



Original Article

Child sleep problems and adult mental health in those born at term or extremely low birth weight



Jacob Young^a, Calan Savoy^a, Louis A. Schmidt^b, Saroj Saigal^c, Ryan J. Van Lieshout^{a,*}

^a Department of Psychiatry and Behavioural Neurosciences, McMaster University, Hamilton, Ontario, Canada

^b Department of Psychology, Neuroscience & Behaviour, McMaster University, Hamilton, Ontario, Canada

^c Department of Pediatrics, McMaster University, Hamilton, Ontario, Canada

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ABSTRACT

Objectives: To examine associations between parent-reported child sleep walking or talking, nightmares, and trouble sleeping at age eight and psychiatric problems in adulthood (age 30–35) in extremely low birth weight (ELBW; <1000 g) survivors and matched normal birth weight (NBW; >2500 g) control participants.

Methods: At age eight, parents of ELBW survivors and NBW control participants completed sleep items on the Child Behavior Checklist assessing the presence of sleep walking/talking, nightmares, or trouble sleeping. At age 30–35, 98 ELBW and 94 NBW individuals completed the Mini International Neuropsychiatric Interview (MINI), Beck Anxiety Inventory (BAI), and Beck Depression Inventory (BDI). Analyses were conducted in each birth weight group independently.

Results: In NBW participants, sleep walking/talking in childhood predicted higher BAI and BDI scores, as well as more than three times the odds of having a mood or anxiety disorder (OR = 3.48; 95% CI, 1.26–9.60) at age 30–35. Sex and childhood sleep problem interactions revealed that females who manifested sleep walking/talking as children had higher BAI scores than males. Nightmares in children born at NBW predicted higher BAI scores. These associations persisted despite adjustment for child mental health, sex, socioeconomic status, sexual or physical abuse, and family functioning. Trouble sleeping in childhood did not predict adult mental health problems. Childhood sleep problems did not predict psychopathology in ELBW adults.

Conclusions: Children born at NBW who manifest sleep walking or talking appear to be at increased risk for developing mood or anxiety disorders in adulthood. No associations between child sleep and adult mental illness were noted in those with ELBW survivors. Childhood sleep walking/talking may be a unique risk factor for mental health problems later in life.

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1. Introduction

According to parental reports, up to 40% of children experience symptoms of at least one persistent sleep problem [1]. Clinically significant difficulties with sleep are frequently classified into two types: parasomnias are problems that occur during sleep (eg, sleep walking, talking, and nightmares), while dyssomnias are problems that occur prior to falling asleep (eg, insomnia). Childhood

parasomnias are common, with nightmares occurring in up to 28% of children [2], while 9–13% of parents report that their children sleep walk [3]. Dyssomnias are similarly common, with up to 29% of children having insomnia [4,5].

Childhood sleep problems can adversely influence health, function, and quality of life. Children with insomnia score more poorly on tests of cognitive functioning [6], report higher rates of school difficulties [2,7], and have more physical health problems [7,8] than in those without insomnia. Children who have persistent nightmares are also three times more likely to experience a psychiatric disorder [9]. Furthermore, those who regularly have nightmares or sleep walk tend to have more social difficulties, and attention-seeking behavior in school [2]. However, much less is known about the correlates of parasomnias than dyssomnias however.

Abbreviations: ELBW <1000 g, extremely low birth weight; NBW >2500 g, normal birth weight.

* Corresponding author. Department of Psychiatry and Behavioural Neurosciences, McMaster University, St. Joseph's Healthcare Hamilton, West 5th Campus, 100 West 5th Street, Hamilton ON, L8N 3K7, Canada.

E-mail address: vanlierj@mcmaster.ca (R.J. Van Lieshout).

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While many childhood sleep difficulties resolve over time [10], they also predict an increased risk of internalizing problems (ie, depression, anxiety), and substance abuse later in adolescence. Children who are overtired report greater difficulty with response inhibition [11] and visuospatial memory, as well as symptoms of anxiety, depression, aggression, and inattention at age 13–15 [12]. Children who sleep less than their peers, who are overtired, or who have trouble sleeping are more likely to develop problems with cannabis, alcohol, and cigarettes [13,14]. In addition, they exhibit more binge drinking and drunk driving [11] in adolescence.

