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Predictors of diagnostically defined insomnia in child and adolescent community samples: A literature review

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Abstract

Diagnostically defined insomnia is prevalent, persistent, and associated with a range of negative outcomes in childhood and adolescence. To inform prevention and treatment, we need to identify relevant predictors that can be addressed in such intervention efforts. Therefore, a systematic search for longitudinal studies involving child and adolescent samples (ages 4 to 19) examining predictors of diagnostically defined insomnia adjusted for previous insomnia was conducted. The search identified 6,419 studies, resulting in 6 included papers involving 5 samples (n = 9,949) conducted in 5 different countries (the US, New Zealand, Norway, China, and Japan). Few longitudinal studies investigated the predictors of diagnostically defined insomnia in children and adolescents, and insomnia is rarely defined according to diagnostic manuals. The results suggested that poor mental health (most notably depression) and female sex may be involved in the etiology of diagnostically defined insomnia. Stress might be the most modifiable factor identified. However, the diversity of the predictors studied in previous reports combined with the lack of replication prevent any firm conclusions from being drawn. This review serves as a summary of the best available evidence.

Keywords: Disorders of Initiation and Maintenance of Sleep, Insomnia, Predictors, Children, Adolescents, Community Samples

Abbreviations

ADHD	Attention-deficit/hyperactivity disorder
CI	Confidence intervals
DSM	Diagnostic and Statistical Manual of Mental Disorders

ICD	International Statistical Classification of Diseases
ICSD	International Classification of Sleep Disorders
K_w	Weighted kappa
MDD	Major depressive disorder
SES	Socioeconomic status

1 Introduction

A large proportion of children (17-36%) and adolescents (14-22%) have difficulties initiating or maintaining sleep [1-7]. Sleep-onset difficulties in early adolescence are increasing in Europe [8], representing a heavy financial burden on the healthcare system [9], especially when sleep problems persist, which they typically do [6, 10-12]. Because problematic sleep is linked to an increased risk of subsequent emotional, physical, behavioral, and cognitive problems in children, adolescent and adults [13-17], knowledge of its determinants is important to aid preventive and treatment efforts. According to one of the most influential models of insomnia, the 3P behavioral model [18] predisposing, precipitating and perpetuating factors contribute to the development and maintenance of the disorder. Predisposing factors (e.g., personality, temperament) make some individuals more vulnerable to insomnia and in combination with precipitating factors, typically threatening or stressful stimuli (e.g., family conflicts) may lead to the threshold of insomnia to be surpassed. Perpetuating factors are typically maladaptive coping strategies (e.g., daytime napping, excessive time in bed) and maladaptive conditioning to the bed/bedroom. Previous reviews of children [19] and adolescents [20] have addressed the associations between such determinants and sleep problems in general. However, due to the correlational nature of the relationships studied in these reviews, the direction of the influence could not be determined. Because medical decisions are based on diagnoses, the use of diagnoses in research conforms to the medical decision-making process. Moreover, general sleep complaints may not warrant clinical attention because such difficulties often lack the severity, duration, intensity, or associated impairment that is a defining feature of formal clinical diagnoses, such as insomnia (i.e., “chronic insomnia”, “insomnia disorder” or “non-organic insomnia” depending on the diagnostic manual used [21-23]). Hence, specifically identifying factors predictive of

diagnosable insomnia is valuable. One narrative review addressed insomnia (i.e., ranging from symptoms of insomnia to diagnostically defined insomnia) and its predictors in adolescence [24]. However, this review was not based on a systematic literature review and only focused on a selected set of risk factors (i.e., sex, puberty, electronic media use, school stress, and caffeine consumption). Thus, there is a need to cast a wider net and systematically identify all relevant and reported predictors of diagnosable insomnia among children and adolescents. During adolescence sleep changes by several mechanisms which may lead to poorer sleep. In terms of biological factors delay of the circadian rhythm [25] and a slower build-up of sleep pressure [26] in the context of stable school start times often leads to curtailed sleep. In addition, potential sleep disturbing environmental factors such as electronic media use [27] , and intake of caffeinated energy drinks [28] seem to increase during adolescence. Also, emotional factors, such as academic stress, which is common in adolescence, has been associated with sleep impairment [29].

However, defining and examining the etiology of insomnia in children and adolescents is challenging for several reasons. (1) The criteria applied to diagnostically defined insomnia have varied across previous editions of the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Classification of Sleep Disorders (ICSD) [30, 31]. Nevertheless, the most recent diagnostic manuals specify childhood insomnia phenotypes and concur that the core symptoms cause *clinically significant distress or daytime impairment due to difficulties initiating and/or maintaining sleep and/or early-morning awakenings with an inability to return to sleep* and occur at least 3 times a week (henceforth, such diagnostically defined insomnia is termed “insomnia”) [21-23]. However, most previous research focused on difficulties in initiating and/or maintaining sleep without considering the frequency per week, duration in months and

distress/daytime impairment caused and, thus, failed to fully consider all diagnostic criteria. (2) A widely held view among many clinicians and researchers has been that insomnia is secondary to medical or mental disorders [32]. Consequently, insomnia has tended to be trivialized or ignored, with interventions focusing on the "primary" disorder despite the tendency for symptoms of insomnia to persist as a residual symptom [33] and sleep problems to forecast subsequent problems [14, 34, 35]. A likely consequence for insomnia research is that studies have mainly viewed insomnia as a result of other disorders or excluded insomnia comorbid with other disorders. (3) Few longitudinal studies exist, which is problematic because knowledge regarding the directions of associations without the ability to adjust for insomnia at baseline is limited. The latter is important because previous insomnia is a well-established risk factor for future insomnia [36] and common genetic factors play a certain role in the etiology of insomnia *and* other psychopathologies (i.e., depression and overanxious disorder) [37, 38]. Thus, failing to control for insomnia at baseline typically leads to inflated effect estimates of included predictors, and such studies carry a higher risk of being biased by confounding (i.e., confusion of effects) [39]. (4) Studies including proxies for insomnia have mainly applied surveys, which is understandable for practical and cost-effectiveness reasons. However, surveys lack diagnostic precision, often suffer from psychometric limitations [40] and typically resort to composite scores with rather arbitrary cutoffs. Although we recognize the helpful role of composite scores when examining group differences for broad purposes, their use is difficult to defend in rigorous research aiming to inform clinical practice and, therefore, requiring higher precision when measuring intricate psychological constructs, such as insomnia [41, 42]. Although objective measurements are often considered the gold standard in sleep assessment, such methods are inadequate when assessing insomnia because these methods do not measure the subjective

