	5.7 (4.0, 7.4)	13.0 (10.3, 15.7)	6.9 (4.9, 8.8)	6.9 (4.7, 9.0)	13.3 (10.4, 16.2)
At least one symptom of DSM-IV insomnia	13.8 (11.5, 16.1)	15.4 (12.7, 18.1)	23.2 (19.8, 26.7)	22.0 (18.8, 25.3)	19.5 (16.3, 22.8)	20.3 (16.9, 23.7)
DSM-5 Insomnia						
Initiating symptom	n/a	n/a	n/a	22.0 (18.7, 25.4)	16.9 (13.8, 20.0)	14.4 (11.3, 17.5)
Maintaining symptom	n/a	n/a	n/a	8.3 (6.1, 10.5)	4.4 (2.6, 6.2)	1.8 (0.7, 2.9)
Early awakening symptom	n/a	n/a	n/a	n/a	n/a	n/a
At least one symptom of DSM-5 insomnia	n/a	n/a	n/a	27.3 (23.7, 30.8)	19.5 (16.2, 22.8)	14.7 (11.7, 17.7)

Note. Age 4–6 years, parent report; age 8–12, joint report. CI = confidence interval. <sup>1</sup> Proxy insomnia at age 8 years – thresholds of 1 h sleep latency / time awake at night

**Table 3.** Stability of DSM-IV and DSM-5 Insomnia (n = 1,037)

	<b>DSM-IV Insomnia Odds ratio (95% CI)</b>	<b>DSM-5 Insomnia Odds ratio (95% CI)</b>
Age 4 to age 6 years	15.28 (4.42, 52.88)	n/a
Age 6 to age 8 years	7.33 (2.57, 20.96)	n/a
Age 8 to age 10 years	5.05 (2.61, 9.75)	n/a
Age 10 to age 12 years	9.29 (4.49, 19.20)	6.24 (2.71, 14.37)
Age 12 to age 14 years	7.06 (3.31, 15.06)	10.50 (4.86, 22.70)
Preschool to middle childhood	5.18 (2.51, 10.68)	n/a
Middle childhood to early adolescence	4.72 (2.79, 8.00)	n/a
Preschool to early adolescence	1.68 (0.73, 3.89)	n/a

Note. CI = confidence interval.

[Figure title]

**Figure 1.** Course of DSM-IV Insomnia

[Figure legend]

Note. Numbers in boxes are prevalence estimates while numbers outside boxes are from pairwise crosstabs (only those present for the two ages in question). Number of subjects rounded to closest whole number, as they are originally population estimates.

[Figure title]

**Figure 2.** Course of DSM-5 Insomnia

[Figure legend]

Note. Numbers in boxes are prevalence estimates while numbers outside boxes are from pairwise crosstabs (only those present for the two ages in question). Number of subjects rounded to closest whole number, as they are originally population estimates.

[Figure title]

**eFigure 1.** Flowchart of Recruitment and Follow-up

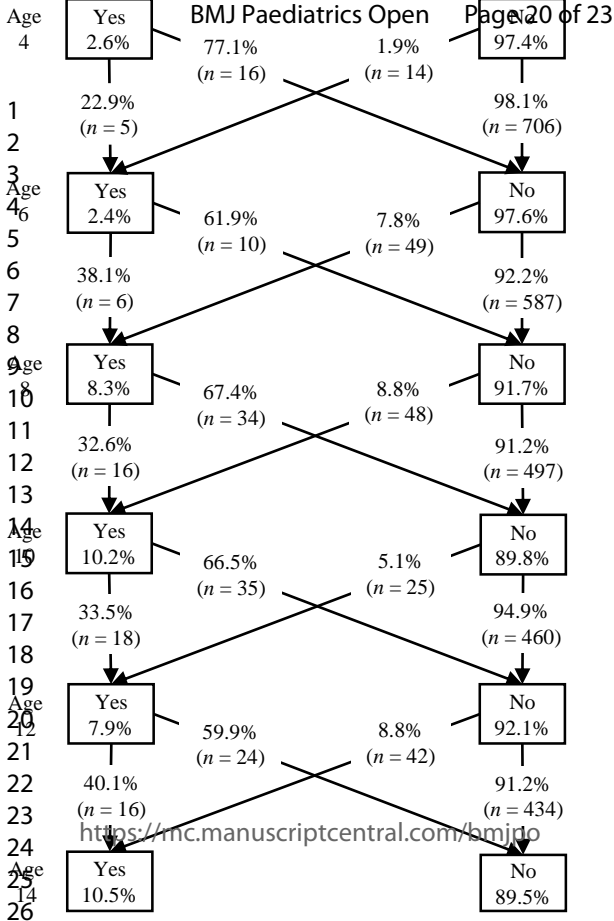
[Figure legend]

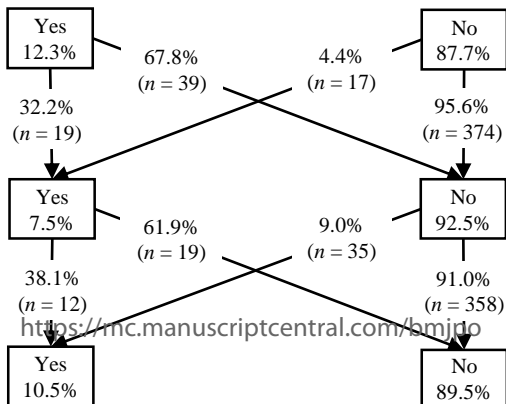
Note. Number of participants at the various assessment points is based on the number of participants invited to participate (n=1,250) minus those who did not participate at the respective measurement points (i.e. T1, T2). To increase variability and thus statistical power, children with mental health problems were oversampled. Included in the invitation to participate was the Strengths and Difficulties Questionnaire (SDQ) for 4- to 16-year-olds,[1] which the parents completed and brought with them to the community health check-up. The children were then divided into four strata based on their SDQ score: 0–4, 5–8, 9–11, and 12–40; the probability of being selected from each stratum increased with SDQ score (37%, 48%, 70%, and 89% respectively).

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[Figure title]

**eFigure 2.** Prevalence of DSM-IV Insomnia by Sex





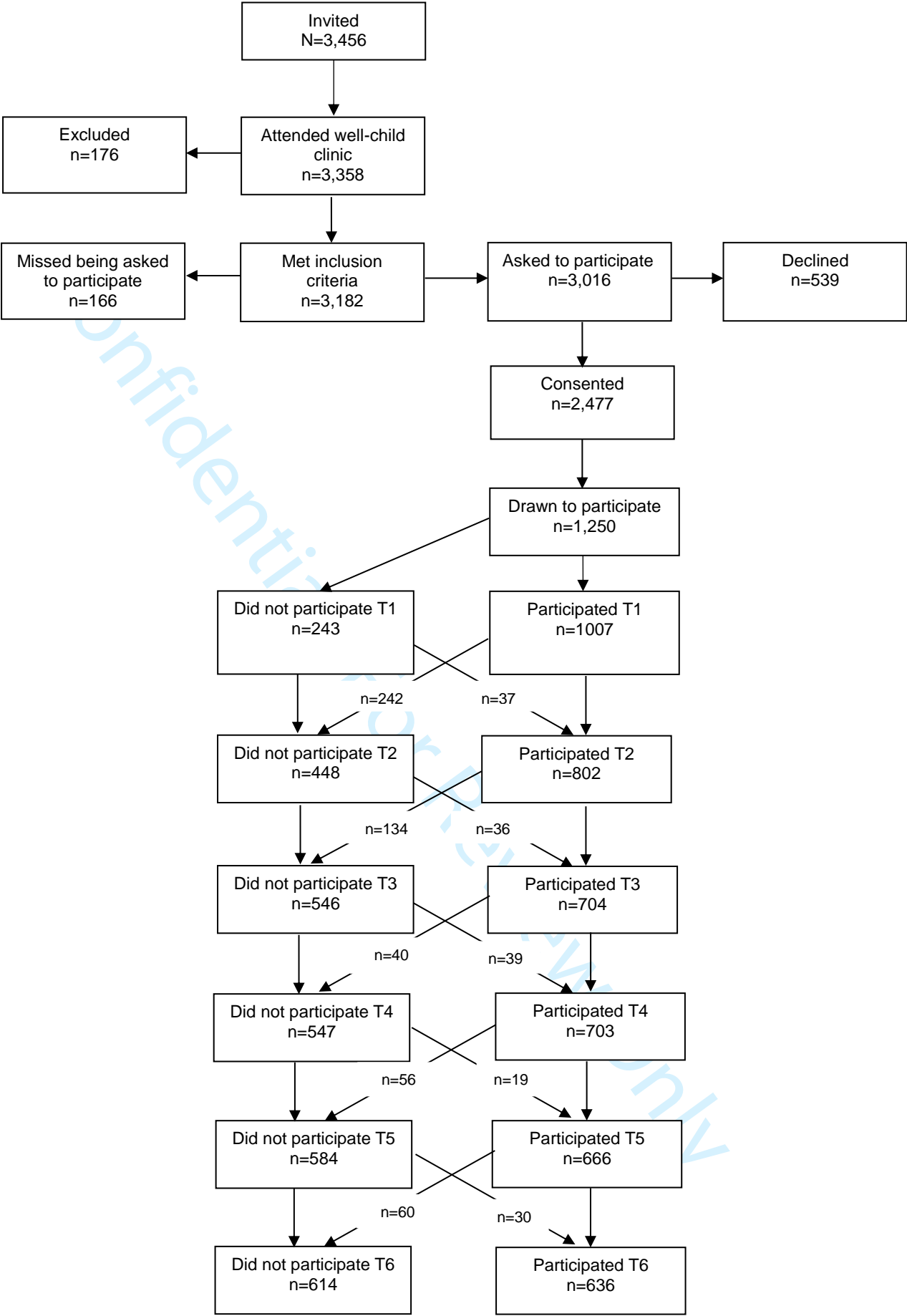
**eTable 1.** Sample Characteristics of the Analytic Sample at T1 (age 4)

Characteristic	%
Sex of child	
Male	50.1
Female	49.9
Sex of parent informant	
Male	15.2
Female	84.8
Ethnic origin of biological mother	
Norwegian	92.8
Western Countries	3.8
Other Countries	3.4
Ethnic origin of biological father	
Norwegian	90.6
Western Countries	6.6
Other Countries	2.8
Biological parents' marital status	
Married	56.7
Cohabiting	34.0
Divorced / Separated	7.9
Other	1.4
Informant parents' socioeconomic status	
Leaders	6.2
Higher professionals	27.1
Lower professionals	40.3
Skilled workers	23.6
Farmers / fishermen	0.5
Unskilled workers	2.5
Households' gross annual income	
0 – 225' NOK (0 – 26 500 USD)	3.0
225' – 525' NOK (26 500 – 62' USD)	15.7
525' – 900' NOK (62' – 106' USD)	52.2
> 900' NOK (> 106' USD)	29.2
Childcare	
Official day care center	95.2
Other	4.8