Although many studies have reported associations between adolescent or adult sleep problems and psychopathology, far fewer have examined the effects of child sleep problems on adult psychiatric outcomes. To our knowledge, only four studies have examined associations between child insomnia and adult psychopathology. Gregory and colleagues reported that children with insomnia between the ages of 5–9 were nearly twice as likely to develop anxiety problems at age 21–26 [15]. In another study, parent-reported insomnia in their 10–19 year old offspring predicted more self-reported symptoms of depression, anxiety, and aggression at age 18–32 [16]. However, data from Armstrong and colleagues suggested that only the most serious cases of child insomnia may be at risk for later psychopathology, as only persistent child insomnia between the ages of four and nine predicted externalizing problems and anxiety at age 18 [17]. Lastly, only one study examined for symptoms of psychosis, and reported that nightmares at age 12 may be predictors of these outcomes at age 18 [39].

Gregory and colleagues' also examined links between child and adolescent sleep walking, sleep talking, or nightmares, and adult psychopathology. Parent-reports of offspring nightmares at 10–19 years predicted symptoms of anxiety, depression, inattention, and aggression between the ages of 18–32, while sleep walking or talking did not [16]. While these longitudinal studies have provided us with the little data we have on these associations, their outcomes were assessed primarily using self-report questionnaires rather than structured psychiatric interviews. Despite these important findings, the long-term psychiatric sequelae of relatively common sleep problems in children including sleep walking, talking, and nightmares remain largely unknown.

Children born at ELBW are at an increased risk for both sleep problems and psychopathology [18,19]. Preterm survivors have more sleep disordered breathing [20], and wake up earlier [21,22] than their NBW counterparts. However, other than a limited number of descriptive studies, very little is known about insomnia, sleep walking/talking, and nightmares, and their long-term sequelae in individuals born at ELBW.

Given these knowledge gaps, we set out to examine associations between the most common types of childhood sleep problems (trouble sleeping, nightmares, sleep walking or sleep talking) and adult mental health in ELBW survivors and in NBW control participants. We predicted that childhood sleep difficulties would predict more psychopathology in adulthood in both birth weight groups, and that this association would persist despite adjustment for covariates (including child psychopathology). We also hypothesized that associations would be stronger in the ELBW survivors given their stress sensitivity and propensity to developing psychiatric problems.

2. Methods

2.1. Participants

2.1.1. ELBW survivors

A cohort of 397 infants born at ELBW born between 1977 and 1982 in central-west Ontario, Canada were recruited. Of these

individuals, 179 (45%) survived to hospital discharge, and 10 more participants died by age eight. Follow-up assessments were completed during childhood (eight years) and in adulthood (30–35 years). At age 30–35, 98 ELBW survivors provided complete data.

2.1.2. NBW control participants

When ELBW survivors were eight years of age, a cohort of 145 NBW children matched on age-, sex-, and familial socioeconomic status were recruited [23]. They were assessed at the same time points as the ELBW group. At age 30–35, 94 NBW individuals provided complete data.

2.2. Procedures

Parents reported their child's sleep problems at age eight, and participants were interviewed themselves and self-completed questionnaire measures of psychopathology at age 30–35 years. Data were collected at McMaster University's Child Emotion Laboratory. Parents provided written consent during the child visit, and all participants provided their own consent at age 30–35. The McMaster University Health Sciences Research Ethics Board approved of all procedures, which were conducted in accordance with the Declaration of Helsinki.

2.3. Measures

2.3.1. Predictor: sleep problems during childhood (age eight)

Parents reported on their child's sleep using the Child Behavior Checklist (CBCL) [24] items 47 ("nightmares"), 92 ("talking/walking during sleep"), and 100 ("trouble sleeping"). Parents responded to each item using a 3-point Likert scale scored 0 = "never", 1 = "occasionally", and 2 = "frequently". These three CBCL sleep items exhibit high levels of convergent validity with previously validated measures of parasomnias and symptoms of insomnia [25].