experience of sleep (e.g., *problems* initiating sleep), which is the heart of the problem and essential according to the diagnostic criteria of insomnia [21, 22]. (5) Although reviews have addressed problematic sleep in patients with developmental disorders, such as autism [43] or attention-deficit/hyperactivity disorder [44, 45], most children with psychiatric disorders are not referred to treatment. Referrals are influenced by a range of factors in addition to the need for treatment [46]; hence, findings based on clinical populations may not generalize well to the general population.

In summary, previous studies and reviews have not consistently adhered to the diagnostic criteria and differ in terms of design (e.g., samples and adjustment for baseline insomnia) and methods (e.g., assessments, criteria used, and predictors included). Therefore, the research landscape of childhood insomnia is complex, and the etiology of diagnosable insomnia is unclear. Because such knowledge is needed to inform prevention and treatment, the present work aimed to systematically review longitudinal research examining all reported predictors of diagnostically defined insomnia in community samples of children and adolescents (aged 4 to 19 years).

2 Material and methods

This inquiry represents a systematized review [47] including several, but not all (i.e., only one insomnia review), elements of a systematic review process. A meta-analysis was deemed inappropriate due to the few included studies and inconsistent reporting of predictors. The PRISMA guidelines [48] were followed when possible (checklist is provided in the online supplement).

2.1 Literature search

A systematic search process was conducted based on scoping review techniques [49] using the following databases: Scopus (Elsevier), Web of Science (ISI), Medline (Ovid), PsycINFO (Ovid), and Psychology and Behavioral Sciences Collection (EBSCO). The initial search process was performed by two research librarians (SSol and MRJ) with expertise in searching academic databases. The search terms are displayed in Table 1 and were grouped into the following three search strings capturing the main aspects of the review: (i) insomnia in (ii) children and adolescents and (iii) longitudinal/prospective studies. The search strings were customized to each database and, therefore, slightly differed among the databases (available in the online supplement, Table S1). To reduce the number of irrelevant hits and increase the accuracy of the searches, a proximity operator was used. The search was last updated on September 20, 2020.

Outcome	Age group	Design/method
(insomnia OR insomnias OR "Sleep onset insomnia" OR "Night waking insomnia" OR "Sleep onset insomnias" OR "Night waking insomnias" OR "Late insomnia" OR "Middle insomnia" OR "Early insomnia" OR "Sleep disorder" OR "Sleep disorders" OR "Sleep disturbance" OR "Sleep problem*" OR "Behavioral insomnia*" OR "Sleep onset latency" OR "Night waking" OR "sleep initiation and maintenance")	(toddler OR preschool OR toddlerhood OR children OR childhood OR preadolescent OR preadolescence OR "School age*" OR paediatric OR pediatric OR youth OR child OR adolescent OR adolescence)	(longitudinal OR follow-up OR "Follow-up study" OR "Follow-up studies" OR prospective OR course OR stability OR continuity OR "Over time" OR forecast OR predict*)

Table 1. Search terms used to capture the main aspects of the review

Note. These search terms formed the basis of the database-specific search strings shown in Table S1.

2.2 Inclusion/exclusion criteria

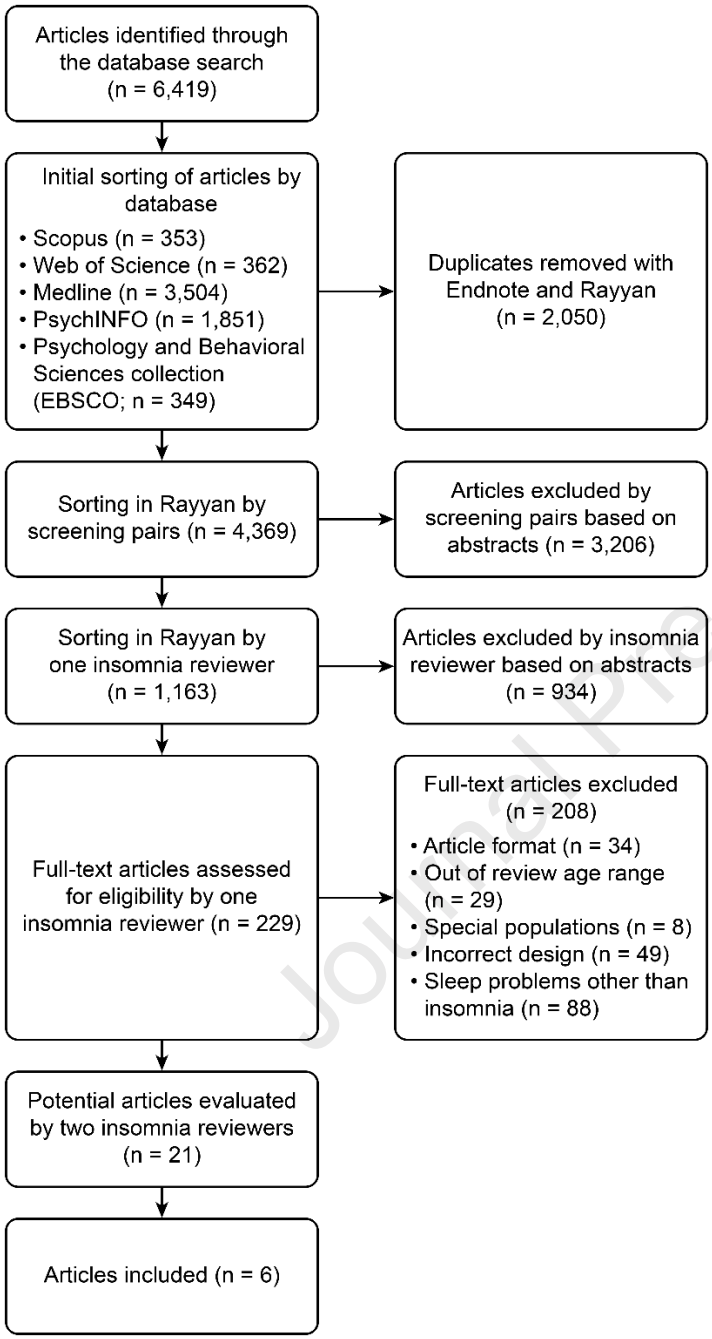
The inclusion criteria included (i) peer-reviewed articles (ii) available in English with a (iii) longitudinal design that (iv) included community samples of children and adolescents with (v) a mean age at follow-up between 4 and 19 years and (vi) diagnostically defined insomnia as the outcome (i.e., insomnia according to the DSM, ICSD or International Statistical Classification of Diseases and Related Health Problems (ICD) criteria). Additional inclusion criteria included (vii) the reporting of predictors of insomnia while (viii) controlling for insomnia at baseline/previous waves. Thus, studies were excluded if the sample consisted of a clinical population (e.g., developmental disorders, mental/medical conditions, or patients) due to limited generalizability. Furthermore, intervention studies were excluded because the aim was to summarize predictors of insomnia development and persistence rather than evaluate the effectiveness of interventions. Notably, given the above reasoning (i.e., Introduction), objective measures of sleep were excluded.