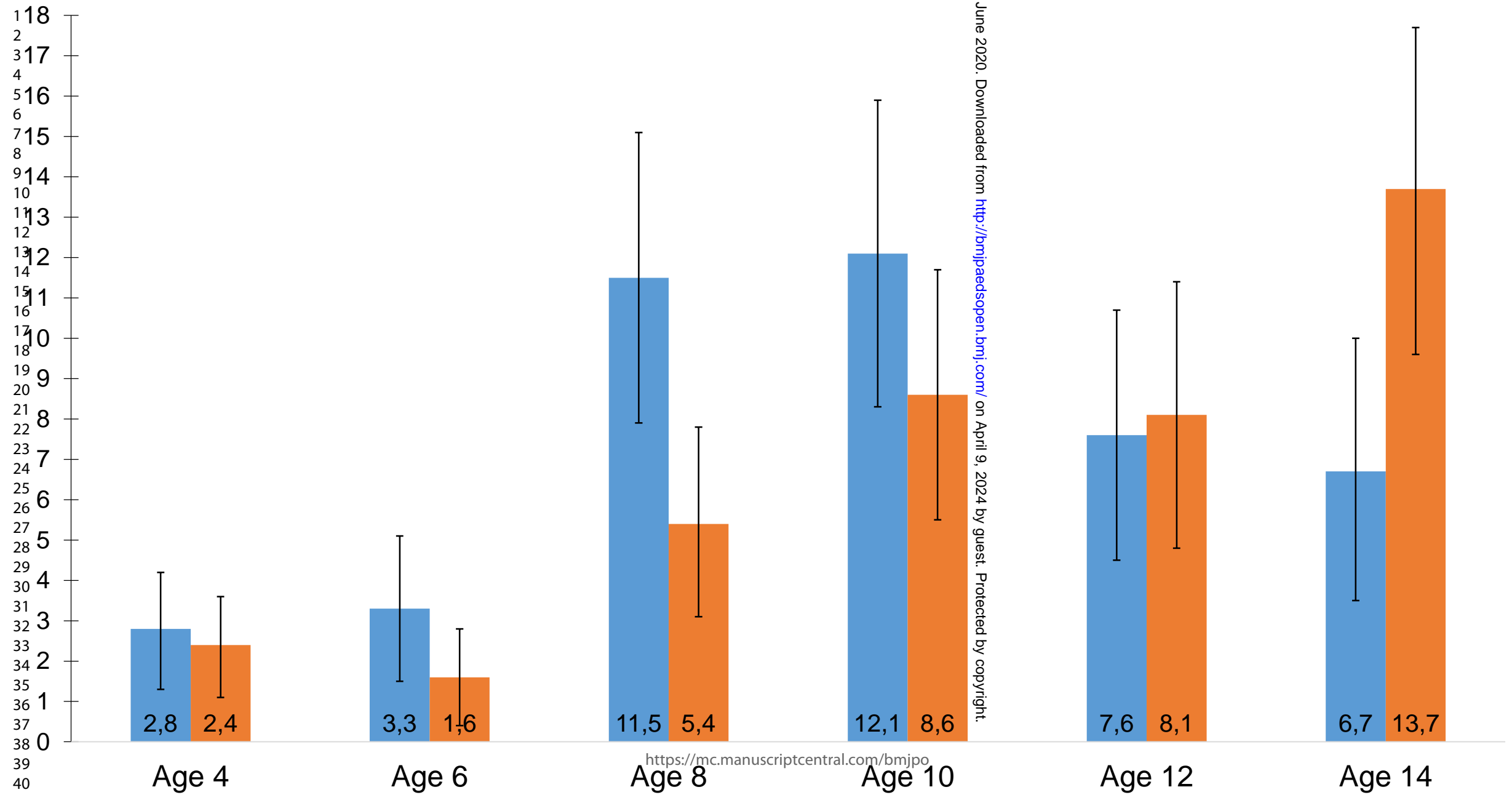
Note. The sample is representative for the Norwegian population regarding parents' level of education[1] and family situation,[2,3] while differences in rates of occupational categories between the sample and the city were negligible, below 3.6%.

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2. Statistics Norway. Families and Households. 2017. <https://www.ssb.no/en/statbank/table/06204/> (accessed: 17 October 2019)
3. The Norwegian Directorate for Children. Barns Familier. 2017. [https://www.bufdir.no/Statistikk\\_og\\_analyse/Oppvekst/Familie\\_omsorg\\_og\\_relasjoner/Barns\\_familier/](https://www.bufdir.no/Statistikk_og_analyse/Oppvekst/Familie_omsorg_og_relasjoner/Barns_familier/) (accessed: 17 October 2019)





Boys Girls



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# BMJ Paediatrics Open

## Prevalence and stability of insomnia from preschool to early adolescence - a prospective cohort study in Norway

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# PREVALENCE AND STABILITY OF INSOMNIA FROM PRESCHOOL TO EARLY ADOLESCENCE – A PROSPECTIVE COHORT STUDY IN NORWAY

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**Contributors' Statement:** PhD. Cand. JFM carried out the main part of the analyses and interpretation of data and drafted, revised and finalized the manuscript. Professor LW and professor SS conceptualized and designed the study, organized the acquisition of data, reviewed and revised both analyses and the manuscript. Professor SP contributed to the study design and tools for data acquisition and critically revised the text for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

**Word Count:** 2,995

ABSTRACT

Background

There is limited knowledge about the prevalence and stability of DSM-defined insomnia. We therefore provide such estimates from preschool to early adolescence and explore potential sex differences.

Methods

We followed a representative community sample ( $n=1,037$ ) biennially from 4 to 14 years of age (2007–2017). Insomnia diagnoses and symptoms were captured by a semi-structured clinical interview of parents and children (from age 8 years).

Results

At ages 4 and 6 years approximately 2.5% of children met the criteria for insomnia, whereas at ages 8, 10, 12, and 14 years the prevalence ranged between 7.5–12.3%. During the 10-year period examined nearly one in five children had insomnia at least once (18.7%). Sex differences were apparent with the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), but not DSM-5, criteria: boys had more insomnia than girls did at ages 4 to 10 years, whereas girls had more insomnia than boys did at ages 12 and 14 years. Insomnia proved moderately stable, with 22.9–40.1% of children retaining their diagnosis two years later. Having current insomnia produced odds ratios of between 5 and 15 for subsequent insomnia compared with not having preceding insomnia.

Conclusions

Insomnia was less prevalent than previous research indicates, with nearly one in five participants having insomnia at least once between the ages of 4 to 14 years. Female preponderance emerged in early adolescence. Having insomnia at one time point was a considerable risk for subsequent insomnia, indicating that insomnia is persistent and warrants clinical attention.

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3 Childhood insomnia is associated with negative outcomes that include emotional,  
4 behavioural, and cognitive problems.[1-3] Prevalence estimates and a description of the  
5 course of insomnia may aid preventative and treatment efforts. However, most previous  
6 research on this topic in children has examined insomnia symptoms[4-11] that may not have  
7 the severity, duration, intensity, or associated impairment that warrants a clinical *diagnosis*.  
8 Moreover, research has almost exclusively relied on questionnaires/checklists,[12-14] with  
9 various biases.[15] In clinical interviews, on the other hand, the interviewer probes until it is  
10 clear whether a symptom is present or not according to diagnostic criteria.

21 Only three previous studies have estimated the prevalence of childhood insomnia  
22 through clinical interviews,[16-18] two addressing early childhood[16,17] and one reporting  
23 averaged rates for the age span 8 to 18 years.[18] In addition, two questionnaire-based  
24 longitudinal studies have assessed insomnia into early adolescence.[12,13] Hence, there is a  
25 dearth of studies on the prevalence of diagnosable insomnia from preschool to adolescence  
26 based on interview data. We will therefore provide such estimates.

35 If, once established, childhood insomnia evinces a chronic course, early intervention  
36 may be warranted. However, if insomnia is transient there is less need to intervene.  
37 Preschool-age insomnia has been found to increase the risk of later insomnia,[17] and studies  
38 of preadolescents indicate that insomnia symptoms are moderately stable.[6-8,12,13]  
39 However, these studies used questionnaires and checklists; thus, the stability reported may  
40 reflect the stability of the rater rather than of the symptoms. By using clinical interviews, as  
41 we do here, rater bias and common method biases are reduced and hence more accurate  
42 stability estimates can be obtained.

53 From the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders  
54 (DSM-IV)[19] to the fifth (DSM-5),[20] the symptom of experiencing sleep as non-  
55 restorative has been replaced with that of early morning awakenings accompanied by the  
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inability to return to sleep. The impact of this change on prevalence estimates and course in children is unknown but will be examined here.

Using a semi-structured clinical interview in a large and representative community sample (over six waves, from age 4 to 14 years) we tested the following hypotheses: 1) the rate of insomnia will decrease from preschool to middle childhood and rise again in early adolescence; 2) insomnia is more prevalent in girls than in boys in early adolescence, as shown earlier regarding insomnia symptoms;[4,18,21-23] 3) the two year persistence of insomnia is moderate.

**METHODS**

**Procedure and participants**

Data came from the Trondheim Early Secure Study (TESS).[24] All children born in 2003 and 2004 in Trondheim (N=3,456), Norway, were invited to participate through a letter of invitation ahead of an ordinary community health check-up at the age of 4 years. Health nurses informed parent(s) about the study and obtained written consents to participate (82.2% of those invited). Included in the letter of invitation was the Strengths and Difficulties Questionnaire (SDQ) for 4- to 16-year-olds,[25] which the parents completed and brought with them to the check-up. The SDQ has proven to be an excellent tool in screening for mental health problems in preschoolers.[26] To increase variability and thus statistical power, children with mental health problems were oversampled. Children were divided into four strata based on their SDQ score: 0-4, 5-8, 9-11 and 12-40. The probability of being selected increased with increased SDQ scores (37%, 48%, 70% and 89% from the respective strata). Parents with insufficient proficiency in Norwegian to fill out the SDQ were excluded ( $n = 176$ ). Of the 1250 families that were drawn and invited, 997 (79.7%) attended at baseline. Details of procedure and participation rates are presented in online supplementary eFigure 1. Mean age in years at initial testing (T1, descriptive statistics in eTable 1) was  $M_{age}=4.59$ ,



$SD=.25$ , and at subsequent assessments was as follows: T2:  $M_{age}=6.72$ ,  $SD=.19$ ; T3:  $M_{age}=8.79$ ,  $SD=.23$ ; T4:  $M_{age}=10.51$ ,  $SD=.17$ ; T5:  $M_{age}=12.50$ ,  $SD=.14$ ; T6:  $M_{age}=14.35$ ,  $SD=.16$ . In all, we had diagnostic information on at least one time-point for 1,037 participants, thus forming the analytical sample. None of the study variables predicted attrition, except that boys had higher attrition at 10 (OR=1.39, 95% CI=1.07, 1.81), 12 (OR=1.31, 95% CI=1.01, 1.69) and 14 years of age (OR=1.40, 95% CI=1.09, 1.80). The proxy  $R^2$  values for sex were all <1%. The Regional Committee for Medical and Health Research Ethics Mid-Norway approved the study.

### Participant and Public involvement

The planning, implementation, carry through and dissemination from TESS is guided by a user group consisting of participating adolescents and parents, researchers from TESS, St Olavs Hospital, the Municipal education officer in Trondheim, the youth division of the user group Mental Health Norway, and Department of Education – Trøndelag county.

### Measures

At ages 4 and 6 years, DSM-IV-defined insomnia was measured by the Preschool Age Psychiatric Assessment (PAPA),[27] a parent interview that follows a structured protocol. PAPA is a revised version of the Child and Adolescent Psychiatric Assessment (CAPA), which is appropriate for older children and hence was used in this study when the children was 8, 10, 12, and 14 years of age.[28] Children and parents were interviewed separately. Symptoms of insomnia were considered present if reported by either parent or child.

The interviewers ( $n=7$ ) had at least a bachelor's degree in a relevant field and extensive prior experience working with children and families. Blinded raters recoded 9% of audio-recorded interviews and interrater reliability between multiple raters for insomnia was  $k=.75$ .

### *Diagnosing Insomnia*

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According to the DSM-IV,[19] the International Classification of Sleep Disorders-3 (ICSD-3),[29] and the International Classification of Diseases-10 (ICD-10),[30] insomnia is characterised by difficulties initiating and/or maintaining sleep and/or a subjective experience of non-restorative sleep despite adequate opportunities for sleep, that lasts for a considerable amount of time and causes clinically significant distress or impairment in important areas of functioning. However, in the absence of a cutoff for the frequency or duration of insomnia symptoms, epidemiological research on insomnia has been challenging. As no child-specific insomnia criteria exist in the DSM, we relied on normative sleep latency, night awakenings, and sleep duration in childhood.[10,31-34] Our data allowed assessing DSM-IV insomnia from age 4 to 14 years and DSM-5 insomnia from age 10 to 14 years. From age 10 years prevalence estimates for DSM-IV and DSM-5 insomnia were analyses parallelly. DSM-IV insomnia at 4 and 6 years of age was classified as preschool insomnia, at ages 8–10 and 12–14 years as middle childhood insomnia and early adolescence insomnia, respectively.

*DSM-IV Insomnia*

Based on these studies and the DSM-IV criteria with suggested cutoffs, we defined DSM-IV insomnia as: (1)  $\geq 30$  minutes to fall asleep or the use of sleep medication; (2)  $\geq 20$  minutes awake after sleep onset; or (3) non-restorative sleep (insufficiently rested after sleep). The symptom(s) had to have occurred at least three times a week and had to be present over the previous three months, as this is the inquiry period of PAPA and CAPA, and be accompanied by reports of clinically significant distress or impairment in important areas of functioning. Because CAPA probes sleep onset or night awakenings in hours rather than minutes, it should be noted that we used  $\geq 1$  hour as the cutoff at age 8 years before correcting this by expanding the insomnia interview from age 10 years onwards to include time in minutes too. Hence, data from age 8 years should be viewed as yielding a conservative, proxy insomnia measure.