2.3.2. Outcome: psychopathology during adulthood (age 30–35)

2.3.2.1. Mini International Neuropsychiatric Interview (MINI). This structured diagnostic interview yields diagnoses consistent with those contained in the DSM-IV and was conducted by trained interviewers who were naive to participant birthweight status [26]. Outcomes examined in this study included the lifetime presence of any alcohol or substance use disorder (ie, alcohol abuse or dependence, or substance abuse or dependence) and a lifetime diagnosis of any non-alcohol/substance use disorder (ie, major depressive disorder, bipolar disorder, dysthymic disorder, panic disorder, and posttraumatic stress disorder) [27].

2.3.2.2. Beck Anxiety Inventory (BAI). In addition to examining clinically significant levels of psychopathology using the MINI, we were also interested in determining if child sleep difficulties were associated with psychopathology as a continuous construct. The BAI is a self-reported, 21-item questionnaire that assesses symptoms of anxiety, and showed high internal consistency in both our NBW ($\alpha = 0.87$) and ELBW ($\alpha = 0.93$) groups. The BAI has shown high convergent validity with other widely-used measures of anxiety [28].

2.3.2.3. Beck Depression Inventory (BDI). The BDI is a self-reported, 21-item questionnaire that assesses symptoms of depression. It showed high reliability in both our NBW ($\alpha = 0.94$) and ELBW ($\alpha = 0.95$) groups. The BDI has shown high internal validity in both psychiatric and non-psychiatric populations [29].

2.4. Covariates

We adjusted for covariates that have been shown to be independently associated with both childhood sleep problems and adult psychopathology.

2.4.1. Sex

Since internalizing problems are more common in females than males, and externalizing problems are more common in males than females [30], sex was adjusted for in our analyses.

2.4.2. Internalizing and externalizing problems during childhood (eight years)

Child sleep problems are commonly associated with symptoms of concurrent internalizing and externalizing problems [25], which are themselves predictive of adult psychopathology. Child internalizing and externalizing problems from the previous six months were assessed by parent-report when participants were eight years old [24]. The externalizing problems scale was created by the summing the totals of the conduct disorder, oppositional disorder, and attention-deficit hyperactivity disorder items of the Ontario Child Health Study Scales [31,32]. The internalizing problems scale was created by summing items contained in the overanxious disorder (generalized anxiety disorder), separation anxiety, and depression scales. We adjusted for child internalizing problems in our analyses of the BAI, BDI, and any non-substance/alcohol use disorder, and for child externalizing problems in our analyses of any alcohol or substance use disorder. The externalizing scale showed high internal consistency in both our NBW ($\alpha = 0.84$) and ELBW ($\alpha = 0.87$) groups (as did the internalizing scale: NBW ($\alpha = 0.87$) and ELBW ($\alpha = 0.80$)).

2.4.3. Familial socioeconomic status (eight years)

Familial socioeconomic status was assessed using the Hollingshead Two-Factor Index of Socioeconomic Status [33]. It assesses familial socioeconomic status using occupational prestige and parental education. Families were categorized into one of five strata (1 = highest socioeconomic status; 5 = lowest socioeconomic status).

2.4.4. Family functioning (eight years)

Family functioning was assessed using the General Functioning Subscale of the McMaster Family Assessment Device [34]. This subscale contains 12-items assessing family dynamics. It showed high reliability in both NBW ($\alpha = 0.89$) and ELBW ($\alpha = 0.88$) groups.

2.4.5. History of sexual or physical abuse (retrospectively reported at 22–26 years)

Sexual and physical abuse are associated with trouble sleeping [35], nightmares [36], and psychopathology in adulthood. When participants were 22–26 years of age, they reported on any experience of sexual or physical abuse before age 16 using a shortened version [37] of the Childhood Experiences of Violence Questionnaire [38]. Any endorsement of the sexual or physical abuse items constituted as a positive report [37].

2.5. Data analysis

Differences in sociodemographic characteristics between birth weight groups were evaluated using *t*-tests for continuous outcomes and chi-squared (χ^2) tests for categorical outcomes. Since survivors of ELBW birth generally experience higher levels of psychopathology and greater rates of sleep problems than NBW individuals, we decided a priori to analyze ELBW and NBW groups

separately for associations between child sleep problems and adult psychopathology.