2.3 Coding and article selection

As illustrated in Fig. 1, 6,419 identified studies formed the basis of the article selection process. After removing the duplicates (n = 2,050), two-thirds of the titles and abstracts (n = 2,972) were screened and coded by the two research librarians conducting the search (SSol and MRJ). However, due to the excused absence of SSol, the remaining abstracts were screened by MRJ and LB (n = 1,397). All three screeners were trained in applying the inclusion/exclusion criteria and blinded to each other's coding. The screeners had the opportunity to flag articles as 'include', 'maybe' or 'exclude' (Table S2). Because using unweighted kappa is inappropriate for continuous-ordinal scales [50], we calculated weighted kappa with quadratic weights (Table S2) [51, 52] using an online calculator [53]. The interrater agreement between both MRJ and SSol (n

= 2,972; 71% agreement; k_w = .29, 95% CI: .26 to .32) and MRJ and LB (n = 1,397; 89% agreement; k_w = .36, 95% CI: .28 to .44) was fair. However, the magnitude of kappa is sensitive to skewed rater disagreement and unbalanced prevalence [50]. As illustrated by the contingency table (Table S2), there was skewed rater disagreement between MRJ and SSol, and prevalence bias was present in both coding pairs because of the few eligible studies. To illustrate the possible effect of such bias, we used a prevalence- and bias-adjusted kappa-ordinal scale calculator [54], which yielded estimates of substantial and almost perfect agreement between the two respective screening pairs (.69 and .87; Table S2).

Fig. 1. Flow chart of the screening and selection process.



Note. Exclusions due to 'article format' include abstract only, conference presentations, dissertations, non-English studies, studies with full text not available, and non-peer-reviewed studies. 'Incorrect design' includes cross-sectional studies, review papers and studies with no predictors of insomnia.

To ensure that no relevant articles were excluded, all articles categorized as 'maybe' or 'include' by one screener (n = 1,163) underwent a second review by a coder with insomnia expertise (JFM; not blinded). This review resulted in 229 full-text requests, and after reviewing these articles, 208 articles were excluded due to the reasons displayed in Fig. 1 (e.g., outside the age range, incorrect design, or sleep problems other than insomnia). The remaining 21 studies were evaluated by two reviewers (SSte and JFM). Because only two papers from one study fully complied to the inclusion criteria [55, 56], we included four additional longitudinal studies that had minor deviations in the insomnia measures or analysis. These four studies address the core symptoms of insomnia and their frequency and duration and adjusted for previous insomnia, but three studies did not include symptoms of daytime impairment in their insomnia measure (hereafter, termed "insomnia without daytime impairment") [57-59], and one study used a weaker than ideal adjustment of baseline insomnia [60]. This process led to the inclusion of 6 papers.

2.4 Data extraction

All included studies reported one or more factors statistically significantly associated with insomnia outcomes using crude and adjusted odds ratios (ORs). In the current review, we report all estimates from multivariate analyses that may provide information regarding the etiology of insomnia regardless of their status as covariates, control variables or risk factors.

2.5 Quality of the included studies

To assess the quality of and risk of bias in the included studies, we used the Newcastle-Ottawa scale for cohort studies [61] as illustrated with stars in Table 2.

Authors	**Setting**	**Age at baseline and follow-up**	**Prospective sample size** (% female)	**Selection** (maximum 4 stars)	**Comparability** (maximum 2 stars)	**Outcome** (maximum 3 stars)	**Insomnia outcome** (% with outcome)	**Covariates** (as reported by the authors)	**Significant predictors in multivariate analyses adjusted for previous insomnia** (other variables in the multivariate model)	**Adjusted/ multivariate odds ratio** (95% CI)
Roberts et al. [55]	Houston, US	11-17 y and 1 y later	3,134 (49%)	****	*	**	Incidence of DSM-IV insomnia with (5.5%) and without DI (13.9%)	Age, sex, family income, ethnic status, physical health functioning, mental health functioning, life stress	Of insomnia without daytime impairment	
									Female sex	1.31 (1.07-1.58)
									Age	0.72 (0.57-0.91)
									Somatic health limitations	1.33 (1.09-1.63)
									Life satisfaction	1.73 (1.34-2.23)
									Perceived mental health	1.46 (1.11-1.93)
									Depressed mood	1.25 (1.02-1.53)
									School stress	1.84 (1.39-2.43)
									Father stress	1.58 (1.19-2.10)
									Of insomnia with daytime impairment	
									Female sex	1.91 (1.35-2.69)
									Somatic health limitations	2.12 (1.45-3.10)
									Life satisfaction	1.65 (1.11-2.45)
									Perceived mental health	1.82 (1.17-2.84)