### *DSM-5 Insomnia*

In recent years both the DSM-5[20] and the ICSD-3[29] have suggested cutoffs for subjective sleep latency and time awake after sleep onset of greater than 20–30 minutes. The DSM-5 parts with DSM-IV criteria regarding non-restorative sleep, replacing it with early morning awakening before eight hours of sleep and being unable to return to sleep. In addition, DSM-5 acknowledges that symptoms of sleep latency and nocturnal awakenings may be masked by caregiver intervention. We therefore regarded always relying on parental help to initiate or maintain sleep as validation of these symptoms.

### **Statistical analyses**

All analyses were performed in Mplus, version 8.[35] We used a full information maximum likelihood approach to handle missing data, that uses all available data to estimate the most likely values for the population parameters in the model. As the sample was screen-stratified, probability weights where the number of children in the stratum were divided by the number of participants in the same stratum were calculated to arrive at corrected population estimates. A robust maximum likelihood estimator was used, which is robust to deviations from normality because it provides corrected error terms with respect to oversampling. Some categorical variables served as both predictor and outcome (e.g. insomnia at ages 6, 8, 10, and 12 years). Because Mplus cannot specify an endogenous variable as categorical, we performed bivariate regressions to assess the stability of insomnia (e.g., insomnia at age 6 years were regressed on insomnia age 4 years). To investigate both the sex differences in the prevalence of insomnia at each time point and the stability between time points, we compared a model in which prevalence/stability was constrained to be equal in the two sexes with another model in which prevalence was freely estimated, using Wald tests. Supplementary analyses were performed to investigate the growth of parent and child reports of insomnia over time. We did growth curve analyses where the slopes reflected

yearly mean change ( $M_{\text{growth}}$ ) in insomnia prevalence (%). Further, we analyzed sex differences at symptom level to investigate sex differences at disorder level.

RESULTS

Prevalence

Table 1 presents the prevalence, incidence and recurrence of DSM-IV- and DSM-5-defined insomnia at all ages. The prevalence of insomnia increased sharply from 6 to 8 years. However, bear in mind that children were not included as informants before the age of 8 years and separate growth curve analyses for parents ( $M_{\text{growth}} = -0.05, p = .56$ ) and children ( $M_{\text{growth}} = 0.13, p = .49$ ) showed no increase in insomnia prevalence with age. Thus, the increase from age 8 years onwards might be due to having two sets of informants, as opposed to only the parents as informants at earlier ages. Close to every fifth child had DSM-IV insomnia at one point between 4 and 14 years of age (18.7%, 95%CI 16.2-21.2); 12.8% had insomnia at one time point only, 4.1% at two points, 1.5% at three points, and 0.3% at four points.

The prevalence of insomnia for the two sexes is displayed online in eFigure 2. DSM-IV insomnia was more common in girls (13.7%) than in boys (6.7%) at the age of 14 years (Wald=6.79, df=1,  $p = 0.009$ ), and marginally more common in girls than in boys when comparing the mean prevalence of DSM-IV-defined insomnia in early adolescence (ages 12–14 years; Wald=4.02, df=1,  $p = 0.045$ ). Additionally, DSM-IV insomnia was more common among boys (11.5%) than among girls (5.4%) at the age of 8 years (Wald=7.64, df=1,  $p = 0.006$ ), and more common among boys than girls when comparing means for insomnia for the two sexes in childhood overall (ages 4–10 years; Wald=8.98, df=1,  $p = 0.003$ ). No sex difference in insomnia was found using DSM-5 insomnia criteria.

The prevalence of the specific symptoms of DSM-IV and DSM-5 insomnia is displayed in Table 2. Prolonged latency of sleep onset was the most common insomnia

symptom throughout the study period. The least frequent DSM-IV symptom was nocturnal awakenings, while none of the participants was troubled with the DSM-5's symptom of early morning awakenings. Comparing the prevalence of DSM-IV and DSM-5 symptoms for the two sexes revealed that the symptom of non-restorative sleep (DSM-IV) was more common in girls (17.8%) than in boys (8.0%) at the age of 14 years (Wald=11.87, df=1,  $p=0.001$ ).

### Stability and course

Figures 1 and 2 display the course of DSM-IV and DSM-5 insomnia. Between 32–40% of those with an insomnia diagnosis at one time point experienced the same disorder two years later, participants aged 4 to 6 years being the exception (23%). Table 3 reveals insomnia to exhibit a moderately high two-year stability, with current insomnia increasing the probability of subsequent insomnia by 5 to 15 times compared with not having an insomnia disorder at the preceding time point. In addition, insomnia during preschool years (ages 4 to 6 years) increased the risk of insomnia in middle childhood (ages 8 to 10 years), and insomnia in middle childhood predicted insomnia in early adolescence (ages 12 to 14 years).

Sex-specific analyses showed that DSM-IV insomnia was more stable in boys from age 4 to age 6 years than in girls (who displayed no stability; Wald=58.81, df=1,  $p<0.001$ ). No other sex differences in stability was found. There was no difference in two-year stability between DSM-IV- and DSM-5-defined insomnia.

## DISCUSSION

Biennial interview-based assessments from ages 4 to 14 years revealed that approximately 2.5% of children met the criteria for insomnia diagnosis at 4 and 6 years of age, whereas at ages 8, 10, 12, and 14 years the prevalence ranged from 7.5% to 12.3%. Insomnia proved to be moderately stable; 23–40% of children had retained their diagnosis two years later and current insomnia increased the probability of insomnia two years later by 5–15 times.

**Prevalence of insomnia diagnosis**

No previous study has examined the prevalence of diagnosable insomnia from preschool to early adolescence. The three studies employing semi-structured interviews that have been carried out reported considerably higher prevalence estimates, ranging from 16.6–21.2%, [16–18] compared with the present findings. The discrepancy may be due to these former studies employing broader age ranges [18] or using DSM-IV criteria with more liberal cutoffs for sleep latency and time awake after sleep onset. [16,17] Notably though, our estimate of the prevalence of insomnia substantially *exceeds* the rate of children and adolescents receiving insomnia diagnoses in primary care (0.05–1.20%), [36,37] suggesting that insomnia is under-diagnosed in children aged 4–14 years.

The increase in insomnia from preschool to middle childhood does not match previous research on childhood insomnia, [12,13,17,18] probably due to our inclusion of children as informants from age 8 years and onwards. As children grow older, parents may be unaware of their offspring’s sleeping difficulties (e.g. staying in bed despite difficulty falling asleep), thus insomnia prevalence research relying on parents only probably underestimates prevalence estimates.

In the current study female preponderance emerged in early adolescence, which is in line with the typical 11–12 years of age reported in the literature. [21,22,38] The sex difference found with DSM-IV criteria indicating that insomnia is more common in boys than in girls in the period from 4 to 10 years of age is novel in the insomnia literature and should therefore be interpreted cautiously. Notably, no sex differences were found with DSM-5 criteria. This may be due to the observed sex difference at age 14 years in non-restorative sleep (DSM-IV), the symptom that was replaced by early morning awakenings in the DSM-5 which we found to be non-existent and therefore not contributing to a sex difference. The absence of early morning awakenings in our study may be a consequence of emerging

circadian delay in early adolescence, yet this probably does not explain the nonexistence at earlier ages. Alternatively, not finding any sex differences with DSM-5 criteria may be a consequence of more missing data (552, 577 and 484 subjects as per complete case analysis) than with DSM-IV criteria (643, 598 and 576, respectively) from 10 to 14 years of age and thus reduced statistical power in gender-specific analyses, although our analytic n of 1,037 with the full information maximum likelihood procedure to account for missing data tried to compensate somewhat for the reduced power.

### **The course of insomnia**

Our results reveal that for approximately 23% to 40% of children, insomnia is stable over a two-year span. Thus, for most children insomnia is transient. In adults, on the other hand, insomnia usually fosters further sleep problems through maladaptive coping behaviours (e.g. daytime naps) and negative beliefs about sleep (e.g. exaggeration of the consequences of the lack of sleep)[39] as well as conditioning.[40] That said, for a subgroup of children insomnia is persistent and warrants clinical attention. Hence, research identifying the characteristics of those with persistent insomnia is much needed.

### **Limitations**

Aside from the strengths of the current study – including entailing a large longitudinal community sample followed up biennially for ten years and administering clinical interviews based on formal diagnostic criteria – there are notable limitations. First, we applied a three-month period for insomnia symptoms as this was the inquired period in PAPA and CAPA and might thus have underestimated the prevalence of DSM-IV insomnia. This underestimation may be especially prominent at 8 years of age, with our conservative proxy insomnia diagnosis (a 1-hour threshold for sleep latency and night awakenings). Conversely, the lack of possibility to exclude other sleep disorders (e.g., circadian disorders, sleep-disordered breathing) may have led to overestimation of insomnia prevalence. Second, as the



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sample was mainly of Norwegian origin our findings may not apply to more ethnically diverse populations or other geographical locations. Lastly, although there are numerous similarities between the DSM-IV and DSM-5 criteria, this study applied only DSM-IV insomnia data for the whole study period as this was the diagnostic manual in use at the start of the study. Still, our results from age 10-14 years with both diagnostic criteria indicate that DSM-IV and DSM-5 insomnia criteria do not yield significantly different prevalence or stability estimates. Sex differences, however, were found with DSM-IV criteria only.

**CONCLUSIONS**

The present study is the first to provide age-specific population prevalence estimates and chronicle the stability of insomnia, from preschool to early adolescence, obtained through clinical interviews. DSM-defined insomnia was less prevalent (i.e. 2.4–10.5%) than has been indicated by previous research. No difference in prevalence or stability estimates for insomnia was found using DSM-IV vs. DSM-5 criteria. Girls had marginally more DSM-IV insomnia in early adolescence (age 12–14 years) than did boys, while boys had more insomnia than did girls in childhood (age 4–10 years). Yet no sex differences were found using the DSM-5 criteria, probably due to no child having the newly added DSM-5 symptom of early morning awakenings. Insomnia proved moderately stable, as illustrated by results showing that between 23–40% maintained their insomnia disorder over a two-year period, and those with current insomnia (compared with those without) were 5–15 times as likely to have subsequent insomnia.



### What is already known on this topic

There is a dearth of studies on the prevalence and stability of interview-based DSM-IV and DSM-5 diagnosable insomnia in childhood. Previous work is characterised by differing estimates depending on the definition of sleep difficulties (e.g. from problems to disorders) and methodological approach (i.e. time-span, informants). In early adolescence, a female preponderance in the prevalence of insomnia is typically reported.

### What this study adds

The present study is the first to provide age-specific population estimates of insomnia, from preschool to early adolescence, obtained through clinical interviews. Both DSM-IV- and DSM-5-defined insomnia were less prevalent in this study than previous research indicates, and sex differences were found applying DSM-IV criteria only. Insomnia was moderately stable; those with current insomnia (compared with those without) were 5–15 times as likely to have subsequent insomnia.

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**Table 1.** Prevalence, incidence and recurrence (%) of DSM-IV and DSM-5 Defined Insomnia (n = 1,037)

Age (in years)	DSM-IV Insomnia (95% CI)			DSM-5 Insomnia (95% CI)		
	Prevalence	Incidence	Recurrence	Prevalence	Incidence	Recurrence
Aged 4	2.6% (1.6, 3.5)	2.6% (1.6, 3.5)	n/a	-	-	-
Aged 6	2.4% (1.4, 3.5)	1.7% (0.9, 2.6)	n/a	-	-	-
Aged 8 <sup>1</sup>	8.3% (6.2, 10.5)	6.2% (4.3, 8.1)	0.3% (0.0, 0.6)	-	-	-
Aged 10	10.2% (7.8, 12.6)	6.5% (4.4, 8.6)	0.7% (0.0, 1.3)	12.3% (9.5, 15.2)	7.7% (5.1, 10.1)	0.7% (0.0, 1.4)
Aged 12	7.9% (5.6, 10.1)	2.3% (0.9, 3.6)	1.2% (0.3, 2.2)	7.5% (5.3, 9.8)	1.6% (0.3, 2.6)	1.1% (0.2, 2.0)
Aged 14	10.5% (7.8, 13.1)	4.9% (3.0, 6.8)	1.4% (0.3, 2.6)	10.5% (7.5, 13.4)	3.7% (1.8, 5.5)	1.1% (0.0, 2.1)

Note. These estimates are population corrected estimates. Age 4–6 years, parent report; age 8–14, joint report. Incidence estimates represent current insomnia cases with no prior history of insomnia. Recurrence estimates are current insomnia cases without insomnia at the preceding time-point, but a history of insomnia prior to the previous time-point. DSM-5 incidence at age 10 years and recurrence at ages 10–14 years are based on DSM-IV data on time-points without DSM-5 data (ages 4–8 years). CI = confidence interval. <sup>1</sup> Proxy measure of insomnia – thresholds of 1 h sleep latency / time awake at night.