We examined unadjusted and adjusted associations using logistic regression for MINI-based outcomes (clinical diagnoses), and linear regression for outcomes from the BDI and BAI (continuous symptom scores). Strengths of observed associations were estimated using odds ratios for categorical outcomes and unstandardized betas for continuous outcomes. We adjusted for sex, child internalizing or externalizing problems, a history of sexual or physical abuse, socioeconomic status, and family functioning during childhood. To examine for potential moderating effects of participant sex, we conducted separate analyses with sex, sleep problems, a term capturing the interaction between the two, and our covariates in both birthweight groups separately. All analyses were conducted using IBM SPSS Statistics 22 (IBM SPSS Statistics, IBM Corporation) with a two-tailed significance level set at $\alpha = 0.05$.

3. Results

3.1. Participant characteristics (Table 1)

The characteristics of study participants are presented in Table 1. Birth weight groups did not differ in the prevalence of nightmares, sleep walking or talking, or trouble sleeping at age eight. ELBW participants were more likely to experience symptoms of anxiety defined by the BAI, and were less likely to experience a lifetime substance use disorder than NBW participants. Given the long period of time intervening our measurement of child sleep and adult psychopathology, we also examined predictors of attrition between these time points. Among participants born at NBW, male sex predicted attrition. In ELBW survivors, higher levels of conduct problems, and lower socioeconomic status predicted loss to follow-up.

3.2. Associations between child sleep problems and adult psychopathology (Tables 2–4).

3.2.1. Sleep walking or talking (Table 2)

In our unadjusted models, NBW adults whose parents reported childhood sleep walking or talking had higher levels of anxiety ($B = 4.88$; 95% CI, 2.13–7.63, $p = 0.001$), and depression ($B = 4.24$; 95% CI, 0.63–7.85, $p = 0.02$), as well as any lifetime non-substance/alcohol use disorder ($OR = 2.47$; 95% CI, 1.02–5.96). In our adjusted models, all results remained statistically significant, as childhood sleep walking or talking predicted later anxiety ($B = 5.28$; 95% CI, 2.31–8.26, $p = 0.001$) and depression ($B = 4.29$; 95% CI, 0.19–8.39, $p = 0.04$), as well as any lifetime non-substance/alcohol use disorder ($OR = 3.48$; 95% CI, 1.26–9.60). Among ELBW survivors, sleep walking or talking did not predict adult psychopathology.

3.2.2. Nightmares (Table 3)

In our unadjusted models, NBW adults whose parents reported that their child had nightmares had more anxiety ($B = 3.37$; 95% CI, 0.63–6.11, $p = 0.02$). After adjustment, these results remained statistically significant ($B = 3.45$; 0.47–6.43, $p = 0.02$). Among ELBW survivors, childhood nightmares did not predict adult psychopathology.

3.2.3. Trouble sleeping (Table 4)

In both unadjusted and adjusted models, trouble sleeping did not predict adult psychopathology in either NBW or ELBW group.

Table 1
Participant characteristics.

Characteristic	Participants	
	ELBW	NBW
Participants at age 30–35, <i>n</i>	98	94
Nightmares at age eight (%)	30/97 (31%)	44/94 (47%)
Sleep walking or talking at age eight (%)	23/98 (23%)	31/94 (33%)
Trouble sleeping at age eight (%)	25/98 (26%)	24/94 (26%)
Female sex, <i>n</i> (%)	58/98 (59%)	57/94 (61%)
Birth weight (g)	829 ^a	3411 ^a
Average Gestational Age (Weeks)	27 ^a	40 ^a
Familial Socioeconomic Status at Age eight	3.08	2.98
Highest SES Level	5	8
Second Highest SES Level	14	21
Middle SES Level	46	33
Second Lowest SES Level	28	27
Lowest SES Level	3	4
Experienced childhood sexual or physical abuse, <i>n</i> (%)	25/96 (25%)	26/93 (27%)
OCHS-R Conduct problems score	10.92	10.82
OCHS-R Emotional problems score	9.14	9.08
Family Functioning score	20.04	19.66
Beck Anxiety Inventory	9.96 ^a	7.08 ^a
Beck Depression Inventory	9.46	7.40
Lifetime non-substance use disorders (MINI)	28/78 (36%)	32/89 (36%)
Lifetime substance use disorders (MINI)	20/80 (25%) ^a	45/88 (51%) ^a

^a Denotes a statistically-significant association between ELBW and NBW groups ($p < 0.05$).