									School stress	2.93 (1.61-5.32)
									School stress	5.01 (2.75-9.13)
									Ethnicity, family income, perceived somatic health, impact of somatic illness, neighborhood stress, mother stress	All nonsignificant
Roberts and Duong [56]	Houston, US	11-17 y and 1 y later	3,134 (49%)	****	*	**	Incidence of DSM-IV insomnia with (5.5%) and without DI (13.9%)	Age, sex, family income	Of insomnia without daytime impairment	
									Depressive symptoms	1.39 (1.14-1.68)
									Of insomnia with daytime impairment	
									Major depression	2.31 (1.01-5.28)
Gregory et al. [60]	Dunedin, New Zealand	7 y and ages 9, 13, 15 and 18 y	936 (49%) with insomnia data at 18 y	**	*	**	Future DSM-IV insomnia with DI (15%)	Concurrent health problems, socioeconomic status, depression, earlier sleep problems	Family conflict	1.42 (1.17-1.73)
									Male sex	0.53 (0.36-0.80)
									Health problems at 18 y (concurrent)	0.62 (0.46-0.83)
									SES, previous sleep problems	All nonsignificant
Steinsbekk and Wichstrøm [57]	Trondheim, Norway	4.4 y and 6.7 y	795 (49.9%)	****	**	**	Future DSM-IV insomnia without inquiring		Symptoms of ADHD	1.08 (1.02-1.15)
									Symptoms of ODD	
									Symptoms of MDD	1.15 (1.03-1.29)

							about DI (21.2%)			1.28 (1.07-1.52)
									Symptoms of conduct disorder, GAD, separation anxiety disorder, social phobia and specific phobia	All nonsignificant
Zhang et al. [58]	Hong Kong, China	9.0 y ± 1.8 and 13.7 y ± 1.8	1,611 (50.9%)	***	*	*	Incidence (6.2%) or persistence (0.6%) of chronic (12 mo) insomnia without including DI in the insomnia criteria	Age, sex, parental educational level, family income	Incident insomnia Paternal education Frequent temper outbursts Feeling tired during the daytime	 2.49 (1.13-5.51) 1.85 (1.16-2.97) 2.17 (1.24-3.77)
									Persistent insomnia Chronic medical disorders	 10.2 (1.99-52.5)
									Sex, family income, maternal education, hyperactivity, feeling unrefreshed/headache after waking, difficulty waking in the morning, morning dry mouth	All nonsignificant
Tokiya et al. [59]	Japan	7th and 10th graders	3,473 (not specified); 776 junior	***	*	**	Incidence of insomnia	Sex, sleep duration, extracurricular	Incident insomnia (junior high school) Sleep paralysis	

and two years later	(52.2%) and 2,697 senior high students (42.3%)		without inquiring about DI in junior (7.8%) and senior high students (9.2%)	learning, hours of mobile use, nightmares, sleep paralysis, poor mental health status, breakfast, coffee/tea intake, exercise habits, availability of an advisor	Poor mental health	3.59 (1.19-10.83)
					Incident insomnia (senior high school)	2.69 (1.41-5.15)
					Extracurricular learning	2.10 (1.23-3.60)
					Mobile phone use	1.39 (1.03-1.89)
					Nightmares	4.46 (2.36-8.42)
					Poor mental health	1.62 (1.18-2.21)
					Sex, sleep duration, skipped breakfast, habitually consumed coffee, exercise habits	All nonsignificant

Table 2. Descriptive characteristics of the included studies and quality assessment according to the Newcastle-Ottawa quality assessment scale

Note. Approx., approximately; mo, month(s); y, year(s); DI, daytime impairment; CI, confidence interval; DSM-IV, Fourth edition of the Diagnostic and Statistical Manual of Mental Disorders; SES, socioeconomic status; ADHD, attention-deficit/hyperactivity disorder; ODD, oppositional defiant disorder; MDD, major depressive disorder; GAD, generalized anxiety disorder. Sample size refers to those followed longitudinally.

3 Results

3.1 Characteristics of the included studies

The 6 included papers originated from 5 studies conducted in 5 different countries (US, New Zealand, Norway, China, and Japan) and consisted of a total sample of 9,949 children and adolescents aged 6 to 18 years at follow-up. The study settings, designs, samples, measures, covariates and predictors are described in Table 2. All studies were longitudinal community studies with two time points of insomnia measures, and the second assessment was conducted one to 9 years after the first assessment. Notably, two studies adjusted for baseline insomnia when predicting future insomnia (i.e., incidence and persistence) [57, 60], three articles examined the predictors of insomnia incidence [55, 56, 59], and one study also provided a separate analysis of insomnia persistence [58].

3.2 Predictors of insomnia in children and adolescents

To group the predictors of insomnia, we categorized the predictors into (i) sociodemographic factors, (ii) mental health factors, (iii) somatic health factors, (iv) parent- and family-related factors, (v) school factors, and (vi) lifestyle factors.

3.2.1 Sociodemographic factors

Two of the four studies addressing the role of biological sex found that females are more likely than males to have subsequent insomnia [55, 60], while this was not the case in the two studies conducted in southeast Asia capturing insomnia without assessing daytime impairment [58, 59]. A difference with regard to whether insomnia with or without assessing daytime impairment

constituted the outcome was also found in age as follows: a younger age predicted the incidence of insomnia without considering daytime impairment but not with such consideration [55]. Ethnicity did not predict insomnia in one study examining this determinant [55]. Both family income and socioeconomic status (SES) were not associated with future insomnia in the two studies addressing these factors [58, 60], and stress was not linked to the neighborhood environment associated with subsequent insomnia [55]. Lower paternal, but not maternal, education was found to forecast the incidence of chronic insomnia but not insomnia persistence [58]. Taken together, four studies reported mixed results regarding the predictive role of the female sex, while the other sociodemographic predictors were largely unrelated to future insomnia and not replicated.