**Table 2.** Prevalence (%) of Symptoms of DSM-IV and DSM-5 Insomnia (n = 1,037)

	<b>Aged 4 years (95% CI)</b>	<b>Aged 6 years (95% CI)</b>	<b>Aged 8 years (95% CI)<sup>1</sup></b>	<b>Aged 10 years (95% CI)</b>	<b>Aged 12 years (95% CI)</b>	<b>Aged 14 years (95% CI)</b>
<b>DSM-IV Insomnia</b>						
Initiating symptom	7.8 (6.0, 9.6)	10.0 (7.8, 12.2)	15.5 (12.6, 18.5)	18.0 (15.0, 21.1)	15.7 (12.8, 18.7)	12.3 (9.5, 15.2)
Maintaining symptom	4.7 (3.3, 6.2)	3.1 (1.8, 4.4)	1.0 (0.2, 1.8)	1.0 (0.3, 1.7)	1.0 (0.2, 1.8)	0.8 (0.0, 1.6)
Not rested symptom	3.3 (2.1, 4.6)	5.7 (4.0, 7.4)	13.0 (10.3, 15.7)	6.9 (4.9, 8.8)	6.9 (4.7, 9.0)	13.3 (10.4, 16.2)
At least one symptom of DSM-IV insomnia	13.8 (11.5, 16.1)	15.4 (12.7, 18.1)	23.2 (19.8, 26.7)	22.0 (18.8, 25.3)	19.5 (16.3, 22.8)	20.3 (16.9, 23.7)
<b>DSM-5 Insomnia</b>						
Initiating symptom	n/a	n/a	n/a	22.0 (18.7, 25.4)	16.9 (13.8, 20.0)	14.4 (11.3, 17.5)
Maintaining symptom	n/a	n/a	n/a	8.3 (6.1, 10.5)	4.4 (2.6, 6.2)	1.8 (0.7, 2.9)
Early awakening symptom	n/a	n/a	n/a	n/a	n/a	n/a
At least one symptom of DSM-5 insomnia	n/a	n/a	n/a	27.3 (23.7, 30.8)	19.5 (16.2, 22.8)	14.7 (11.7, 17.7)

Note. Age 4–6 years, parent report; age 8–14, joint report. CI = confidence interval. <sup>1</sup> Proxy insomnia at age 8 years – thresholds of 1 h sleep latency / time awake at night

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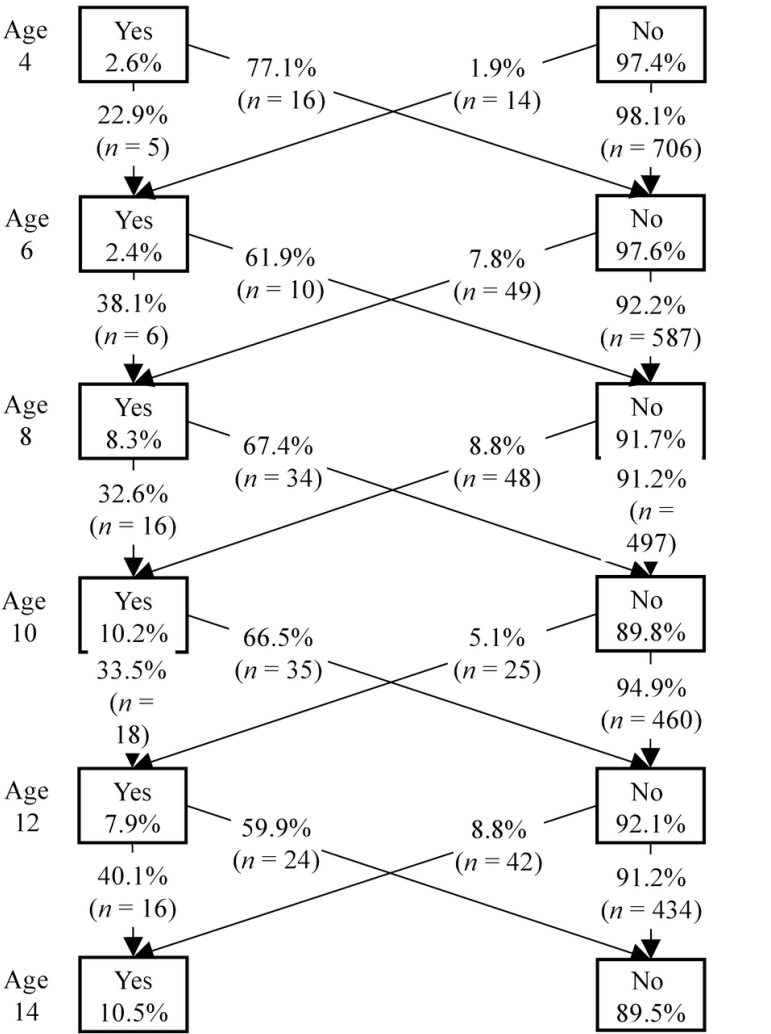
**Table 3.** Stability of DSM-IV and DSM-5 Insomnia (n = 1,037)

	<b>DSM-IV Insomnia Odds ratio (95% CI)</b>	<b>DSM-5 Insomnia Odds ratio (95% CI)</b>
Age 4 to age 6 years	15.28 (4.42, 52.88)	n/a
Age 6 to age 8 years	7.33 (2.57, 20.96)	n/a
Age 8 to age 10 years	5.05 (2.61, 9.75)	n/a
Age 10 to age 12 years	9.29 (4.49, 19.20)	6.24 (2.71, 14.37)
Age 12 to age 14 years	7.06 (3.31, 15.06)	10.50 (4.86, 22.70)
Preschool to middle childhood	5.18 (2.51, 10.68)	n/a
Middle childhood to early adolescence	4.72 (2.79, 8.00)	n/a
Preschool to early adolescence	1.68 (0.73, 3.89)	n/a

Note. Reference category is those without insomnia which continues to not have insomnia. N/a as data not available, DSM-5 criteria introduced at 10 years of age. CI = confidence interval.

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Figure 1. Course of DSM-IV Insomnia

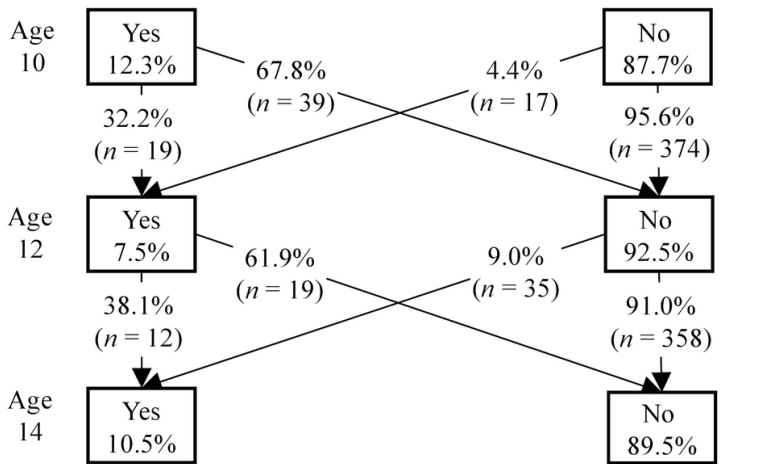


Note. Numbers in boxes are prevalence estimates while numbers outside boxes are from pairwise crosstabs (only those present for the two ages in question). Number of subjects rounded to closest whole number, as they are originally population estimates.

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**Figure 2.** Course of DSM-5 Insomnia



Note. Numbers in boxes are prevalence estimates while numbers outside boxes are from pairwise crosstabs (only those present for the two ages in question). Number of subjects rounded to closest whole number, as they are originally population estimates.

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**eTable 1.** Sample Characteristics from T1 (age 4 years) of the Trondheim Early Secure Study (*n* = 1007)

Characteristic	%	<i>n</i>
Sex of child		
Male	50.5	507
Female	49.5	497
Sex of parent informant		
Male	15.0	149
Female	85.0	845
Ethnic origin of biological mother		
Norwegian	92.4	908
Western Countries	3.3	32
Other Countries	4.3	42
Ethnic origin of biological father		
Norwegian	90.5	887
Western Countries	6.2	61
Other Countries	3.3	32
Biological parents' marital status		
Married	54.7	536
Cohabiting	33.6	330
Divorced / Separated	9.8	96
Other	1.9	19
Informant parents' socioeconomic status		
Leaders	5.7	54
Higher professionals	25.5	242
Lower professionals	39.3	374
Skilled workers	25.8	245
Farmers / fishermen	0.5	5
Unskilled workers	3.2	30
Households' gross annual income		
0 – 225' NOK (0 – 20' USD)	3.4	33
225' – 525' NOK (20' – 47' USD)	18.3	180
525' – 900' NOK (47' – 81' USD)	51.8	509
> 900' NOK (> 81' USD)	26.5	260
Childcare		
Official day care center	94.8	942
Other	5.2	52

Note. Unweighted sample characteristics of the 1007 children attending t1 in TESS. Missing data not included in percentages. The sample is representative for the Norwegian population regarding parents' level of education[1] and family situation,[2,3] while differences in rates of occupational categories between the sample and the city were negligible, below 3.6%. NOK to USD exchange rate from 24<sup>th</sup> March 2020.

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## Supplement – Semi-structured interview questions

If not stated, a three months period was used. Interviewers instructed to follow-up with questions in order to code precise and relevant answers. *Italics* represent questions as stated in manuals, while roman text represent instructions or information to the interviewers.

### Preschool Age Psychiatric Assessment (PAPA)

Relevant questions used at T1 and T2 (age 4 and 6 years) in interviews with parent only to provide information to evaluate insomnia symptoms.

#### **Time to Sleep Initiation**

From the time parent says goodnight, after any rituals are completed, the average time it takes the child to fall asleep.

*How long does it take him/her to fall asleep?*

#### **Medication for Insomnia**

Note here any medication (prescription or over the counter) specifically used in an attempt to improve sleep pattern.

*Does s/he take anything to help him/her sleep? What? Does it work?*

#### **Night Waking**

Child wakes up from sleep during the night after child has been asleep for over ten minutes.

*Does s/he wake up during the night?*

*How many times PER NIGHT does s/he wake up?*

*In the last 3 months, how often has this happened?*

*On average, how long would you say s/he is awake per night?*

Remember to consider if child wakes up multiple times per night.

*When did this start?*

#### **Inadequately Rested by Sleep**

Subject describes being inadequately rested by sleep upon waking.

*Does s/he usually get a good night's sleep?*

*Does s/he seem inadequately rested when s/he gets up?*

*How does s/he feel?*

*When did that start?*

**The child and adolescent psychiatric assessment (CAPA)**

Relevant questions used at T3 (age 8) in interviews with parent and child separately to provide information to evaluate insomnia symptoms. Wording here is from the child interview, similar questions were asked the parent.

**Insomnia**

Disturbance of usual sleep pattern involving a reduction in actual sleep time during the subject's sleep period that is accompanied by a subjective feeling of a need for more sleep. Do NOT include externally imposed changes in overall sleep pattern (e.g., change in job hours, arrival of new baby), or insomnia during first 2 weeks following such changes. Sleep problems are scored irrespective of taking medication for them, but note whether medication is being taken. Also include changes attributed to side effects of medication or substance use.

**Sleep Initiation and Night Waking**

*Is it hard for you to fall asleep when you want to?*

*Once you're off to sleep, do you wake up again during the night?*

If yes to any question, continue:

*What time do you usually go to bed?*

*How long does it take you to fall asleep?*

*In the last 3 months, has it taken you an hour or more to get to sleep?*

*Why do you wake up?*

Exclude waking up to use bathroom.

*How many nights do you have trouble sleeping in the last 3 months?*

*When did you first start having sleep problems?*

**Medication for Insomnia**

Note here any medication (prescription or over the counter) specifically used in an attempt to improve sleep pattern.

*Do you take anything to help you sleep? What? Does it work?*

**Inadequately Rested by Sleep**

Subject describes being inadequately rested by sleep upon waking.

*Do you usually get a good night's sleep?*

*Do you feel like you are NOT well rested when you get up?*

*How do you feel?*

*When did that start?*

### **SLEEP INTERVIEW as a supplement to the Sleep section in CAPA**

Used at T4-T6 (ages 10, 12 and 14 years) in interviews with parent and child separately. Wording here is from the child interview, similar questions were asked the parent. In addition to the following questions, we used the question regarding sleep medication from CAPA to determine insomnia. The sleep interview contains questions that cover symptoms of DSM-IV and DSM-5 insomnia, allowing investigations of DSM-5 insomnia prevalence and stability from age 10 and onwards in addition to the study of DSM-IV insomnia from age 4 to 14 years.