Table 2
Unadjusted and adjusted associations between talking/walking during sleep at eight years and adult mental health.

Predictor: Talking/Walking	ELBW Survivors				NBW Participants			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	Unstandardized B (95% CI)	<i>p</i>	Unstandardized B (95% CI)	<i>p</i>	Unstandardized B (95% CI)	<i>p</i>	Unstandardized B (95% CI)	<i>p</i>
Questionnaire Measures								
BAI	0.54 (-4.78–5.86)	0.84	-0.06 (-5.51–5.38)	0.98	4.88 (2.13–7.63)	0.001 ^a	5.28 (2.31–8.26)	0.001 ^a
BDI	1.93 (-3.57–7.42)	0.49	-0.03 (-5.60–5.55)	0.99	4.24 (0.63–7.85)	0.02 ^a	4.29 (0.19–8.39)	0.04 ^a
MINI	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Non-Substance Use Disorder (Lifetime)	1.16 (0.42–3.19)	0.78	0.82 (0.22–3.04)	0.77	2.47 (1.02–5.96)	0.04 ^a	3.48 (1.26–9.60)	0.02 ^a
Substance Use Disorder (Lifetime)	1.18 (0.39–3.54)	0.77	1.14 (0.34–3.83)	0.84	0.86 (0.37–2.00)	0.72	0.86 (0.30–2.44)	0.78

Analyses were adjusted for child mental health, sex, socioeconomic status, sexual or physical abuse, and family functioning.

^a Denotes a statistically-significant association between child sleep walking/talking and adult psychiatric symptoms within birthweight groups ($p < 0.05$).

Table 3
Unadjusted and adjusted associations between nightmares at eight years and adult mental health.

Predictor: Nightmares	ELBW Survivors				NBW Participants			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	Unstandardized B (95% CI)	<i>p</i>	Unstandardized B (95% CI)	<i>p</i>	Unstandardized B (95% CI)	<i>p</i>	Unstandardized B (95% CI)	<i>p</i>
Questionnaire Measures								
BAI	1.59 (-3.24–6.42)	0.52	0.09 (-5.38–5.56)	0.98	3.37 (0.63–6.11)	0.02 ^a	3.45 (0.47–6.43)	0.02 ^a
BDI	0.65 (-4.33–5.62)	0.80	-1.04 (-6.63–4.55)	0.71	1.73 (-1.86–5.31)	0.34	1.55 (-2.53–5.63)	0.45
MINI	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Non-Substance Use Disorder (Lifetime)	1.54 (0.57–4.18)	0.40	0.96 (0.26–3.58)	0.96	1.71 (0.77–3.81)	0.19	2.39 (0.97–5.88)	0.06
Substance Use Disorder (Lifetime)	0.53 (0.16–1.79)	0.30	0.47 (0.12–1.84)	0.28	0.74 (0.34–1.60)	0.44	0.95 (0.36–2.46)	0.91

Analyses were adjusted for child mental health, sex, socioeconomic status, sexual or physical abuse, and family functioning.

^a Denotes a statistically-significant association between child nightmares and adult psychiatric symptoms within birthweight groups ($p < 0.05$).

3.2.4. Moderating influences of sex

In each of our birthweight groups, we examined interactions between participant sex and sleep problems predicting adult psychopathology. There were no statistically significant sex by sleep interactions for ELBW survivors. However, in the NBW group, females whose parents reported sleep walking and/or talking had higher BAI scores than males ($B = 6.19$; 95% CI, 0.57–11.82, $p = 0.03$), and females who were reported to have had trouble sleeping had higher levels of anxiety on the BAI than males

($B = 7.66$; 95% CI, 0.91–14.40, $p = 0.03$). Interactions were not significant for any other predictor or outcome among NBW participants.

4. Discussion

Children born at NBW and who sleep walk or talk appear more likely to develop mood and anxiety disorders into their 30s, a finding that persists even after adjustment for child mental health

Table 4
Unadjusted and adjusted associations between trouble sleeping at eight years and adult mental health.