3.2.2 Mental health factors

Two studies revealed that self-reports of poor overall mental health and low life satisfaction in adolescence predicted the incidence of insomnia with [48] and without considering daytime impairment [55, 59]. Roberts and Duong [56] found that major depressive disorder (MDD) forecasted insomnia incidence in adolescence, whereas these and other authors reported that the symptoms of depression and depressed mood (i.e., not full-blown disorders) predicted insomnia without measuring daytime impairment [55-57]. However, when daytime impairment was considered, the symptoms of depression were not associated with the incidence of insomnia in the study by Roberts and Duong [56]. Frequent temper outbursts, which may reflect the symptom of irritability in depression [22] or represent a trait indicator of emotional instability (i.e., difficult temperament or neuroticism) [62], were reported to be predictive of the incidence, but not persistence, of chronic insomnia without daytime impairment [58]. Insomnia was also found

to be more likely in preschoolers displaying symptoms of oppositional defiant disorder and attention-deficit/hyperactivity disorder [57]. However, hyperactivity in school-aged children was unrelated to both the incidence and persistence of chronic insomnia in adolescence [58]. Our results further show that other indicators of mental health, including poor life satisfaction [55], feeling tired during the daytime (but not persistence) [58] and nightmares (senior high students only) [59], predicted the incidence of insomnia. In contrast, symptoms of conduct, generalized anxiety, and separation anxiety disorders and social and specific phobia in preschoolers were unrelated to future insomnia without daytime impairment [57]. Moreover, feeling unrefreshed after waking up and having difficulty waking in the morning were not associated with the incidence or persistence of insomnia without daytime impairment [58]. In summary, studies involving 7,402 individuals aged 4 to 18 years suggested that depression, markers of depression, and certain indicators of poor general mental health predicted insomnia. Notably, some replicated results stem from the same sample.

3.2.3 Somatic health factors

Perceived limitations due to physical health problems in adolescence have been reported to predict insomnia incidence in insomnia both with and without daytime impairment [55]. Having a chronic medical condition forecasted chronic persistent insomnia without daytime impairment but not insomnia incidence [58]. Among junior, but not senior, high school students, the incidence of insomnia without daytime impairment was forecasted by sleep paralysis [59]. In contrast, several measures of somatic health problems, including perceived somatic health and impact of somatic illness [55], morning headache and morning dry mouth [58], and sleep duration [59], were not related to prospective insomnia in the aforementioned studies. Thus,

although a few indicators of somatic health forecast insomnia, the results are difficult to compare as the reported predictors did not overlap.

3.2.4 Parent- and family-related factors

Gregory et al. [60] identified that family conflict from middle childhood to early adolescence predicts insomnia in late adolescence. Additionally, high levels of stress among both fathers and mothers forecasted insomnia without daytime impairment, but these associations did not remain when insomnia with daytime impairment was considered [55].

3.2.5 School factors

Adolescents who reported school-related stress were more likely to report incident insomnia one year later when daytime impairment was considered [55]. Moreover, excessive time spent on extracurricular learning (i.e., studying at home or a cram school after regular school hours) among senior, but not junior, high students was found to predict incident insomnia without daytime impairment, whereas the availability of a school advisor was unrelated to insomnia incidence [59].

3.2.6 Lifestyle factors

Excessive mobile phone use predicted insomnia incidence in senior high students but not junior high students [59]. Moreover, several lifestyle indicators, including skipping breakfast, habitually consuming caffeine, and exercising habits, were unrelated to incident insomnia [59].

4 Discussion

In the present review, we synthesized the results of longitudinal studies of predictors of insomnia among children and adolescents representing community samples. In total, 6 articles from 5 separate studies were included. Although the evidence suggests that poor mental health (most notably depression) may play a role in insomnia etiology, the cultural diversity, broad age span, and different predictors studied combined with the lack of replication prevent any firm conclusions from being drawn.

4.1 Sociodemographic factors – are females at risk?

There was no overlap in sociodemographic predictors examined across the studies, except for the female sex, which yielded mixed results. Notably, the two studies that found the female sex a risk factor applied insomnia outcomes that included daytime impairment. This finding may suggest that girls are more prone to resulting daytime impairments than boys, which may be informed by cross-sectional studies given that biological gender (i.e., sex) rarely changes. Three studies of insomnia with daytime impairments reported a female preponderance in adolescence [37, 63, 64], and one study showed a trend in that direction, albeit the difference was marginally nonsignificant [65]. Moreover, a female preponderance of insomnia has been identified in adults [66], and a review by de Zambotti et al. [24] covering adolescence reported that a sex difference has been suggested to emerge with the onset of menses [63, 65, 67]. Overall, these findings suggest that the female sex is a risk factor when entering puberty, which contrasts the mixed evidence summarized in the current review. Finally, the included studies did not find that indicators of other demographic factors (i.e., SES, family income, and parental education) were risk factors, except of low paternal education, which was reported as a risk factor for persistent chronic insomnia [58]. A review of associations of more general sleep problems in children

concluded that a lower composite SES should be considered a well-established risk factor, whereas results of its specific components (i.e., family income and parental education) have been equivocal [19]. However, several studies included SES only as a covariate and did not specifically report SES as a predictor. Therefore, future studies investigating insomnia in childhood and adolescence should include estimates of the predictive value of such measures.