#### **Insomnia**

Experiences difficulties with 1) sleep initiation, 2) night awakenings or 3) feelings of inadequately rested by sleep (DSM-IV) or problems with early morning awakenings (DSM-5).

#### **Sleep Initiation**

*Is it hard for you to fall asleep?*

*How long does it take you to fall asleep?*

*Is it hard for you to fall asleep every night? How often?*

*If you are not able to sleep, what do you normally do? Does it happen that your parent co-sleeps with you? Are there other things your parents do to help you to sleep?*

#### **Night Waking**

*Once you're off to sleep, do you wake up again during the night?*

*Does it happen every night? How often?*

*If you wake up during the night, how long time does it usually take before you are able to return to sleep?*

*If you wake up during the night, does your parents do anything to help you go to sleep again? What do they do?*

#### **Inadequately Rested by Sleep**

*Does it happen that you feel like you are not well rested when you wake up, even if you have slept long enough?*

*How often?*

#### **Early morning awakenings**

*Do you wake up early in the morning and can't go back to sleep?*

*Is it earlier than you are supposed to get up?*

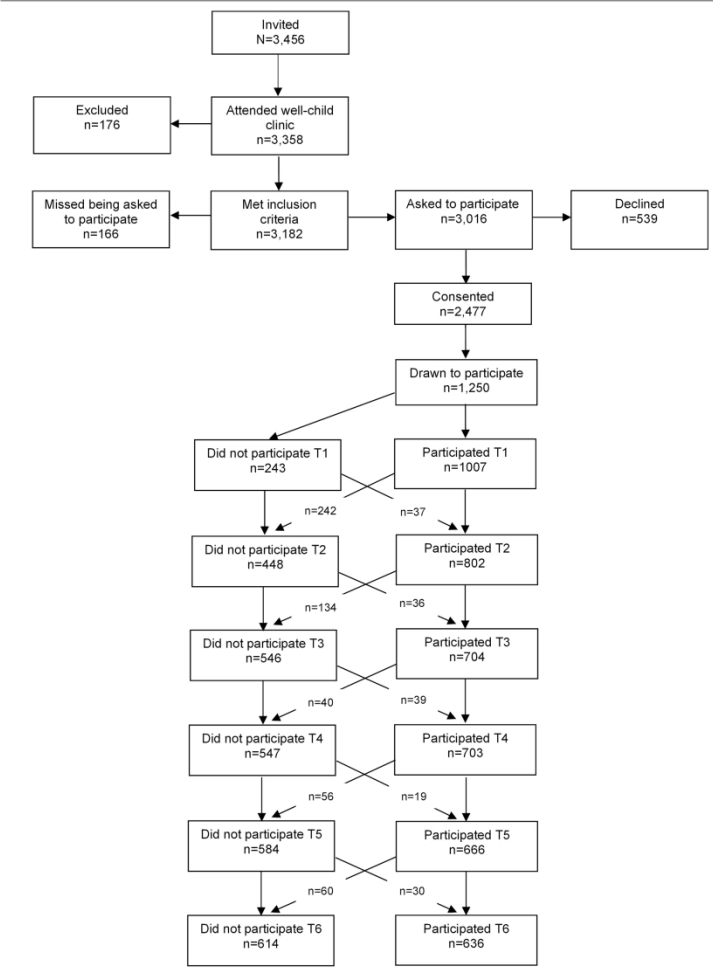
*Do you feel like you need more sleep?*

*How often?*

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Note. All these questions covering insomnia were part of a larger interview covering sleep in general. Additionally, we used the comprehensive interview on impairment in important areas of functioning which is included in both PAPA and CAPA.

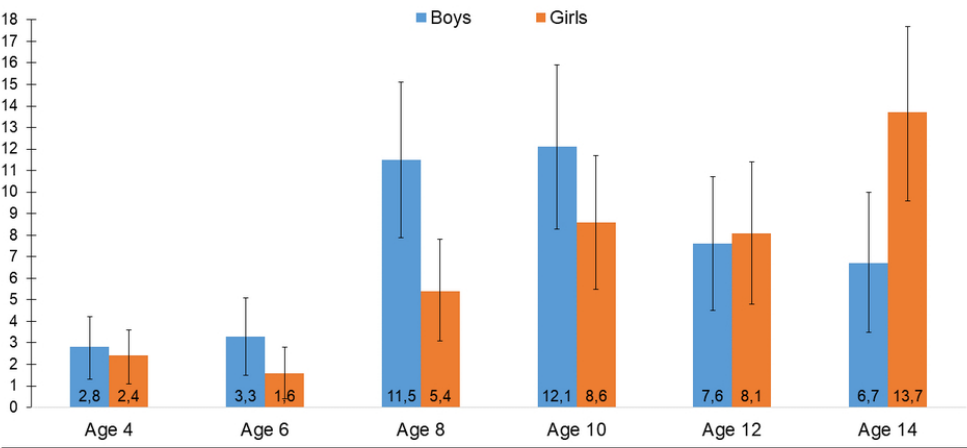
eFigure 1. Flowchart of Recruitment and Follow-up



Note. Number of participants at the various assessment points is based on the number of participants invited to participate (n=1,250) minus those who did not participate at the respective measurement points (i.e. T1, T2).

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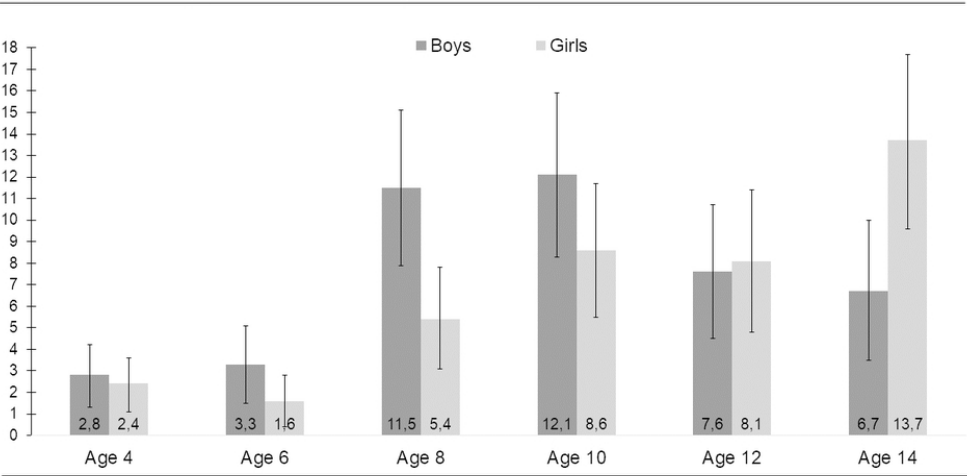
**eFigure 2.** Prevalence (%) of DSM-IV Insomnia by Sex (n = 1,037)



Note. Error bars represent 95% confidence intervals.

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**eFigure 2.** Prevalence (%) of DSM-IV Insomnia by Sex (n = 1,037)



Note. Error bars represent 95% confidence intervals.

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## Prevalence and stability of insomnia from preschool to early adolescence - a prospective cohort study in Norway

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# PREVALENCE AND STABILITY OF INSOMNIA FROM PRESCHOOL TO EARLY ADOLESCENCE – A PROSPECTIVE COHORT STUDY IN NORWAY

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**Contributors' Statement:** PhD. Cand. JFM carried out the main part of the analyses and interpretation of data and drafted, revised and finalized the manuscript. Professor LW and professor SS conceptualized and designed the study, organized the acquisition of data, reviewed and revised both analyses and the manuscript. Professor SP contributed to the study design and tools for data acquisition and critically revised the text for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

**Word Count:** 3,143

ABSTRACT

Background

There is limited knowledge about the prevalence and stability of insomnia defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM). We therefore provide such estimates from preschool to early adolescence and explore potential sex differences.

Methods

We followed a representative community sample ( $n=1,037$ ) biennially from 4 to 14 years of age (2007–2017). Insomnia diagnoses and symptoms were captured by a semi-structured clinical interview of parents and children (from age 8 years).

Results

At ages 4 and 6 years approximately 2.5% of children met the criteria for insomnia, whereas at ages 8, 10, 12, and 14 years the prevalence ranged between 7.5–12.3%. During the 10-year period examined nearly one in five children had insomnia at least once (18.7%). Sex differences were apparent with DSM-IV, but not DSM-5, criteria: boys (8.1%) had more insomnia than girls (4.5%) did at ages 4 to 10 years, whereas girls (11.4%) had more insomnia than boys (7.1%) did at ages 12 and 14 years. Insomnia proved stable, with 22.9–40.1% of children retaining their diagnosis two years later. Having current insomnia produced medium to large odds ratios of between 5.1 (95%CI 2.6-9.8) and 15.3 (95%CI 4.4-52.9) for subsequent insomnia two years later compared with not having preceding insomnia.

Conclusions

Insomnia was less prevalent than previous research indicates, with nearly one in five participants having insomnia at least once between the ages of 4 to 14 years. Female preponderance emerged in early adolescence. Having insomnia at one time point was a considerable risk for subsequent insomnia, indicating that insomnia is persistent and warrants clinical attention.

Childhood insomnia is associated with negative outcomes that include emotional, behavioural, and cognitive problems.[1-3] Prevalence estimates and a description of the course of insomnia may aid preventative and treatment efforts. However, most previous research on this topic in children has examined insomnia symptoms[4-11] that may not have the severity, duration, intensity, or associated impairment that warrants a clinical *diagnosis*. Moreover, research has almost exclusively relied on questionnaires/checklists,[12-14] with various biases.[15] In clinical interviews, on the other hand, the interviewer probes until it is clear whether a symptom is present or not according to diagnostic criteria.

Only three previous studies have estimated the prevalence of childhood insomnia through clinical interviews,[16-18] two addressing early childhood[16,17] and one reporting averaged rates for the age span 8 to 18 years.[18] In addition, two questionnaire-based longitudinal studies have assessed insomnia into early adolescence.[12,13] Hence, there is a dearth of studies on the prevalence of diagnosable insomnia from preschool to adolescence based on interview data. We will therefore provide such estimates.

If, once established, childhood insomnia evinces a chronic course, early intervention may be warranted. However, if insomnia is transient there is less need to intervene. Preschool-age insomnia has been found to increase the risk of later insomnia,[17] and studies of preadolescents indicate that insomnia symptoms are moderately stable.[6-8,12,13] However, these studies used questionnaires and checklists; thus, the stability reported may reflect the stability of the rater rather than of the symptoms. By using clinical interviews, as we do here, rater bias and common method biases are reduced and hence more accurate stability estimates can be obtained.

From the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)[19] to the fifth (DSM-5),[20] the symptom of experiencing sleep as non-restorative has been replaced with that of early morning awakenings accompanied by the

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inability to return to sleep. The impact of this change on prevalence estimates and course in children is unknown but will be examined here.

Using a semi-structured clinical interview in a large and representative community sample (over six waves, from age 4 to 14 years) we tested the following hypotheses: 1) the rate of insomnia will decrease from preschool to middle childhood and rise again in early adolescence; 2) insomnia is more prevalent in girls than in boys in early adolescence, as shown earlier regarding insomnia symptoms;[4,18,21-23] 3) the two year persistence of insomnia is of medium effect size.

**METHODS**

**Procedure and participants**

Data came from the Trondheim Early Secure Study (TESS).[24] All children born in 2003 and 2004 in Trondheim (N=3,456), Norway, were invited to participate through a letter of invitation ahead of an ordinary community health check-up at the age of 4 years. Health nurses informed parent(s) about the study and obtained written consents to participate (82.2% of those invited). Included in the letter of invitation was the Strengths and Difficulties Questionnaire (SDQ) for 4- to 16-year-olds,[25] which the parents completed and brought with them to the check-up. The SDQ has proven to be an excellent tool in screening for mental health problems in preschoolers.[26] To increase variability and thus statistical power, children with mental health problems were oversampled. Children were divided into four strata based on their SDQ score: 0-4, 5-8, 9-11 and 12-40. The probability of being selected increased with increased SDQ scores (37%, 48%, 70% and 89% from the respective strata). Parents with insufficient proficiency in Norwegian to fill out the SDQ were excluded ( $n = 176$ ) and 166 parents were missed being asked to participate in the study. Of the 2477 eligible families, 1250 were drawn and invited (three children with SDQ score >25), 997 (79.7%) attended at baseline. Details of procedure and participation rates are presented in online

supplementary eFigure 1. Mean age in years at initial testing (T1, descriptive statistics in eTable 1) was  $M_{age}=4.59$ , standard deviation ( $SD$ )=.25, and at subsequent assessments was as follows: T2:  $M_{age}=6.72$ ,  $SD=.19$ ; T3:  $M_{age}=8.79$ ,  $SD=.23$ ; T4:  $M_{age}=10.51$ ,  $SD=.17$ ; T5:  $M_{age}=12.50$ ,  $SD=.14$ ; T6:  $M_{age}=14.35$ ,  $SD=.16$ . In all, we had diagnostic information on at least one time-point for 1,037 participants, thus forming the analytical sample. To examine attrition at each time point, attrition (i.e., not attending) were regressed on every study variable on the preceding time points. None of the study variables predicted attrition, except that boys had higher attrition at 10 (OR=1.39, 95% CI=1.07, 1.81), 12 (OR=1.31, 95% CI=1.01, 1.69) and 14 years of age (OR=1.40, 95% CI=1.09, 1.80). The proxy  $R^2$  values for sex were all <1%. The Regional Committee for Medical and Health Research Ethics Mid-Norway approved the study.