Predictor: Trouble Sleeping	ELBW Survivors				NBW Participants			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	Unstandardized B (95% CI)	<i>p</i>						
Questionnaire Measures								
BAI	0.35 (−4.70–5.40)	0.89	−0.33 (−5.55–4.88)	0.90	1.06 (−2.25–4.37)	0.53	0.56 (−3.03–4.14)	0.76
BDI	0.82 (−4.38–6.02)	0.75	0.97 (−4.32–6.26)	0.72	0.10 (−4.12–4.31)	0.96	−0.62 (−5.36–4.12)	0.80
MINI	OR (95% CI)	<i>p</i>						
Non-Substance Use Disorder (Lifetime)	1.05 (0.38–2.87)	0.93	0.71 (0.19–2.73)	0.62	1.18 (0.47–2.97)	0.73	1.37 (0.50–3.73)	0.54
Substance Use Disorder (Lifetime)	0.66 (0.20–2.15)	0.49	1.00 (0.26–3.83)	1.00	0.76 (0.31–1.91)	0.56	0.55 (0.17–1.75)	0.31

Analyses were adjusted for child mental health, sex, socioeconomic status, sexual or physical abuse, and family functioning.

* Denotes a statistically-significant association between child trouble sleeping and adult psychiatric symptoms within birthweight groups ($p < 0.05$).

difficulties. Nightmares in childhood also predicted elevated levels of anxiety symptoms in adulthood. However, trouble sleeping during childhood did not appear to predict adult psychiatric problems in our sample. Additionally, no associations were observed between childhood sleep problems and adult psychopathology among ELBW survivors. Females who experienced sleep walking/talking and trouble sleeping as a child had higher BAI scores than males. Given the relative ease with which sleep problems can be identified and their predictive value for mental health problems in adulthood, these findings may be of value to clinicians and to families.

To our knowledge, although a number of studies have reported associations between adolescent or adult sleep problems and adult psychopathology, only four studies have examined for these predictors in childhood [15–17,39]. Gregory and colleagues reported that children with symptoms of insomnia between the ages of 5–9 were nearly twice as likely to develop anxiety problems at age 21–26 [15]. Similarly, Armstrong and colleagues reported that child insomnia between the ages 4.5 to 9 predicted adult psychopathology [17]. However, both of these studies only examined serious cases of sleep problems, as they only included persistent cases of insomnia [15,17]. In another study, nightmares at age 10–19 predicted symptoms of anxiety, depression, inattention, and aggression in adulthood, but sleep walking or talking did not [16]. However, these findings were no longer statistically significant after adjustment for covariates [16]. In addition, these authors utilized an older sample of youth, as well as a broader range of ages at follow up (age 18–32) [16], and their outcomes were based on questionnaires, not structured clinical interviews. Thompson and colleagues reported that nightmares at age 12 predicted symptoms of psychosis in adulthood, although we did not assess for these disorders [39]. Our study has extended the existing literature in this area by utilizing structured diagnostic interviews across a much longer period of follow-up and reports novel associations between sleep walking and talking in childhood and psychopathology in adulthood.

Why childhood sleep walking or talking may be associated with adult psychopathology is not clear, although we propose four possible explanations: (1) It may be that sleep problems reduce sleep and increase stress, which could predispose children to developing later psychopathology. However, this explanation is not supported by previous research, as parasomnias typically resolve spontaneously by adolescence, and only 4% of affected children continue to experience them [40]. (2) These sleep problems are symptoms of child psychopathology, and our results simply represent a continuation of these. Yet, this explanation is not supported by our findings, as our results remained statistically significant after adjusting for child internalizing or externalizing problems. (3) Sleep problems could be very early (ie, prodromal) signs of latent psychopathology that only become apparent with

age/over time. (4) Finally, these associations may be due to unique physiological and/or genetic linkages between childhood sleep walking and/or talking with adult psychopathology.

Research suggests that sleep walking is strongly influenced by genetics [41,42] and physiological differences in GABA_A receptor neurotransmission in central pattern generator (CPG) pathways can affect movement during sleep [43]. Central pattern generators are glutaminergic and serotonergic populations of interneurons that synapse with motor pathways of the brain and spinal cord [42,44]. Central pattern generators are activated by glutamate and inhibited via GABA, and it is hypothesized that insufficient inhibition of these CPGs contributes to motion during sleep [43,45]. A genetic predisposition towards higher levels of glutamate and/or lower levels of GABA may increase the risk of sleep movement. Since elevated glutamate concentrations in the frontal cortex [46] and reduced GABA concentrations in the occipital cortex [47] have both been linked to mood disorders in adults, this may partially explain the associations observed here.