4.2 Mental and somatic health – a role of depression?

The indicators of mental and somatic health mostly did not overlap across the studies, but when they did, the results were not compatible. Nevertheless, the most consistent finding was that indicators of depression forecasted insomnia both at the disorder (i.e., MDD predicting insomnia) and symptom (i.e., depressive symptoms/mood predicting insomnia without daytime impairment) levels. In contrast, a meta-analysis found limited support for the predictive role of depressive symptoms in the development of more broadly defined sleep disturbance in adolescence but noted the sparsity of available data [68]. A review examining both cross-sectional and longitudinal studies involving children concluded that a more broadly defined construct, such as "internalizing problems" (i.e., corresponding to anxiety and depressive symptoms), was a well-established risk factor for general sleep problems [19]. A possible explanation for the predictive role of depression and its symptoms is their relationships with other risk factors for problematic sleep, including bedtime cognitive processes, such as presleep worry or rumination [19, 20]. The revealed relation may also be due to common genes [38]. Nevertheless, while it is conceivable that indicators of depression impair sleep, as our results suggest, some considerations should indeed be noted. First, two of the three articles reporting a prospective relationship between indicators of depression and insomnia stem from the same

study, and therefore, the consistency of the available data might be misleading. Furthermore, insomnia is one of nine symptoms of major depression in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [22]. None of the above noted studies reporting a prospective relationship between indicators of depression and insomnia reported adjusting for this symptom overlap. Therefore, the seeming prediction of insomnia may instead be indicative of the stability of depressive disorders and symptoms [69]. Overall, mental and somatic health indicators may be considered potential predictors of insomnia in future investigations, but the results summarized here should be considered equivocal.

4.3 Family, parental, school and lifestyle factors – lack of consistent findings

Among the family, parental, school and lifestyle factors summarized here, some studies indicated that stress in the family system or at school forecasted insomnia [55, 60]. Similarly, meta-analyses of factors correlated and longitudinally linked to general sleep problems in children [19] and adolescents [20] have reported that marital conflict and a negative family environment are 'emerging' risk factors (but not family problems and parenting stress). Although it seems reasonable that family distress may produce disruptive emotions or rumination/worry in children and adolescents, which, in turn, may lead to difficulties initiating and maintaining sleep, the results summarized here are far from conclusive regarding the role of these factors in the etiology of insomnia. Furthermore, school stress was the strongest predictor of insomnia in terms of odds ratios in a study that adjusted for several potential confounders. School stress has been reported elsewhere to increase when entering adolescence [70]. Thus, school may contribute to stress, which, consistent with stress-reactivity thinking, may trigger insomnia, especially if combined with vulnerability towards reactivity (e.g., difficult temperament and neuroticism).

Finally, excessive mobile phone use predicted the insomnia incidence in one included study examining this issue [59]. Similarly, electronics use has been reported by other authors as a well-established risk factor for sleep problems in children [19], and a trend in this direction has been observed in adolescents [20]. The other lifestyle factors examined in the current review, such as skipping breakfast, habitually consuming caffeine, and exercising habits, were unrelated to insomnia [59].

4.4 Methodological considerations

Some methodological considerations are warranted regarding the articles included in the current review. As described above, the present field of research is characterized by variations in insomnia assessments (e.g., with or without daytime impairment), measurement methods (e.g., questionnaires and interviews), informants (e.g., parental or self-report), age, time between measurements, and outcome (incidence, persistence or future insomnia), which may partially explain the inconsistent findings revealed. Although it might be tempting to place stronger emphasis on studies addressing insomnia with daytime impairment (as opposed to without) because of their concurrence with diagnostic manuals, it is difficult to evaluate whether the differences in the reported predictors are a result of different definitions or simply increased statistical power (i.e., more frequent outcome). Moreover, as we extracted the results from multivariate analyses, direct comparisons of the estimates (i.e., effects) across these studies should be performed cautiously. The magnitude of odds ratios is influenced by the scaling of the independent variables, further impeding comparisons across studies. The included results may have been affected not only by the predictor being examined but also by several other parameters (e.g., sample size, outcome frequency, time between measurements, and number of potential

confounders adjusted) as illustrated in the quality assessment. In addition, several other factors beyond those investigated in the present review may impair sleep among children and adolescents. Examples of such factors are poor sleep hygiene, low physical activity, low extracurricular activity, pre-sleep worry, negative family environment, excessive electronic media use, evening light and lack of parental sleep involvement [20]. However, in future studies these need to be more stringently investigated as predictors of insomnia in children and adolescents.

4.5 Limitations

The strengths of the present review include the comprehensive, systematic search and screening procedure conducted and the clearly defined inclusion criteria applied. However, there are several notable limitations. In terms of diagnostics, it should be noted that different diagnostic manuals include different insomnia criteria, some which seem specific to children and probably less relevant for adolescents. According to the 3rd edition of the ICSD one operates with two insomnia inclusion criteria (resistance going to bed on appropriate schedule or difficulty sleeping without parent or caregiver intervention) which seem specific for children. Similar age specific criteria are found in the DSM-5 (difficulty initiating sleep without caregiver intervention, difficulty returning to sleep without caregiver intervention). However, age specific criteria are not reflected by the diagnostic insomnia criteria in the ICD-10. According to the latter manual a problem reflecting a difficulty in the management of bedtime routines should not be coded as a sleep disorder, but rather as inadequate parental supervision and control. These differences between different diagnostic systems should thus be taken into consideration when interpreting the findings from the current review.

The agreement between the screeners was only fair, but as illustrated, these kappa estimates may have been influenced by the high prevalence of 'exclusion' and bias due to skewed rater disagreement. This finding highlights the importance of considering potential biases when interpreting the magnitude of kappa, which may have been somewhat better in this study than the weighted kappa estimates suggested. Furthermore, only one reviewer performed the selection of studies after the initial screening, increasing the subjectivity involved in this process. Thus, some papers may have been rejected, while other papers could have been deemed admissible and vice versa. Moreover, although we strove to nuance the reported results from the included articles, our reporting was based on significant and nonsignificant factors for insomnia. Categorizing the results in such a dichotomous way may be misleading as two similar estimates with p-values slightly below or above a significance threshold are not categorically different [71]. Furthermore, even though longitudinal data adjusting for insomnia at baseline may inform regarding the etiology of insomnia, only randomized trials may truly prove cause-and-effect relationships. Additionally, the few eligible studies, diversity of predictors and lack of replications prevented a meta-analytic approach, which would have been preferable. Thus, this review carries the risk of being composed of selective publications with favorable or statistically significant results, threatening the validity of the results. Overall, these limitations limit the conclusions drawn from this review, although we present the best available evidence related to this issue.