### Participant and Public involvement

The planning, implementation, carry through and dissemination from TESS is guided by a user group consisting of participating adolescents and parents, researchers from TESS, St Olavs Hospital, the Municipal education officer in Trondheim, the youth division of the user group Mental Health Norway, and Department of Education – Trøndelag county.

### Measures

At ages 4 and 6 years, DSM-IV-defined insomnia was measured by the Preschool Age Psychiatric Assessment (PAPA),[27] a parent interview that follows a structured protocol. PAPA is a revised version of the Child and Adolescent Psychiatric Assessment (CAPA), which is appropriate for older children and hence was used in this study when the children was 8, 10, 12, and 14 years of age.[28] Children and parents were interviewed separately. Symptoms of insomnia were considered present if reported by either parent or child.

The interviewers ( $n=7$ ) had at least a bachelor's degree in a relevant field and extensive prior experience working with children and families. Blinded raters recoded 9% of audio-recorded interviews and interrater reliability between multiple raters for insomnia was  $k=.75$ .

*Diagnosing Insomnia*

According to the DSM-IV,[19] the International Classification of Sleep Disorders-3 (ICSD-3),[29] and the International Classification of Diseases-10 (ICD-10),[30] insomnia is characterised by difficulties initiating and/or maintaining sleep and/or a subjective experience of non-restorative sleep despite adequate opportunities for sleep, that lasts for a considerable amount of time and causes clinically significant distress or impairment in important areas of functioning. However, in the absence of a cutoff for the frequency or duration of insomnia symptoms, epidemiological research on insomnia has been challenging. As no child-specific insomnia criteria exist in the DSM, we relied on normative sleep latency, night awakenings, and sleep duration in childhood.[10,31-34] Our data allowed assessing DSM-IV insomnia from age 4 to 14 years and DSM-5 insomnia from age 10 to 14 years. From age 10 years prevalence estimates for DSM-IV and DSM-5 insomnia were analyses parallelly. DSM-IV insomnia at 4 and 6 years of age was classified as preschool insomnia, at ages 8–10 and 12–14 years as middle childhood insomnia and early adolescence insomnia, respectively.

*DSM-IV Insomnia*

Based on these studies and the DSM-IV criteria with suggested cutoffs, we defined DSM-IV insomnia as: (1)  $\geq 30$  minutes to fall asleep or the use of sleep medication; (2)  $\geq 20$  minutes awake after sleep onset; or (3) non-restorative sleep (insufficiently rested after sleep). The symptom(s) had to have occurred at least three times a week and had to be present over the previous three months, as this is the inquiry period of PAPA and CAPA, and be accompanied by reports of clinically significant distress or impairment in important areas of functioning. Because CAPA probes sleep onset or night awakenings in hours rather than



minutes, it should be noted that we used  $\geq 1$  hour as the cutoff at age 8 years before correcting this by expanding the insomnia interview from age 10 years onwards to include time in minutes too. Hence, data from age 8 years should be viewed as yielding a conservative, proxy insomnia measure.

### *DSM-5 Insomnia*

In recent years both the DSM-5[20] and the ICSD-3[29] have suggested cutoffs for subjective sleep latency and time awake after sleep onset of greater than 20–30 minutes. The DSM-5 parts with DSM-IV criteria regarding non-restorative sleep, replacing it with early morning awakening before eight hours of sleep and being unable to return to sleep. In addition, DSM-5 acknowledges that symptoms of sleep latency and nocturnal awakenings may be masked by caregiver intervention. We therefore regarded always relying on parental help to initiate or maintain sleep as validation of these symptoms.

### **Statistical analyses**

All analyses were performed in Mplus, version 8.[35] We used a full information maximum likelihood approach to handle missing data,[36] that uses all available data to estimate the most likely values for the population parameters in the model. As the sample was screen-stratified, probability weights where the number of children in the stratum were divided by the number of participants in the same stratum were calculated to arrive at corrected population estimates. A robust maximum likelihood estimator was used, which is robust to deviations from normality because it provides corrected error terms with respect to oversampling. Some categorical variables served as both predictor and outcome (e.g. insomnia at ages 6, 8, 10, and 12 years). Because Mplus cannot specify an endogenous variable as categorical, we performed bivariate regressions to assess the stability of insomnia (e.g., insomnia at age 6 years were regressed on insomnia age 4 years). To investigate both the sex differences in the prevalence of insomnia at each time point and the stability between

time points, we compared a model in which prevalence/stability was constrained to be equal in the two sexes with another model in which prevalence was freely estimated, using Wald tests. Supplementary analyses were performed to investigate the growth of parent and child reports of insomnia over time. We did latent linear growth curve analyses where the slopes reflected yearly mean change ( $M_{\text{growth}}$ ) in insomnia prevalence (%). The growth was allowed to correlate with the intercept, set at age 4 and 8 years for parent and child analysis, respectively. Further, we analyzed sex differences in insomnia symptoms to elucidate any sex differences found at disorder level.

RESULTS

Prevalence

Table 1 presents the prevalence, incidence and recurrence of DSM-IV- and DSM-5-defined insomnia at all ages. The prevalence of insomnia increased sharply from 6 to 8 years. However, bear in mind that children were not included as informants before the age of 8 years and separate growth curve analyses for parents ( $M_{\text{growth}} = -0.05, p = .56$ ) and children ( $M_{\text{growth}} = 0.13, p = .49$ ) showed no increase in insomnia prevalence with age. Thus, the increase from age 8 years onwards might be due to having two sets of informants, as opposed to only the parents as informants at earlier ages. Close to every fifth child had DSM-IV insomnia at one point between 4 and 14 years of age (18.7%, 95%CI 16.2-21.2); 12.8% had insomnia at one time point only, 4.1% at two points, 1.5% at three points, and 0.3% at four points.

The prevalence of insomnia for the two sexes is displayed online in eFigure 2. DSM-IV insomnia was more common in girls (13.7%, 95%CI 9.6-17.7) than in boys (6.7%, 95%CI 3.5-10.0) at the age of 14 years (Wald=6.79, df=1,  $p = 0.009$ ), and marginally more common in girls (11.4%, 95%CI 8.2-14.6) than in boys (7.1%, 95%CI 4.5-9.8) when comparing the mean prevalence of DSM-IV-defined insomnia in early adolescence (ages

12–14 years; Wald=4.02, df=1,  $p=0.045$ ). Additionally, DSM-IV insomnia was more common among boys (11.5%, 95%CI 7.9-15.1) than among girls (5.4%, 95%CI 3.1-7.8) at the age of 8 years (Wald=7.64, df=1,  $p=0.006$ ), and more common among boys (8.1%, 95%CI 6.1-10.2) than girls (4.5%, 95%CI 3.1-5.8) when comparing means for insomnia for the two sexes in childhood overall (ages 4–10 years; Wald=8.98, df=1,  $p=0.003$ ). No sex difference in insomnia was found using DSM-5 insomnia criteria.

The prevalence of the specific symptoms of DSM-IV and DSM-5 insomnia is displayed in Table 2. Prolonged latency of sleep onset was the most common insomnia symptom throughout the study period. The least frequent DSM-IV symptom was nocturnal awakenings, while none of the participants was troubled with the DSM-5's symptom of early morning awakenings. Comparing the prevalence of DSM-IV and DSM-5 symptoms for the two sexes revealed that the symptom of non-restorative sleep (DSM-IV) was more common in girls (17.8%) than in boys (8.0%) at the age of 14 years (Wald=11.87, df=1,  $p=0.001$ ).

### Stability and course

Figures 1 and 2 display the course of DSM-IV and DSM-5 insomnia. Between 32–40% of those with an insomnia diagnosis at one time point experienced the same disorder two years later, participants aged 4 to 6 years being the exception (23%). Table 3 reveals insomnia to exhibit a moderate to high two-year stability, with current insomnia increasing the probability of subsequent insomnia by 5 to 15 times compared with not having an insomnia disorder at the preceding time point. In addition, insomnia during preschool years (ages 4 to 6 years) increased the risk of insomnia in middle childhood (ages 8 to 10 years), and insomnia in middle childhood predicted insomnia in early adolescence (ages 12 to 14 years).

Sex-specific analyses showed that DSM-IV insomnia was more stable in boys from age 4 to age 6 years than in girls (who displayed no stability; Wald=58.81, df=1,  $p<0.001$ ).

No other sex differences in stability was found. There was no difference in two-year stability between DSM-IV- and DSM-5-defined insomnia.

DISCUSSION

Biennial interview-based assessments from ages 4 to 14 years revealed that approximately 2.5% of children met the criteria for insomnia diagnosis at 4 and 6 years of age, whereas at ages 8, 10, 12, and 14 years the prevalence ranged from 7.5% to 12.3%. Insomnia proved to be stable; 23–40% of children had retained their diagnosis two years later and current insomnia increased the probability of insomnia two years later by 5–15 times.

Prevalence of insomnia diagnosis

No previous study has examined the prevalence of diagnosable insomnia from preschool to early adolescence. The three studies employing semi-structured interviews that have been carried out reported considerably higher prevalence estimates, ranging from 16.6–21.2%, [16–18] compared with the present findings. The discrepancy may be due to these former studies employing broader age ranges [18] or using DSM-IV criteria with more liberal cutoffs for sleep latency and time awake after sleep onset. [16,17] Notably though, our estimate of the prevalence of insomnia substantially exceeds the rate of children and adolescents receiving insomnia diagnoses in primary care (0.05–1.20%), [37,38] suggesting that insomnia is under-diagnosed in children aged 4–14 years. Given that receiving treatment for insomnia usually depends on being diagnosed with insomnia, this gap is problematic and might indicate that many children who need treatment do not receive it.

The increase in insomnia from preschool to middle childhood does not match previous research on childhood insomnia, [12,13,17,18] probably due to our inclusion of children as informants from age 8 years and onwards. As children grow older, parents may be unaware of their offspring’s sleeping difficulties (e.g. staying in bed despite difficulty falling

asleep), thus insomnia prevalence research relying on parents only probably underestimates prevalence estimates.

In the current study female preponderance emerged in early adolescence, which is in line with the typical 11–12 years of age reported in the literature.[21,22,39] The sex difference found with DSM-IV criteria indicating that insomnia is more common in boys than in girls in the period from 4 to 10 years of age is novel in the insomnia literature and should therefore be interpreted cautiously. Notably, no sex differences were found with DSM-5 criteria. This may be due to the observed sex difference at age 14 years in non-restorative sleep (DSM-IV), the symptom that was replaced by early morning awakenings in the DSM-5 which we found to be non-existent and therefore not contributing to a sex difference. The absence of early morning awakenings in our study may be a consequence of emerging circadian delay in early adolescence, yet this probably does not explain the nonexistence at earlier ages. Alternatively, not finding any sex differences with DSM-5 criteria may be a consequence of more missing data than with DSM-IV criteria (see Figure 1 and 2 for numbers) from 10 to 14 years of age and thus reduced statistical power in gender-specific analyses, although our analytic n of 1,037 with the full information maximum likelihood procedure to account for missing data tried to compensate somewhat for the reduced power.

### **The course of insomnia**

Our results reveal that for approximately 23% to 40% of children, insomnia is stable over a two-year span. Thus, for most children insomnia is transient. In adults, on the other hand, insomnia usually fosters further sleep problems through maladaptive coping behaviours (e.g. daytime naps) and negative beliefs about sleep (e.g. exaggeration of the consequences of the lack of sleep)[40] as well as conditioning.[41] That said, for a subgroup of children insomnia is persistent and warrants clinical attention. Hence, research identifying the characteristics of those with persistent insomnia is much needed.