Our results also suggest that childhood nightmares predicted adult anxiety. It may be that some anxious children may express their anxiety as nightmares rather than overtly displaying internalizing symptoms as measured by the Child Behavioral Checklist. It is possible that as the child ages, this evolves into more traditionally recognized forms of anxiety, such as the symptoms measured by the BAI. Individuals who have a negative attributional style towards stress are more likely to respond strongly to distressing dream content due to limbic system overactivation or insufficient inhibition during sleep [48]. The limbic system is normally activated during REM sleep [49] in order to create dream content, and cortical areas subsequently suppress the amygdala in order to reduce any distress associated with the dream imagery [48]. It may be the case that cortical inhibition during REM sleep becomes more effective throughout childhood, as the prevalence of nightmares significantly decreases after age 10. However, this disposition towards a negative attributional style may persist, thereby leading to susceptibility towards adult anxiety.

Lastly, trouble sleeping did not predict future psychopathology in either birth weight group. The disparity between our findings and previous studies may be due to differences in the definition of sleep problems. Gregory and colleagues assessed persistent symptoms of insomnia (ie, that lasted at least two years) [15]. Similarly, Armstrong and colleagues reported that only persistent cases of child insomnia between the ages 4.5 to 9 predicted adult psychopathology [17]. Our study only assessed symptoms of child insomnia that occurred over the previous six months, and our null findings are in agreement with previous findings examining non-persistent child insomnia as a predictor. Another study that found that child insomnia predicts symptoms of later anxiety, depression, and inattention [16] assessed the presence of insomnia any time between the ages of 10–19; therefore so their results may refer to

concurrent adolescent associations. Previous studies also reported an association between child insomnia and later alcohol or substance abuse problems [11,13,14]. However, most reported on adolescent outcomes [13,14], and all studies used a cohort of predominantly male children who had parents with a substance abuse history [11,13,14].

Contrary to our expectations, sleep problems did not predict psychopathology in ELBW survivors. The reason may be that the consistent familial support and medical monitoring they receive from a young age may lead them to be more likely to seek help for mental health problems as adults. Alternatively, individuals born at ELBW have elevated rates of psychopathology as adults [27], but given the number of struggles they face [50], any increase in risk conferred by sleep problems is obscured. Finally, these null results may be due to low statistical power owing to a limited sample size.

The strengths of this study include the use of both structured diagnostic interviews alongside self-report symptom scales, as well as a long period of follow-up over 25 years. Despite the novelty of our findings, a number of study limitations must be considered. Since this longitudinal study followed participants over 30 years, participant attrition has resulted in a reduction in statistical power. In NBW participants, male sex predicted attrition, and in ELBW participants, higher levels of childhood conduct problems and lower socioeconomic status predicted loss to follow-up. As these factors could introduce some bias and raise the potential for type II error, we attempted to minimize the impact of these factors by adjusting for predictors of attrition in our sample (ie, male sex, child externalizing problems, and lower socioeconomic status). In addition, our measures of sleep problems are parent-reported and based on individual items on the CBCL. However, this scale has been used in previous studies and may be sensitive to the long-term impact of sleep problems in children. The sleep walking or talking item used in this study also failed to differentiate between these two phenomena, though they likely share similar etiology [39]. Moreover, our adjusted statistical models containing sleep walking or talking as predictors showed evidence of a suppression effect, which was due to adjustment for child internalizing problems and family functioning. However, our unadjusted results were also statistically significant, increasing our confidence that these are not spurious or due to statistical error. The majority of our sex by sleep problem interactions were not statistically significant. This may have been due to limitations in statistical power, and so warrant further study. Lastly, as our findings are based on an observational study design, they are not able to establish causality.

5. Conclusion

The results of this study suggest that children born at NBW who experience sleep walking or talking may be more prone to developing mood and anxiety disorders in adulthood. While more research is needed to replicate these findings, and to better understand the nature of these associations, it may be of benefit for parents and pediatricians to be aware of children's experience of sleep walking or talking and assess and monitor these individuals over time.

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Conflict of interest

The authors have no conflicts of interest relevant to this article to disclose.

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