5 Conclusions

The present review suggests that poor mental health (most notably depression) and female sex may be involved in the etiology of diagnostically defined insomnia in childhood and adolescence. However, few longitudinal studies of predictors of insomnia in children and

adolescents exist, and the vast number of studies excluded in the present work indicates that insomnia is rarely defined according to diagnostic manuals. This is problematic because clinical practice relies on research based on adherence to diagnostic criteria. Firm conclusions can therefore not be drawn, but the current review serves as a summary of the best available evidence. Although few predictors were consistently identified, female gender seems to be one potent risk factor, which may be explained by hormonal influences, and increased susceptibility to mental disorders that might disturb sleep [72]. Various stressors, such as school and social stress, were also found to predict insomnia and typically trigger increased activity in the hypothalamo-pituitary-adrenal axis, which is known to impair sleep [73]. Although identified by only one study, mobile phone use was a risk factor for insomnia. In this regard sleep impairing mechanisms such as displacement of sleep, increased arousal, and activation and delay of circadian rhythms due to light exposure have been identified as possible mechanisms [27]. Finally, mental disorders also seem to increase the risk for insomnia. One interesting explanation to this link is formulated by the transdiagnostic approach, emphasizing common denominators in sleep and mental disorders, such as problems with emotion regulation and interacting neurobiological substrates [74]. Overall, these factors are compatible with the 3P behavioral model, especially in term of predisposing and precipitating factors [18].

We call for more high-quality prospective studies with a well-defined operationalization of insomnia that can improve our understanding of its predictors in children and adolescents in community populations. In accordance with a psycho-bio-behavioral model of insomnia [75], future research should also investigate more comprehensive etiological models of diagnosable insomnia that include factors from different levels of influence across childhood. The field would probably also advance if consensus were reached on how to operationalize insomnia across

studies. Also, including a minimum of common predictors across studies would enable researchers to be better positioned to identify relevant predictors, which may guide preventive as well as treatment efforts.

In terms of clinical implications, the review suggests that stress might be the most modifiable factor identified. Thus, for adolescents who are exposed to various stressors, preventive efforts to maintain good sleep may be warranted. More research is needed to identify transdiagnostic factors relevant for sleep and other psychopathologies.

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Declarations of interest

None.

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Outcome	Age group	Design/method
(insomnia OR insomnias OR "Sleep onset insomnia" OR "Night waking insomnia" OR "Sleep onset insomnias" OR "Night waking insomnias" OR "Late insomnia" OR "Middle insomnia" OR "Early insomnia" OR "Sleep disorder" OR "Sleep disorders" OR "Sleep disturbance" OR "Sleep problem*" OR "Behavioral insomnia*" OR "Sleep onset latency" OR "Night waking" OR "sleep initiation and maintenance")	(toddler OR preschool OR toddlerhood OR children OR childhood OR preadolescent OR preadolescence OR "School age*" OR paediatric OR pediatric OR youth OR child OR adolescent OR adolescence)	(longitudinal OR follow-up OR "Follow-up study" OR "Follow-up studies" OR prospective OR course OR stability OR continuity OR "Over time" OR forecast OR predict*)

Table 1. Search terms used to capture the main aspects of the review

Note. These search terms formed the basis of the database-specific search strings shown in Table S1.

Authors	**Setting**	**Age at baseline and follow-up**	**Prospective sample size** (% female)	**Selection** (maximum 4 stars)	**Comparability** (maximum 2 stars)	**Outcome** (maximum 3 stars)	**Insomnia outcome** (% with outcome)	**Covariates** (as reported by the authors)	**Significant predictors in multivariate analyses adjusted for previous insomnia** (other variables in the multivariate model)	**Adjusted/ multivariate odds ratio** (95% CI)
Roberts et al. [55]	Houston, US	11-17 y and 1 y later	3,134 (49%)	****	*	**	Incidence of DSM-IV insomnia with (5.5%) and without DI (13.9%)	Age, sex, family income, ethnic status, physical health functioning, mental health functioning, life stress	Of insomnia without daytime impairment	
									Female sex	1.31 (1.07-1.58)
									Age	0.72 (0.57-0.91)
									Somatic health limitations	1.33 (1.09-1.63)
									Life satisfaction	1.73 (1.34-2.23)
									Perceived mental health	1.46 (1.11-1.93)
									Depressed mood	1.25 (1.02-1.53)
									School stress	1.84 (1.39-2.43)
									Father stress	1.58 (1.19-2.10)
									Of insomnia with daytime impairment	
									Female sex	1.91 (1.35-2.69)
									Somatic health limitations	2.12 (1.45-3.10)
									Life satisfaction	1.65 (1.11-2.45)