**Limitations**

Aside from the strengths of the current study – including entailing a large longitudinal community sample followed up biennially for ten years and administering clinical interviews based on formal diagnostic criteria – there are notable limitations. First, we applied a three-month period for insomnia symptoms as this was the inquired period in PAPA and CAPA and might thus have underestimated the prevalence of DSM-IV insomnia. This underestimation may be especially prominent at 8 years of age, with our conservative proxy insomnia diagnosis (a 1-hour threshold for sleep latency and night awakenings). Conversely, the lack of possibility to exclude other sleep disorders (e.g., circadian disorders, sleep-disordered breathing) may have led to overestimation of insomnia prevalence. Second, as the sample was mainly of Norwegian origin our findings may not apply to more ethnically diverse populations or other geographical locations. Third, although there are numerous similarities between the DSM-IV and DSM-5 criteria, this study applied only DSM-IV insomnia data for the whole study period as this was the diagnostic manual in use at the start of the study. Still, our results from age 10-14 years with both diagnostic criteria indicate that DSM-IV and DSM-5 insomnia criteria do not yield significantly different prevalence or stability estimates. Lastly, with regards to the revealed sex differences in DSM-IV defined insomnia at both disorder and symptom level, it should be acknowledged that these analyses by sex and age led to multiple estimations, which increases the risk of false positives.

**CONCLUSIONS**

The present study is the first to provide age-specific population prevalence estimates and chronicle the stability of insomnia, from preschool to early adolescence, obtained through clinical interviews. DSM-defined insomnia was less prevalent (i.e. 2.4–10.5%) than has been indicated by previous research. No difference in prevalence or stability estimates for insomnia was found using DSM-IV vs. DSM-5 criteria. Girls had marginally more DSM-IV

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3 insomnia in early adolescence (age 12–14 years) than did boys, while boys had more  
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5 insomnia than did girls in childhood (age 4–10 years). Yet no sex differences were found  
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7 using the DSM-5 criteria, probably due to no child having the newly added DSM-5 symptom  
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9 of early morning awakenings. Insomnia proved moderately to highly stable, as illustrated by  
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11 results showing that between 23–40% maintained their insomnia disorder over a two-year  
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13 period, and those with current insomnia (compared with those without) were 5–15 times as  
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15 likely to have subsequent insomnia.  
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**What is already known on this topic**

There is a dearth of studies on the prevalence and stability of interview-based DSM-IV and DSM-5 diagnosable insomnia in childhood. Previous work is characterised by differing estimates depending on the definition of sleep difficulties (e.g. from problems to disorders) and methodological approach (i.e. time-span, informants). In early adolescence, a female preponderance in the prevalence of insomnia is typically reported.

**What this study adds**

Both DSM-IV- and DSM-5-defined insomnia were less prevalent in this study than previous research indicates. Sex differences were apparent with DSM-IV, but not DSM-5, criteria: boys had more insomnia than girls did at ages 4 to 10 years, whereas girls had more insomnia than boys did at ages 12 and 14 years. Insomnia was moderately to highly stable; those with current insomnia (compared with those without) were 5–15 times as likely to have subsequent insomnia.

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**Table 1.** Prevalence, incidence and recurrence (%) of DSM-IV and DSM-5 Defined Insomnia (n = 1,037)

Age (in years)	DSM-IV Insomnia (95% CI)			DSM-5 Insomnia (95% CI)		
	Prevalence	Incidence	Recurrence	Prevalence	Incidence	Recurrence
Aged 4	2.6% (1.6, 3.5)	2.6% (1.6, 3.5)	n/a	-	-	-
Aged 6	2.4% (1.4, 3.5)	1.7% (0.9, 2.6)	n/a	-	-	-
Aged 8 <sup>1</sup>	8.3% (6.2, 10.5)	6.2% (4.3, 8.1)	0.3% (0.0, 0.6)	-	-	-
Aged 10	10.2% (7.8, 12.6)	6.5% (4.4, 8.6)	0.7% (0.0, 1.3)	12.3% (9.5, 15.2)	7.7% (5.1, 10.1)	0.7% (0.0, 1.4)
Aged 12	7.9% (5.6, 10.1)	2.3% (0.9, 3.6)	1.2% (0.3, 2.2)	7.5% (5.3, 9.8)	1.6% (0.5, 2.6)	1.1% (0.2, 2.0)
Aged 14	10.5% (7.8, 13.1)	4.9% (3.0, 6.8)	1.4% (0.3, 2.6)	10.5% (7.5, 13.4)	3.7% (1.8, 5.5)	1.1% (0.0, 2.1)

Note. These estimates are population corrected estimates. Age 4–6 years, parent report; age 8–14, joint report. Incidence estimates represent current insomnia cases with no prior history of insomnia. Recurrence estimates are current insomnia cases without insomnia at the preceding time-point, but a history of insomnia prior to the previous time-point. DSM-5 incidence at age 10 years and recurrence at ages 10–14 years are based on DSM-IV data on time-points without DSM-5 data (ages 4–8 years). CI = confidence interval. <sup>1</sup> Proxy measure of insomnia – thresholds of 1 h sleep latency / time awake at night.

**Table 2.** Prevalence (%) of Symptoms of DSM-IV and DSM-5 Insomnia (n = 1,037)

	Aged 4 years (95% CI)	Aged 6 years (95% CI)	Aged 8 years (95% CI) <sup>1</sup>	Aged 10 years (95% CI)	Aged 12 years (95% CI)	Aged 14 years (95% CI)
DSM-IV Insomnia						
Initiating symptom	7.8 (6.0, 9.6)	10.0 (7.8, 12.2)	15.5 (12.6, 18.5)	18.0 (15.0, 21.1)	15.7 (12.8, 18.7)	12.3 (9.5, 15.2)
Maintaining symptom	4.7 (3.3, 6.2)	3.1 (1.8, 4.4)	1.0 (0.2, 1.8)	1.0 (0.3, 1.7)	1.0 (0.2, 1.8)	0.8 (0.0, 1.6)
Not rested symptom	3.3 (2.1, 4.6)	5.7 (4.0, 7.4)	13.0 (10.3, 15.7)	6.9 (4.9, 8.8)	6.9 (4.7, 9.0)	13.3 (10.4, 16.2)
At least one symptom of DSM-IV insomnia	13.8 (11.5, 16.1)	15.4 (12.7, 18.1)	23.2 (19.8, 26.7)	22.0 (18.8, 25.3)	19.5 (16.3, 22.8)	20.3 (16.9, 23.7)
DSM-5 Insomnia						
Initiating symptom	n/a	n/a	n/a	22.0 (18.7, 25.4)	16.9 (13.8, 20.0)	14.4 (11.3, 17.5)
Maintaining symptom	n/a	n/a	n/a	8.3 (6.1, 10.5)	4.4 (2.6, 6.2)	1.8 (0.7, 2.9)
Early awakening symptom	n/a	n/a	n/a	n/a	n/a	n/a
At least one symptom of DSM-5 insomnia	n/a	n/a	n/a	27.3 (23.7, 30.8)	19.5 (16.2, 22.8)	14.7 (11.7, 17.7)

Note. Age 4–6 years, parent report; age 8–14, joint report. CI = confidence interval. <sup>1</sup> Proxy insomnia at age 8 years – thresholds of 1 h sleep latency / time awake at night

**Table 3.** Stability of DSM-IV and DSM-5 Insomnia (n = 1,037)

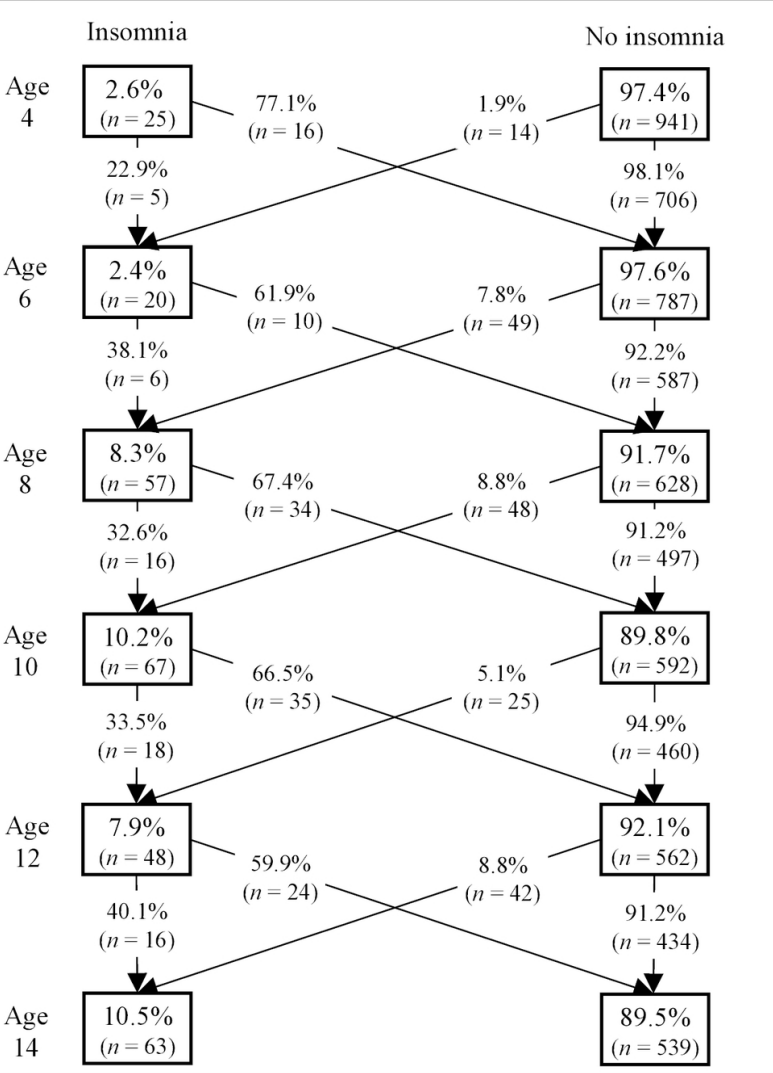
	<b>DSM-IV Insomnia Odds ratio (95% CI)</b>	<b>DSM-5 Insomnia Odds ratio (95% CI)</b>
Age 4 to age 6 years	15.28 (4.42, 52.88)	n/a
Age 6 to age 8 years	7.33 (2.57, 20.96)	n/a
Age 8 to age 10 years	5.05 (2.61, 9.75)	n/a
Age 10 to age 12 years	9.29 (4.49, 19.20)	6.24 (2.71, 14.37)
Age 12 to age 14 years	7.06 (3.31, 15.06)	10.50 (4.86, 22.70)
Preschool to middle childhood	5.18 (2.51, 10.68)	n/a
Middle childhood to early adolescence	4.72 (2.79, 8.00)	n/a
Preschool to early adolescence	1.68 (0.73, 3.89)	n/a

Note. Reference category is those without insomnia which continues to not have insomnia. N/a as data not available, DSM-5 criteria introduced at 10 years of age. CI = confidence interval.

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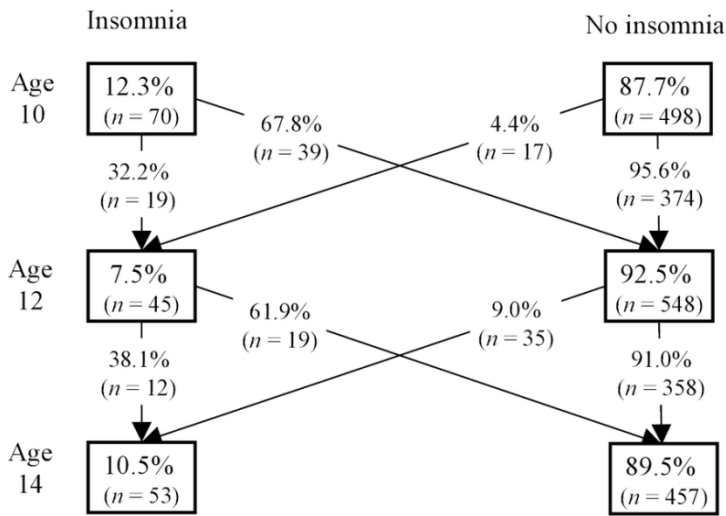
Figure 1. Course of DSM-IV Insomnia



Note. Numbers in boxes are prevalence estimates while numbers outside boxes are from pairwise crosstabs (only those present for the two ages in question). Number of subjects rounded to closest whole number, as they are originally population estimates.

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Figure 2. Course of DSM-5 Insomnia



Note. Numbers in boxes are prevalence estimates while numbers outside boxes are from pairwise crosstabs (only those present for the two ages in question). Number of subjects rounded to closest whole number, as they are originally population estimates.

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## Supplement – Semi-structured interview questions

If not stated, a three months period was used. Interviewers instructed to follow-up with questions in order to code precise and relevant answers. *Italics* represent questions as stated in manuals, while roman text represent instructions or information to the interviewers.

### Preschool Age Psychiatric Assessment (PAPA)

Relevant questions used at T1 and T2 (age 4 and 6 years) in interviews with parent only to provide information to evaluate insomnia symptoms.

#### **Time to Sleep Initiation**

From the time parent says goodnight, after any rituals are completed, the average time it takes the child to fall asleep.

*How long does it take him/her to fall asleep?*

#### **Medication for Insomnia**

Note here any medication (prescription or over the counter) specifically used in an attempt to improve sleep pattern.

*Does s/he take anything to help him/her sleep? What? Does it work?*

#### **Night Waking**

Child wakes up from sleep during the night after child has been asleep for over ten minutes.

*Does s/he wake up during the night?*

*How many times PER NIGHT does s/he wake up?*

*In the last 3 months, how often has this happened?*

*On average, how long would you say s/he is awake per night?*

Remember to consider if child wakes up multiple times per night.

*When did this start?*

#### **Inadequately Rested by Sleep**

Subject describes being inadequately rested by sleep upon waking.

*Does s/he usually get a good night's sleep?*

*Does s/he seem inadequately rested when s/he gets up?*

*How does s/he feel?*

*When did that start?*

**The child and adolescent psychiatric assessment (CAPA)**

Relevant questions used at T3 (age 8) in interviews with parent and child separately to provide information to evaluate insomnia symptoms. Wording here is from the child interview, similar questions were asked the parent.

**Insomnia**

Disturbance of usual sleep pattern involving a reduction in actual sleep time during the subject's sleep period that is accompanied by a subjective feeling of a need for more sleep. Do NOT include externally imposed changes in overall sleep pattern (e.g., change in job hours, arrival of new baby), or insomnia during first 2 weeks following such changes. Sleep problems are scored irrespective of taking medication for them, but note whether medication is being taken. Also include changes attributed to side effects of medication or substance use.

**Sleep Initiation and Night Waking**

*Is it hard for you to fall asleep when you want to?*

*Once you're off to sleep, do you wake up again during the night?*

If yes to any question, continue:

*What time do you usually go to bed?*

*How long does it take you to fall asleep?*

*In the last 3 months, has it taken you an hour or more to get to sleep?*

*Why do you wake up?*

Exclude waking up to use bathroom.

*How many nights do you have trouble sleeping in the last 3 months?*

*When did you first start having sleep problems?*

**Medication for Insomnia**

Note here any medication (prescription or over the counter) specifically used in an attempt to improve sleep pattern.

*Do you take anything to help you sleep? What? Does it work?*

**Inadequately Rested by Sleep**

Subject describes being inadequately rested by sleep upon waking.

*Do you usually get a good night's sleep?*

*Do you feel like you are NOT well rested when you get up?*

*How do you feel?*

*When did that start?*

### **SLEEP INTERVIEW as a supplement to the Sleep section in CAPA**

Used at T4-T6 (ages 10, 12 and 14 years) in interviews with parent and child separately. Wording here is from the child interview, similar questions were asked the parent. In addition to the following questions, we used the question regarding sleep medication from CAPA to determine insomnia. The sleep interview contains questions that cover symptoms of DSM-IV and DSM-5 insomnia, allowing investigations of DSM-5 insomnia prevalence and stability from age 10 and onwards in addition to the study of DSM-IV insomnia from age 4 to 14 years.

#### **Insomnia**

Experiences difficulties with 1) sleep initiation, 2) night awakenings or 3) feelings of inadequately rested by sleep (DSM-IV) or problems with early morning awakenings (DSM-5).

#### **Sleep Initiation**

*Is it hard for you to fall asleep?*

*How long does it take you to fall asleep?*

*Is it hard for you to fall asleep every night? How often?*

*If you are not able to sleep, what do you normally do? Does it happen that your parent co-sleeps with you? Are there other things your parents do to help you to sleep?*

#### **Night Waking**

*Once you're off to sleep, do you wake up again during the night?*

*Does it happen every night? How often?*

*If you wake up during the night, how long time does it usually take before you are able to return to sleep?*

*If you wake up during the night, does your parents do anything to help you go to sleep again? What do they do?*

#### **Inadequately Rested by Sleep**

*Does it happen that you feel like you are not well rested when you wake up, even if you have slept long enough? How often?*

#### **Early morning awakenings**

*Do you wake up early in the morning and can't go back to sleep?*

*Is it earlier than you are supposed to get up?*

*Do you feel like you need more sleep? How often?*

#### **Impairment in important areas of functioning**

We used the comprehensive interview on impairment in important areas of functioning which is included in both PAPA and CAPA.

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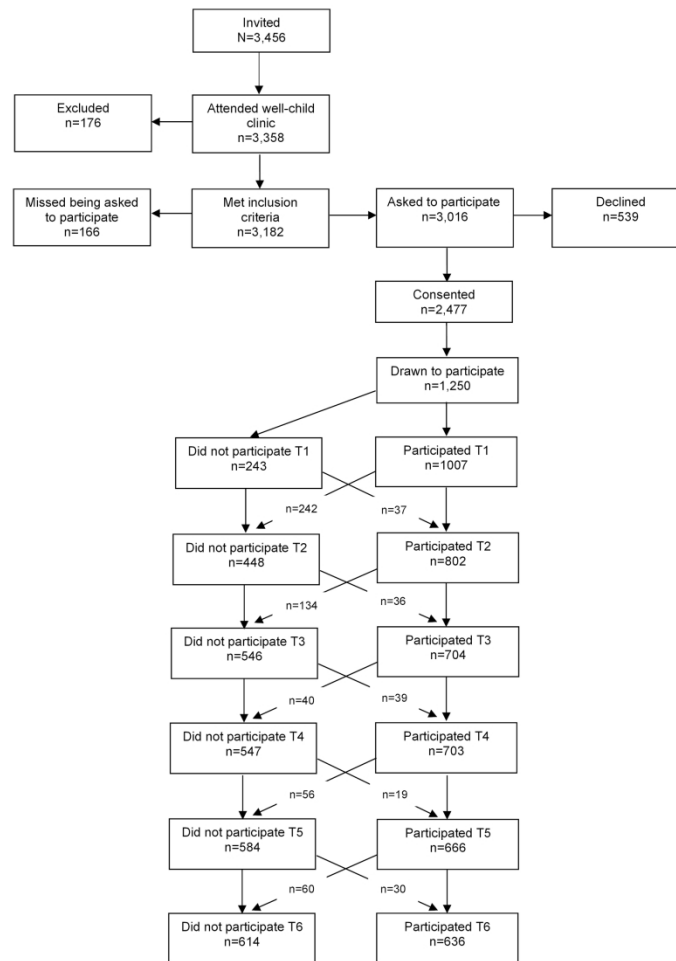
Note. All these questions covering insomnia were part of a larger interview covering sleep in general.

**eTable 1.** Sample Characteristics from T1 (age 4 years) of the Trondheim Early Secure Study (*n* = 1007)

Characteristic	%	<i>n</i>
Sex of child		
Male	50.5	507
Female	49.5	497
Sex of parent informant		
Male	15.0	149
Female	85.0	845
Ethnic origin of biological mother		
Norwegian	92.4	908
Western Countries	3.3	32
Other Countries	4.3	42
Ethnic origin of biological father		
Norwegian	90.5	887
Western Countries	6.2	61
Other Countries	3.3	32
Biological parents' marital status		
Married	54.7	536
Cohabiting	33.6	330
Divorced / Separated	9.8	96
Other	1.9	19
Informant parents' socioeconomic status		
Leaders	5.7	54
Higher professionals	25.5	242
Lower professionals	39.3	374
Skilled workers	25.8	245
Farmers / fishermen	0.5	5
Unskilled workers	3.2	30
Households' gross annual income		
0 – 225' NOK (0 – 20' USD)	3.4	33
225' – 525' NOK (20' – 47' USD)	18.3	180
525' – 900' NOK (47' – 81' USD)	51.8	509
> 900' NOK (> 81' USD)	26.5	260
Childcare		
Official day care center	94.8	942
Other	5.2	52

Note. Unweighted sample characteristics of the 1007 children attending t1 in TESS. Missing data not included in percentages. The sample is representative for the Norwegian population regarding parents' level of education[1] and family situation,[2,3] while differences in rates of occupational categories between the sample and the city were negligible, below 3.6%. NOK to USD exchange rate from 24<sup>th</sup> March 2020.

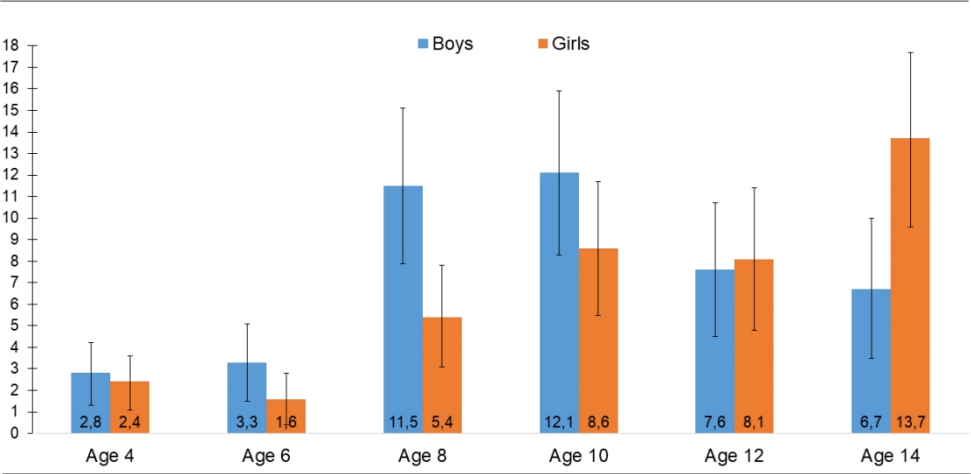
1. Statistics Norway. Population's Level of Education. 2012. <http://www.ssb.no/en/utdanning/statistikker/utniv/aar> (accessed: 17 October 2019)
2. Statistics Norway. Families and Households. 2017. <https://www.ssb.no/en/statbank/table/06204/> (accessed: 17 October 2019)
3. The Norwegian Directorate for Children. Barns Familier. 2017. [https://www.bufdir.no/Statistikk\\_og\\_analyse/Oppvekst/Familie\\_omsorg\\_og\\_relasjoner/Barns\\_familier/](https://www.bufdir.no/Statistikk_og_analyse/Oppvekst/Familie_omsorg_og_relasjoner/Barns_familier/) (accessed: 17 October 2019)

**eFigure 1.** Flowchart of Recruitment and Follow-up

Note. Number of participants at the various assessment points is based on the number of participants invited to participate (n=1,250) minus those who did not participate at the respective measurement points (i.e. T1, T2). Parents with insufficient proficiency in Norwegian to fill out the SDQ were excluded.

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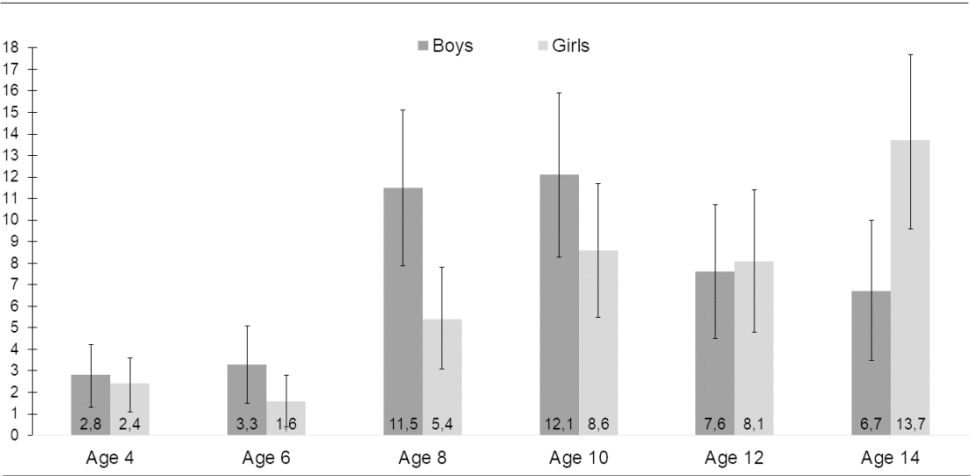
**eFigure 2.** Prevalence (%) of DSM-IV Insomnia by Sex (n = 1,037)



Note. Error bars represent 95% confidence intervals.

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**eFigure 2.** Prevalence (%) of DSM-IV Insomnia by Sex (n = 1,037)



Note. Error bars represent 95% confidence intervals.

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