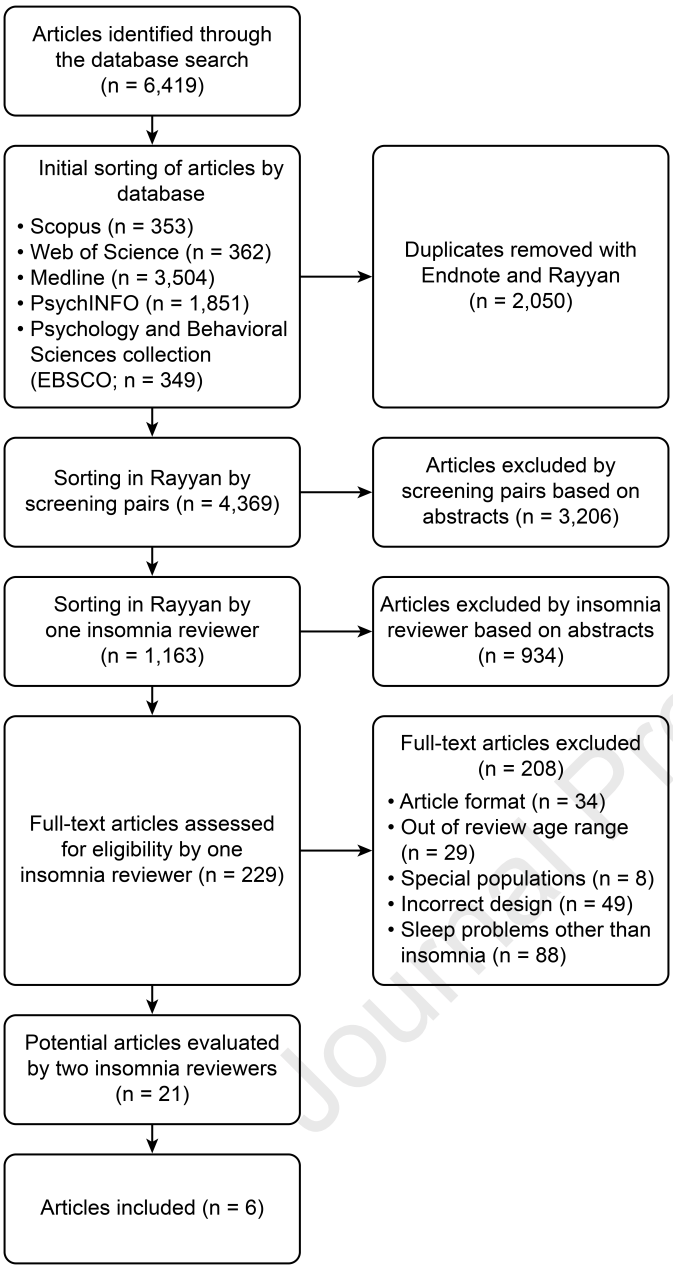
									Perceived mental health	1.82 (1.17-2.84)
									School stress	2.93 (1.61-5.32)
									School stress	5.01 (2.75-9.13)
									Ethnicity, family income, perceived somatic health, impact of somatic illness, neighborhood stress, mother stress	All nonsignificant
Roberts and Duong [56]	Houston, US	11-17 y and 1 y later	3,134 (49%)	****	*	**	Incidence of DSM-IV insomnia with (5.5%) and without DI (13.9%)	Age, sex, family income	Of insomnia without daytime impairment	
									Depressive symptoms	1.39 (1.14-1.68)
									Of insomnia with daytime impairment	
									Major depression	2.31 (1.01-5.28)
Gregory et al. [60]	Dunedin, New Zealand	7 y and ages 9, 13, 15 and 18 y	936 (49%) with insomnia data at 18 y	**	*	**	Future DSM-IV insomnia with DI (15%)	Concurrent health problems, socioeconomic status, depression, earlier sleep problems	Family conflict	1.42 (1.17-1.73)
									Male sex	0.53 (0.36-0.80)
									Health problems at 18 y (concurrent)	0.62 (0.46-0.83)
									SES, previous sleep problems	All nonsignificant

Steinsbekk and Wichstrøm [57]	Trondheim, Norway	4.4 y and 6.7 y	795 (49.9%)	****	**	**	Future DSM-IV insomnia without inquiring about DI (21.2%)		Symptoms of ADHD Symptoms of ODD Symptoms of MDD	1.08 (1.02-1.15) 1.15 (1.03-1.29) 1.28 (1.07-1.52)
									Symptoms of conduct disorder, GAD, separation anxiety disorder, social phobia and specific phobia	All nonsignificant
Zhang et al. [58]	Hong Kong, China	9.0 y ± 1.8 and 13.7 y ± 1.8	1,611 (50.9%)	***	*	*	Incidence (6.2%) or persistence (0.6%) of chronic (12 mo) insomnia without including DI in the insomnia criteria	Age, sex, parental educational level, family income	Incident insomnia Paternal education Frequent temper outbursts Feeling tired during the daytime	 2.49 (1.13-5.51) 1.85 (1.16-2.97) 2.17 (1.24-3.77)
									Persistent insomnia Chronic medical disorders	 10.2 (1.99-52.5)
									Sex, family income, maternal education, hyperactivity, feeling unrefreshed/headache after waking, difficulty waking in	All nonsignificant

										the morning, morning dry mouth	
Tokiya et al. [59]	Japan	7th and 10th graders and two years later	3,473 (not specified); 776 junior (52.2%) and 2,697 senior high students (42.3%)	***	*	**	Incidence of insomnia without inquiring about DI in junior (7.8%) and senior high students (9.2%)	Sex, sleep duration, extracurricular learning, hours of mobile use, nightmares, sleep paralysis, poor mental health status, breakfast, coffee/tea intake, exercise habits, availability of an advisor	Incident insomnia (junior high school) Sleep paralysis Poor mental health Incident insomnia (senior high school) Extracurricular learning Mobile phone use Nightmares Poor mental health Sex, sleep duration, skipped breakfast, habitually consumed coffee, exercise habits	 3.59 (1.19-10.83) 2.69 (1.41-5.15) 2.10 (1.23-3.60) 1.39 (1.03-1.89) 4.46 (2.36-8.42) 1.62 (1.18-2.21) All nonsignificant

Table 2. Descriptive characteristics of the included studies and quality assessment according to the Newcastle-Ottawa quality assessment scale

Note. Approx., approximately; mo, month(s); y, year(s); DI, daytime impairment; CI, confidence interval; DSM-IV, Fourth edition of the Diagnostic and Statistical Manual of Mental Disorders; SES, socioeconomic status; ADHD, attention-deficit/hyperactivity disorder; ODD, oppositional defiant disorder; MDD, major depressive disorder; GAD, generalized anxiety disorder. Sample size refers to those followed longitudinally.



Highlights

- Insomnia is prevalent in childhood and adolescence and associated with negative health outcomes. To inform prevention and treatment, predictors of insomnia must be identified
- Our systematic review of longitudinal studies suggests that girls are more at risk for insomnia than boys
- Poor mental health may be involved in the etiology of insomnia
- Stress seems to be the most modifiable predictor
- Due to lack of longitudinal studies, no firm conclusions can be drawn